

Office of Environmental Management – Grand Junction



Environmental Air Monitoring Data
Quarterly Report for the Moab and
Crescent Junction, Utah, Sites
Fourth Quarter 2017
(October through December 2017)

Revision 0

September 2018



U.S. Department
of Energy

Office of Environmental Management

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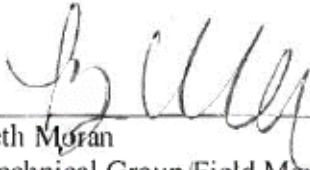
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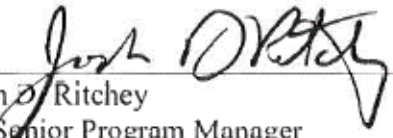
**Moab UMTRA Project Environmental Air Monitoring Data Quarterly Report
for the Moab and Crescent Junction, Utah, Sites Fourth Quarter 2017
(October – December 2017)**

Revision 0

Review and Approval

 3/27/18

Elizabeth Moran Date
TAC Technical Group/Field Manager

 9/5/18

Joseph Ritchey Date
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Revision History

Revision	Date	Reason for Revision
0	September 2018	Initial issue.

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1.0 Introduction

The purpose of this Report is to present the results of environmental air monitoring at the U.S. Department of Energy (DOE) Moab Uranium Mill Tailings Remedial Action (UMTRA) Project sites during the 4th quarter of 2017. 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 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 (yr). 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 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, excluding 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 2017

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 average radon results for the past year, including background, for on- and off-site locations.

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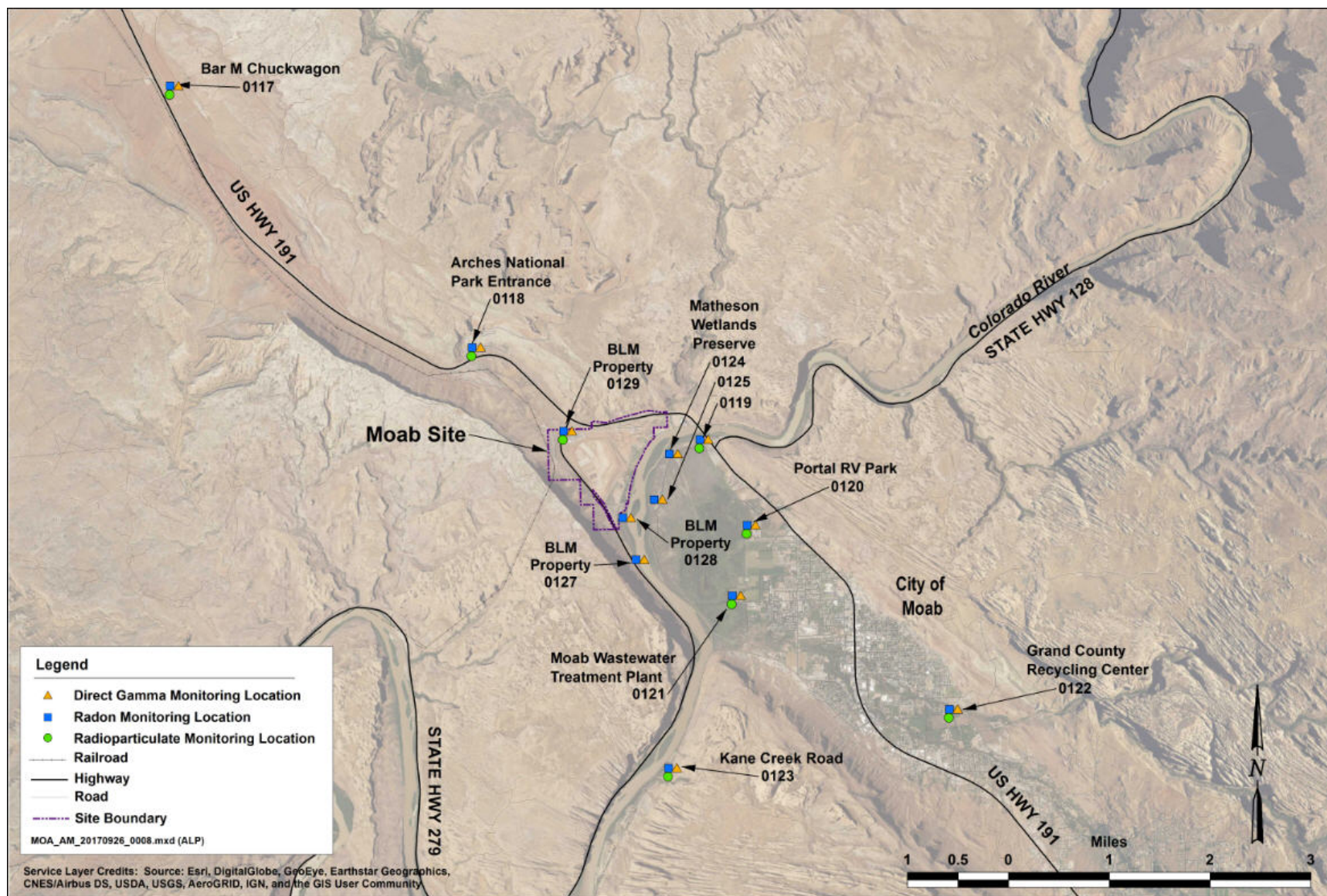


Figure 1. Moab Off-site Environmental Air Monitoring Locations

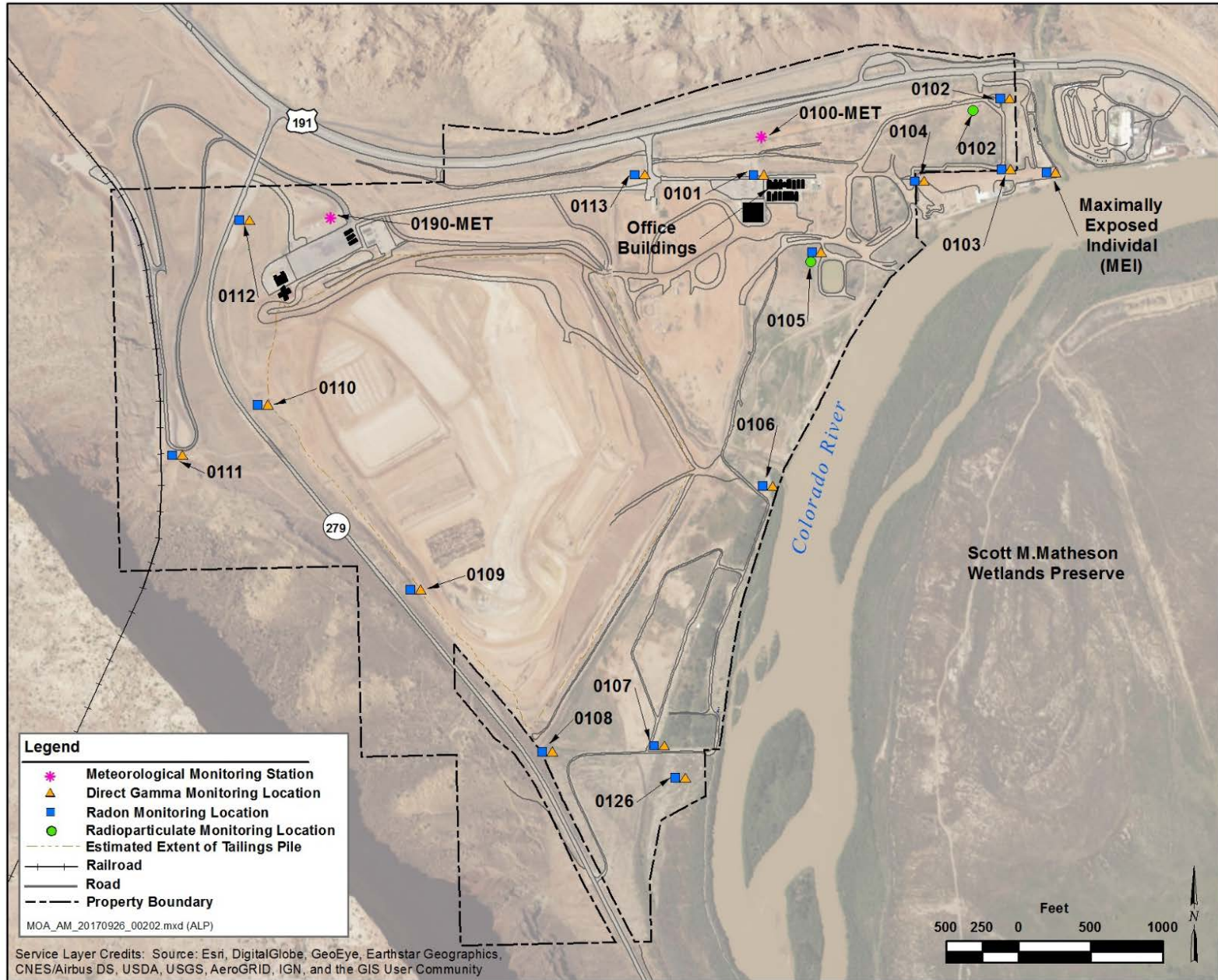


Figure 2. Moab On-site and MEI Environmental Air Monitoring Locations

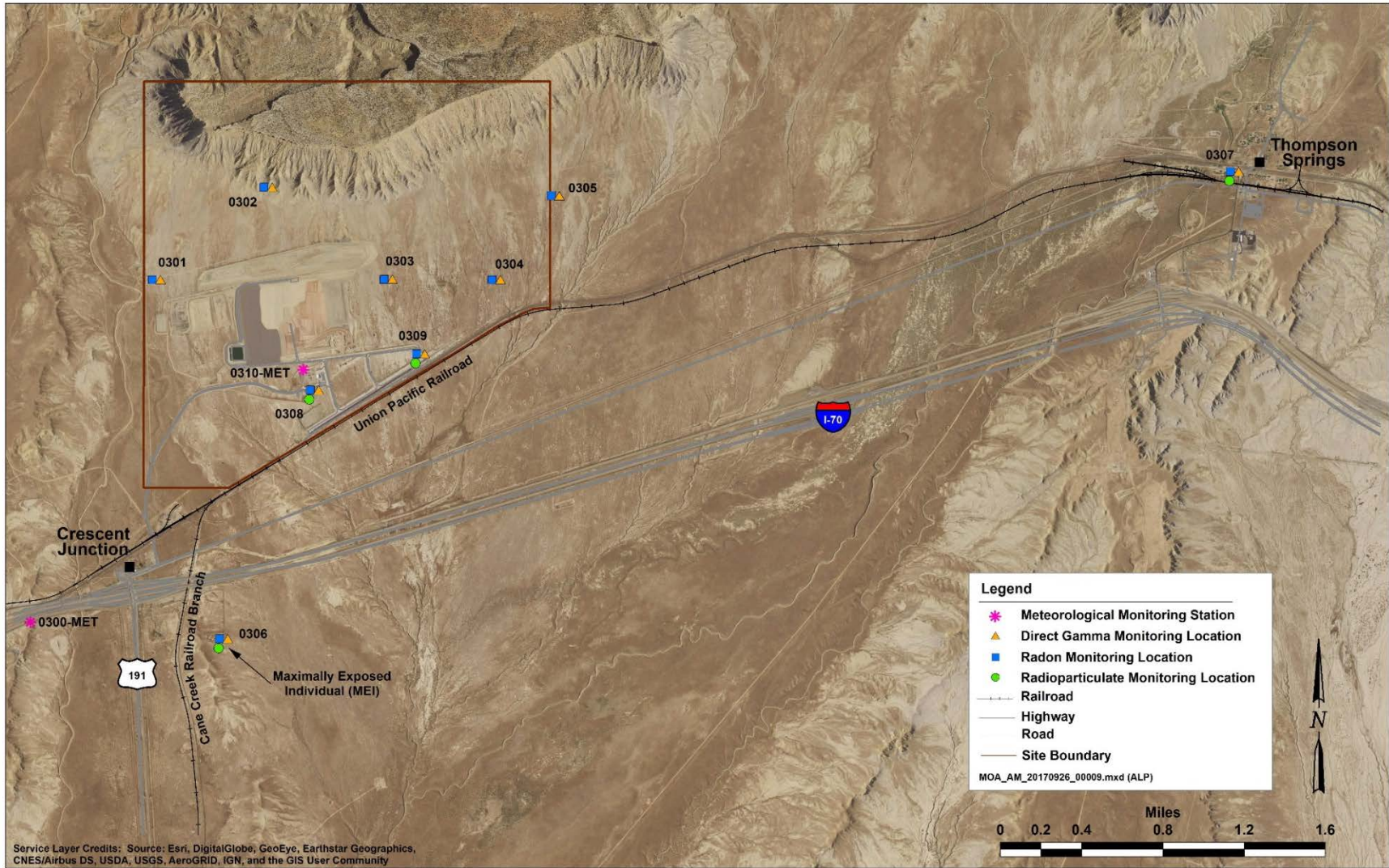


Figure 3. Crescent Junction Site Environmental Air Monitoring Locations

Annual 4th quarter results are typically higher compared to the rest of the year, and in particular the 4th quarter 2017 results were approximately double the highest measured radon concentration compared to the previous 5 years data collected. This increase was detected at both on- and off-site locations at both Moab and Crescent Junction. Drought conditions have likely impacted the results, as relative humidity data in the 4th quarter 2017 was on average one-half of the relative humidity measured during the 2013 through 2016 4th quarters.

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

Station Number	1st Quarter 2017 (pCi/L)	2nd Quarter 2017 (pCi/L)	3rd Quarter 2017 (pCi/L)	4th Quarter 2017 (pCi/L)	Annual Average Concentration Based on Four Quarters (pCi/L)
On-Site Locations					
0101	3.0	1.4	1.4	7.0	3.2
0102	1.1	0.8	0.6	3.4	1.5
0103	1.7	0.6	0.7	4.2	1.8
0104	1.9	1.3	1.1	5.4	2.4
0105	2.0	1.4	1.2	6.4	2.8
0106	2.9	1.4	1.4	7.3	3.3
0107	2.8	1.2	1.4	6.2	2.9
0108	3.0	2.1	2.4	7.4	3.7
0109	1.2	1.4	1.8	2.7	1.8
0110	1.1	2.2	1.4	2.2	1.7
0111	0.6	0.4	NDA	1.1	0.7
0112	1.6	1.3	2.1	3.3	2.1
0113	2.5	1.8	2.2	7.5	3.5
0126	2.5	1.1	1.2	5.5	2.6
Off-Site Locations					
0117	0.6	<0.4	<0.4	0.6	0.5
0118	0.4	<0.4	0.7	1.1	0.7
0119	0.7	0.5	0.5	1.7	0.9
0120	0.6	<0.4	0.5	1.2	0.7
0121	<0.4	<0.4	<0.4	0.9	0.5
0122	<0.4	0.5	<0.4	<0.4	0.4
0123	<0.6	<0.4	<0.4	1.2	0.7
0124	0.7	0.5	0.5	2.6	1.1
0125	1.2	0.6	0.7	2.4	1.2
0127	0.8	<0.4	0.5	1.8	0.9
0128	2.3	1.2	1.4	5.2	2.5
0129	1.6	1.2	1.6	3.3	1.9
MEI	1.1	0.5	0.5	3.5	1.4

NDA= No data available, sensor missing or damaged

Sampling in 4th quarter 2017 included a duplicate radon detector for location 0108, which is located off the southern tip of the tailings pile. The sample result was 7.6 pCi/L, and the duplicate was 7.2 pCi/L. If the two results were averaged (7.4 pCi/L), the 4th quarter 2017 annual average is 3.7 pCi/L (including background of 0.7 pCi/L), which is equal to the DOE standard per DOE O 458.1.

The 4th quarter 2017 results represent the first time since the 4th quarter 2009 that the annual average 3.7 pCi/L standard was either met or exceeded at this location. Between the 1st quarter 2010 and the 3rd quarter 2017 the location 0108 annual average ranged from 2.2 to 3.5 pCi/L. Figure 4 is a plot displaying the radon data for the last four quarters for locations 0108, 0109, 0110, 0112, and 0113.

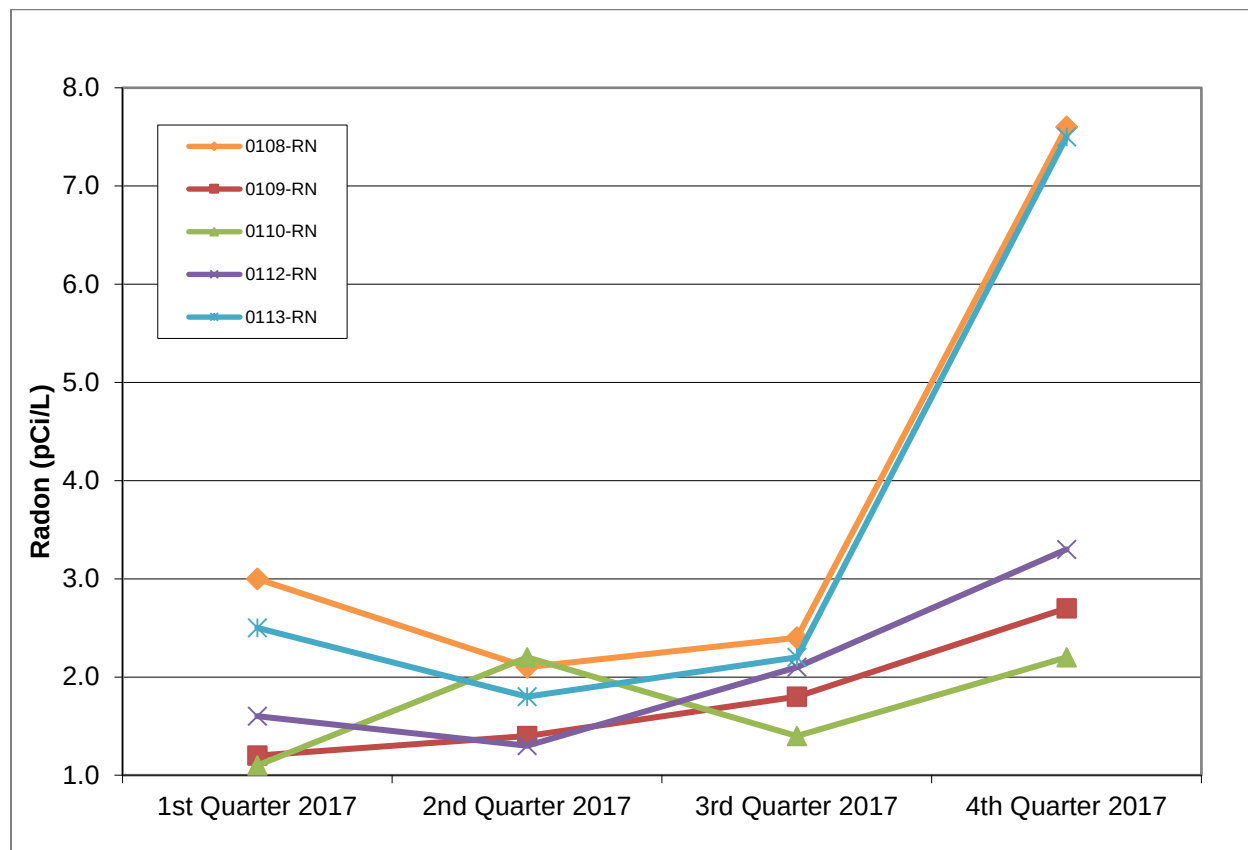


Figure 4. Radon Concentrations at Select Moab Monitoring Locations

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 for each monitoring location were all higher compared to the 2017 3rd quarter results.

These readings represent the gamma dose an individual would receive from occupying a location for an entire year. Although several on-site 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 to cause the individual to receive a dose in excess of the annual limit. The gamma dose associated with any of the off-site locations did not exceed the DOE O 458.1 standard.

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 9 monitoring locations at or near the Moab site. Actinium-227 and protactinium-231 were added in the 4th 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 (0117 and 0122), as would be expected. Fourth quarter results were higher than previous data reported. Seasonal air particulate analyte concentrations and corresponding dose fluctuations have occurred historically within 4th quarter intervals.

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

Station Number	1st Quarter 2017 (mrem)	2nd Quarter 2017 (mrem)	3rd Quarter 2017 (mrem)	4th Quarter 2017 (mrem)	Annual Dose Based on Four Quarters (mrem)
On-site Locations					
0101	45.2	40.5	42.2	47.5	175.4
0102	23.1	25.0	21.4	29.0	98.5
0103	23.4	21.5	21.6	27.5	94.0
0104	26.4	27.5	25.7	33.8	113.4
0105	22.9	25.5	21.5	29.5	99.4
0106	33.9	37.8	33.5	44.1	149.3
0107	27.9	24.5	27.6	31.1	111.1
0108	44.2	45.1	44.8	52.2	186.3
0109	124.9	120.4	119.0	129.1	493.4
0110	92.0	105.7	99.8	105.8	403.3
0111	41.5	39.8	39.3	42.6	163.2
0112	46.1	49.0	46.2	61.7	203.0
0113	39.4	41.7	40.0	53.9	175.0
0126	24.1	25.3	25.1	32.6	107.1
Off-site Locations					
0117	28.3	22.9	23.8	26.6	101.6
0118	22.4	21.9	22.4	25.5	92.2
0119	21.4	20.4	21.0	26.1	88.9
0120	19.1	21.1	18.3	25.5	84.0
0121	23.3	20.5	22.4	25.9	92.1
0122	15.1	17.6	14.3	21.7	68.7
0123	20.1	17.4	19.6	22.8	79.9
0124	26.4	22.5	24.4	31.2	104.5
0125	28.2	26.7	26.6	36.3	117.8
0127	24.3	24.5	22.9	30.1	101.8
0128	25.9	26.1	22.7	33.0	107.7
0129	29.8	31.4	28.6	37.6	127.4
MEI	22.6	21.4	20.7	28.6	93.3

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

Station Number	Isotope	1st Quarter 2017 (mrem)	2nd Quarter 2017 (mrem)	3rd Quarter 2017 (mrem)	4th Quarter 2017 (mrem)	Annual Dose Based on Four Quarters (mrem)
On-site Locations						
0102-RP ¹	Total Uranium	0.011	0.022	0.002	0.004	3.03
	Thorium-230	0.034	0.043	0.037	0.043	
	Radium-226	0.000	0.011	0.044	0.048	
	Polonium-210	0.579	0.383	0.236	1.058	
	Actinium-227	0.036	0.087	0.035	0.159	
	Protactinium-231	0.034	0.082	0.008	0.036	
0105-RP	Total Uranium	0.013	0.031	0.005	0.005	4.31
	Thorium-230	0.050	0.143	0.115	0.061	
	Radium-226	0.009	0.020	0.097	0.079	
	Polonium-210	0.566	0.445	0.326	1.221	
	Actinium-227	0.000	0.165	0.420	0.233	
	Protactinium-231	0.000	0.156	0.097	0.054	
Off-site Locations						
0117-RP	Total Uranium	0.009	0.021	0.002	0.004	2.04
	Thorium-230	0.015	0.027	0.017	0.016	
	Radium-226	0.002	0.009	0.002	0.003	
	Polonium-210	0.325	0.334	0.187	0.708	
	Actinium-227	0.032	0.039	0.179	0.00	
	Protactinium-231	0.030	0.036	0.041	0.00	
0118-RP	Total Uranium	0.013	0.031	0.002	0.003	2.83
	Thorium-230	0.077	0.125	0.048	0.024	
	Radium-226	0.045	0.026	0.070	0.030	
	Polonium-210	0.463	0.400	0.228	0.724	
	Actinium-227	0.000	0.093	0.114	0.163	
	Protactinium-231	0.000	0.088	0.026	0.038	
0119-RP	Total Uranium	0.009	0.021	0.003	0.003	2.78
	Thorium-230	0.019	0.046	0.032	0.021	
	Radium-226	0.003	0.021	0.057	0.007	
	Polonium-210	0.393	0.360	0.317	0.684	
	Actinium-227	0.037	0.143	0.221	0.128	
	Protactinium-231	0.035	0.136	0.051	0.029	
0121-RP	Total Uranium	0.010	0.025	0.003	0.003	2.67
	Thorium-230	0.025	0.055	0.032	0.023	
	Radium-226	0.004	0.006	0.038	0.039	
	Polonium-210	0.457	0.327	0.228	0.659	
	Actinium-227	0.047	0.035	0.256	0.210	
	Protactinium-231	0.044	0.034	0.059	0.048	
0122-RP	Total Uranium	0.009	0.025	0.003	0.003	2.55
	Thorium-230	0.015	0.042	0.021	0.010	
	Radium-226	0.004	0.005	0.224	0.018	
	Polonium-210	0.367	0.350	0.252	0.651	
	Actinium-227	0.018	0.139	0.147	0.051	
	Protactinium-231	0.017	0.131	0.034	0.012	

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

Station Number	Isotope	1st Quarter 2017 (mrem)	2nd Quarter 2017 (mrem)	3rd Quarter 2017 (mrem)	4th Quarter 2017 (mrem)	Annual Dose Based on Four Quarters (mrem)
Off-site Locations (continued)						
0123-RP	Total Uranium	0.009	0.025	0.002	0.003	2.73
	Thorium-230	0.023	0.050	0.019	0.014	
	Radium-226	0.002	0.009	0.207	0.036	
	Polonium-210	0.411	0.383	0.260	0.676	
	Actinium-227	0.007	0.117	0.182	0.114	
	Protactinium-231	0.006	0.111	0.042	0.026	
0129-RP	Total Uranium	0.017	0.053	0.006	0.005	6.72
	Thorium-230	0.177	0.636	0.264	0.093	
	Radium-226	0.021	0.103	0.202	0.092	
	Polonium-210	0.404	0.439	0.407	0.814	
	Actinium-227	0.152	0.305	1.072	0.629	
	Protactinium-231	0.144	0.289	0.247	0.145	

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

¹MEI location

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 14.33 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 93.3 mrem and then adding the radioparticulate dose of 3.03 mrem for location 0102, the closest radioparticulate station to the MEI.

3.2 Crescent Junction Site

After mill tailings disposal began in the 2nd quarter of 2009, Crescent Junction monitoring location 0306 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 4 shows quarterly and annual average radon results for the past year, including background, for on- and off-site locations.

None of the on- or off-site stations exceeded the limit of 3.0 pCi/L above background. Similar to the Moab monitoring locations, the radon concentrations at each of the Crescent Junction locations increased compared to the previous quarter likely due to drought conditions. In addition, seasonal trends and corresponding results fluctuations have occurred historically within 4th quarter intervals. Radon data for the last four quarters were plotted on a graph (Figure 5) for Crescent Junction monitoring locations 0301, 0305, and 0309.

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

Station Number	1st Quarter 2017 (pCi/L)	2 nd Quarter 2017 (pCi/L)	3rd Quarter 2017 (pCi/L)	4th Quarter 2017 (pCi/L)	Annual Average Concentration Based on Four Quarters (pCi/L)
On-site Locations					
0301	0.5	0.8	0.4	1.1	0.7
0302	<0.4	<0.4	0.6	1.1	0.6
0303	0.6	0.5	0.6	2.4	1.0
0304	<0.4	0.5	<0.4	0.9	0.6
0305	1.0	<0.4	0.5	0.8	0.7
0308	1.1	1.4	1.5	4.9	2.2
0309	0.6	0.6	0.6	2.2	1.0
Off-site Locations					
0306¹	0.6	0.4	<0.4	0.7	0.5
0307	0.5	<0.4	<0.4	0.5	0.5

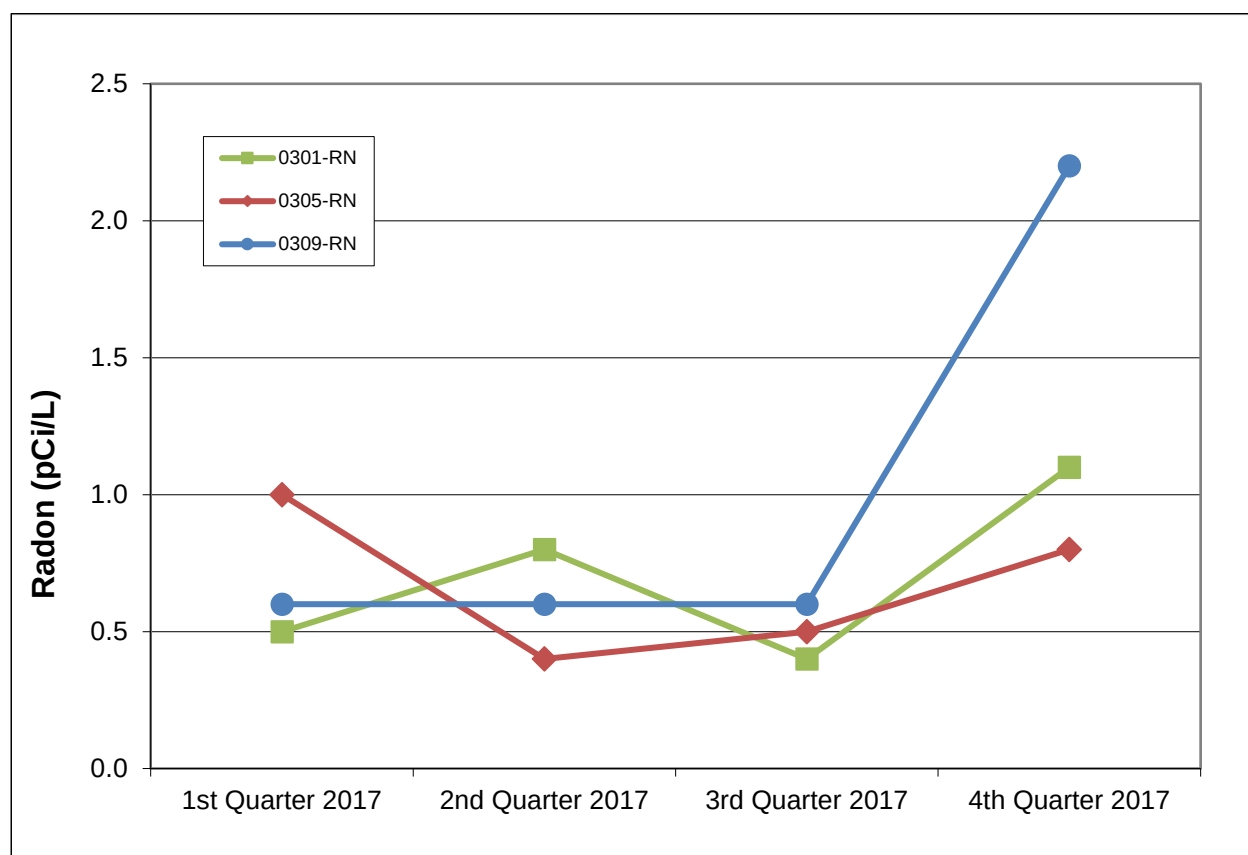


Figure 5. Radon Concentrations at Select Crescent Junction Monitoring Locations

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 2017 (mrem)	2nd Quarter 2017 (mrem)	3rd Quarter 2017 (mrem)	4th Quarter 2017 (mrem)	Annual Dose Based on Four Quarters (mrem)
On-site Locations					
0301	29.5	22.9	22.7	27.4	102.5
0302	26.9	22.0	24.5	25.3	98.7
0303	27.8	28.6	27.6	31.8	115.8
0304	25.1	21.2	24.5	24.9	95.7
0305	25.3	25.7	24.3	28.0	103.3
0308	32.6	23.9	26.4	27.8	110.7
0309	22.5	22.6	21.3	26.1	92.5
Off-site Locations					
0306¹	23.4	20.7	22.5	24.7	91.3
0307	29.7	24.7	26.3	28.0	108.7

¹MEI location

These readings represent the gamma dose an individual would receive from occupying a location for an entire year. As displayed in Table 5, the dose associated with any of the on- or off-site monitoring locations did not exceed the DOE O 458.1 standard.

3.2.3 Radioparticulates

As with the Moab sampling results, beginning with the 2016 4th 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. In general the 2017 4th quarter dose results were higher compared to the 3rd quarter 2017 results.

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

Station Number	Isotope	1st Quarter 2017 (mrem)	2nd Quarter 2017 (mrem)	3rd Quarter 2017 (mrem)	4th Quarter 2017 (mrem)	Annual Dose Based on Four Quarters (mrem)
On-site Locations						
0308-RP	Total Uranium	0.010	0.024	0.002	0.003	2.89
	Thorium-230	0.103	0.130	0.059	0.040	
	Radium-226	0.004	0.020	0.022	0.070	
	Polonium-210	0.351	0.355	0.260	0.684	
	Actinium-227	0.077	0.052	0.196	0.212	
	Protactinium-231	0.073	0.050	0.045	0.049	
0309-RP	Total Uranium	0.012	0.040	0.003	0.004	4.57
	Thorium-230	0.116	0.338	0.093	0.088	
	Radium-226	0.020	0.050	0.106	0.158	
	Polonium-210	0.406	0.443	0.301	0.765	
	Actinium-227	0.097	0.207	0.396	0.443	
	Protactinium-231	0.091	0.196	0.091	0.102	

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

Station Number	Isotope	1st Quarter 2017 (mrem)	2nd Quarter 2017 (mrem)	3rd Quarter 2017 (mrem)	4th Quarter 2017 (mrem)	Annual Dose Based on Four Quarters (mrem)
Off-site Locations						
0306-RP¹	Total Uranium	0.009	0.017	0.002	0.002	2.58
	Thorium-230	0.015	0.022	0.014	0.007	
	Radium-226	0.003	0.000	0.017	0.000	
	Polonium-210	0.417	0.319	0.269	0.643	
	Actinium-227	0.000	0.167	0.280	0.128	
	Protactinium-231	0.000	0.158	0.064	0.029	
0307-RP	Total Uranium	0.008	0.023	0.002	0.003	2.48
	Thorium-230	0.015	0.044	0.014	0.016	
	Radium-226	0.003	0.001	0.079	0.010	
	Polonium-210	0.362	0.368	0.269	0.545	
	Actinium-227	0.028	0.151	0.212	0.091	
	Protactinium-231	0.026	0.143	0.049	0.021	

NA = Sample not analyzed for this isotope during this quarter

¹MEI location

3.2.4 Total Effective Dose

The annual total effective dose to the MEI was 1.38 mrem, which is well below the annual limit of 100 mrem above background. This is calculated by subtracting the background dose of 92.5 mrem from the MEI (location 0306) gamma radiation dose of 91.3 mrem and then adding the radioparticulate dose of 2.58 mrem for the MEI.

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/GJTAC2219). Qualified Project personnel evaluated the analytical data received for consistency with other data points and sample duplicates.

The radon cup collected from the Moab “MEI” location was mis-labeled as a “TRIP BLANK” when the samples were submitted for analysis to Radonova. The error was verified by checking the radon cup serial numbers that were documented in the 4th quarter 2017 Moab UMTRA Project Moab Radon Cup Sample Log sheet. In the Radonova issued Radon Monitoring Report (report number 4804499:1) issued on January 19, 2018, the result for the “TRIP BLANK” location of 3.5 pCi/L was applied to the “MEI” location. There was no trip blank associated with this sampling event.

4.1 Duplicate Sampling

Duplicate samples for radon were collected at Moab locations 0108 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 2017

Location	Result	Duplicate Result
Moab		
Radon:	pCi/L	pCi/L
0108	7.6	7.2
0121	0.9	0.8
Gamma:	mrem	mrem
0108	52.2	55.5
0129	37.6	38.3
Crescent Junction		
Radon:	pCi/L	pCi/L
0303	2.4	1.7
0308	4.9	5.1
Gamma:	mrem	mrem
0301	27.4	26.7
0305	28.0	27.1

4.2 Suspected Anomalies

As discussed in Section 3.1.1, historically 4th quarter radon results are typically higher compared to the rest of the year. In particular the 4th quarter 2017 both on- and off-site locations at both Moab and Crescent Junction sites results were approximately double the highest measured radon concentration compared to the previous 5 years data collected. Drought conditions have likely impacted the results, as relative humidity data in the 4th quarter 2017 was on average one-half of the relative humidity measured during the 2013 through 2016 4th quarters.

All analytical data were reviewed for anomalous or outlying data points, and evaluated against historical and minimum/maximum values to determine if the reported data are within reasonable expected ranges that did not exceed any limitations. As a result of the higher radon concentrations, these data were considered to be anomalous.

4.3 Summary

Data collected during the 4th quarter of 2017 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.

5.0 References

DOE (U.S. Department of Energy), *Moab UMTRA Project Environmental Air Monitoring Sampling and Analysis Plan* (DOE-EM/GJTAC2219).

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."