



**CAMECO RESOURCES
CROW BUTTE OPERATION**

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August 29, 2018

ATTN: Document Control Desk Director
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Semiannual Radiological Effluent and Environmental Monitoring Report
Source Materials License No. SUA-1534, Docket No. 40-8943

Dear Document Control:

Enclosed please find one copy of the Semiannual Radiological Effluent and Environmental Monitoring Report for the Crow Butte Uranium Project. The report is provided in accordance with License Condition 11.1(B) of Source Materials License SUA-1534 and 10 CFR Part 40. This report covers the first and second quarters of 2018.

If you have any questions concerning the report, please feel free to call me at (308) 665-2215 Ext 117.

Sincerely,
CAMECO RESOURCES
CROW BUTTE OPERATION

Walter D. Nelson
SHEQ Coordinator

cc: Ron Burrows – NRC
CBO – File
cc: Amanda Jones – NDEQ Program Coordinator
CR – Electronic File

IE48
IE25
NM5520
NM55



**CAMECO RESOURCES
CROW BUTTE OPERATION**

**First Half 2018 Semiannual Radiological Effluent
and Environmental Monitoring Report**

**CROW BUTTE URANIUM PROJECT

RADIOLOGICAL EFFLUENT
AND
ENVIRONMENTAL MONITORING
REPORT**

for

FIRST AND SECOND QUARTERS, 2018

USNRC Source Materials License SUA 1534



**CAMECO RESOURCES
CROW BUTTE OPERATION**

**First Half 2018 Semiannual Radiological Effluent
and Environmental Monitoring Report**

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1 WATER QUALITY MONITORING DATA

1.1 Excursion Monitoring

Biweekly excursion monitoring in the shallow aquifer and perimeter monitor wells was continued in Mine Units 2 through 11 during the first and second quarters of 2018.

On June 2, 2018, SM8-28 was placed on excursion status when the multiple concentration limits for alkalinity and conductivity were exceeded. Upon investigation, it was determined that the excursion was caused by high spring precipitation, and not an actual excursion of mining solutions. SM8-28 has been placed on excursion status four times in the past due to similar environmental circumstances.

As conditions have dried and warmed, the excursion parameters in the well trended back toward normal levels. No additional corrective measures were necessary. The samples collected on June 14, 21, and 28, 2018, were below the excursion parameters, removing the well from excursion status.

1.2 Water Supply Wells and Surface Water

Summary sheets of quarterly radiological analytical data for the reporting period from all surface waters and water supply wells within one kilometer of the active wellfield boundary are included in Appendix A.

The reported radiological data are within the expected ranges for each well and surface water sampling point, with the exception of the second quarter radium result for Well 435, which was significantly higher than historical data. A recheck of the result has been requested from the contract laboratory, but the result of the recheck was not available as of this writing. The result will be supplied to NRC under separate cover when it becomes available. Samples were obtained from all sample locations with the exceptions noted in Appendix A.

2 OPERATIONAL

2.1 Production Data Summary

Mining operations continued through the first and second quarters of 2018. The average operating production flow rate was 2,130 gpm for the first quarter and 263 gpm for the second quarter. Injection



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and production totals from the totalizers and the calculated bleed totals for the reporting period are included in Appendix B. Production injection pressures are included in Appendix C.

2.2 Restoration

Restoration activities continued in Mine Units 2, 3, 4, 5, and 6 during the first half of 2018. Permeate continued to be injected into Mine Units 4, 5, and 6. Spot treatment of P246 in Mine Unit 3 continued as well. On June 19, 2013, Mine Unit 2 was placed into stabilization, and stability monitoring continued in mine unit 2 during the first half of 2018. Restoration injection and production totals are included in Appendix B. Restoration injection pressures are included in Appendix C.

2.3 Wastewater Summary

The total volume of wastewater discharged to the ponds was 1,801,370 gallons during the first quarter and 739,570 gallons during the second quarter. Currently, all five evaporation ponds contain wastewater.

Wastewater that is not disposed of in the evaporation ponds is injected into the two Deep Disposal Wells (DDWs). On January 1, 2018, continuous monitoring of DDW 1 indicated the potential that the integrity of the well had been compromised. The well was shut-in for testing and repair. The well was not returned to service until March 20, 2018, following repair of the well and a successful mechanical integrity test (MIT). Currently, the wells are operated on a nearly continuous basis and 34,749,085 gallons of wastewater was injected into the wells during the first half of 2018. A summary of the total volume of wastewater injected and the average radionuclide content is contained in Appendix D.

2.4 Effluent Release

10 CFR §40.65 requires licensees to report quantities of radionuclides in liquid and gaseous effluent releases to the environment. In the Application for Renewal of Source Materials License SUA-1534, submitted December 1995, Table 7.3(A) presented calculations of the annual radon emissions for the Crow Butte Plant. These calculations assumed a 7.04×10^{-4} Curies/m³ radon release from leaching operations and the radon release calculations for the first half of 2018 use this release rate estimate.

During the first quarter, production occurred at an average flow rate of 2,130 gpm (8,063 lpm). Production was maintained continuously for 90 days during the first quarter with an operating factor of 100%. The production flow for the first quarter results in a calculated radon release of 530 Curies.



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During the second quarter, production occurred at an average flow rate of 263 gpm (996 lpm). Production was maintained continuously for 91 days during the second quarter with an operating factor of 100%. The production flow for the second quarter results in a calculated radon release of 17 Curies. Calculations for radon release from production operations are shown in Appendix E.

There were no additional wells brought on line during the first half of 2018.

The total radon emission due to leaching operations from the Crow Butte plant for the first half of 2018 was 547 Curies. This calculated release rate is comparable with the releases estimated in CBR's License Renewal Application.

Radon gas is also released from restoration activities. For restoration water that is treated by ion exchange only, the radon concentration is 0.697 $\mu\text{Ci/l}$. Of the total restoration production flow it is assumed that 25% of the radon is released through wellfield loss and 10% of the remaining radon is released during pressurized ion exchange treatment. For water that is treated by reverse osmosis, it is assumed that 100% of the remaining radon is released. For water treated by reverse osmosis the radon concentration is 0.470 $\mu\text{Ci/l}$ after adjusting for wellfield loss and ion exchange loss.

During the first half of 2018, a total of 88,544,282 gallons (335,176,568 l) of restoration water was produced from Mine Units 2, 3, 4, 5, and 6. Based upon an estimated radon concentration of 0.697 $\mu\text{Ci/l}$, the total amount of radon in the restoration solution was calculated to be 234 Curies as shown in Appendix E. The estimated release of radon through wellfield loss at 25% of this total was 58 Curies. The plant loss for ion exchange treatment of the restoration water is estimated at 10% of the remaining radon, or 18 Curies. For water that is treated by reverse osmosis, it is assumed that 100% of the remaining radon is released. For water treated by reverse osmosis the radon concentration is 0.470 $\mu\text{Ci/l}$ after adjusting for wellfield loss and ion exchange loss.

Of the total amount of restoration water produced in the first half of 2018, 41,034,169 gallons (155,331,227 l) of the water was treated by reverse osmosis. The total estimated radon release from reverse osmosis treatment was 73 Curies.

No additional acres of wellfields were placed into restoration during the first half of 2018. The calculated radon released from start-up of 0 acres is 0 Curies. Calculations for the start-up of 0 acres of a wellfield placed in restoration are shown in Appendix E.

Based upon the calculations shown in Appendix E, the total estimated semiannual radon emission for the first half of 2018 from restoration activities was 149 Curies. This resulted in a total estimated radon release from the leaching operation during the first half of 2018 of 696 Curies.



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This information is included for historical purposes as a comparison for the requirements in License Condition 11.11.

2.5 License Condition 11.11

By letter dated January 6, 2016, the NRC staff indicated that it had completed the technical review of the licensee's January 2, 2015 submittal describing the site's operational airborne effluent and environmental monitoring program.

The licensee identified three primary sources of airborne effluents at the Crow Butte Project. These sources included the main plant, wellfield, and the wellhouses.

Main Plant

Radon and radon progeny

The licensee will measure ambient radon gas concentrations using track etch detectors and working level measurements at six different locations.

The licensee will use scintillation cell measurements quarterly at each tank vent for radon gas measurements.

Particulates

The licensee shall conduct isotopic analyses for alpha- and beta-emitting radionuclides on airborne samples at each in-plant air particulate sampling location at a frequency on once every six months for the first two years after the license renewal (November 2014) and annually thereafter to ensure compliance with 10 CFR 20.1204(g). For any changes to operations, the licensee shall conduct an evaluation to determine if more frequent isotopic analyses are required for compliance with 10 CFR 20.1204(g).

There were no changes made to the operation during the first half of 2018. Samples were collected from each of the in-plant air particulate sampling locations.

The summary of the Main Plant samples are shown in Appendix F.

Wellfield

The licensee identified two potential sources of radon in the wellfield. The first potential source of radon is when wellheads are opened to the atmosphere to depressurize a wellhead that has become



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pressurized. When these wellheads are depressurized, the licensee will obtain a grab sample using a scintillation cell. The licensee has committed to sampling at least one wellhead per quarter.

The other potential sources of radon in the wellfield include unplanned releases of process fluids from spills. The amount of radon released will be estimated based on the amount of fluid released and an estimate of the concentration of radon in the process fluid. The licensee will assume that all radon in the fluid is released to the atmosphere.

The summary of the Wellfield samples are shown in Appendix G.

Wellhouses

Radon and radon progeny

The licensee will measure radon in the wellhouses using track etch detectors with a six-month exposure time. The licensee will use the average radon concentration (collected quarterly) along with the flow rate of the wellhouse exhaust fans to determine the total radon released from the wellhouses. Four production and four restoration wellhouses will be monitored annually in this manner.

Radon daughters will be measured semi-annually in the wellhouses where radon gas is being measured. The licensee will determine the total radon daughters released in the same manner as the radon gas using the flow rate of the wellhouse exhaust fan.

Particulates

The licensee will estimate the emission of particulate releases based on isotopic analyses of semiannual air particulate samples performed in each of the wellhouses that are monitored for radon. The exhaust rate of the wellhouses will be the same as described above for the radon emissions.

The summary of the Wellhouse samples are shown in Appendix H.

Estimated emissions for the first half of the year are summarized in the following table. The estimated emissions is 1071.24 curies.



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First Half of 2018

Emissions in Ci for First 6 Months by Source

Source	Radon Progeny (Ci)	Radon Gas (Ci)	Particulate (Ci)	Total by Source	% by Source
Plant Floor Vents	0.12	1.53	3.66E-05	1.66	0.2%
Wellhouses (64)	0.07	1.96	1.66E-05	2.03	0.2%
Well Fields (Wellheads)	N/A	N/A	N/A	0.00E+00	0.0%
Plant Tanks/vents	51.3	1016.3	N/A	1067.6	99.7%
Spills	N/A	0.00E+00	N/A	0.00E+00	0.0%
Deepwells	N/A	N/A	9.18E-07	9.18E-07	0.0%
Total by Type	51.46	1019.78	5.42E-05		

Estimated Emissions for First Half of the Year = **1071.24** Curies (Ci)

3 ENVIRONMENTAL MONITORING

3.1 Air Monitor Stations

Eight air monitoring stations are used to monitor the Crow Butte Plant. Ambient radon-222 concentrations and radionuclide concentrations in air for each monitoring site are listed in Appendix I. Six track etch cups were deployed at the background monitoring station and the nearest residence to check for potential variability in data using only one track etch cup. All air monitoring results were within expected historical ranges.

3.2 TLD Monitors

Environmental TLD monitors are located at each air monitoring station. The results of the area TLD monitors fall within the expected ranges and are listed in Appendix J.

The site is provided with both a deployment and a transient dosimeter by the provider. The process used by the dosimeter provider, Landauer, is to subtract the deployment badge result from the badges used for environmental monitoring. If the deployment badge is lost, damaged, etc. the transient badge result is subtracted instead. If neither is available to be read, the average of a set number of previous quarter's background results is subtracted. Only one of the badge results is subtracted, not multiple. The purpose of these deployment and transient badges is to subtract off any radiation that was accumulated on the environmental badges during times when they were not deployed to ensure that



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only dose accumulated while in the prescribed monitoring location is returned to the site as a final result.

3.3 Mechanical Integrity Testing (MIT)

Mechanical integrity tests shall be performed on each injection and production well before the wells are utilized and on wells that have been serviced with equipment or procedures that could damage the well casing. Additionally, each well shall be retested at least once each five (5) years it is in use. The following table summarizes the MIT's performed during the first half of 2018.

Five (5) Year Retesting			
Required Testing	Number Tested	Number Passed	Number Failed
585	585	585	0

Wells Serviced			
Required Testing	Number Tested	Number Passed	Number Failed
0	0	0	0

Appendix A

Private Well and Surface Water Radiological Monitoring Results

First and Second Quarter, 2018

CROW BUTTE RESOURCES, INC.

PRIVATE WELL AND SURFACE WATER RADIOLOGICAL MONITORING RESULTS

First Quarter, 2018

SAMPLE ID	DATE SAMPLED	URANIUM mg/l	URANIUM μCi/ml	RADIUM-226 pCi/l	RADIUM-226 precision \pm
Well #8	03/13/18	0.0122	8.30E-09	0.3	0.1
Well #11	03/12/18	0.0060	4.10E-09	0.2	0.1
Well #12	03/16/18	0.0028	1.90E-09	<.2	0.04
Well #26	03/12/18	0.0044	3.00E-09	0.20	0.1
Well #28	03/13/18	0.0050	3.40E-09	0.3	0.1
Well #38	03/12/18	0.0036	2.40E-09	<.2	0.04
Well #41	03/14/18	0.0072	4.90E-09	0.20	0.1
Well #61	03/14/18	<.0003	<2.0E-10	3.3	0.3
Well #63	02/08/18	0.0148	1.00E-08	0.4	0.1
Well #66	03/12/18	0.0187	1.30E-08	0.3	0.1
Well #125	03/09/18	0.0046	3.10E-09	0.40	0.1
Well #129	03/09/18	0.0049	3.30E-09	<.2	0.05
Well #131	03/14/18	0.0043	2.90E-09	<.2	0.1
Well #133	03/09/18	0.0078	5.30E-09	0.3	0.1
Well #134	03/09/18	0.0094	6.40E-09	0.2	0.1
Well #135	03/09/18	0.0131	8.90E-09	0.3	0.1
Well #138	03/12/18	0.0086	5.80E-09	0.3	0.1
Well #140	03/13/18	<.0003	<2.0E-10	0.3	0.1
Well #435	03/14/18	0.0082	5.60E-09	0.20	0.1
Well #445	03/14/18	0.0078	5.30E-09	<.2	0.05
Drinking Water Well	03/09/18	0.0062	4.20E-09	<.2	0.05
Stream S-1	03/12/18	0.0033	2.20E-09	<.2	0.04
Stream S-2	03/09/18	0.0032	2.20E-09	<.2	0.03
Stream S-5	03/09/18	0.0037	2.50E-09	<.2	0.04
Stream E-1 & 2 Composite	03/09/18	0.0486	3.30E-08	0.3	0.1
Stream E-5	03/09/18	0.0156	1.10E-08	<.2	0.1
Impoundment I-3	03/09/18	0.0386	2.60E-08	<.2	0.1
Impoundment I-4	03/09/18	0.0295	2.00E-08	<.2	0.1
Impoundment I-5	03/09/18	0.0177	1.20E-08	<.2	0.1
Reporting Limit		0.0003	2.00E-10	0.2	-

ND-Not detected at the reporting limit

CROW BUTTE RESOURCES, INC.

PRIVATE WELL AND SURFACE WATER RADIOLOGICAL MONITORING RESULTS

Second Quarter, 2018

SAMPLE ID	DATE SAMPLED	URANIUM mg/l	URANIUM µCi/ml	RADIUM-226 pCi/l	RADIUM-226 precision ±
Well #8	06/07/18	0.0142	9.60E-09	0.5	0.1
Well #11	06/06/18	0.0081	5.50E-09	0.5	0.1
Well #12	06/06/18	0.0033	2.20E-09	0.4	0.1
Well #26	06/07/18	0.0060	4.10E-09	0.6	0.1
Well #28	06/07/18	0.0070	4.70E-09	0.4	0.1
Well #38	06/06/18	0.0033	2.20E-09	0.4	0.1
Well #41	06/07/18	0.0074	5.00E-09	0.4	0.1
Well #61	06/07/18	<.0003	<2.0E-10	3.2	0.2
Well #63	06/19/18	0.0175	1.80E-08	0.5	0.1
Well #66	06/07/18	0.0216	1.46E-08	0.6	0.1
Well #125	06/19/18	0.0054	3.70E-09	0.4	0.1
Well #129	06/14/18	0.0063	4.30E-09	0.5	0.1
Well #131	06/07/18	0.0049	3.30E-09	0.3	0.1
Well #133	06/07/18	0.0086	5.80E-09	0.5	0.1
Well #134	06/14/18	0.0086	5.80E-09	0.4	0.1
Well #135	06/07/18	0.0171	1.16E-08	0.4	0.1
Well #138	06/07/18	0.0175	1.18E-08	0.8	0.1
Well #140	06/07/18	0.0092	6.20E-09	0.5	0.1
Well #435	06/07/18	0.0078	5.30E-09	1.2	0.1
Well #445	06/07/18	0.0107	7.20E-09	0.3	0.1
Drinking Water Well	06/11/18	0.0062	4.20E-09	0.3	0.1
Stream S-1	06/06/18	0.0046	3.10E-09	0.3	0.1
Stream S-2	06/06/18	0.0035	2.40E-09	0.3	0.1
Stream S-5	06/07/18	0.0042	2.80E-09	0.3	0.1
Stream E-1 & 2 Composite	06/19/18	0.0560	3.79E-08	0.5	0.1
Stream E-5	06/14/18	0.0037	2.50E-09	0.2	0.1
Impoundment I-3	06/14/18	0.0099	6.70E-09	0.4	0.1
Impoundment I-4	06/14/18	0.0095	6.40E-09	<.2	0.1
Impoundment I-5	06/14/18	0.0061	4.10E-09	0.2	0.1
Reporting Limit		0.0003	2.00E-10	0.2	-

ND-Not detected at the reporting limit

Appendix B
Plant Production and Waste Totals
First and Second Quarter, 2018

WASTE VOLUME
First Quarter 2018

TOTALIZER	PLANT TO PONDS	PLANT TO DDW 1 & 2	RESTORATION TO DDW	CLEAN WATER INTO PLANT	DDW TOTAL INJECTED	TRUCKS TO POND	POND WATER TREATMENT
January	620,420	1,154,780	93,440	35,843	1,248,220	0	0
February	778,980	999,905	0	47,060	999,905	0	0
March	401,970	3,161,293	1,225,165	35,211	4,386,458	0	0
TOTAL GAL. EOQ	1,801,370	5,315,978	1,318,605	118,114	6,634,583	0	0

TOTAL 2nd QTR VOLUME

DISCHARGED TO WASTE PONDS LESS POND WATER TREATMENT GALLONS =	1,801,370 GALLONS
DISCHARGED TO DEEP WELL=	6,634,583 GALLONS
DISCHARGED TO WASTE PONDS + DPWELL =	8,435,953 GALLONS
WF BLEED FROM WELLFIELDS=	8,317,839 GALLONS

COMMERCIAL WELLFIELD BLEED
First Quarter 2018

MONTH	January	February	March
BLEED	1.1%	1.9%	14.1%

RESTORATION WELLFIELD BLEED
First Quarter 2018

MONTH	January	February	March
BLEED	0.9%	0.0%	16.5%

PLANT FLOW

First Quarter 2018

AVERAGE OPERATING FLOW RATE=	2,130 GPM EOQ
TOTAL GALLONS PRODUCED=	276,098,740 GALLONS EOQ
TOTAL GALLONS INJECTED=	269,099,506 GALLONS EOQ

	TOTAL GALS. PRODUCED	TOTAL GALS. INJECTED	HOURS IN MONTH	HOURS IN PRODUCTION	AVERAGE PROD. GPM	AVERAGE COM INJ GPM	AVERAGE REST INJ GPM	HRS. DOWN TIME
Prev. YTD	0	0	0	0	0	0	0	0
January	158,969,091	157,229,734	744	744	3,561	3,522	240	0
February	92,058,430	90,326,605	672	672	2,283	2,240	82	0
March	25,071,219	21,543,167	744	744	562	483	140	0
EOQ TOTAL	276,098,740	269,099,506	2,160	2,160	2,130	2,076	157	0
YTD TOTAL	276,098,740	269,099,506	2,160	2,160	2,130	2,076	157	0

	TOTAL MUII GALS PRODUCED	TOTAL MUIII GALS PRODUCED	TOTAL MUIV GALS PRODUCED	TOTAL MUJ GALS PRODUCED	TOTAL MUVI GALS PRODUCED	MUII BLEED TO WASTE	MUIII BLEED TO WASTE	MUIV BLEED TO WASTE	MUV BLEED TO WASTE	MUVI BLEED TO WASTE
Prev. YTD	0	0	0	0	0	0	0	0	0	0
January	0	208,174	1,429,745	1,541,574	7,338,705	0	189,228	-285,538	-352,884	731,861
February	0	0	1,157,204	1,911,303	6,610,294	0	0	0	0	0
March	0	99,363	1,102,745	401,640	5,912,659	0	13,066	1,071,109	390,129	-236,074
EOQ TOTAL	0	307,537	3,689,694	3,854,517	19,861,658	0	202,294	785,572	37,246	495,788
YTD TOTAL	0	307,537	3,689,694	3,854,517	19,861,658	0	202,294	785,572	37,246	495,788

	TOTAL BRINE GALS PRODUCED	TOTAL PERM GALS PRODUCED	COMM BLEED TO RO FEED
Prev. YTD			0
January	93,440	320,985	0
February	0	0	0
March	1,225,165	3,311,560	0
EOQ TOTAL	1,318,605	3,632,545	0
YTD TOTAL	1,318,605	3,632,545	0

WASTE VOLUME
Second Quarter 2018

TOTALIZER	PLANT TO PONDS	PLANT TO DDW 1 & 2	RESTORATION TO DDW	CLEAN WATER INTO PLANT	DDW TOTAL INJECTED	TRUCKS TO POND	POND WATER TREATMENT
April	333,290	7,124,791	3,823,833	43,133	10,948,624	0	0
May	156,900	7,571,583	4,376,354	35,199	11,947,937	0	0
June	248,380	8,110,369	3,742,155	35,515	11,852,524	1,000	0
TOTAL GAL. EOQ	738,570	22,806,743	11,942,342	113,847	34,749,085	1,000	0

TOTAL 2nd QTR VOLUME

DISCHARGED TO WASTE PONDS LESS POND WATER TREATMENT GALLONS =	739,570 GALLONS
DISCHARGED TO DEEP WELL=	34,749,085 GALLONS
DISCHARGED TO WASTE PONDS + DPWELL =	35,488,655 GALLONS
WF BLEED FROM WELLFIELDS=	35,374,808 GALLONS

COMMERCIAL WELLFIELD BLEED
Second Quarter 2018

MONTH	April	May	June
BLEED	41.6%	97.5%	100.0%

RESTORATION WELLFIELD BLEED
Second Quarter 2018

MONTH	April	May	June
BLEED	21.1%	20.4%	14.5%

PLANT FLOW

Second Quarter 2018

AVERAGE OPERATING FLOW RATE=	263 GPM EOQ
TOTAL GALLONS PRODUCED=	34,487,333 GALLONS EOQ
TOTAL GALLONS INJECTED=	10,596,362 GALLONS EOQ

	TOTAL GALS. PRODUCED	TOTAL GALS. INJECTED	HOURS IN MONTH	HOURS IN PRODUCTION	AVERAGE PROD. GPM	AVERAGE COM INJ GPM	AVERAGE REST INJ GPM	HRS. DOWN TIME
Prev. YTD	276,098,740	269,099,506	2,160	2,160	2,130	2,076	157	0
April	17,811,877	10,396,929	720	720	412	241	343	0
May	7,892,718	199,434	744	744	177	4	393	0
June	8,782,739	0	720	720	203	0	394	0
EOQ TOTAL	34,487,333	10,596,362	2,184	2,184	263	81	377	0
YTD TOTAL	310,586,074	279,695,869	4,344	4,344	1,192	1,073	267	0

	TOTAL MUII GALS PRODUCED	TOTAL MUIII GALS PRODUCED	TOTAL MUIV GALS PRODUCED	TOTAL MUV GALS PRODUCED	TOTAL MUVI GALS PRODUCED	MUII BLEED TO WASTE	MUIII BLEED TO WASTE	MUIV BLEED TO WASTE	MUV BLEED TO WASTE	MUVI BLEED TO WASTE
Prev. YTD	0	307,537	3,689,694	3,854,517	19,861,658	0	202,294	785,572	37,246	495,788
April	0	626,815	1,276,244	4,339,514	12,512,841	0	-306,018	1,250,711	2,842,699	36,440
May	0	566,567	3,869,624	5,816,466	11,792,271	0	-298,403	1,390,208	3,667,114	-382,565
June	0	306,598	4,246,816	5,076,141	10,400,979	0	-269,719	-271,790	2,894,944	506,108
EOQ TOTAL	0	1,499,980	9,392,684	15,232,121	34,706,091	0	-874,140	2,369,130	9,404,757	159,983
YTD TOTAL	0	1,807,517	13,082,378	19,086,638	54,567,749	0	-671,846	3,154,701	9,442,002	655,771

	TOTAL BRINE GALS PRODUCED	TOTAL PERM GALS PRODUCED	COMM BLEED TO RO FEED
Prev. YTD	1,318,605	3,632,545	0
April	3,823,833	12,891,994	0

Appendix C

Wellfield Injection Pressures

First and Second Quarter, 2018

WELLFIELD INJECTION PRESSURE - PSI										
First Quarter 2018										
	WF HOUSE #3		WF HOUSE #4		WF HOUSE #5		WF HOUSE #6		WF HOUSE #7	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	1	5	7	26	10	34	21	47	1	15
February	0	6	13	24	14	26	25	38	2	24
March	0	6	8	14	8	15	19	59	3	17
AVERAGE	0	6	9	26	11	34	21	59	2	24
	WF HOUSE #8		WF HOUSE #9		WF HOUSE #10		WF HOUSE #11		WF HOUSE #12	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	25	26	1	24	0	14	0	12	2	26
February	24	24	0	0	0	0	0	0	2	4
March	23	24	0	0	0	0	0	2	1	4
AVERAGE	24	26	0	24	0	14	0	12	2	26
	WF HOUSE #13		WF HOUSE #14		WF HOUSE #15		WF HOUSE #16		WF HOUSE #17	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	1	22	1	2	4	29	11	42	1	6
February	1	4	1	2	1	10	10	12	1	4
March	1	4	1	2	1	4	10	12	0	2
AVERAGE	1	22	1	2	2	29	10	42	1	6
	WF HOUSE #18		WF HOUSE #19		WF HOUSE #20		WF HOUSE #21		WF HOUSE #22	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	7	32	1	42	1	30	48	65	60	76
February	9	40	2	42	0	0	45	78	57	93
March	5	22	0	0	0	0	66	78	79	90
AVERAGE	7	40	1	42	0	30	53	78	65	93
	WF HOUSE #23		WF HOUSE #24		WF HOUSE #25		WF HOUSE #26		WF HOUSE #27	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	53	70	74	90	71	83	66	78	73	84
February	51	85	69	96	68	91	63	94	70	90
March	73	82	88	95	86	93	84	94	86	90
AVERAGE	59	85	77	96	75	93	71	94	76	90
	WF HOUSE #28		WF HOUSE #29		WF HOUSE #30		WF HOUSE #31		WF HOUSE #32	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	64	69	67	70	64	66	38	40	42	44
February	19	67	75	80	72	76	46	51	51	56
March	1	2	78	80	74	77	47	56	53	56
AVERAGE	28	69	73	80	70	77	43	56	49	56
	WF HOUSE #33		WF HOUSE #34		WF HOUSE #35		WF HOUSE #36		WF HOUSE #37	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	50	68	90	94	92	95	93	96	90	94
February	43	64	89	94	63	96	90	96	85	95
March	57	66	81	84	65	90	81	83	76	86
AVERAGE	50	68	87	94	74	96	88	96	84	95
	WF HOUSE #38		WF HOUSE #39		WF HOUSE #40		WF HOUSE #41		WF HOUSE #42	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	88	94	85	94	88	92	90	92	79	81
February	88	95	75	88	61	91	91	94	79	90
March	78	80	56	72	2	4	92	94	64	86
AVERAGE	85	95	72	94	50	92	91	94	74	90
	WF HOUSE #43		WF HOUSE #44		WF HOUSE #45		WF HOUSE #46		WF HOUSE #46A	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	95	96	95	96	95	96	87	88	75	94
February	91	96	116	884	80	96	86	88	65	94
March	87	89	86	90	75	78	84	86	50	92
AVERAGE	91	96	99	884	84	96	85	88	63	94
	WF HOUSE #47		WF HOUSE #47A/65		WF HOUSE #48		WF HOUSE #49		WF HOUSE #50	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	96	96	95	96	86	98	92	94	91	94
February	81	96	84	96	59	89	65	92	71	93
March	67	70	57	60	36	88	5	9	56	88
AVERAGE	81	96	79	96	60	98	54	94	73	94
	WF HOUSE #51		WF HOUSE #52		WF HOUSE #53		WF HOUSE #54		WF HOUSE #55	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	92	93	91	92	90	91	76	78	86	88
February	78	92	62	92	90	91	73	78	83	88
March	79	94	4	88	78	92	65	66	74	76
AVERAGE	83	94	52	92	86	92	71	78	81	88
	WF HOUSE #56		WF HOUSE #57							
	AVERAGE	MAXIMUM		AVERAGE	MAXIMUM					
January	79	80	January	93	94					
February	54	84	February	72	95					
March	0	0	March	35	82					
AVERAGE	44	84	AVERAGE	67	95					
	WF HOUSE #60		WF HOUSE #61		WF HOUSE #62		WF HOUSE #63		WF HOUSE #64	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
January	91	92	90	92	82	84	75	76	89	92
February	91	96	80	94	67	84	42	76	63	90
March	90	95	55	83	41	73	7	18	38	50
AVERAGE	90	96	75	94	63	84	24	76	50	92

WELLFIELD INJECTION PRESSURE - PSI										
Second Quarter 2017										
	WF HOUSE #3		WF HOUSE #4		WF HOUSE #5		WF HOUSE #8		WF HOUSE #7	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	11	41	45	62	50	60	45	47	27	28
May	16	46	43	68	50	78	46	70	27	28
June	7	18	33	42	37	46	31	69	27	38
AVERAGE	12	46	41	68	46	78	41	70	27	38
	WF HOUSE #8		WF HOUSE #9		WF HOUSE #10		WF HOUSE #11		WF HOUSE #12	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	18	18	63	68	53	56	50	56	69	74
May	18	28	60	65	49	56	46	52	65	70
June	16	18	60	66	49	56	46	66	63	71
AVERAGE	17	28	61	68	51	56	48	66	65	74
	WF HOUSE #13		WF HOUSE #14		WF HOUSE #15		WF HOUSE #16		WF HOUSE #17	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	60	64	73	78	69	74	45	72	58	62
May	56	62	69	75	64	70	43	60	54	60
June	55	62	68	76	63	71	37	71	53	60
AVERAGE	57	64	70	78	65	74	42	72	55	62
	WF HOUSE #18		WF HOUSE #19		WF HOUSE #20		WF HOUSE #21		WF HOUSE #22	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	75	80	81	86	69	74	83	90	81	90
May	71	78	77	84	65	78	77	82	82	88
June	70	77	77	84	64	72	75	82	82	90
AVERAGE	72	80	78	86	66	78	78	90	82	90
	WF HOUSE #23		WF HOUSE #24		WF HOUSE #25		WF HOUSE #26		WF HOUSE #27	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	87	92	84	88	87	90	82	87	85	90
May	82	88	84	86	88	88	82	84	79	84
June	81	88	87	90	86	88	82	84	77	85
AVERAGE	83	92	85	90	87	90	82	87	80	90
	WF HOUSE #28		WF HOUSE #29		WF HOUSE #30		WF HOUSE #31		WF HOUSE #32	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	84	86	88	90	84	86	59	86	63	64
May	72	86	77	90	73	86	50	60	55	91
June	84	86	88	90	83	86	57	60	62	64
AVERAGE	80	86	84	90	80	86	55	86	60	91
	WF HOUSE #33		WF HOUSE #34		WF HOUSE #35		WF HOUSE #36		WF HOUSE #37	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	71	90	92	94	89	90	92	94	91	94
May	60	72	93	96	88	93	93	95	88	94
June	69	72	90	96	88	90	92	94	89	94
AVERAGE	67	90	92	96	88	93	92	95	89	94
	WF HOUSE #38		WF HOUSE #39		WF HOUSE #40		WF HOUSE #41		WF HOUSE #42	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	89	94	82	86	87	88	89	90	81	82
May	91	94	83	86	87	90	77	90	64	84
June	89	92	82	86	87	90	89	90	64	82
AVERAGE	90	94	82	86	87	90	85	90	70	84
	WF HOUSE #43		WF HOUSE #44		WF HOUSE #45		WF HOUSE #46		WF HOUSE #46A	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	92	94	94	95	91	92	86	87	56	94
May	80	95	82	95	81	96	86	87	24	88
June	94	96	94	96	93	95	85	88	5	10
AVERAGE	89	96	90	96	88	96	86	88	28	94
	WF HOUSE #47		WF HOUSE #47A/65		WF HOUSE #48		WF HOUSE #49		WF HOUSE #50	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	91	94	93	94	90	92	88	92	89	96
May	80	95	83	95	83	92	88	90	88	90
June	94	95	91	95	77	90	89	92	89	90
AVERAGE	88	95	89	95	83	92	89	92	89	96
	WF HOUSE #51		WF HOUSE #52		WF HOUSE #53		WF HOUSE #54		WF HOUSE #55	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	90	92	91	92	89	90	74	76	83	84
May	90	92	90	92	78	90	75	78	84	86
June	90	94	90	92	90	92	74	78	84	86
AVERAGE	90	94	90	92	86	92	74	78	84	86
	WF HOUSE #56		WF HOUSE #57							
	AVERAGE	MAXIMUM		AVERAGE	MAXIMUM					
April	76	83	April	88	90					
May	76	82	May	88	90					
June	76	78	June	89	92					
AVERAGE	76	83	AVERAGE	88	92					
	WF HOUSE #60		WF HOUSE #81		WF HOUSE #82		WF HOUSE #83		WF HOUSE #84	
	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM	AVERAGE	MAXIMUM
April	91	92	89	90	80	82	94	95	94	95
May	80	92	78	92	72	84	83	96	81	95
June	90	92	90	93	81	82	94	95	93	95
AVERAGE	87	92	86	93	78	84	89	96	87	95

Appendix D

Deep Disposal Wells Injection Radiological Data

First and Second Quarter, 2018

Crow Butte Uranium Mine
Deep Disposal Well #1 Injection Radiological Data

Month	Total Gallons Injected	Average Natural Uranium (mg/l)	Total Natural Uranium Injected (mg)	Total Natural Uranium Injected (uCi)	Average Radium- 226 (pCi/l)	Total Radium- 226 Injected (uCi)
January-18	232,704	0.69	6.08E+05	4.11E+02	513	4.52E+02
February-18	0	0	0.00E+00	0.00E+00	0	0.00E+00
March-18	3,247,680	0.94	1.16E+07	7.82E+03	393	4.83E+03
April-18	9,942,528	0.507	1.91E+07	1.29E+04	442	1.66E+04
May-18	11,028,736	0.634	2.65E+07	1.79E+04	424	1.77E+04
June-18	10,961,984	3.47	1.44E+08	9.75E+04	301	1.25E+04
Totals	35,413,632		2.02E+08	1.37E+05		5.21E+04

Crow Butte Uranium Mine
Deep Disposal Well #2 Injection Radiological Data

Month	Total Gallons Injected	Average Natural Uranium (mg/l)	Total Natural Uranium Injected (mg)	Total Natural Uranium Injected (uCi)	Average Radium- 226 (pCi/l)	Total Radium- 226 Injected (uCi)
January-18	1,015,516	0.69	2.65E+06	1.80E+03	513	1.97E+03
February-18	999,905	0.408	1.54E+06	1.05E+03	544	2.06E+03
March-18	1,138,778	0.621	2.68E+06	1.81E+03	480	2.07E+03
April-18	1,006,096	0.507	1.93E+06	1.31E+03	442	1.68E+03
May-18	919,201	0.634	2.21E+06	1.49E+03	424	1.48E+03
June-18	890,540	0.654	2.20E+06	1.49E+03	301	1.01E+03
Totals	5,970,036		1.32E+07	8.95E+03		1.03E+04

Appendix E

Radon Release Calculations

First and Second Quarter, 2018

Radon Effluent Release Calculation (Production and Startup)

First Quarter 2018 Radon Release from Leaching Operations:

<i>Curies/M3</i>	<i>Production Flow (liters)</i>	<i>Radon-222 Decay Constant</i>	<i>Operating Days</i>	<i>Operating Factor</i>	<i>M3/liter conversion</i>	<i>Hours/Day Conversion</i>	<i>Minutes/Hour Conversion</i>	<i>Total Radon Release from Leaching</i>
7.04E-04	8,063	0.72	90	100.0%	0.001	24	60	530

Second Quarter 2018 Radon Release from Leaching Operations:

<i>Curies/M3</i>	<i>Production Flow (liters)</i>	<i>Radon-222 Decay Constant</i>	<i>Operating Days</i>	<i>Operating Factor</i>	<i>M3/liter conversion</i>	<i>Hours/Day Conversion</i>	<i>Minutes/Hour Conversion</i>	<i>Total Radon Release from Leaching</i>
7.04E-04	263	0.72	91	100.0%	0.001	24	60	17

First Half 2017 Radon Release From Startup:

<i>Curies/M3</i>	<i>Total Acres of New Wellfield</i>	<i>Meter2/Acre Conversion</i>	<i>Orebody Thickness (meters)</i>	<i>Porosity</i>	<i>Total Radon Release from Startup</i>
7.04E-04	0.0	4,074	1.52	0.29	0

Total Estimated Radon Release from Production:

547

Radon Effluent Release Calculation (Restoration)

First Half 2018 Radon Release From Restoration:

<i>Total Restoration Flow (liters)</i>	<i>Microcuries/liter</i>	<i>Curies/Microcurie</i>	<i>Production Potential</i>
335,176,568	0.697	1.00E-06	234

Wellfield Loss (25% of Production Potential):

58

Ion Exchange Loss (10% of Production Potential minus Wellfield Loss):

18

Reverse Osmosis Loss (100% of remaining activity at 0.470 microcuries/liter)

73

<i>Total Reverse Osmosis Flow (liters)</i>	<i>Microcuries/liter</i>	<i>Curies/Microcurie</i>
155,331,227	0.470	1.00E-06

First Half 2018 Radon Release From Startup of New Restoration:

<i>Curies/M3</i>	<i>Total Acres of New Wellfield</i>	<i>Meter2/Acre Conversion</i>	<i>Orebody Thickness (meters)</i>	<i>Porosity</i>	<i>Total Radon Release from Startup</i>
7.04E-04	0.00	4074	1.52	0.29	0

Total Estimated Radon Release from Restoration:

149

Total Estimated Radon Release, First Half 2018:

696

Appendix F

Main Plant

Track Etch Detectors

Working Level Measurements

Scintillation Cell Measurements

Isotopic Analyses

First Half, 2018

Calculation of Radon Gas Emissions from the Main Plant

First Half of 2018

Locations	RnG Concentration (x 10 ⁻⁹ µCi/ml)
01 Blower Pipe (Injection Filters)	2.3
02 Blower Pipe (Between Injection Tanks)	2.4
03 Boxed Fan (PWT West)	2.2
04 Boxed Fan (PWT East)	2
05 Pipe Duct (PWT)	2.4
09 Boxed Fan (Behind Acid Scrubber)	1.1
12 Shaker Room Blower/Exhaust	16.6

	Average RnG Concentration (µCi/ml)	Plant Vent Rate (CFM)	Plant Vent Rate (ml/6 months)	RnG Emissions (Ci/6 Months)
Plant Average	4.1E-09	49748	3.7E+14	1.53

Formula Ci/yr = average (µCi/ml) * ventilation (ml/yr) / (1e6 µCi/Ci)

First Half of 2018

Exhaust Rate for Building (CFM)	49748
Total Flow from Building (ml/ 6 months)	3.7E+14

Total In Plant Radon Progeny Emissions (Ci/yr)	0.12
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Formula $\text{Ci/yr} = \text{WL} * (3\text{e-}8 \mu\text{Ci/ml}/0.33 \text{ WL}) * \text{ventilation (ml/6 months)} / (1\text{e}6 \mu\text{Ci/Ci})$

Start Date	1/1/2018	Average	0.0036
End Date	6/30/2018		

				AREA_SAMPLE	PLE_TYPE
SITE_CODE	LOCATION_NAME	START_DATE	RNP_VALUE	CLASS_CODE	CODE
CB	R8 Motor Control Room	1/17/2018	Dosimetry	0.00316925	R
CB	R7 Between Precip Cells and Raw Water Tank	1/17/2018	Dosimetry	0.00756261	R
CB	R1 Between IX Columns and Precip Cells	1/17/2018	Dosimetry	0.01526746	R
CB	R2 Between Precip Cells and Eluent Tanks	1/17/2018	Dosimetry	0.00513341	R
CB	R12 Down Flow Column Area	1/17/2018	Dosimetry	0.00337904	R
CB	R13-E Pond Water Treatment Room East	1/17/2018	Dosimetry	0.00589294	R
CB	R13-M Pond Water Treatment Room Middle	1/17/2018	Dosimetry	0.0107575	R
CB	R13-W Pond WaterTreatment Room West	1/17/2018	Dosimetry	0.00381373	R
CB	R3 Between IX Columns and Injection Tanks	1/17/2018	Dosimetry	0.00656259	R
CB	R4 Between IX Columns and Resin Transfer Tanks	1/17/2018	Dosimetry	0.00506586	R
CB	R5 Between IX Columns and Column Drain Tank	1/17/2018	Dosimetry	0.00622315	R
CB	R6 Between IX Column Trains	1/17/2018	Dosimetry	0.01155016	R
CB	R8 Motor Control Room	2/14/2018	Dosimetry	0.00104546	R
CB	R7 Between Precip Cells and Raw Water Tank	2/14/2018	Dosimetry	0.00510136	R
CB	R1 Between IX Columns and Precip Cells	2/14/2018	Dosimetry	0.0059776	R
CB	R2 Between Precip Cells and Eluent Tanks	2/14/2018	Dosimetry	0.00190298	R
CB	R12 Down Flow Column Area	2/14/2018	Dosimetry	0.00337503	R

CB	R13-E Pond Water Treatment Room East	2/14/2018 Dosimetry	0.00646881 R
CB	R13-M Pond Water Treatment Room Middle	2/14/2018 Dosimetry	0.0033873 R
CB	R13-W Pond WaterTreatment Room West	2/14/2018 Dosimetry	0.00719525 R
CB	R3 Between IX Columns and Injection Tanks	2/14/2018 Dosimetry	0.00325702 R
CB	R4 Between IX Columns and Resin Transfer Tanks	2/14/2018 Dosimetry	0.00653415 R
CB	R5 Between IX Columns and Column Drain Tank	2/14/2018 Dosimetry	0.00730892 R
CB	R6 Between IX Column Trains	2/14/2018 Dosimetry	0.00792352 R
CB	R8 Motor Control Room	3/14/2018 Dosimetry	0.00210826 R
CB	R7 Between Precip Cells and Raw Water Tank	3/14/2018 Dosimetry	0.00102873 R
CB	R1 Between IX Columns and Precip Cells	3/14/2018 Dosimetry	0.00301358 R
CB	R2 Between Precip Cells and Eluent Tanks	3/14/2018 Dosimetry	0.00334842 R
CB	R12 Down Flow Column Area	3/14/2018 Dosimetry	0.00287814 R
CB	R13-E Pond Water Treatment Room East	3/14/2018 Dosimetry	0.00247492 R
CB	R13-M Pond Water Treatment Room Middle	3/14/2018 Dosimetry	0.00207532 R
CB	R13-W Pond WaterTreatment Room West	3/14/2018 Dosimetry	0.0037 R
CB	R3 Between IX Columns and Injection Tanks	3/14/2018 Dosimetry	0.00328403 R
CB	R4 Between IX Columns and Resin Transfer Tanks	3/14/2018 Dosimetry	0.00448006 R
CB	R5 Between IX Columns and Column Drain Tank	3/14/2018 Dosimetry	0.00660715 R
CB	R6 Between IX Column Trains	3/14/2018 Dosimetry	0.00515253 R
CB	R8 Motor Control Room	4/18/2018 Dosimetry	0.00137849 R
CB	R7 Between Precip Cells and Raw Water Tank	4/18/2018 Dosimetry	0.00230145 R
CB	R1 Between IX Columns and Precip Cells	4/18/2018 Dosimetry	0.00127128 R
CB	R2 Between Precip Cells and Eluent Tanks	4/18/2018 Dosimetry	0.00178773 R
CB	R12 Down Flow Column Area	4/18/2018 Dosimetry	0.00143019 R
CB	R13-W Pond WaterTreatment Room West	4/18/2018 Dosimetry	0.00192525 R
CB	R13-M Pond Water Treatment Room Middle	4/18/2018 Dosimetry	0.00317819 R
CB	R13-E Pond Water Treatment Room East	4/18/2018 Dosimetry	0.00153234 R
CB	R3 Between IX Columns and Injection Tanks	4/18/2018 Dosimetry	0.00271242 R
CB	R4 Between IX Columns and Resin Transfer Tanks	4/18/2018 Dosimetry	0.0033371 R
CB	R5 Between IX Columns and Column Drain Tank	4/18/2018 Dosimetry	0.00138405 R
CB	R6 Between IX Column Trains	4/18/2018 Dosimetry	0.00245813 R
CB	R8 Motor Control Room	5/17/2018 Dosimetry	0.00195237 R
CB	R7 Between Precip Cells and Raw Water Tank	5/17/2018 Dosimetry	0.00300365 R
CB	R1 Between IX Columns and Precip Cells	5/17/2018 Dosimetry	0.00392856 R
CB	R2 Between Precip Cells and Eluent Tanks	5/17/2018 Dosimetry	0.00174319 R
CB	R12 Down Flow Column Area	5/17/2018 Dosimetry	0.00134647 R
CB	R13-E Pond Water Treatment Room East	5/17/2018 Dosimetry	0.00260317 R

CB	R13-M Pond Water Treatment Room Middle	5/17/2018 Dosimetry	0.00122023 R
CB	R13-W Pond WaterTreatment Room West	5/17/2018 Dosimetry	0.00239066 R
CB	R3 Between IX Columns and Injection Tanks	5/17/2018 Dosimetry	0.00287114 R
CB	R4 Between IX Columns and Resin Transfer Tanks	5/17/2018 Dosimetry	0.00331535 R
CB	R5 Between IX Columns and Column Drain Tank	5/17/2018 Dosimetry	0.00212986 R
CB	R6 Between IX Column Trains	5/17/2018 Dosimetry	0.00154135 R
CB	R8 Motor Control Room	6/20/2018 Dosimetry	0.00175554 R
CB	R7 Between Precip Cells and Raw Water Tank	6/20/2018 Dosimetry	0.00068569 R
CB	R1 Between IX Columns and Precip Cells	6/20/2018 Dosimetry	0.00098231 R
CB	R2 Between Precip Cells and Eluent Tanks	6/20/2018 Dosimetry	0.00310021 R
CB	R12 Down Flow Column Area	6/20/2018 Dosimetry	0.0008921 R
CB	R13-E Pond Water Treatment Room East	6/20/2018 Dosimetry	0.00336254 R
CB	R13-M Pond Water Treatment Room Middle	6/20/2018 Dosimetry	0.00350783 R
CB	R13-W Pond WaterTreatment Room West	6/20/2018 Dosimetry	0.00468353 R
CB	R3 Between IX Columns and Injection Tanks	6/20/2018 Dosimetry	0.00174852 R
CB	R4 Between IX Columns and Resin Transfer Tanks	6/20/2018 Dosimetry	0.00027492 R
CB	R5 Between IX Columns and Column Drain Tank	6/20/2018 Dosimetry	0.00057141 R
CB	R6 Between IX Column Trains	6/20/2018 Dosimetry	0.00168127 R

Tank Vent Effluent (RnP and RnG Emissions from Tank Vents)

First Half of 2018 Data

Location	Ventilation Blower Flow Rates (cfm)	Ventilation Blower Flow Rates (m ³ /min)	Ventilation Blower Flow Rates (L/min)	First Quarter Results						Second Quarter Results					
				RnG Filling pCi/l	RnP Filling WL	RnG Draining pCi/l	RnP Draining WL	RnG Steady pCi/l	RnP Steady WL	RnG Filling pCi/l	RnP Filling WL	RnG Draining pCi/l	RnP Draining WL	RnG Steady pCi/l	RnP Steady WL
6 - Pond Water Treat. Fan	4700	133.1	133089.0					5.95	0.012					1.59	0.0090
7 - Chem Mix Demister Fan	4700	133.1	133089.0	6145.7	0.982	1506.13	0.056	14.45	0.004	0.000	0.0010	3.07	0.0000	0.46	0.0010
8 - Waste Tank Blower	1500	42.5	42475.2					10982.06	33.068					302.25	0.0330
10 - Precip Demister Fan	1500	42.5	42475.2	8205.94	2.699	24.75	0.026	3.31	0.006	824.120	0.0370	0	0.0010	7.38	0.0210
11 - Shaker Deck Blower	800	22.7	22653.4	2004.99	1.199	41.21	0.001	0.44	0.008	5154.360	1.3100	1.26	0.0050	13.65	0.00900
13 - Eluent Tank Blower	1500	42.5	42475.2	7149.16	2.922	31.38	0.024	9.96	0.005	155.900	0.0200	33.23	0.0070	0.49	0.00200
14 - Precip A Blower	185	5.2	5238.6					0	0.007					1.81	0.0060
15 - East Train Blower	6000	169.9	169900.8	6447.27	3.428	5745.7	2.45	16484.16	4.252					10812.86	5.0770
16 - West Train Blower	6000	169.9	169900.8	5370.87	5.065	1605.21	0.255	1639.78	0.261	138.580	0.0450	16.91	0.006	0	0.0110
17 - Backwash Tank Blower	800	22.7	22653.4					261	0.041					13.47	0.00100

Footnote: Locations numbered per HPC Air Ventilation Study - August 2013 (LRA SUA 1534 November 2014 Appendix C) ML15310A373

First Half of 2018 Results

Location	Ventilation Blower Flow Rates (cfm)	Ventilation Blower Flow Rates (m ³ /min)	Ventilation Blower Flow Rates (L/min)	Average for First Half of Year						Average RnG (pCi/l)	Average RnG (pCi/min)	Average RnG Emissions (Ci/6 months)	Average RnP Emissions (Ci/6 months)	Max RnG (pCi/l)	Max RnG (pCi/min)	Maximum RnG Emissions (Ci/6 months)	Maximum RnP Emissions (Ci/6 months)
				RnG Filling pCi/l	RnP Filling WL	RnG Draining pCi/l	RnP Draining WL	RnG Steady pCi/l	RnP Steady WL								
6 - Pond Water Treat. Fan	4700	133.1	133089.0					3.8	0.0	3.8	5.02E+05	0.13	0.0	3.8	5.02E+05	0.13	0.03
7 - Chem Mix Demister Fan	4700	133.1	133089.0	3072.9	0.4915	754.6	0.0	7.5	0.0	1278.3	1.70E+08	44.71	0.6	3072.9	4.09E+08	107.48	1.56
8 - Waste Tank Blower	1500	42.5	42475.2					5642.2	16.6	5642.2	2.40E+08	62.98	16.8	5642.2	2.40E+08	62.98	16.79
10 - Precip Demister Fan	1500	42.5	42475.2	4515.0	1.4	12.4	0.0	5.3	0.0	1510.9	6.42E+07	16.87	0.5	4515.0	1.92E+08	50.40	1.39
11 - Shaker Deck Blower	800	22.7	22653.4	3579.7	1.3	21.2	0.0	7.0	0.0	1202.7	2.72E+07	7.16	0.2	3579.7	8.11E+07	21.31	0.68
13 - Eluent Tank Blower	1500	42.5	42475.2	3652.5	1.5	32.3	0.0	5.2	0.0	1230.0	5.22E+07	13.7	0.5	3652.5	1.55E+08	40.77	1.49
14 - Precip A Blower	185	5.2	5238.6					0.9	0.0	0.9	4.74E+03	0.0	0.0	0.9	4.74E+03	0.00	0.00
15 - East Train Blower	6000	169.9	169900.8	6447.3	3.4	5745.7	2.5	13648.5	4.7	8613.8	1.46E+09	384.6	14.3	13648.5	2.32E+09	609.41	18.93
16 - West Train Blower	6000	169.9	169900.8	2754.7	2.6	811.1	0.1	819.9	0.1	1461.9	2.48E+08	65.3	3.8	2754.7	4.68E+08	123.00	10.37
17 - Backwash Tank Blower	800	22.7	22653.4					137.2	0.0	137.2	3.11E+06	0.8	0.0	137.2	3.11E+06	0.82	0.01

Footnote: Locations numbered per HPC Air Ventilation Study - August 2013 (LRA SUA 1534 November 2014 Appendix C) ML15310A373

Sum	596.3	36.7
First Half 2017 Tank RnP and RnG		

1016.29	51.27
1067.56	

Calculation of Particulate Emissions from the Plant

First Half of 2018

	Run Time (min)	Flow Rate (LPM)	Total Volume (L)	Lab Result (μCi/ml)				Calculated Result (μCi/ml)	
				Lead 210	Radium 226	Thorium 230	Uranium	Th234	Po-210
Between IX Train	10200	44.19	450738.0	2.10E-14	2.60E-16	5.00E-17	6.50E-15	3.19E-15	2.10E-14
Below Thickener Tank	10196	40.95	417526.2	2.30E-14	2.50E-16	1.70E-15	8.70E-15	4.26E-15	2.30E-14
Top of Precip B	10202	43.36	442358.7	2.20E-14	2.10E-16	5.00E-17	7.40E-15	3.63E-15	2.20E-14
Belt Filter Room	11432	40.75	465854.0	3.10E-14	2.40E-16	7.40E-16	2.30E-13	1.13E-13	3.10E-14
Top of Tall White Tanks	10198	40.75	415568.5	1.70E-14	5.00E-17	1.30E-15	2.20E-14	1.08E-14	1.70E-14
Dryer Change Room	11443	40.95	468590.9	1.10E-14	2.00E-16	5.00E-17	3.00E-15	1.47E-15	1.10E-14
R.O. Building	11162	49.70	554762.0	8.80E-15	2.20E-16	5.00E-15	5.20E-16	2.55E-16	8.80E-15
10 CFR 20 Effluent Limit				1.00E-10	3.00E-10	6.00E-12	2.00E-11	3.00E-10	9.00E-13
RL				2.00E-15	1.00E-16	1.00E-16	1.00E-16		

Note: if result was non-detect, 1/2 RL was used

Exhaust Rate for Building (CFM)	49748
Total Flow from Building (ml/ 6 months)	3.70E+14

Total Emissions of Each Radionuclide for First Half of 2018

	Emission (Ci/yr)
Lead 210	7.08E-06
Radium 226	7.56E-08
Thorium 230	4.70E-07
Uranium	1.47E-05
Th234	7.21E-06
Po-210	7.08E-06
Sum	3.66E-05

Appendix G

Wellfield

Scintillation Cell Measurements

First and Second Quarter, 2018

Calculation of Radon Gas Emissions from Venting Wellheads

First Half of 2018

RnG (pCi/L)	
Average RnG vented from Wellheads - Q1	N/A
Average RnG vented from Wellheads - Q2	N/A

Total Emissions for First Half

Average RnG (pCi/L)	0	
Casing volume (L)	1563.75	(4.5 in diameter, 500 ft depth)
Wellheads bled/Month	0	
Wellheads bled/6 Months	0	
Ci/6 Months	0.00E+00	

Appendix H

Wellhouses

Track Etch Detectors

Working Level Measurements

Isotopic Analyses

First and Second Quarter, 2018

Calculation of Radon Gas Emissions from Wellhouses

First Half of 2018

Wellhouses	RnG Concentration (x 10 ⁻⁹ µCi/ml)
Wellhouse 5 (Restoration)	2.5
Wellhouse 8 (Restoration)	2.9
Wellhouse 19 (Restoration)	2.2
Wellhouse 24 (Restoration)	6
Wellhouse 30 (Production)	2.9
Wellhouse 36 (Production)	10.8
Wellhouse 43 (Production)	6.8
Wellhouse 50 (Production)	1.1
Wellhouse 9 (Restoration)*	37

Total Emissions for First Half of 2018

	Average RnG Concentration (µCi/ml)	WH Vent Rate (CFM)	WH Vent Rate (ml/6 months)	# WH	RnG Emissions (Ci/6 Months)
WH Avg Concentration (Restoration)	3.40E-09	800	6.0E+12	24	0.49
WH Avg Concentration (Production)	5.40E-09	800	6.0E+12	39	1.25
*WH Not part of Average	0.000000037	800	6.0E+12	1	0.22
Total Radon Gas Emissions from WH's					1.96

$$\text{Formula Ci/yr} = \text{average } (\mu\text{Ci/ml}) * \text{ventilation (ml/yr)} * \# \text{ WH} / (1\text{e}6 \mu\text{Ci/Ci})$$

Calculation of Radon Progeny Emissions from Wellhouses

First Half of 2018

Wellhouses	WL Q1	Q2	Average
Wellhouse 5 (Restoration)	0.004	0	0.002
Wellhouse 8 (Restoration)	0.004	0	0.002
Wellhouse 19 (Restoration)	0	0	0.000
Wellhouse 24 (Restoration)	0	0.003	0.002
Wellhouse 30 (Production)	0.005	0.001	0.003
Wellhouse 36 (Production)	0.004	0	0.002
Wellhouse 43 (Production)	0.004	0	0.002
Wellhouse 50 (Production)	0.002	0.002	0.002

Wellhouse 9 (Restoration)*	0.018	0.004	0.011
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Total Emissions for First Half of 2017

	Average WL	WH Vent Rate (CFM)	WH Vent Rate (ml/ 6months)	# of WH	Ci/6 Months (RnP)
WH Avg Concentration (Restoration)	0.001	800	6.0E+12	24	0.02
WH Avg Concentration (Production)	0.002	800	6.0E+12	39	0.05
*WH Not part of Average	0.011	800	6.0E+12	1	0.01
First Half Radon Progeny Emissions from WH					0.07

Formula Ci/yr = WL * (3e-8 µCi/ml/0.33 WL) * ventilation (ml/6 months) * # of WH / (1e6 µCi/Ci)

Calculation of Particulate Emissions from the Wellhouses

First Half of 2018

	Run Time (min)	Flow Rate (LPM)	Total Volume (L)	Lab Result (µCi/ml)				Calculated Result (µCi/ml)	
				Lead 210	Radium 226	Thorium 230	Uranium	Th234	Po-210
Wellhouse 5 (Restoration)	20258	49.5000	1002771.0	2.50E-14	5.00E-17	5.00E-17	5.00E-17	2.45E-17	2.50E-14
Wellhouse 8 (Restoration)	20276	49.3900	1001431.6	1.50E-14	1.20E-16	1.00E-15	2.50E-16	1.23E-16	1.50E-14
Wellhouse 19 (Restoration)	20315	49.2400	1000310.6	1.30E-14	1.20E-16	2.60E-16	5.00E-17	2.45E-17	1.30E-14
Wellhouse 24 (Restoration)	20271	48.9400	992062.7	2.00E-14	5.00E-17	7.00E-16	7.30E-17	3.58E-17	2.00E-14
Wellhouse 30 (Production)	20239	49.1000	993734.9	2.30E-14	2.50E-16	5.00E-17	8.90E-16	4.36E-16	2.30E-14
Wellhouse 36 (Production)	18691	49.7363	929621.0	2.60E-14	2.70E-16	3.50E-16	3.40E-16	1.67E-16	2.60E-14
Wellhouse 43 (Production)	18730	49.7016	930911.0	2.40E-14	2.50E-16	2.50E-16	3.50E-16	1.72E-16	2.40E-14
Wellhouse 50 (Production)	18692	49.7337	929623.0	2.50E-14	1.20E-16	2.60E-16	2.20E-16	1.08E-16	2.50E-14
10 CFR 20 Effluent Limit				1.00E-10	3.00E-10	6.00E-12	2.00E-11	3.00E-10	9.00E-13
RL				2.00E-15	1.00E-16	1.00E-16	1.00E-16		

Note: if result was non-detect, 1/2 RL was used

Exhaust Rate for Wellhouse (CFM) 800
 Total Flow from Building (ml/ 6 months) 6.0E+12 (1 ft3 = 28316.84659 ml)
 # Wellhouses 64

Total Emissions of Each Radionuclide for First Half of Year

	Emission (Ci/6 Months)
Lead 210	8.14E-06
Radium 226	5.86E-08
Thorium 230	1.39E-07
Uranium	1.06E-07
Th234	5.19E-08
Po-210	8.14E-06
Sum	1.66E-05

Calculation of Particulate Emissions from DeepWell Buildings

First Half of 2018

	Run Time (min)	Flow Rate (LPM)	Total Volume (L)	Lab Result (µCi/ml)				Calculated Result (µCi/ml)	
				Lead 210	Radium 226	Thorium 230	Uranium	Th234	Po-210
				4.50E-14	2.10E-16	7.80E-16	3.30E-16	1.62E-16	4.50E-14
DeepWell Building #1	15829	49.70900	786843.8	3.10E-14	5.00E-17	5.00E-17	3.90E-16	1.91E-16	3.10E-14
DeepWell Building #2	18706	49.84030	932312.7	1.00E-10	3.00E-10	6.00E-12	2.00E-11	3.00E-10	9.00E-13
10 CFR 20 Effluent Limit				2.00E-15	1.00E-16	1.00E-16	1.00E-16		
RL									

Note: if result was non-detect, 1/2 RL was used

	Building 1	Building 2
Exhaust Rate for Wellhouse (CFM)	800	800
Total Flow from Building (ml/ 6 months)	6.0E+12	6.0E+12

(1 ft³ = 28316.84659 ml)

Total Emissions of Each Radionuclide for First Half of Year

	Emission (Ci/6 Months)	
	Building 1	Building 2
Lead 210	2.68E-07	1.85E-07
Radium 226	1.25E-09	2.98E-10
Thorium 230	4.64E-09	2.98E-10
Uranium	1.96E-09	2.32E-09
Th234	9.63E-10	1.14E-09
Po-210	2.68E-07	1.85E-07
By Building	5.45E-07	3.73E-07
Total	9.18E-07	

Crow Butte Resources

Wellhouse Radon Daughters Summary

C.Yada

WH#	2018 2nd Qtr.	Date	2018 1st Qtr.	Date
	Working Level Concentration		Working Level Concentration	
3	0.001	4/19/2018	0.003	1/18/2018
4	0.001	4/19/2018	0.004	1/18/2018
5	0.000	4/19/2018	0.004	1/18/2018
6	0.001	4/19/2018	0.005	1/18/2018
7	0.002	4/19/2018	0.003	1/18/2018
8	0.000	4/19/2018	0.004	1/18/2018
9	0.004	4/19/2018	0.017	1/18/2018
10	0.026	4/19/2018	0.019	1/18/2018
11	0.001	4/19/2018	0.001	1/18/2018
12	0.000	4/19/2018	0.002	1/18/2018
13	0.000	4/19/2018	0.002	1/18/2018
14	0.003	4/19/2018	0.008	1/18/2018
15	0.001	4/19/2018	0.003	1/18/2018
16	0.009	4/19/2018	0.013	1/18/2018
17	0.002	4/19/2018	0.000	1/19/2018
18	0.001	4/19/2018	0.002	1/19/2018
19	0.000	4/19/2018	0.000	1/19/2018
20	0.001	4/19/2018	0.002	1/19/2018
21	0.001	4/19/2018	0.001	1/19/2018
22	0.008	4/20/2018	0.005	1/19/2018
23	0.001	4/20/2018	0.000	1/19/2018
24	0.003	4/20/2018	0.000	1/19/2018
25	0.001	4/20/2018	0.001	1/19/2018
26	0.004	4/20/2018	0.002	1/19/2018
27	0.002	4/20/2018	0.000	1/19/2018
28	0.012	5/15/2018	0.018	2/14/2018
29	0.002	5/15/2018	0.003	2/14/2018
30	0.001	5/15/2018	0.005	2/14/2018
31	0.002	5/15/2018	0.004	2/14/2018
32	0.000	5/15/2018	0.003	2/14/2018
33	0.002	5/15/2018	0.003	2/14/2018
34	0.001	5/15/2018	0.007	2/14/2018
35	0.001	5/15/2018	0.002	2/14/2018
36	0.000	5/15/2018	0.004	2/14/2018
37	0.005	5/15/2018	0.016	2/14/2018

Crow Butte Resources

Wellhouse Radon Daughters Summary

C.Yada

	2018 2nd Qtr.		2018 1st Qtr.	
	Working Level	Date	Working Level	Date
WH#	Concentration		Concentration	
38	0.001	5/15/2018	0.013	2/14/2018
39	0.004	5/15/2018	0.011	2/14/2018
40	0.003	5/15/2018	0.003	2/14/2018
41	0.001	5/16/2018	0.003	2/15/2018
42	0.004	5/16/2018	0.004	2/15/2018
43	0.000	5/16/2018	0.004	2/15/2018
44	0.001	5/16/2018	0.002	2/15/2018
45	0.002	5/16/2018	0.002	2/15/2018
46	0.001	5/16/2018	0.006	2/15/2018
46A	0.000	5/16/2018	0.003	2/15/2018
47	0.001	5/16/2018	0.002	2/15/2018
47A	0.002	5/16/2018	0.001	2/15/2018
48	0.003	5/16/2018	0.005	2/15/2018
49	0.014	5/16/2018	0.033	2/15/2018
50	0.002	5/16/2018	0.002	2/15/2018
51	0.002	6/6/2018	0.001	3/14/2018
52	0.002	6/6/2018	0.001	3/14/2018
53	0.001	6/6/2018	0.001	3/14/2018
54	0.003	6/6/2018	0.001	3/14/2018
55	0.002	6/6/2018	0.002	3/14/2018
56	0.000	6/6/2018	0.002	3/14/2018
57	0.001	6/6/2018	0.005	3/14/2018
60	0.002	6/6/2018	0.001	3/14/2018
61	0.002	6/12/2018	0.001	3/14/2018
62	0.000	6/12/2018	-0.001	3/14/2018
63	0.001	6/12/2018	0.000	3/14/2018
64	0.001	6/12/2018	0.000	3/14/2018
DDW-1	0.004	6/12/2018	0.002	3/14/2018
DDW-2	0.000	6/12/2018	0.000	3/14/2018

Appendix I

Environmental Air Monitoring Results

First and Second Quarter, 2018

Crow Butte Resources, Inc.
Crow Butte Uranium Project

Track Etch Cup Ambient Radon Concentrations

*Air
Monitoring
Station No.*

Period: January 2, 2018 to June 29, 2018

	Gross Count	Average Radon Concentration (x 10 ⁻⁹ µCi/ml)	Accuracy (x 10 ⁻⁹ µCi/ml)	Percent Effluent Concentration
AM-1	52.0	0.30	0.04	3.0%
AM-2	87.0	0.49	0.05	4.9%
AM-3	54.0	0.30	0.04	3.0%
AM-4	52.0	0.30	0.04	3.0%
AM-5	43.0	0.24	0.04	2.4%
AM-6A	44.0	0.24	0.04	2.4%
AM-6B	43.0	0.24	0.04	2.4%
AM-6C	47.0	0.27	0.04	2.7%
AM-6D	39.0	0.22	0.04	2.2%
AM-6E	34.0	0.19	0.03	1.9%
AM-6F	44.0	0.24	0.04	2.4%
AM-8	37.0	0.22	0.04	2.2%
AM-9A	52.0	0.30	0.04	3.0%
AM-9B	35.0	0.19	0.03	1.9%
AM-9C	47.0	0.27	0.04	2.7%
AM-9D	50.0	0.27	0.04	2.7%
AM-9E	39.0	0.22	0.04	2.2%
AM-9F	34.0	0.19	0.03	1.9%

LLD (x 10 ⁻⁹ µCi/ml)	0.2
Effluent Concentration Limit, 10 CFR 20 App B Column 2:	10



Inter-Mountain Labs

Your Environmental Monitoring Partner

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Air Filter Summary Report**Client: Cameco Resources, Crow Butte Operation****Client Sampler ID: AM-1**

Lab ID S1804040-001 Sampled 1/2/18-3/29/18 (2018 1sr Qtr)						Sample Air Volume: 6156023 Liters		
Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	82.4	5.3	1.3E-14	8.6E-16	2E-15	6 E-13	Day	2.2
Radium 226	0.4	0.1	6.2E-17	1.6E-17	1E-16	9 E-13	Week	0.0069
Thorium 230	0.1	0.1	0.0E+0	1.6E-17	1E-16	3 E-14	Year	0
Uranium	0.1		1.5E-17		1E-16	9 E-14	Year	0.017

Client Sampler ID: AM-1

Lab ID S1807064-001 Sampled 4/5/18-6/29/18 (2nd Qtr 2018)						Sample Air Volume: 6583462 Liters		
Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	69.7	5.0	1.1E-14	7.6E-16	2E-15	6 E-13	Day	1.8
Radium 226	0.1	0.1	1.7E-17	1.5E-17	1E-16	9 E-13	Week	0.0019
Thorium 230	0.9	0.3	1.4E-16	4.6E-17	1E-16	3 E-14	Year	0.47
Uranium	0.0		3.7E-18		1E-16	9 E-14	Year	0.0041

Client Sampler ID: AM-2

Lab ID S1804040-002 Sampled 1/2/18-3/29/18 (2018 1sr Qtr)						Sample Air Volume: 6074908 Liters		
Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	84.7	3.8	1.4E-14	6.3E-16	2E-15	6 E-13	Day	2.3
Radium 226	0.3	0.1	5.1E-17	1.6E-17	1E-16	9 E-13	Week	0.0057
Thorium 230	0.6	0.3	9.2E-17	4.9E-17	1E-16	3 E-14	Year	0.31
Uranium	0.1		1.8E-17		1E-16	9 E-14	Year	0.020

Client Sampler ID: AM-2

Lab ID S1807064-002 Sampled 4/5/18-6/29/18 (2nd Qtr 2018)						Sample Air Volume: 6577710 Liters		
Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	63.3	4.8	9.6E-15	7.3E-16	2E-15	6 E-13	Day	1.6
Radium 226	0.3	0.1	4.4E-17	1.5E-17	1E-16	9 E-13	Week	0.0049
Thorium 230	1.8	0.5	2.7E-16	7.6E-17	1E-16	3 E-14	Year	0.90
Uranium	0.1		8.3E-18		1E-16	9 E-14	Year	0.0092

Client Sampler ID: AM-3

Lab ID S1804040-003 Sampled 1/2/18-3/29/18 (2018 1sr Qtr)						Sample Air Volume: 6157995 Liters		
Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	93.3	4.0	1.5E-14	6.5E-16	2E-15	6 E-13	Day	2.5
Radium 226	0.3	0.1	5.1E-17	1.6E-17	1E-16	9 E-13	Week	0.0057
Thorium 230	0.2	0.2	3.9E-17	3.2E-17	1E-16	3 E-14	Year	0.13
Uranium	0.1		1.7E-17		1E-16	9 E-14	Year	0.019

Client Sampler ID: AM-3

Lab ID S1807064-003

Sample Air Volume: 6584676 Liters

Sampled 4/5/18-6/29/18 (2nd Qtr 2018)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	72.8	4.9	1.1E-14	7.4E-16	2E-15	6 E-13	Day	1.8
Radium 226	0.4	0.1	5.9E-17	1.5E-17	1E-16	9 E-13	Week	0.0066
Thorium 230	1.1	0.4	1.6E-16	6.1E-17	1E-16	3 E-14	Year	0.53
Uranium	0.2		2.3E-17		1E-16	9 E-14	Year	0.026

Client Sampler ID: AM-4

Lab ID S1804040-004

Sample Air Volume: 6164348 Liters

Sampled 1/2/18-3/29/18 (2018 1sr Qtr)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	99.2	4.2	1.6E-14	6.8E-16	2E-15	6 E-13	Day	2.7
Radium 226	0.2	0.1	3.7E-17	1.6E-17	1E-16	9 E-13	Week	0.0041
Thorium 230	0.6	0.4	9.0E-17	6.5E-17	1E-16	3 E-14	Year	0.30
Uranium	0.3		4.2E-17		1E-16	9 E-14	Year	0.047

Client Sampler ID: AM-4

Lab ID S1807064-004

Sample Air Volume: 6583338 Liters

Sampled 4/5/18-6/29/18 (2nd Qtr 2018)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	66.4	4.8	1.0E-14	7.3E-16	2E-15	6 E-13	Day	1.7
Radium 226	0.3	0.1	5.1E-17	1.5E-17	1E-16	9 E-13	Week	0.0057
Thorium 230	0.4	0.3	6.6E-17	4.6E-17	1E-16	3 E-14	Year	0.22
Uranium	0.1		1.2E-17		1E-16	9 E-14	Year	0.013

Client Sampler ID: AM-5

Lab ID S1804040-005

Sample Air Volume: 6160888 Liters

Sampled 1/2/18-3/29/18 (2018 1sr Qtr)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	11.8	1.8	1.9E-15	2.9E-16	2E-15	6 E-13	Day	0.32
Radium 226	0.4	0.1	7.1E-17	1.6E-17	1E-16	9 E-13	Week	0.0079
Thorium 230	0.3	0.2	4.8E-17	3.2E-17	1E-16	3 E-14	Year	0.16
Uranium	0.3		5.3E-17		1E-16	9 E-14	Year	0.059

Client Sampler ID: AM-5

Lab ID S1807064-005

Sample Air Volume: 6583579 Liters

Sampled 4/5/18-6/29/18 (2nd Qtr 2018)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	72.9	5.0	1.1E-14	7.6E-16	2E-15	6 E-13	Day	1.8
Radium 226	0.4	0.1	6.5E-17	1.5E-17	1E-16	9 E-13	Week	0.0072
Thorium 230	0.8	0.3	1.3E-16	4.6E-17	1E-16	3 E-14	Year	0.43
Uranium	0.0		5.5E-18		1E-16	9 E-14	Year	0.0061

Client Sampler ID: AM-6

Lab ID S1804040-006

Sample Air Volume: 6154512 Liters

Sampled 1/2/18-3/29/18 (2018 1sr Qtr)

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	101	4.2	1.6E-14	6.8E-16	2E-15	6 E-13	Day	2.7
Radium 226	0.3	0.1	4.7E-17	1.6E-17	1E-16	9 E-13	Week	0.0052
Thorium 230	0.1	0.2	0.0E+0	3.2E-17	1E-16	3 E-14	Year	0
Uranium	0.5		7.5E-17		1E-16	9 E-14	Year	0.083

Client Sampler ID: AM-6**Lab ID S1807064-006****Sample Air Volume: 6576395 Liters****Sampled 4/5/18-6/29/18 (2nd Qtr 2018)**

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	79.5	5.2	1.2E-14	7.9E-16	2E-15	6 E-13	Day	2.0
Radium 226	0.17	0.1	2.6E-17	1.5E-17	1E-16	9 E-13	Week	0.0029
Thorium 230	0.3	0.2	5.2E-17	3.0E-17	1E-16	3 E-14	Year	0.17
Uranium	0.0		4.8E-18		1E-16	9 E-14	Year	0.0053

Client Sampler ID: AM-8**Lab ID S1804040-007****Sample Air Volume: 6156905 Liters****Sampled 1/2/18-3/29/18 (2018 1sr Qtr)**

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	101	4.3	1.6E-14	7.0E-16	2E-15	6 E-13	Day	2.7
Radium 226	0.3	0.1	4.9E-17	1.6E-17	1E-16	9 E-13	Week	0.0054
Thorium 230	0.6	1.3	1.0E-16	2.1E-16	1E-16	3 E-14	Year	0.33
Uranium	0.2		3.1E-17		1E-16	9 E-14	Year	0.034

Client Sampler ID: AM-8**Lab ID S1807064-007****Sample Air Volume: 6583608 Liters****Sampled 4/5/18-6/29/18 (2nd Qtr 2018)**

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	82.4	18.6	1.3E-14	2.8E-15	2E-15	6 E-13	Day	2.2
Radium 226	0.1	0.1	1.9E-17	1.5E-17	1E-16	9 E-13	Week	0.0021
Thorium 230	0.4	0.2	6.2E-17	3.0E-17	1E-16	3 E-14	Year	0.21
Uranium	0.0		4.2E-18		1E-16	9 E-14	Year	0.0047

Client Sampler ID: AM-9**Lab ID S1804040-008****Sample Air Volume: 5957273 Liters****Sampled 1/2/18-3/29/18 (2018 1sr Qtr)**

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	98.4	4.3	1.7E-14	7.2E-16	2E-15	6 E-13	Day	2.8
Radium 226	0.3	0.1	4.5E-17	1.7E-17	1E-16	9 E-13	Week	0.0050
Thorium 230	0.5	0.4	7.9E-17	6.7E-17	1E-16	3 E-14	Year	0.26
Uranium	0.1		1.7E-17		1E-16	9 E-14	Year	0.019

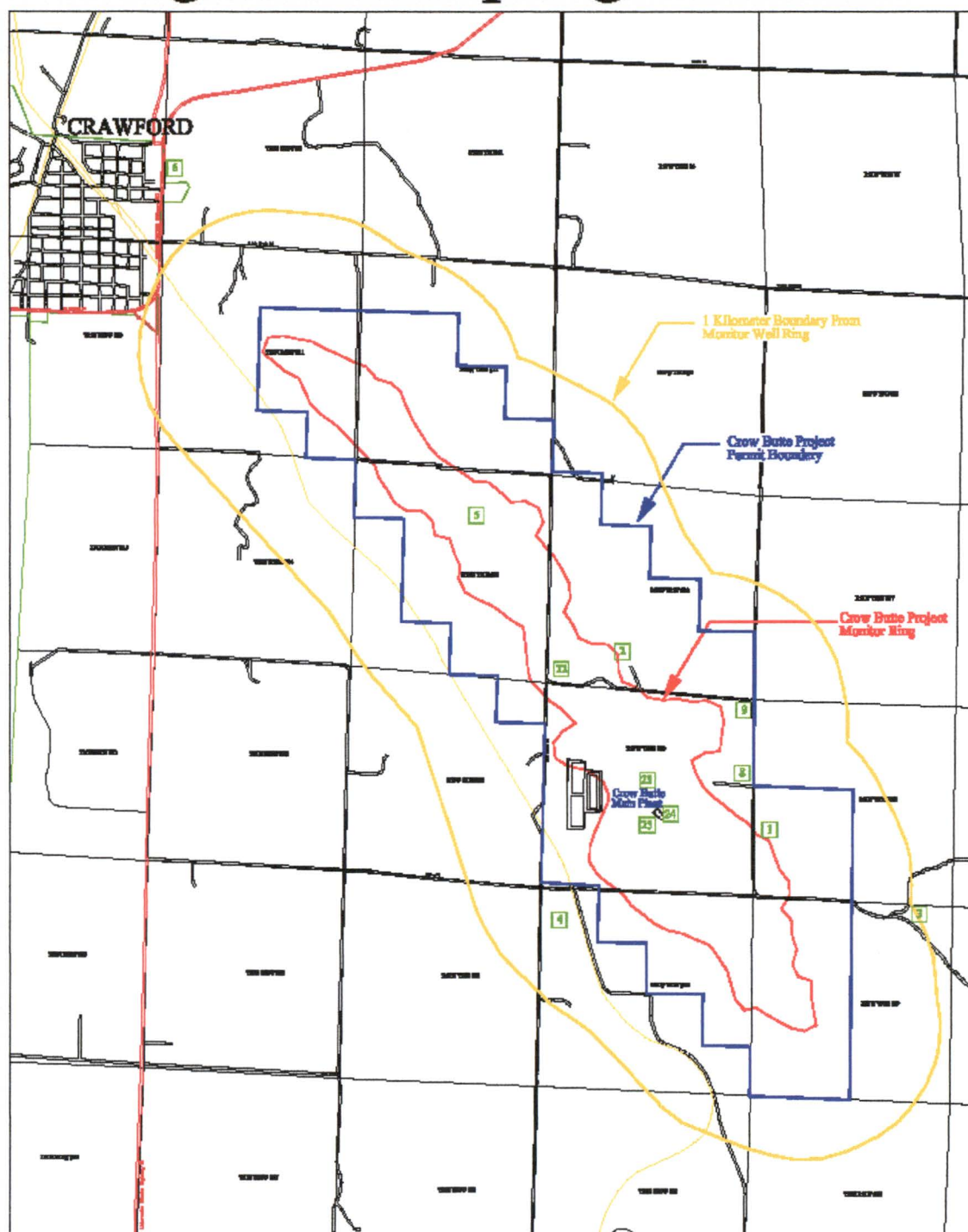
Client Sampler ID: AM-9**Lab ID S1807064-008****Sample Air Volume: 6585630 Liters****Sampled 4/5/18-6/29/18 (2nd Qtr 2018)**

Analyte	Result pCi/filter	Precision ± pCi/filter	Result µCi/ml	Precision ± µCi/ml	RL	10 CFR Pt 20 Effluent Limit	Effluent Class	% Effluent Conc.
Lead 210	64.6	4.5	9.8E-15	6.8E-16	2E-15	6 E-13	Day	1.6
Radium 226	0.4	0.1	5.4E-17	1.5E-17	1E-16	9 E-13	Week	0.0060
Thorium 230	2.1	0.5	3.2E-16	7.6E-17	1E-16	3 E-14	Year	1.1
Uranium	0.1		9.8E-18		1E-16	9 E-14	Year	0.011

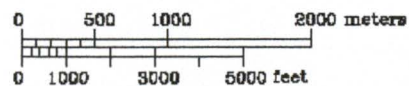
Effluent Limits are from 10 CFR Part 20 Appendix B Table 2

ND - Not Detected at the Reporting Limit

Regional Sampling Locations



1 Air Monitoring Station, Rain, Soil, Direct Radiation



Appendix J

Environmental OSL Monitoring Results

First and Second Quarter, 2018

Crow Butte Resources
Crow Butte Uranium Project
Perimeter Air Monitoring Stations

Gamma Exposure Results

Location	Exposure of Dosimeter		Net Cumulative Totals		
	(mrems ambient dose equivalent)				
	Gross	Net	Calendar Quarter	Year to Date	Permanent
1/1/2018 -3/31/2018					
Transient Control	--	0.0	Q1	2018	--
Deploy Control	29.4	0.0	--	--	--
AM-1	40.1	10.7	10.7	10.7	320.2
AM-2	40.5	11.1	11.1	11.1	343.4
AM-3	40.0	10.6	10.6	10.6	375.6
AM-4	35.8	6.4	6.4	6.4	283.5
AM-5	47.3	17.9	17.9	17.9	371.1
AM-6	42.4	13.0	13.0	13.0	330.5
AM-8	41.7	12.3	12.3	12.3	441.2
AM-9	40.5	11.1	-	-	--

mrem – millirems

AM-1 air sampling locations

Minimum Detectable Dose = 0.1 mrems ambient dose equivalent

Crow Butte Resources
Crow Butte Uranium Project
Perimeter Air Monitoring Stations

Gamma Exposure Results

Location	Exposure of Dosimeter		Net Cumulative Totals		
	(mrems ambient dose equivalent)				
	Gross	Net	Calendar Quarter	Year to Date	Permanent
4/1/2018 - 6/30/2018					
Transient Control	--	0.0	Q2	2018	--
Deploy Control	25.5	0.0	--	--	--
AM-1	36.0	10.6	10.6	21.3	330.8
AM-2	42.5	17.0	17.0	28.1	360.4
AM-3	37.9	12.5	12.5	23.1	388.0
AM-4	37.9	12.4	12.4	18.7	295.8
AM-5	42.4	16.9	16.9	34.8	388.0
AM-6	39.7	14.3	14.3	27.2	344.8
AM-8	45.3	19.8	19.8	32.1	461.0
AM-9	39.1	13.7	-	--	--

mrem – millirems

AM-1 air sampling locations

Minimum Detectable Dose = 0.1 mrems ambient dose equivalent