

Office of Environmental Management – Grand Junction



Environmental Air Monitoring Data
Quarterly Report for the Moab and
Crescent Junction, Utah, Sites
Fourth Quarter 2016
(October through December 2016)

Revision 1

October 2017



U.S. Department
of Energy

Office of Environmental Management

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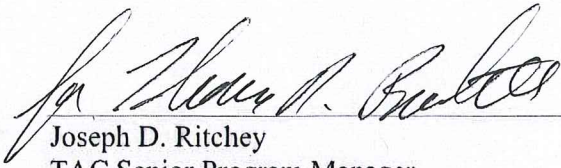
**Moab UMTRA Project
Environmental Air Monitoring Data Quarterly Report
for the Moab and Crescent Junction, Utah, Sites Fourth Quarter 2016
(October – December 2016)**

Revision 1

Review and Approval


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10-11-17
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10/14/2017
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Revision History

Revision	Date	Reason for Revision
0	July 2017	Initial issue.
1	October 2017	Corrected total effective dose data and updated location figures.

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Acronyms and Abbreviations

DOE	U.S. Department of Energy
DOE O	DOE Order
EPA	U.S. Environmental Protection Agency
MEI	maximally exposed individual
mrem	millirems
pCi/L	picocuries per liter
SAP	<i>Environmental Air Monitoring Sampling and Analysis Plan</i>
TLD	thermoluminescent dosimeter
UMTRA	Uranium Mill Tailings Remedial Action

1.0 Introduction

The purpose of this report is to present the results associated with environmental air monitoring at the U.S. Department of Energy (DOE) Moab Uranium Mill Tailings Remedial Action (UMTRA) Project sites during the fourth quarter of 2016. The Project sites consist of the former uranium ore processing mill located 3 miles north of Moab, Utah, and the disposal site located near Crescent Junction, Utah.

2.0 Regulatory Requirements

This report demonstrates compliance with DOE O 458.1, Admin Chg 3, “Radiation Protection of the Public and the Environment,” which states that DOE radiological activities must be conducted in a manner that does not cause a total effective dose to the public exceeding 100 millirems (mrem) in a year. This limit excludes doses from background radiation, radon gas and its decay products in air, occupational doses, and medical exposures. For the Moab Project, the total effective dose is the sum of the direct gamma radiation and radioactive particulate material (radioparticulate) exposure. DOE O 458.1 also specifies that releases of radioactive material to the atmosphere from DOE activities shall not exceed an annual average concentration of 3 picocuries per liter (pCi/L) of radon or its decay products, not including background, at the site boundary.

Compliance with DOE O 458.1 may be demonstrated by calculating the dose to the maximally exposed individual (MEI) or the representative person or group from the public likely to receive the most radiation dose based on exposure pathways and parameters. The Moab Project established an MEI for each of the Project sites.

3.0 Results for October through December 2016

Monitoring data are reported quarterly for radon, direct gamma radiation, and select radioparticulates. Off-site monitoring locations for the Moab site are shown on Figure 1 and on-site and MEI locations are shown on Figure 2. Monitoring locations for the Crescent Junction site are shown on Figure 3.

3.1 Moab Site

3.1.1 Radon

Based on 5 years of data from stations 0117 and 0123 between 2003 and 2008, the average background concentration of radon in the Moab area was established as 0.7 pCi/L; therefore, the project must limit radon emissions at the Moab site boundary to 3.7 pCi/L. On-site monitoring locations close to the site boundary or publically accessible areas are used to demonstrate compliance at the boundary.

Table 1 shows quarterly and annual radon results for the past year, including background, for on- and off-site locations. When compared to monitoring data for the third quarter of 2016, on-site locations in general showed an increase, whereas off-site locations were similar to historical data. No annual average concentration exceeded the 3.0 pCi/L plus background annual limit.

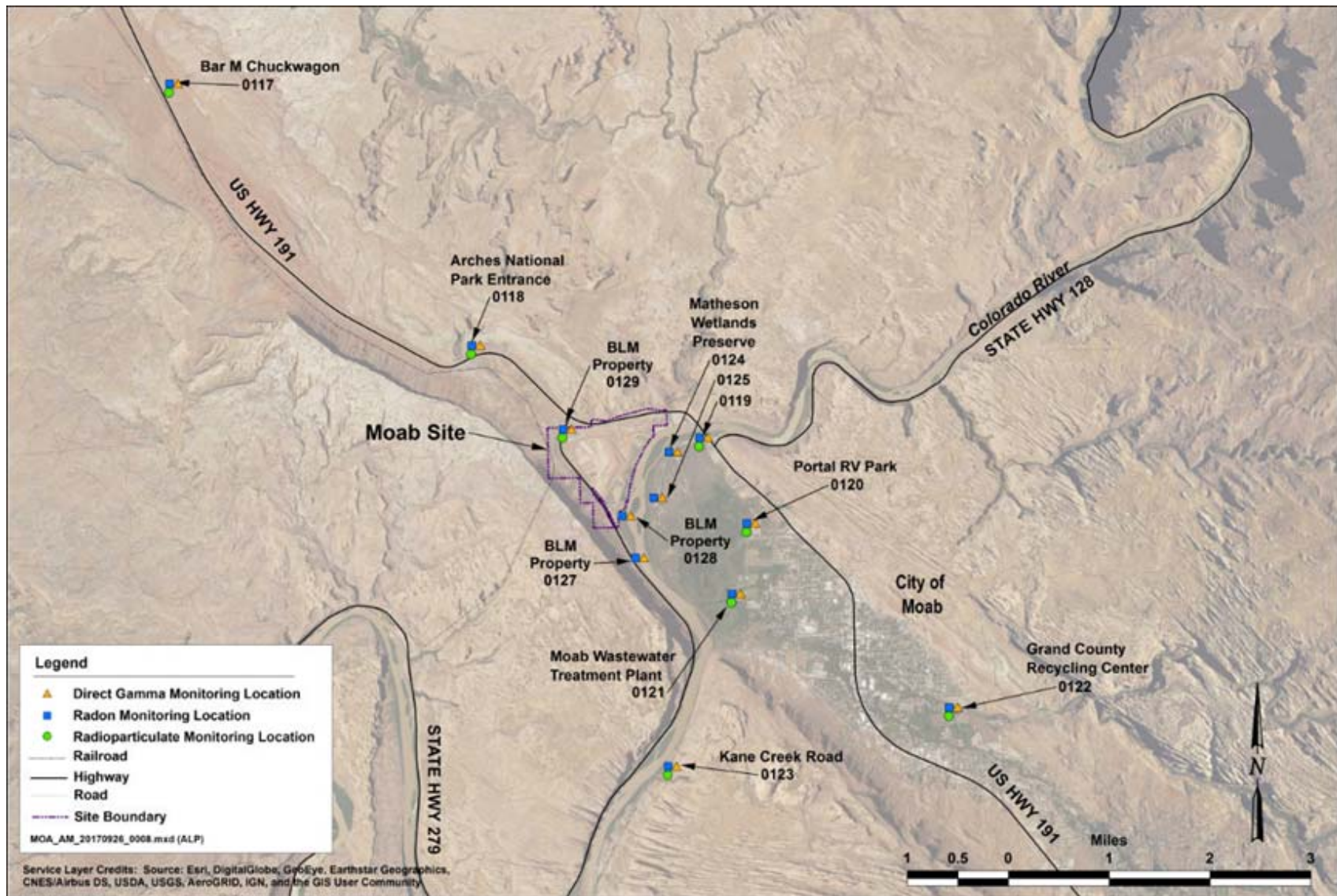
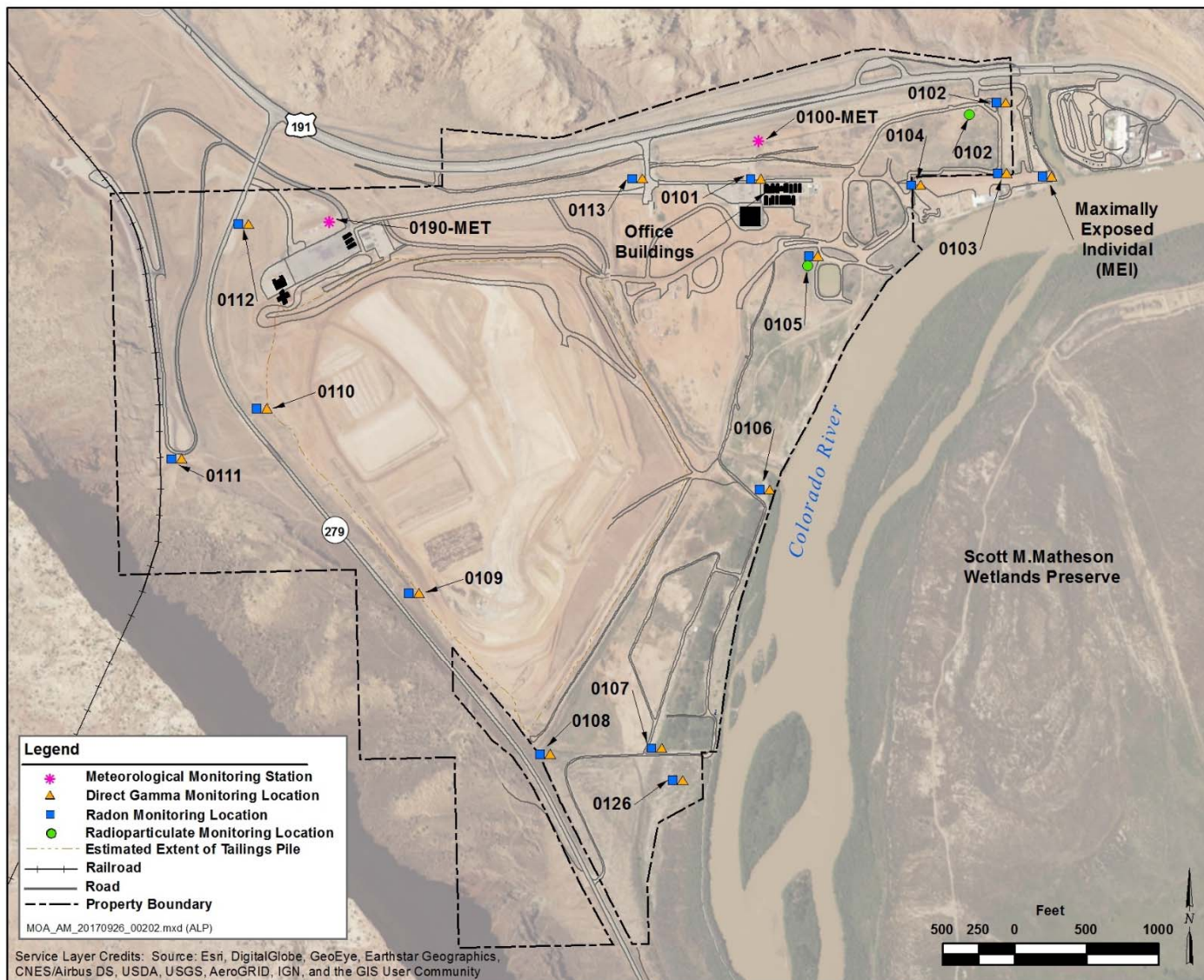


Figure 1. Moab Off-site Environmental Air Monitoring Locations



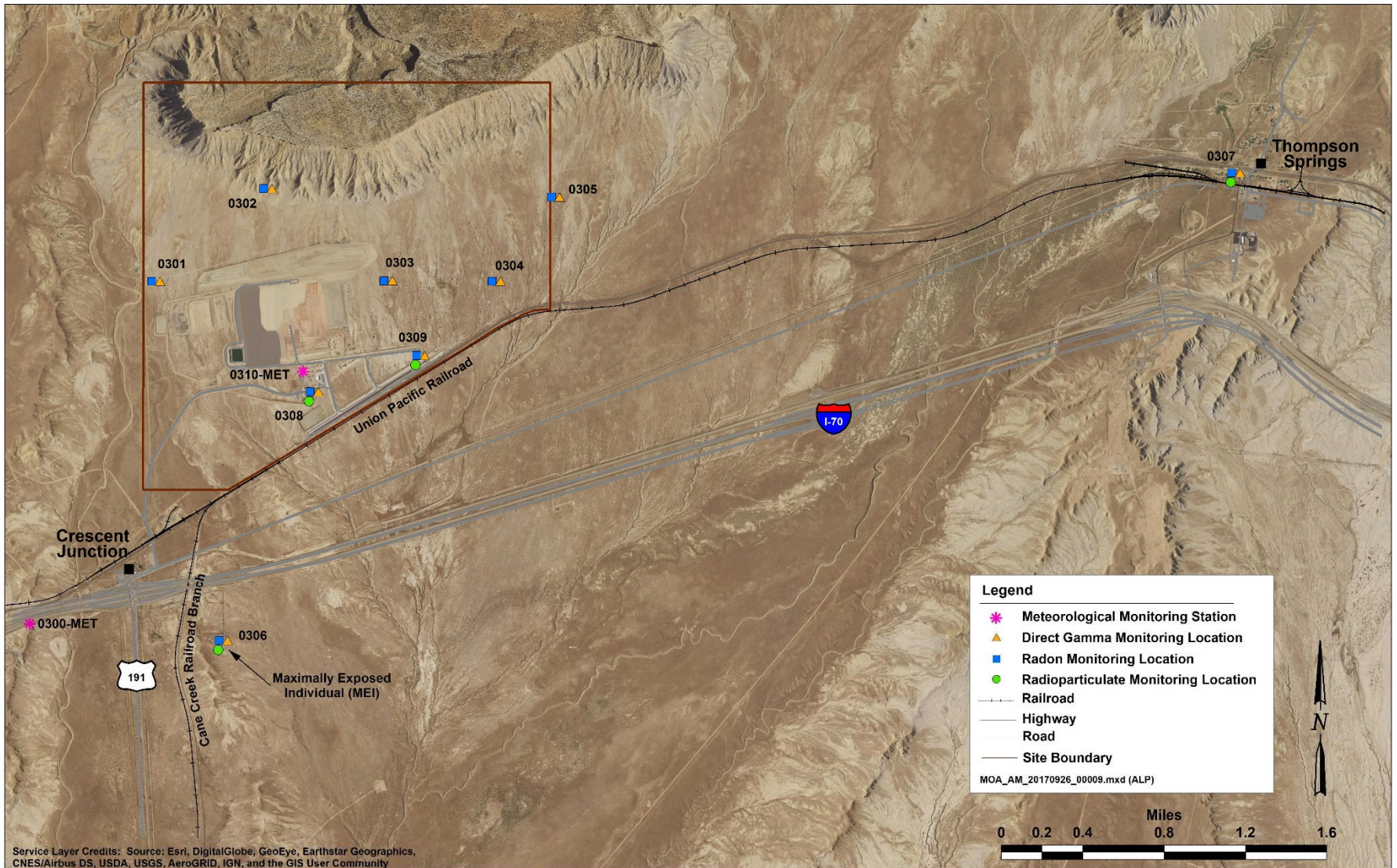


Figure 3. Crescent Junction Site Environmental Air Monitoring Locations

Table 1. Radon Concentrations for the Moab Site for the Past Year

Station Number	1 st Quarter 2016 (pCi/L)	2 nd Quarter 2016 (pCi/L)	3 rd Quarter 2016 (pCi/L)	4 th Quarter 2016 (pCi/L)	Annual Average Concentration Based on Four Quarters (pCi/L)
On-site Locations					
0101	2.4	1.1	2.2	3.8	2.4
0102	1.6	0.7	1.2	1.8	1.3
0103	1.9	0.9	1.1	2.1	1.5
0104	2.8	1.1	1.7	3.6	2.3
0105	2.8	1.1	1.9	3.7	2.4
0106	3.4	1.2	2.2	4.3	2.8
0107	3.7	1.4	2.2	3.9	2.8
0108	2.6	1.5	2.9	4.4	2.9
0109	2.0	1.6	1.9	2.2	1.9
0110	1.2	1.3	1.9	1.9	1.6
0111	0.5	1.2	0.9	0.9	0.9
0112	NDA	1.7	2.2	2.8	2.2
0113	4.2	1.5	3.0	4.6	3.3
0126	2.4	0.7	1.8	3.6	2.1
Off-site Locations					
0117	0.4	0.3	0.6	0.5	0.5
0118	0.3	0.6	0.8	0.7	0.6
0119	0.6	0.7	0.9	1.1	0.8
0120	0.3	0.5	0.7	0.6	0.5
0121	0.4	0.4	0.7	0.8	0.6
0122	0.3	0.3	0.5	0.4	0.4
0123	0.3	0.3	0.4	0.5	0.4
0124	1.2	0.8	0.9	1.4	1.1
0125	1.1	1.0	1.2	1.9	1.3
0127	0.8	0.6	0.9	1.1	0.9
0128	3.1	1.0	1.6	3.8	2.4
0129	1.8	1.3	2.4	2.7	2.1
MEI	1.3	0.7	1.1	1.9	1.3

NDA= No data available, sensor missing or damaged

Radon data were plotted on a graph (Figure 4) for Moab site monitoring locations 0108, 0109, 0110, 0112, 0113, which demonstrate compliance with the public dose limit in DOE O 458.1.

3.1.2 Direct Gamma Radiation

The average annual background direct gamma radiation effective dose for the Moab area was established as 82 mrem. Table 2 shows quarterly and annual gamma results for the past year, including background, at on- and off-site locations. Fourth quarter analytical results were similar to that of the third quarter of 2016.

These readings represent the gamma dose an individual would receive from occupying a location for an entire year. Although several monitoring locations in Table 2 show annual readings greater than the 100 mrem above background limit, no member of the public occupies any of these locations for a sufficient amount of time that would cause the individual to receive a dose in excess of the annual limit.

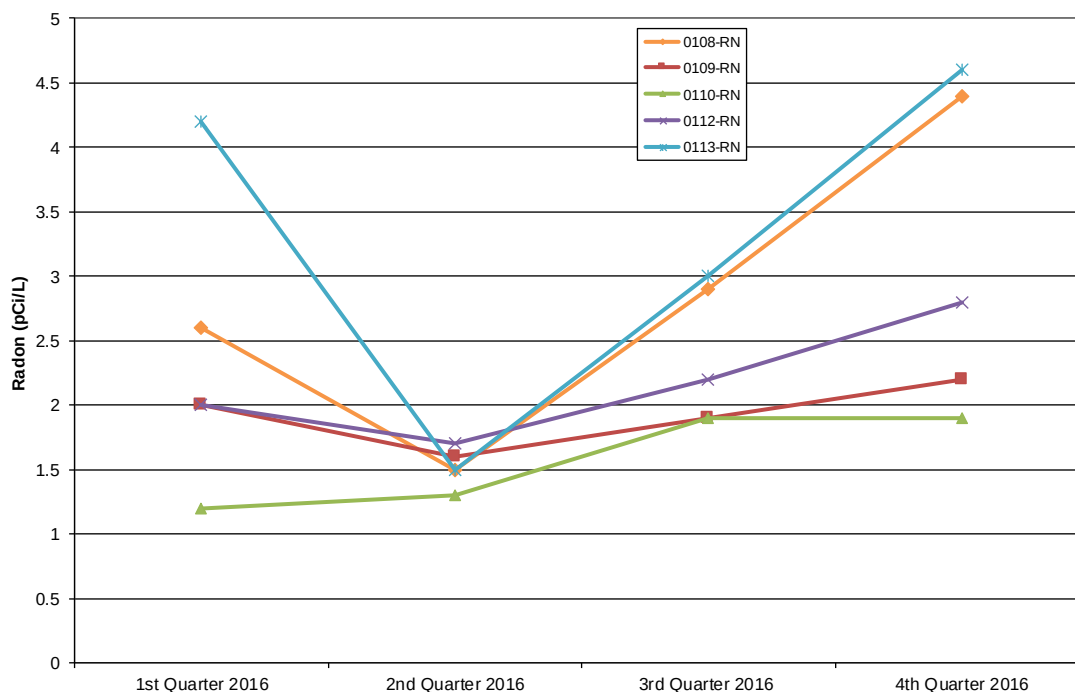


Figure 4. Radon Concentrations at Select Moab Monitoring Locations

Table 2. Gamma Radiation Effective Doses for the Moab Site for the Past Year

Station Number	1st Quarter 2016 (mrem)	2nd Quarter 2016 (mrem)	3rd Quarter 2016 (mrem)	4th Quarter 2016 (mrem)	Annual Dose Based on Four Quarters (mrem)
On-site Locations					
0101	48.2	40.8	50.6	48.5	188.1
0102	22.4	25.0	24.1	30.6	102.1
0103	26.9	22.2	26.3	27.3	102.7
0104	27.3	23.9	26.2	29.0	106.4
0105	24.1	24.1	23.1	29.7	101.0
0106	30.0	30.5	35.1	36.8	132.4
0107	28.1	24.0	28.3	30.0	110.4
0108	43.3	41.6	47.2	50.0	182.1
0109	154.2	131.5	143.8	135.9	565.4
0110	85.2	101.4	101.6	108.3	396.5
0111	40.9	40.5	41.9	45.4	168.7
0112	61.9	53.4	53.7	53.9	222.9
0113	38.6	42.5	39.3	48.3	168.7
0126	27.8	24.4	28.0	31.0	111.2
Off-site Locations					
0117	27.7	22.8	27.5	27.0	105.0
0118	22.7	22.7	22.3	25.7	93.4
0119	20.1	21.4	18.2	26.6	86.3
0120	22.2	21.3	21.6	25.3	90.4
0121	22.2	20.3	21.6	25.1	89.2
0122	21.9	18.3	14.6	22.1	76.9
0123	20.9	17.2	19.8	21.9	79.8
0124	26.5	22.9	25.6	29.3	104.3
0125	28.5	27.4	27.8	32.9	116.6

Table 2. Gamma Radiation Effective Doses for the Moab Site for the Past Year (continued)

Station Number	1st Quarter 2016 (mrem)	2nd Quarter 2016 (mrem)	3rd Quarter 2016 (mrem)	4th Quarter 2016 (mrem)	Annual Dose Based on Four Quarters (mrem)
Off-site Locations (continued)					
0127	23.8	24.0	25.1	29.6	102.5
0128	25.9	24.9	26.1	31.1	108.0
0129	26.7	31.3	30.1	35.8	123.9
MEI	20.9	25.0	21.5	27.6	95.0

3.1.3 Radioparticulates

The effective background dose from inhalation of radioparticulates was not determined, so all effective dose from radioparticulates measured at the Project's monitoring stations is considered to be from the Project.

Samples to determine the concentrations of total uranium, thorium-230, radium-226, and polonium-210 are collected at 10 monitoring locations at or near the Moab site. Actinium-227 and protactinium-231 were added beginning in the fourth quarter of 2016 to better represent the potential dose associated with airborne emissions. Because these two isotopes are assumed to be in equilibrium, the concentration of protactinium-231 is estimated by dividing the analyzed actinium-227 concentration by a correction factor of 0.614, which is consistent with the *Moab UMTRA Project Health Physics Plan* (DOE-EM/GJ3003). The analytical results are used to calculate effective dose from the inhalation of radioparticulates.

Table 3 shows calculated quarterly and annual effective dose from inhalation of radioparticulates for the past year for the Moab site. Although all results are below the limit, stations closer to the site operations (0105 and 0129) show higher results than more distant stations (0102 and 0117), as would be expected. The effective dose from radioparticulates increased compared to the third quarter 2016 results because of the activity associated with the additional isotopes.

3.1.4 Total Effective Dose

The Project must ensure the annual effective dose to gamma radiation and radioparticulates from Project activities does not exceed 100 mrem above background. The annual total effective dose to the MEI was 15.2 mrem, which is well below the DOE limit. This value was calculated by subtracting the background dose of 82 mrem from the MEI gamma radiation dose of 95.0 mrem and then adding the radioparticulate dose of 2.20 mrem for location 0102, the closest radioparticulate station to the MEI.

3.2 Crescent Junction Site

After mill tailings disposal began in the second quarter of 2009, monitoring location 0306 at the Crescent Junction site became the MEI.

3.2.1 Radon

Based on 3 years of data from 2006 to 2009, the background concentration of radon in the Crescent Junction area was established as 0.9 pCi/L; therefore, the project must limit radon emissions at the Crescent Junction site boundary (withdrawal area) to 3.9 pCi/L. Locations 0301, 0305, and 0309 are used to demonstrate compliance at the site boundary.

Table 3. Radioparticulate Effective Doses for the Moab Site for the Past Year

Station Number	Isotope	1st Quarter 2016 (mrem)	2nd Quarter 2016 (mrem)	3rd Quarter 2016 (mrem)	4th Quarter 2016 (mrem)	Annual Dose Based on Four Quarters (mrem)
On-site Locations						
0102 ¹	Total Uranium	0.002	0.001	0.017	0.012	2.20
	Thorium-230	0.053	0.088	0.186	0.045	
	Radium-226	0.003	0.002	0.023	0.008	
	Polonium-210	0.300	0.068	0.381	0.891	
	Actinium-227	NA	NA	NA	0.061	
	Protactinium-231	NA	NA	NA	0.058	
0105	Total Uranium	0.002	0.002	0.030	0.014	2.84
	Thorium-230	0.100	0.144	0.449	0.095	
	Radium-226	0.005	0.006	0.073	0.008	
	Polonium-210	0.300	0.088	0.439	0.984	
	Actinium-227	NA	NA	NA	0.050	
	Protactinium-231	NA	NA	NA	0.048	
Off-site Locations						
0117	Total Uranium	0.001	0.001	0.012	0.009	1.28
	Thorium-230	0.034	0.058	0.040	0.025	
	Radium-226	0.002	0.001	0.008	0.003	
	Polonium-210	0.250	0.055	0.278	0.393	
	Actinium-227	NA	NA	NA	0.056	
	Protactinium-231	NA	NA	NA	0.053	
0118	Total Uranium	0.001	0.001	0.012	0.010	2.05
	Thorium-230	0.088	0.100	0.100	0.069	
	Radium-226	0.004	0.003	0.016	ND	
	Polonium-210	0.275	0.060	0.289	0.751	
	Actinium-227	NA	NA	NA	0.139	
	Protactinium-231	NA	NA	NA	0.132	
0119	Total Uranium	0.001	0.001	0.010	0.010	1.46
	Thorium-230	0.088	0.047	0.048	0.017	
	Radium-226	0.003	0.003	0.007	0.003	
	Polonium-210	0.240	0.053	0.226	0.614	
	Actinium-227	NA	NA	NA	0.045	
	Protactinium-231	NA	NA	NA	0.042	
0120	Total Uranium	0.001	0.001	0.010	0.010	1.50
	Thorium-230	0.045	0.050	0.032	0.026	
	Radium-226	0.003	0.002	0.003	0.006	
	Polonium-210	0.245	0.038	0.275	0.705	
	Actinium-227	NA	NA	NA	0.025	
	Protactinium-231	NA	NA	NA	0.024	
0121	Total Uranium	0.001	0.001	0.010	0.011	1.59
	Thorium-230	0.044	0.057	0.035	0.035	
	Radium-226	0.002	0.002	0.004	0.003	
	Polonium-210	0.235	0.055	0.277	0.717	
	Actinium-227	NA	NA	NA	0.051	
	Protactinium-231	NA	NA	NA	0.048	
0122	Total Uranium	0.001	0.001	0.010	0.009	1.36
	Thorium-230	0.044	0.075	0.028	0.022	
	Radium-226	0.002	0.001	0.005	0.004	
	Polonium-210	0.228	0.048	0.254	0.567	
	Actinium-227	NA	NA	NA	0.032	
	Protactinium-231	NA	NA	NA	0.030	

Table 3. Radioparticulate Effective Doses for the Moab Site for the Past Year (continued)

Station Number	Isotope	1st Quarter 2016 (mrem)	2nd Quarter 2016 (mrem)	3rd Quarter 2016 (mrem)	4th Quarter 2016 (mrem)	Annual Dose Based on Four Quarters (mrem)
Off-site Locations (continued)						
0123	Total Uranium	0.001	0.001	0.010	0.008	1.36
	Thorium-230	0.033	0.075	0.041	0.026	
	Radium-226	0.010	0.004	0.004	0.003	
	Polonium-210	0.240	0.048	0.328	0.494	
	Actinium-227	NA	NA	NA	0.019	
	Protactinium-231	NA	NA	NA	0.018	
0129	Total Uranium	0.002	0.001	0.030	0.015	2.95
	Thorium-230	0.188	0.256	0.500	0.187	
	Radium-226	0.005	0.007	0.086	0.022	
	Polonium-210	0.233	0.048	0.440	0.719	
	Actinium-227	NA	NA	NA	0.107	
	Protactinium-231	NA	NA	NA	0.101	

NA = Sample not analyzed for this isotope during this quarter, ND = Isotope not present in a detectable concentration

¹MEI location

Table 4 shows quarterly and annual radon results for the past year, including background, for on- and off-site locations. None of the stations exceeded the limit of 3.0 pCi/L above background, and these results were generally similar to previous data.

Table 4. Radon Concentrations for the Crescent Junction Site for the Past Year

Station Number	1st Quarter 2016 (pCi/L)	2nd Quarter 2016 (pCi/L)	3rd Quarter 2016 (pCi/L)	4th Quarter 2016 (pCi/L)	Annual Average Concentration Based on Four Quarters (pCi/L)
On-site Locations					
0301	0.6	0.3	0.5	0.6	0.5
0302	0.8	0.4	0.7	0.7	0.7
0303	1.0	0.8	0.9	1.1	1.0
0304	0.8	0.4	0.7	0.7	0.7
0305	1.0	0.3	0.6	0.9	0.7
0308	1.3	0.9	1.3	2.3	1.5
0309	1.2	0.6	1.0	1.3	1.0
Off-site Locations					
0306¹	0.9	0.4	0.6	0.5	0.6
0307	0.9	0.3	0.5	0.6	0.6

¹MEI location

Radon data were plotted on a graph (Figure 5) for Crescent Junction monitoring locations 0301, 0305, and 0309, which demonstrate compliance with the public dose limit in DOE O 458.1.

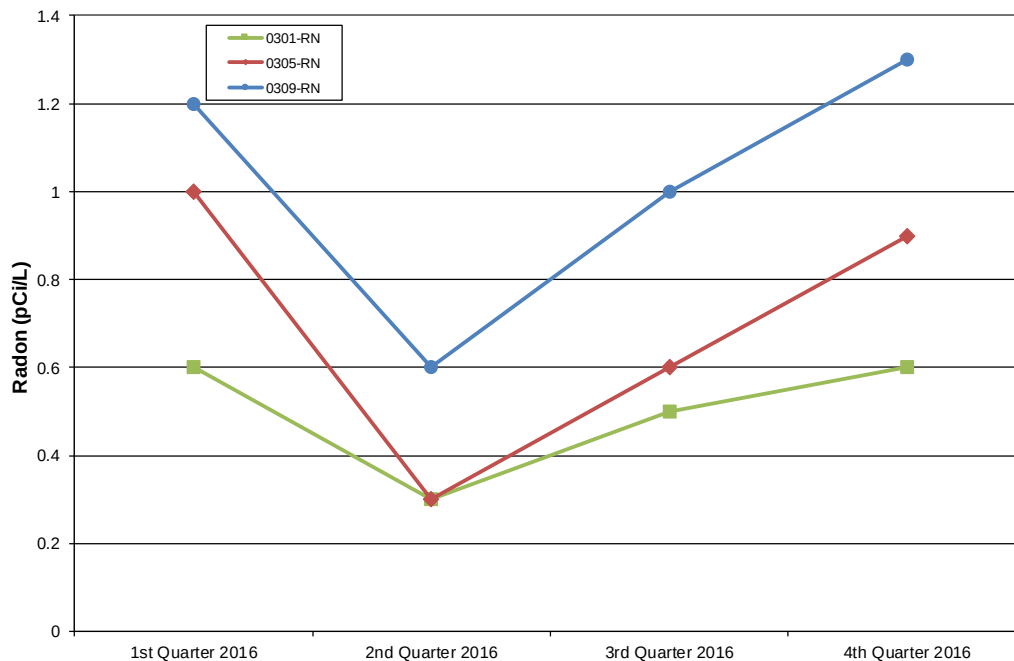


Figure 5. Radon Concentrations at Select Crescent Junction Monitoring Locations

3.2.2 Direct Gamma Radiation

The average annual background direct gamma radiation exposure dose for the Crescent Junction area was established as 92.5 mrem. Table 5 shows quarterly and annual results for the past year, including background, for on- and off-site locations.

Table 5. Gamma Radiation Effective Doses for the Crescent Junction Site for the Past Year

Station Number	1st Quarter 2016 (mrem)	2nd Quarter 2016 (mrem)	3rd Quarter 2016 (mrem)	4th Quarter 2016 (mrem)	Annual Dose Based on Four Quarters (mrem)
On-site Locations					
0301	27.0	24.5	26.6	29.2	107.3
0302	20.6	23.5	24.5	29.0	97.6
0303	31.0	26.9	32.2	32.6	122.7
0304	27.6	22.3	27.1	29.0	106
0305	27.7	26.2	28.8	32.3	115
0308	28.5	24.1	29.5	33.0	115.1
0309	21.9	22.3	20.6	27.9	92.7
Off-site Locations					
0306¹	29.0	22.2	27.5	28.5	107.2
0307	24.9	24.6	26.5	30.6	106.6

¹MEI location

3.2.3 Radioparticulates

As with the Moab sampling results, beginning with the 2016 fourth quarter sample collection, actinium-227 and protactinium-231 were added to the evaluation of dose for Crescent Junction locations. Refer to Section 3.1.3 for more information regarding these isotopes.

Table 6 shows quarterly and annual radioparticulate doses for the past year for the Crescent Junction site. The 2016 fourth quarter dose results were all higher compared to the previous quarter because of the additional isotopes and associated dose.

3.2.4 Total Effective Dose

The annual total effective dose to the MEI was 16.4 mrem, which is well below the annual limit of 100 mrem above background. This value was calculated by subtracting the background dose of 92.5 mrem from the MEI (location 0306) gamma radiation dose of 107.2 mrem and then adding the radioparticulate dose of 1.65 mrem for the MEI.

Table 6. Radioparticulate Effective Doses for the Crescent Junction Site for the Past Year

Station Number	Isotope	1st Quarter 2016 (mrem)	2nd Quarter 2016 (mrem)	3rd Quarter 2016 (mrem)	4th Quarter 2016 (mrem)	Annual Dose Based on Four Quarters (mrem)
On-site Locations						
0308	Total Uranium	0.001	0.001	0.016	0.013	2.02
	Thorium-230	0.088	0.131	0.141	0.109	
	Radium-226	0.003	0.004	0.027	0.010	
	Polonium-210	0.213	0.073	0.324	0.795	
	Actinium-227	NA	NA	NA	0.037	
	Protactinium-231	NA	NA	NA	0.035	
0309	Total Uranium	0.002	0.001	0.017	0.017	2.75
	Thorium-230	0.200	0.188	0.177	0.255	
	Radium-226	0.008	0.004	0.031	0.020	
	Polonium-210	0.155	0.058	0.466	0.781	
	Actinium-227	NA	NA	NA	0.192	
	Protactinium-231	NA	NA	NA	0.182	
Off-site Locations						
0306 ¹	Total Uranium	0.001	0.001	0.010	0.011	1.65
	Thorium-230	0.038	0.059	0.015	0.019	
	Radium-226	0.002	0.001	0.006	0.006	
	Polonium-210	0.230	0.053	0.359	0.843	
	Actinium-227	NA	NA	NA	0.000	
	Protactinium-231	NA	NA	NA	0.000	
0307	Total Uranium	0.001	0.001	0.010	0.010	1.48
	Thorium-230	0.049	0.050	0.050	0.013	
	Radium-226	0.002	0.001	0.006	0.004	
	Polonium-210	0.183	0.048	0.356	0.666	
	Actinium-227	NA	NA	NA	0.016	
	Protactinium-231	NA	NA	NA	0.015	

NA = Sample not analyzed for this isotope during this quarter

¹MEI location

4.0 Data Assessment

Radon detectors, thermoluminescent dosimeters (TLDs) used for continuous dose measurements, and radioparticulate sample filters were sent to certified off-site laboratories for analyses in accordance with the *Moab UMTRA Project Environmental Air Monitoring Sampling and Analysis Plan (SAP)* (DOE-EM/GJRAC1434). Qualified Project personnel evaluated the analytical data received for consistency with other data points and sample duplicates.

4.1 Duplicate Sampling

Duplicate samples for radon were collected at Moab locations 0108, 0111, and 0121. Duplicate direct gamma measurements were taken at locations 0108 and 0129. Duplicate radon measurements were collected at Crescent Junction locations 0303 and 0308. Duplicate direct gamma measurements were taken at locations 0301 and 0305.

The results of the duplicates can be found in Table 7. Duplicates were not collected for radioparticulate samples per the SAP.

Table 7. Duplicate Results for Fourth Quarter 2016

Location	Result	Duplicate Result
Moab		
Radon:	pCi/L	pCi/L
0108	2.9	2.7
0111	0.9	1.0
0121	0.7	0.6
Gamma:	mrem	mrem
0108	50.0	49.0
0129	35.8	33.0
Crescent Junction		
Radon:	pCi/L	pCi/L
0303	0.9	0.8
0308	1.3	1.5
Gamma:	mrem	mrem
0301	29.2	30.1
0305	32.3	30.6

4.2 Suspected Anomalies

Analytical data are reviewed for anomalous or outlying data points. Monitoring data are evaluated against historical and minimum/maximum values to determine if the reported data are within reasonable expected ranges. No anomalous data were noted for the fourth quarter of 2016.

4.3 Summary

Data collected during the fourth quarter of 2016 met the applicable laboratory control criteria for their respective analyses. The results were within the acceptable limits associated with each matrix. Data in this Report are considered validated and may be treated as final results. The quarterly Environmental Air Monitoring Field Activities Verification Checklist is shown on the following page.

Environmental Air Monitoring Field Activities Verification Checklist

Project	<u>Moab/Crescent Junction, Utah</u>	Date(s) of Air Sampling	<u>October-December 2016</u>
Date(s) of Verification	<u>March 24, 2017</u>	Name of Verifier	<u>Elizabeth Moran</u>

	Response (Yes, No, NA)	Comments
1. Is the SAP the primary document directing field procedures?	<u>Yes</u>	
2. Were the sampling locations specified in the SAP?	<u>Yes</u>	
3. Were low-volume air samplers on and operating at or near 60 liters/minute $\pm 10\%$?	<u>No</u>	<u>0123 was not running during the October 5 visit. It was re-energized on October 18.</u>
4. Did any of the samplers require airflow adjustment?	<u>Yes</u>	<u>Normal quarterly calibration with all units within proper range</u>
5. Were detectors (radon cups, TLDs) and monitoring equipment found to be undisturbed and in operable condition upon arrival?	<u>Yes</u>	
6. Were the hourly clocks on the low-volume air samplers operational upon arrival?	<u>No</u>	<u>The hourly meter on 0123 was not operational when the pump was down from October 5-18.</u>
7. Were the run times recorded for each radioparticulate monitoring location?	<u>Yes</u>	
8. Were duplicates (for radon and gamma radiation) taken at a frequency of one per 20 samples?	<u>Yes</u>	
9. Were filter blanks (for radioparticulates) taken at a frequency of one per 20 samples?	<u>No</u>	<u>Not required per the SAP.</u>
10. Were trip blanks (for gamma radiation/radon) included with each shipment?	<u>Yes</u>	
11. Was the identity of the quality-control sample locations protected?	<u>Yes</u>	
12. Were the true locations of the quality-control samples recorded in the Field Log Book?	<u>Yes</u>	
13. Were all samples collected as specified in the SAP?	<u>Yes</u>	
14. Were chain-of-custody records completed, and was sample custody maintained?	<u>Yes</u>	
15. Are field data sheets signed and dated by sampling personnel?	<u>Yes</u>	
16. Was all other pertinent information documented on the field data sheets?	<u>Yes</u>	

5.0 References

DOE (U.S. Department of Energy), *Moab UMTRA Project Environmental Air Monitoring Sampling and Analysis Plan* (DOE-EM/GJRAC1434).

DOE (U.S. Department of Energy), *Moab UMTRA Project Health Physics Plan* (DOE-EM/GJ3003).

DOE (U.S. Department of Energy) Order 458.1, Admin Chg 3, “Radiation Protection of the Public and the Environment.”