



Moab UMTRA Project  
Environmental Air Monitoring Data Quarterly  
Report for the Moab and Crescent Junction,  
Utah, Sites Fourth Quarter 2021  
(October - December 2021)

Revision 0

April 2022



U.S. Department  
of Energy

**Office of Environmental Management**

**Moab UMTRA Project  
Environmental Air Monitoring Data Quarterly Report for the Moab and Crescent  
Junction, Utah, Sites Fourth Quarter 2021 (October - December 2021)**

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**Revision 0**

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**Review and Approval**

3/30/2022

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## Revision History

Revision	Date	Description
0	April 2022	Initial issue.

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## Acronyms and Abbreviations

DOE	Department of Energy
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MEI	maximally exposed individual
mrem	millirems
O	Order
pCi	picocurie
pCi/L	picocurie per liter
SAP	Sampling Analysis Plan
TED	total effective dose
TLD	thermoluminescent dosimeter
UMTRA	Uranium Mill Tailings Remedial Action

## **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 fourth quarter of 2021. The Project sites consist of the former uranium ore-processing mill located three miles north of Moab, Utah, and the disposal site located near Crescent Junction, Utah.

## **2.0 Regulatory Requirements**

This Report demonstrates compliance with DOE Order (O) 458.1, Admin Chg. 4, “Radiation Protection of the Public and the Environment,” which states DOE radiological activities must be conducted in a manner that does not cause total effective dose (TED) to the public to exceed 100 millirems (mrem) in a year, or an equivalent dose to the lens of the eye exceeding 1,500 mrem in a year, or an equivalent dose to the skin or extremities of 5,000 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 Project, the total effective dose is the sum of the direct gamma radiation (minus background) 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 is demonstrated by calculating the total effective dose to the maximally exposed individual (MEI) or the representative person or group from the public likely to receive the highest radiation dose based on exposure pathways and parameters. The Project has established a MEI for the Moab and Crescent Junction Project sites.

## **3.0 Results for October through December 2021**

Monitoring data are reported quarterly for radon, direct gamma radiation, and Site specific 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**

There is a total of 27 air monitoring stations equipped with radon and gamma detectors associated with the Moab site. Fifteen of these stations are located within the site boundary, while the additional 12 are located at relevant locations off-site. Of these 27 stations, three on-site and six off-site stations are also equipped with air sampling pumps to measure air radioparticulates.

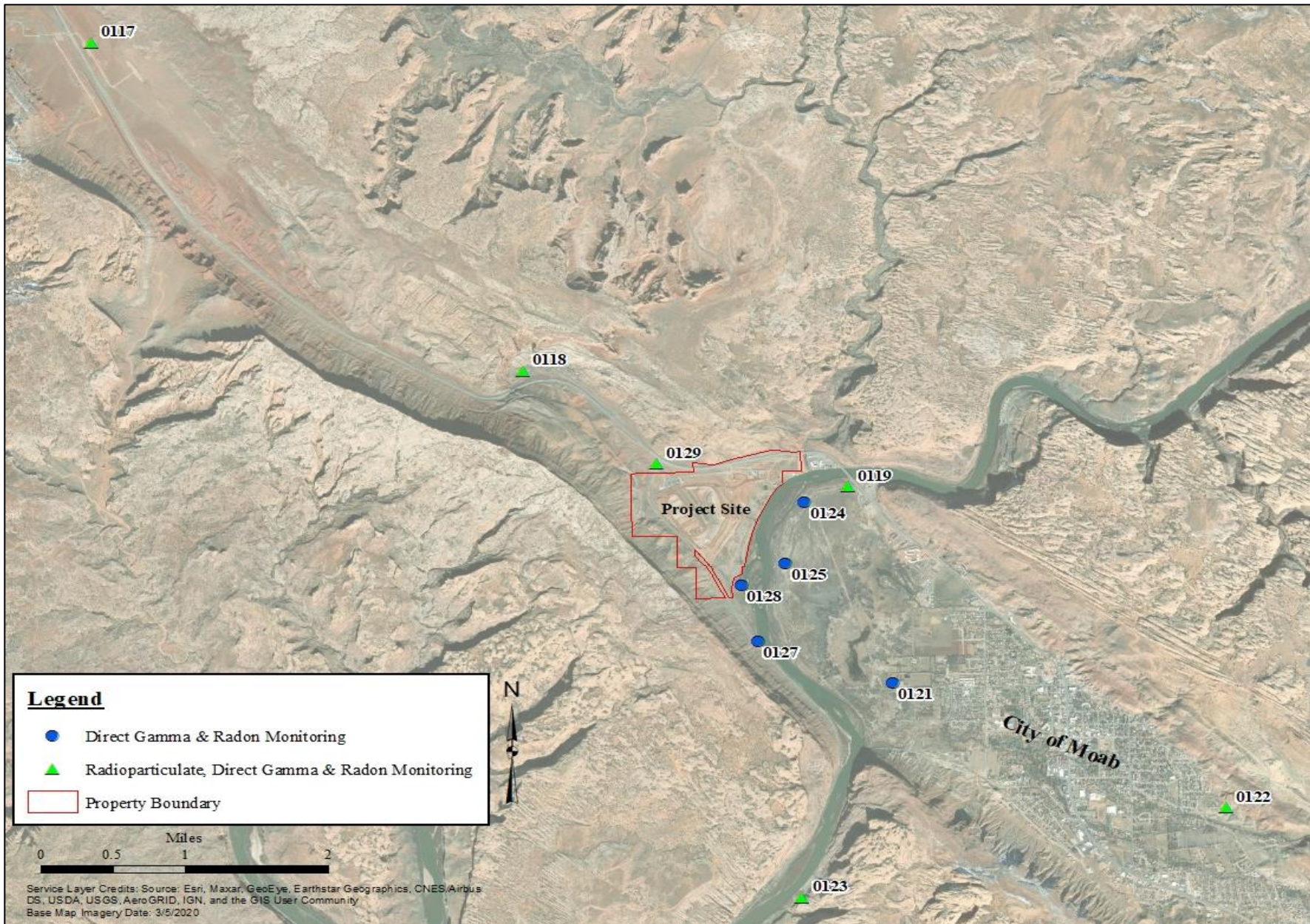


Figure 1. Moab Off-site Environmental Air Monitoring Locations



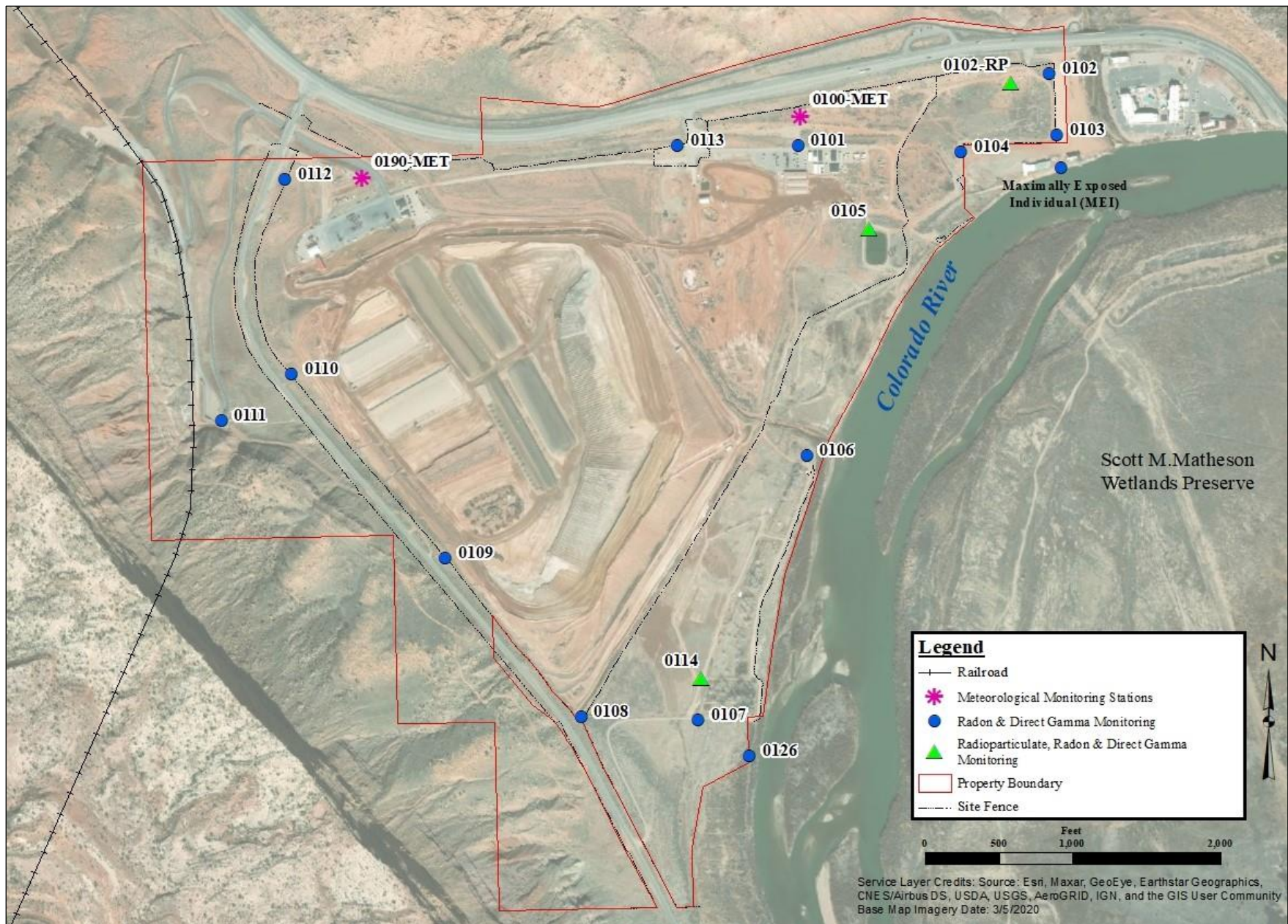


Figure 2. Moab On-site and Maximally Exposed Individual Environmental Air Monitoring Locations

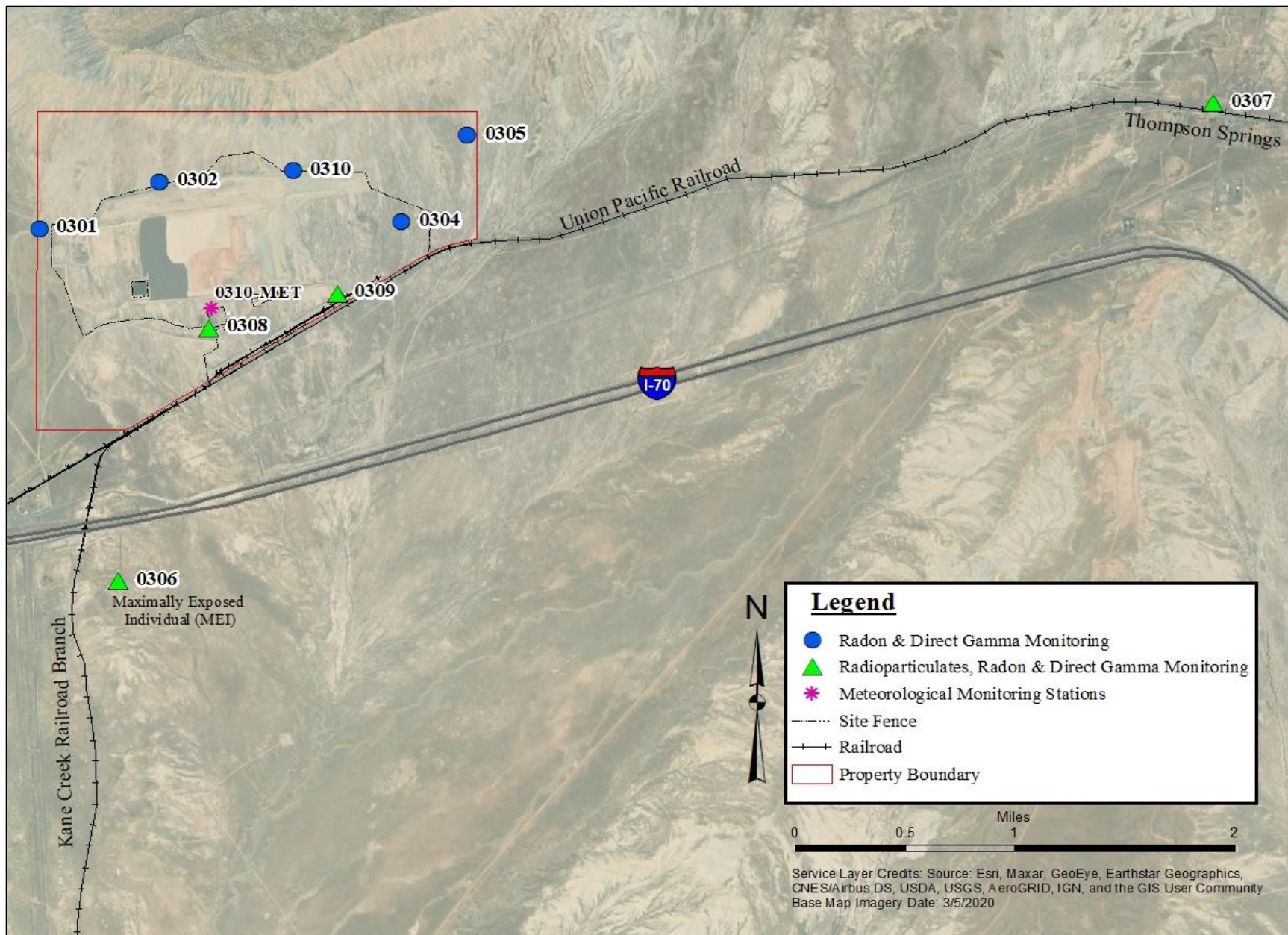


Figure 3. Crescent Junction Site Environmental Air Monitoring Locations

### 3.1.1 Meteorological Analysis

Meteorological data were collected from the on-site meteorological station (0190-Met) and downloaded from the Vista Data Vision online database, where meteorological data are uploaded from the Site. Hourly averages were analyzed. Figure 4 displays the wind rose for this quarter, with the wedges on the wind rose showing which direction the wind is coming from. In fourth quarter 2021, the winds were primarily out of the northwest with the strongest winds from the southeast. The average temperature for the quarter was 47°F. The lowest recorded temperature for the quarter was 19°F, and the highest was 84°F.

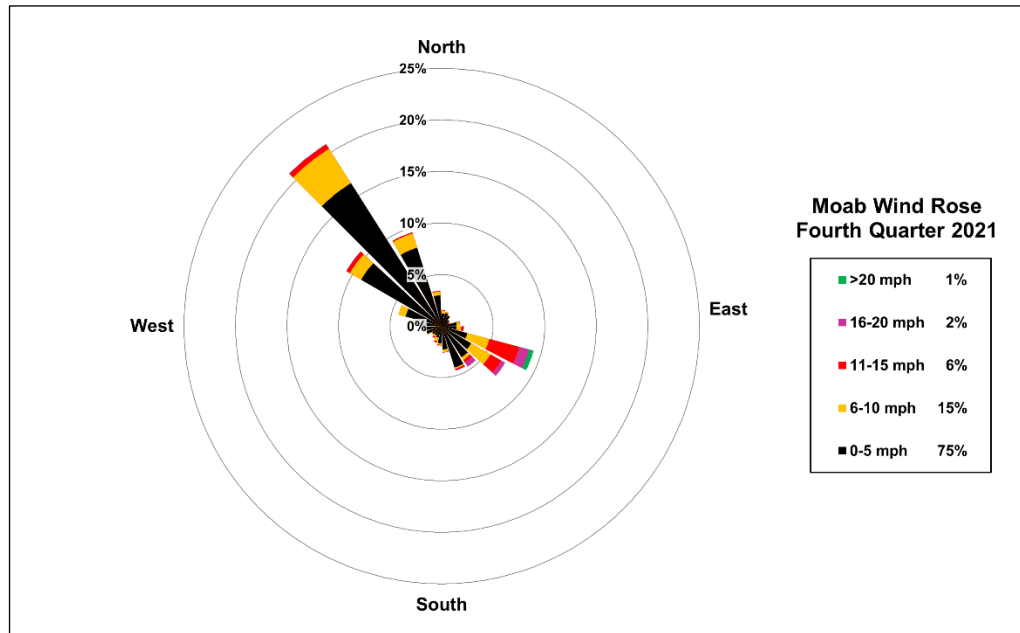


Figure 4. Moab Wind Rose for Fourth Quarter 2021

The Site received 2.9 inches of precipitation during fourth quarter 2021. Figure 5 presents the Moab ten-year average (based on data collected from 2010 through 2020) along with 2020 and 2021 cumulative precipitation. As this graph displays, fourth quarter 2021 precipitation was above the Site’s ten-year average. The Site received a total of 8.4 inches for annual precipitation in 2021.

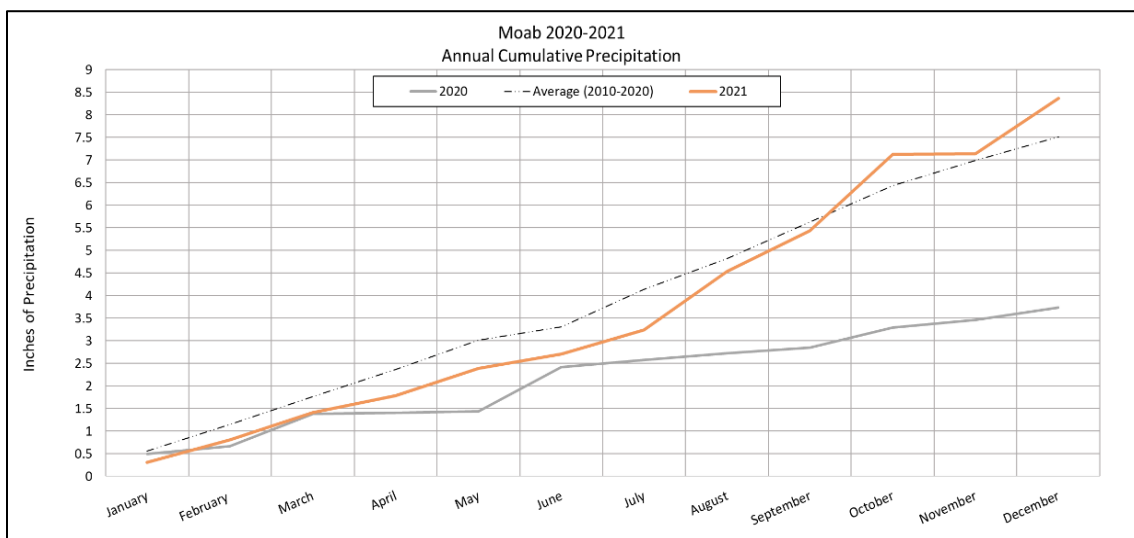


Figure 5. Moab Average, 2020, and Fourth Quarter 2021 Cumulative Precipitation

### 3.1.2 Radon

Based on five years of data collected between 2003 and 2008 from stations 0117 and 0123, the average background concentration of radon in the Moab area was established as 0.7 pCi/L. Therefore, the Project's annual average radon emission limit at the Moab site boundary is 3.7 pCi/L. On-site monitoring locations close to the site boundary or publicly 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.

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

Station Number	First Quarter 2021 (pCi/L)	Second Quarter 2021 (pCi/L)	Third Quarter 2021 (pCi/L)	Fourth Quarter 2021 (pCi/L)	Annual Average Concentration Based on Four Quarters (pCi/L)
<b>On-site Locations</b>					
<b>0101</b>	2.3	1.4	2.0	4.0	<b>2.4</b>
<b>0102</b>	2.0	0.9	1.1	2.5	<b>1.6</b>
<b>0103</b>	1.6	0.8	1.0	2.8	<b>1.5</b>
<b>0104</b>	2.1	1.2	1.7	4.0	<b>2.3</b>
<b>0105</b>	2.4	1.4	1.9	4.4	<b>2.5</b>
<b>0106</b>	3.5	1.9	1.9	5.3	<b>3.2</b>
<b>0107</b>	3.1	1.5	2.2	4.0	<b>2.7</b>
<b>0108</b>	2.9	2.1	3.0	4.7	<b>3.2</b>
<b>0109</b>	1.4	1.5	2.1	1.8	<b>1.7</b>
<b>0110</b>	1.2	0.9	1.5	1.9	<b>1.4</b>
<b>0111</b>	0.7	0.4	0.6	0.6	<b>0.6</b>
<b>0112</b>	1.4	1.0	1.8	2.2	<b>1.6</b>
<b>0113</b>	2.1	1.7	2.4	3.9	<b>2.5</b>
<b>0114</b>	3.5	1.8	2.3	4.8	<b>3.1</b>
<b>0126</b>	2.5	1.2	1.5	3.3	<b>2.1</b>
<b>Off-site Locations</b>					
<b>0117</b>	0.5	0.2	0.4	0.5	<b>0.4</b>
<b>0118</b>	0.7	0.3	0.6	0.6	<b>0.6</b>
<b>0119</b>	1.2	0.5	0.6	1.2	<b>0.9</b>
<b>0121</b>	0.6	0.3	0.4	0.7	<b>0.5</b>
<b>0122</b>	0.5	0.2	0.3	0.4	<b>0.4</b>
<b>0123</b>	0.5	0.2	0.3	0.5	<b>0.4</b>
<b>0124</b>	1.4	0.6	0.8	1.6	<b>1.3</b>
<b>0125</b>	1.6	0.8	1.0	1.7	<b>1.4</b>
<b>0127</b>	1.1	0.4	0.7	1.3	<b>1.0</b>
<b>0128</b>	2.3	1.3	1.5	3.1	<b>2.3</b>
<b>0129</b>	1.2	0.9	1.6	2.3	<b>1.6</b>
<b>MEI</b>	1.5	0.7	0.9	2.4	<b>1.5</b>

Background has not been subtracted from annual values

The Moab locations with the highest annual average radon concentrations as of fourth quarter 2021 are displayed in Figure 6. Locations 0106, 0107, 0108, 0113, and 0114 continue to have the highest annual average from the last quarter. When compared to the previous quarter, the data indicate fourth quarter 2021 concentrations at all locations increased as much as 3.4 pCi/L, except stations 0111 and 0118 which indicated no change, and station 109 resulted in a decrease. While radon concentrations between the quarters have increased, the annual averages have been on a downward trend since second quarter 2021 as seen in Figure 6.

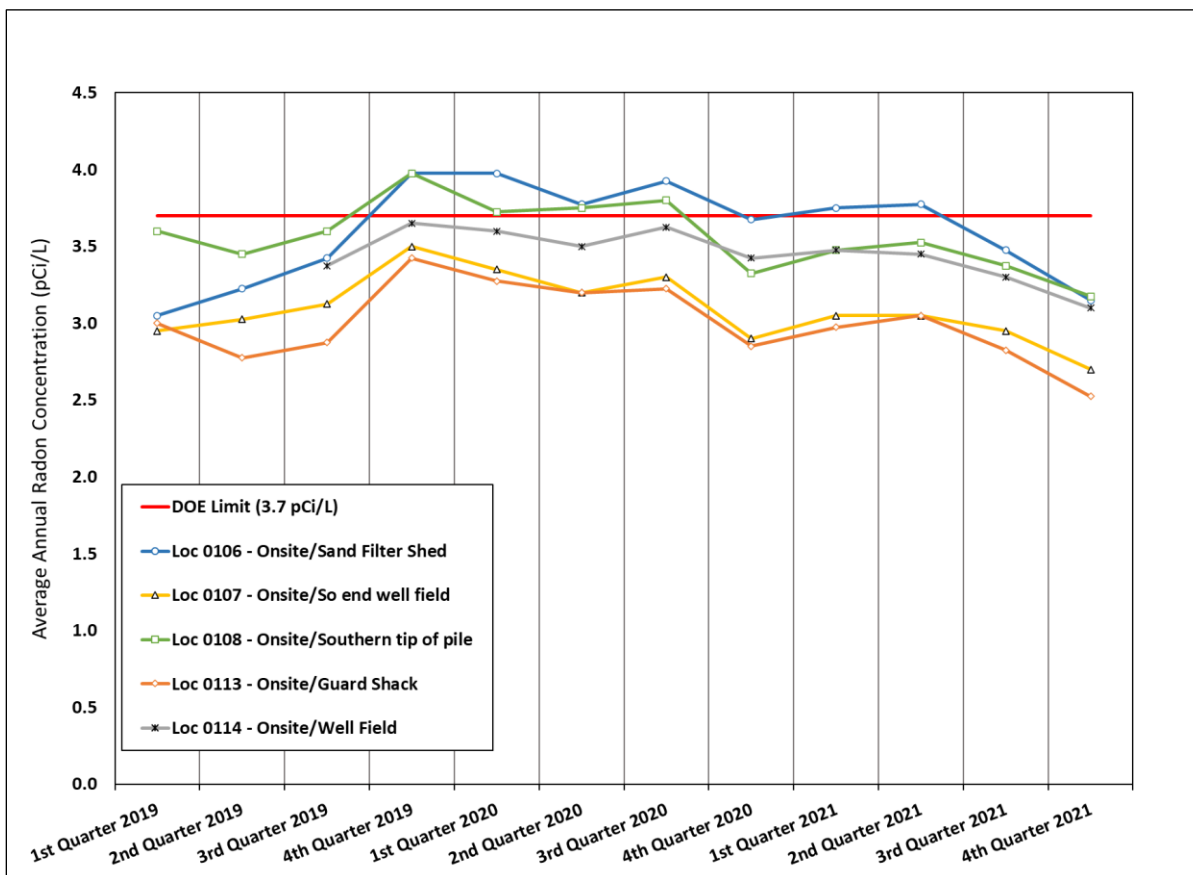


Figure 6. Moab Locations with Highest Fourth Quarter 2021 Average Annual Radon Concentrations

### 3.1.3 Direct Gamma Radiation

The average annual background (based on five years of data collected between 2003 and 2008) of direct gamma radiation effective dose for the Moab area was established as 82 mrem/year. Table 2 provides quarterly and annual gamma results for the past year, including background, at on- and off-site locations. The annual gamma dose represents the dose an individual would receive from occupying a location continuously for an entire year. Compared to the previous quarter, this quarter's results indicate the dose increased at all locations as much as 11 mrem, while two stations (0107 and 123) indicated no change and one station (0101) decrease.

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

Station Number	First Quarter 2021 (pCi/L)	Second Quarter 2021 (pCi/L)	Third Quarter 2021 (pCi/L)	Fourth Quarter 2021 (pCi/L)	Annual Dose Based on Four Quarters (mrem)
<b>On-site Locations</b>					
<b>0101</b>	40	43	45	42	<b>170</b>
<b>0102</b>	29	25	26	29	<b>109</b>
<b>0103</b>	28	27	26	28	<b>109</b>
<b>0104</b>	31	31	28	30	<b>120</b>
<b>0105</b>	30	29	27	29	<b>115</b>
<b>0106</b>	41	37	36	39	<b>153</b>
<b>0107</b>	34	33	33	33	<b>133</b>
<b>0108</b>	48	50	42	49	<b>189</b>
<b>0109</b>	109	122	106	117	<b>454</b>
<b>0110</b>	97	98	93	104	<b>392</b>
<b>0111</b>	NS	41	36	38	<b>NA</b>
<b>0112</b>	51	51	48	51	<b>201</b>
<b>0113</b>	37	38	38	39	<b>152</b>
<b>0114</b>	37	34	35	38	<b>144</b>
<b>0126</b>	34	34	30	32	<b>129</b>
<b>Off-site Locations</b>					
<b>0117</b>	30	29	26	NS	<b>NA</b>
<b>0118</b>	28	29	26	27	<b>110</b>
<b>0119</b>	32	30	28	29	<b>119</b>
<b>0121</b>	26	25	23	24	<b>98</b>
<b>0122</b>	25	23	22	NS	<b>NA</b>
<b>0123</b>	26	25	23	23	<b>97</b>
<b>0124</b>	28	29	28	29	<b>114</b>
<b>0125</b>	33	31	30	32	<b>126</b>
<b>0127</b>	29	28	26	28	<b>111</b>
<b>0128</b>	31	29	28	30	<b>118</b>
<b>0129</b>	34	37	30	33	<b>134</b>
<b>MEI</b>	26	28	26	27	<b>107</b>

Background has not been subtracted from annual values

NS = No Sample collected from this location, TLD missing upon collection (unknown cause)

NA = Not Applicable, insufficient data to calculate a representative annual dose

### 3.1.4 Radioparticulates

The effective background dose from inhalation of radioparticulates was not determined, therefore, all effective dose from radioparticulates measured at the Project's monitoring stations are assumed to be from the Project. Table 3 provides the calculated quarterly and annual effective dose from inhalation of radioparticulates for the past year for the Moab site. Filters were analyzed for concentrations of total uranium, actinium-227, thorium-230, radium-226, and polonium-210. Since actinium-227 and protactinium-231 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).

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

Station Number	Isotope	First Quarter 2021 (mrem)	Second Quarter 2021 (mrem)	Third Quarter 2021 (mrem)	Fourth Quarter 2021 (mrem)	Annual Total Dose Based on Four Quarters (mrem)
<b>On-site Locations</b>						
<b>0102-RP (MEI)</b>	Total Uranium	0.002	0.003	0.003	0.002	<b>4.07</b>
	Thorium-230	0.021	0.025	0.056	0.032	
	Radium-226	0.013	0.035	0.023	0.029	
	Polonium-210	0.716	0.407	0.000	0.895	
	Actinium-227	0.072	0.513	0.699	0.184	
	Protactinium-231	0.017	0.118	0.161	0.042	
<b>0105-RP</b>	Total Uranium	0.003	0.004	0.005	0.003	<b>4.75</b>
	Thorium-230	0.080	0.083	0.104	0.053	
	Radium-226	0.101	0.101	0.123	0.141	
	Polonium-210	0.790	0.554	0.000	1.058	
	Actinium-227	ND	0.373	0.606	0.280	
	Protactinium-231	ND	0.086	0.139	0.064	
<b>0114-RP</b>	Total Uranium	0.003	0.005	0.006	0.003	<b>6.72</b>
	Thorium-230	0.131	0.165	0.200	0.032	
	Radium-226	0.185	0.211	0.154	0.048	
	Polonium-210	0.895	0.505	0.000	1.140	
	Actinium-227	0.816	0.653	0.839	0.163	
	Protactinium-231	0.188	0.150	0.193	0.038	
<b>Off-site Locations</b>						
<b>0117-RP</b>	Total Uranium	0.002	0.003	0.003	0.003	<b>2.80</b>
	Thorium-230	0.014	0.011	0.015	0.013	
	Radium-226	0.020	0.029	0.023	0.167	
	Polonium-210	0.700	0.301	0.000	0.692	
	Actinium-227	0.149	0.051	0.193	0.256	
	Protactinium-231	0.034	0.012	0.045	0.059	
<b>0118-RP</b>	Total Uranium	0.002	0.003	0.003	0.002	<b>3.58</b>
	Thorium-230	0.012	0.064	0.061	0.048	
	Radium-226	0.003	0.092	0.114	0.158	
	Polonium-210	0.513	0.350	0.350	0.757	
	Actinium-227	ND	0.217	0.217	0.420	
	Protactinium-231	ND	0.050	0.050	0.097	
<b>0119-RP</b>	Total Uranium	0.002	0.003	0.003	0.002	<b>3.40</b>
	Thorium-230	0.025	0.016	0.021	0.029	
	Radium-226	0.053	0.025	0.048	0.023	
	Polonium-210	0.724	0.334	0.000	0.741	
	Actinium-227	0.373	0.028	0.163	0.536	
	Protactinium-231	0.086	0.006	0.038	0.123	
<b>0122-RP</b>	Total Uranium	0.002	0.003	0.003	0.002	<b>3.84</b>
	Thorium-230	0.019	0.019	0.017	0.014	
	Radium-226	0.012	0.040	0.040	0.027	
	Polonium-210	0.659	0.317	0.000	0.586	
	Actinium-227	0.233	0.231	0.443	ND	
	Protactinium-231	0.054	0.053	0.102	ND	

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

Station Number	Isotope	First Quarter 2021 (mrem)	Second Quarter 2021 (mrem)	Third Quarter 2021 (mrem)	Fourth Quarter 2021 (mrem)	Annual Total Dose Based on Four Quarters (mrem)
<b>Off-site Locations (continued)</b>						
<b>0123-RP</b>	Total Uranium	0.002	0.003	0.003	0.002	<b>2.63</b>
	Thorium-230	0.020	0.023	0.017	0.014	
	Radium-226	0.027	0.032	0.053	0.048	
	Polonium-210	0.651	0.317	0.000	0.619	
	Actinium-227	0.168	0.103	0.156	0.224	
	Protactinium-231	0.039	0.024	0.036	0.051	
<b>0129-RP</b>	Total Uranium	0.003	0.005	0.006	0.004	<b>7.58</b>
	Thorium-230	0.104	0.264	0.266	0.147	
	Radium-226	0.132	0.128	0.251	0.110	
	Polonium-210	0.684	0.366	0.000	0.814	
	Actinium-227	0.396	1.235	0.886	0.979	
	Protactinium-231	0.091	0.284	0.204	0.225	

ND = not detected; analyte concentration below detection limit

These analytical results are used to calculate the effective dose from the inhalation of radioparticulates. The annual dose associated with the stations closest to the site operations (0102, 0105, 0114, and 0129) is higher compared to the remaining stations. Compared to the previous quarter annual dose, six stations increased up to 0.508 mrem, and three stations decreased as much as 0.963 mrem.

### 3.1.5 Total Effective Dose

The Project must ensure the annual total effective dose from gamma radiation and radioparticulates from Project activities does not exceed 100 mrem above background. The MEI annual total effective dose for this quarter was 29.07 mrem, which is well below the DOE limit. This value was calculated by subtracting the background dose of 82 mrem from the MEI annual gamma radiation dose of 107 mrem and then adding the radioparticulate total dose of 4.07 mrem from location 0102, the closest radioparticulate station to the MEI. Nearly all dose to the MEI is due to direct gamma radiation. The dose to the lens of the eye, skin, and extremities is the same as a full body dose and is below the regulatory limit of 1500 mrem in a year to the lens of the eye and 5000 mrem in a year to the skin or extremities. Figure 7 shows total effective dose measured at the Moab site since 2019.



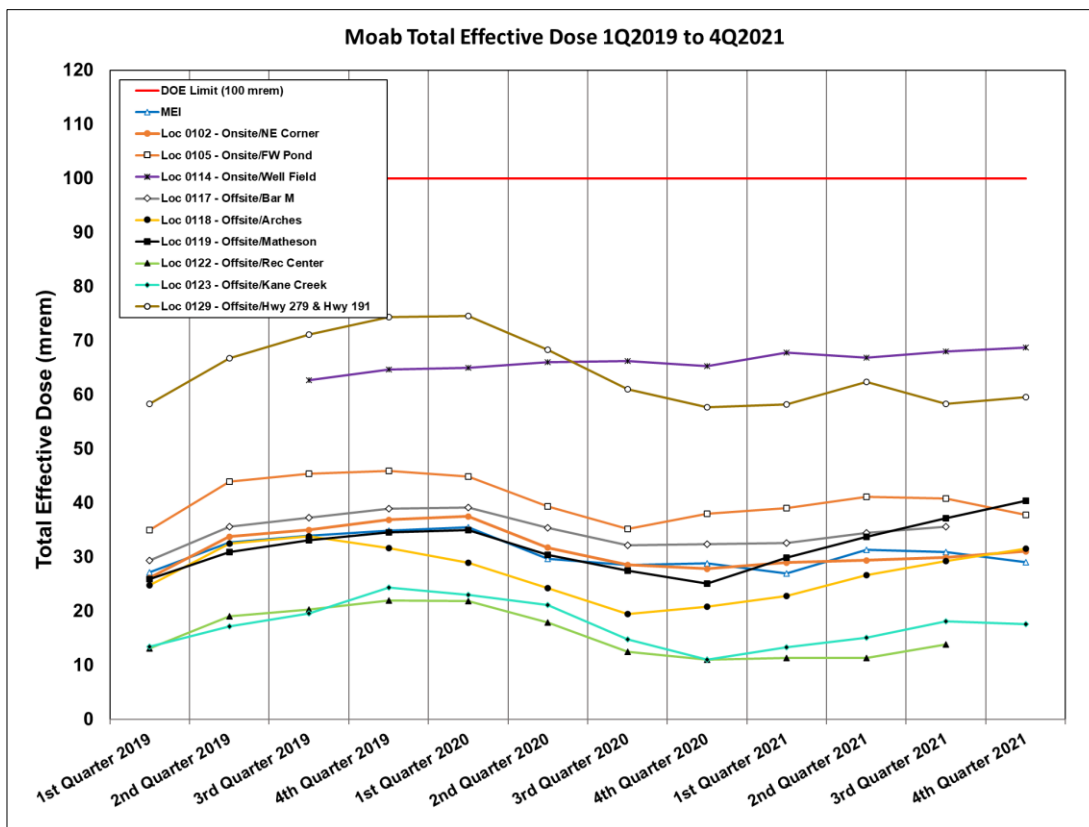


Figure 7. Total Effective Dose Measured at Moab Locations Since 2019

### 3.2 Crescent Junction Site

There are nine air monitoring stations associated with the Crescent Junction Site, two located off-site and seven on-site. All nine are equipped with radon and gamma detectors. Two on-site and two off-site stations are also equipped with air sampling pumps to measure air radioparticulates. After mill tailings disposal began in the second quarter of 2009, the Crescent Junction monitoring location 0306 became the MEI.

#### 3.2.1 Meteorological Analysis

Meteorological data were collected from the on-site meteorological station and downloaded from the Vista Data Vision online database, where meteorological data are uploaded from the Site. Hourly averages were analyzed. Figure 8 displays the wind rose for this quarter, with the wedges on the wind rose showing which direction the wind is coming from. In fourth quarter 2021, the prevailing winds were primarily out of the west. The site received 2.5 inches of precipitation during the fourth quarter 2021. The Site received 7.5 inches for annual precipitation in 2021. Figure 9 presents the Crescent Junction average precipitation (based on data collected from 2010 through 2020) in addition to the 2020 and 2021 cumulative precipitation. The average temperature for the quarter was 44°F. The lowest recorded temperature for the quarter was 16°F, and the highest was 79°F.

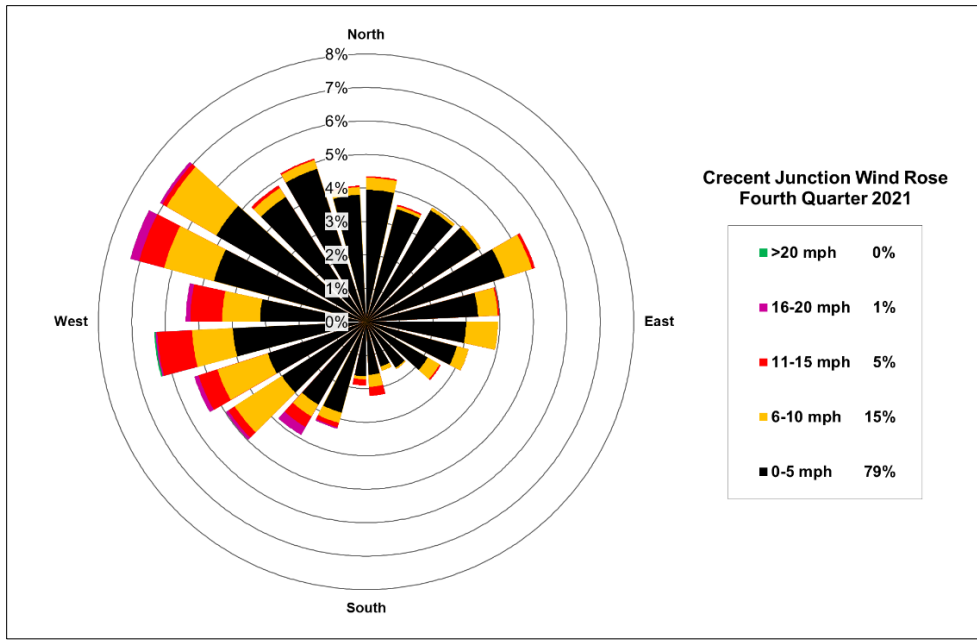


Figure 8. Crescent Junction Wind Rose for Fourth Quarter 2021

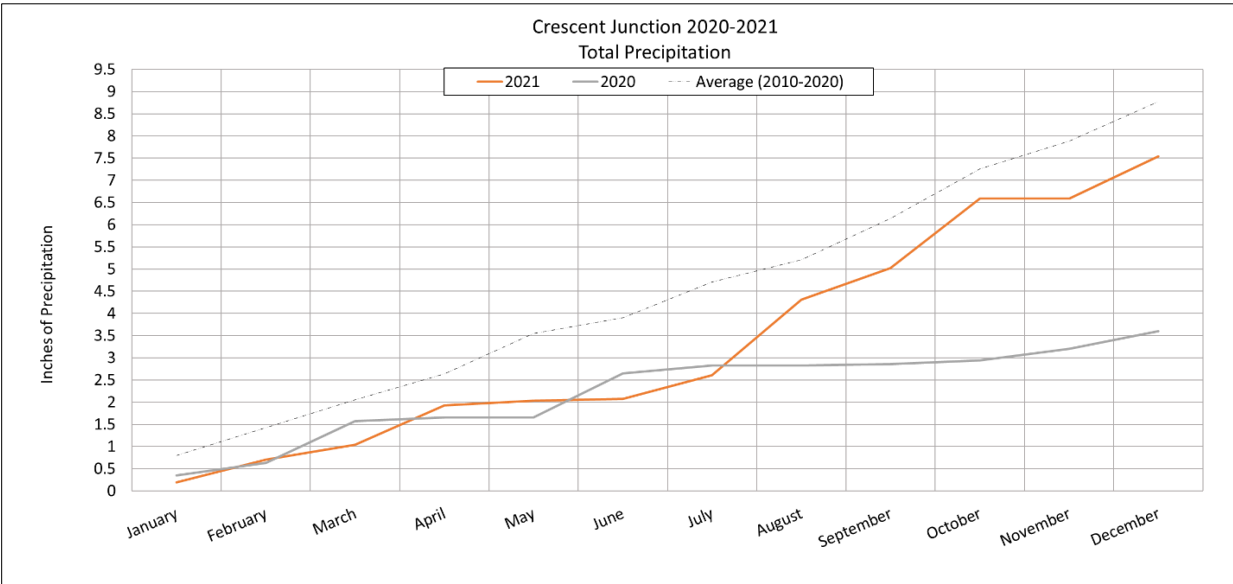


Figure 9. Crescent Junction Average, 2020, and Fourth Quarter 2021 Cumulative Precipitation

### 3.2.2 Radon

Based on three 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. None of the on- or off-site stations exceeded the limit of 3.9 pCi/L in fourth quarter 2021. Locations 0301 and 0305 are used to demonstrate compliance with the public dose limit in DOE O 458.1 at the site boundary. Table 4 shows quarterly and annual radon results for the past year, including background for on- and off-site locations.

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

Station Number	First Quarter 2020 (pCi/L)	Second Quarter 2021 (pCi/L)	Third Quarter 2021 (pCi/L)	Fourth Quarter 2021 (pCi/L)	Annual Average Concentration Based on Four Quarters (pCi/L)
<b>On-site Locations</b>					
<b>0301</b>	0.6	0.2	0.5	0.7	<b>0.5</b>
<b>0302</b>	0.7	0.5	0.6	0.9	<b>0.7</b>
<b>0304</b>	0.8	0.5	0.8	0.9	<b>0.7</b>
<b>0305</b>	0.5	0.3	0.5	0.7	<b>0.5</b>
<b>0308</b>	2.1	1.3	2.1	3.1	<b>2.2</b>
<b>0309</b>	1.8	1.2	1.5	2.7	<b>1.8</b>
<b>0310</b>	0.7	0.5	0.7	0.7	<b>0.6</b>
<b>Off-site Locations</b>					
<b>0306 (MEI)</b>	0.5	0.3	0.5	0.9	<b>0.5</b>
<b>0307</b>	0.5	0.2	0.3	0.5	<b>0.4</b>

Background has not been subtracted from annual values.

Compared to the previous quarter, the quarterly radon concentrations at all stations increased as much as 1.2 pCi/L, except for station 0310 which indicated no change. The Crescent Junction locations with the highest annual average radon concentrations during the fourth quarter are shown on Figure 10, which displays the annual average concentrations results for these locations since the first quarter of 2019.

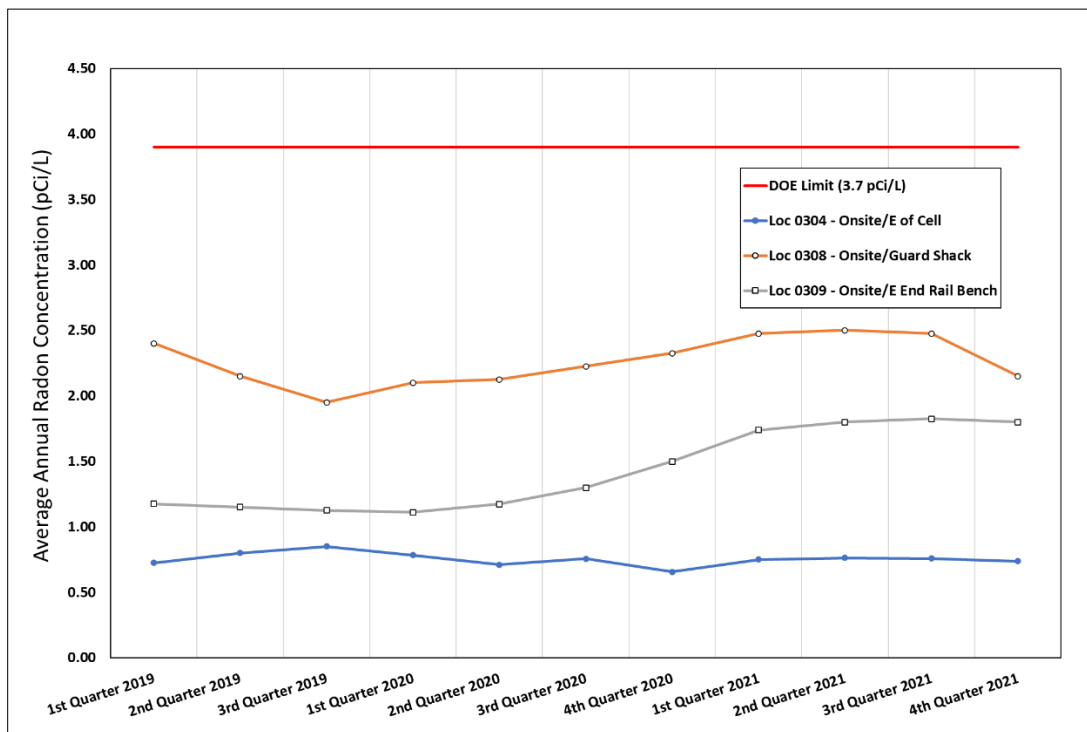


Figure 10. Crescent Junction Locations with Highest Fourth Quarter 2021 Average Annual Radon Concentrations

### 3.2.3 Direct Gamma Radiation

The average annual background direct gamma radiation exposure dose for the Crescent Junction area was established as 92.5 mrem based on three years of data collected from 2006 to 2009. Table 5 shows quarterly and annual results for the past year, including background for on- and off-site locations. The annual gamma dose represents the dose an individual would receive from occupying a location continuously for an entire year. This quarter's analytical results compared to the previous quarter's indicated that the gamma radiation dose increased at all locations, as much as 2 mrem.

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

Station Number	First Quarter 2021 (mrem)	Second Quarter 2021 (mrem)	Third Quarter 2021 (mrem)	Fourth Quarter 2021 (mrem)	Annual Total Dose Based on Four Quarters (mrem)
<b>On-site Locations</b>					
<b>0301</b>	30	29	27	28	<b>114</b>
<b>0302</b>	31	27	27	29	<b>114</b>
<b>0304</b>	32	31	27	29	<b>119</b>
<b>0305</b>	32	31	28	30	<b>121</b>
<b>0308</b>	31	32	28	29	<b>120</b>
<b>0309</b>	33	34	33	35	<b>135</b>
<b>0310</b>	29	30	28	30	<b>117</b>
<b>Off-site Locations</b>					
<b>0306 (MEI)</b>	30	27	27	29	<b>113</b>
<b>0307</b>	31	33	29	31	<b>124</b>

Background has not been subtracted from annual values

### 3.2.4 Radioparticulates

The effective background dose from inhalation of radioparticulates at the Crescent Junction site was not determined. Therefore, all effective dose measured at the Project's monitoring stations is assumed to be from the Project. Samples were collected at the four monitoring locations at or near the Crescent Junction site to determine the air particulate concentrations of total uranium, thorium-230, radium-226, polonium-210, actinium-227, and protactinium-231 (based on the actinium-227 concentration, as described in Section 3.1.4). All the Crescent Junction locations saw a decrease in annual dose, as much as 0.780 mrem. Table 6 shows radioparticulate effective doses for the Crescent Junction site for the past year.

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

Station Number	Isotope	First Quarter 2020 (mrem)	Second Quarter 2021 (mrem)	Third Quarter 2021 (mrem)	Fourth Quarter 2021 (mrem)	Annual Total Dose Based on Four Quarters (mrem)
<b>On-site Locations</b>						
<b>0308-RP</b>	Total Uranium	0.003	0.003	0.003	0.002	<b>3.91</b>
	Thorium-230	0.069	0.077	0.069	0.040	
	Radium-226	0.092	0.123	0.088	0.062	
	Polonium-210	0.684	0.326	0.000	0.602	
	Actinium-227	0.049	0.373	0.490	0.443	
	Protactinium-231	0.011	0.086	0.113	0.102	
<b>0309-RP</b>	Total Uranium	0.003	0.003	0.003	0.003	<b>5.05</b>
	Thorium-230	0.141	0.101	0.080	0.061	
	Radium-226	0.216	0.114	0.097	0.070	
	Polonium-210	0.651	0.317	0.000	0.667	
	Actinium-227	0.536	0.490	0.326	0.699	
	Protactinium-231	0.123	0.113	0.075	0.161	
<b>Off-site Locations</b>						
<b>306-RP MEI</b>	Total Uranium	0.002	0.002	0.002	0.002	<b>2.14</b>
	Thorium-230	0.015	0.017	0.009	0.020	
	Radium-226	0.030	0.002	NA	0.032	
	Polonium-210	0.627	0.285	0.000	0.667	
	Actinium-227	0.154	0.023	0.033	0.140	
	Protactinium-231	0.035	0.005	0.008	0.032	
<b>0307-RP</b>	Total Uranium	0.002	0.003	0.003	0.002	<b>1.89</b>
	Thorium-230	0.013	0.021	0.010	0.023	
	Radium-226	0.009	0.015	0.005	0.015	
	Polonium-210	0.521	0.269	0.000	0.602	
	Actinium-227	ND	ND	0.000	0.280	
	Protactinium-231	ND	ND	0.000	0.064	

ND = not detected; analyte concentration below detection limit

### 3.2.5 Total Effective Dose

The annual total effective dose to the Crescent Junction MEI was 22.64 mrem, which is well below the annual limit of 100 mrem. This is calculated by subtracting the background dose of 92.5 mrem from the MEI (location 0306) gamma radiation dose of 113 mrem, and then adding the radioparticulate dose of 2.14 mrem for the MEI. Figure 11 is a plot of the total effective dose from the four Crescent Junction locations since 2019. In Figure 11, the background was subtracted from the total effective dose calculations, therefore, the DOE limit is shown as 100 mrem. Nearly all of the dose to the MEI is due to direct gamma radiation. The dose to the lens of the eye, skin, and extremities is the same as a full body dose and is below the regulatory limit of 1500 mrem in a year to the lens of the eye and 5000 mrem in a year to the skin or extremities.

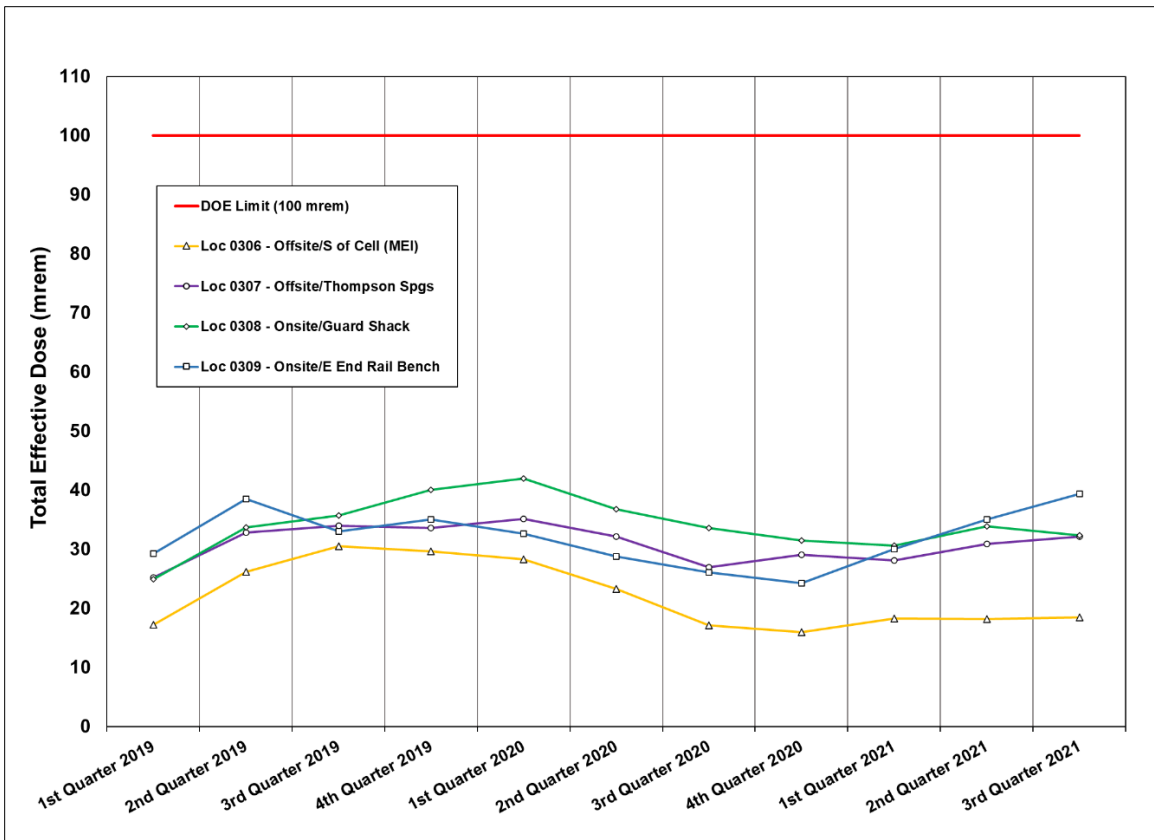


Figure 11. Total Effective Dose Measured at Crescent Junction Locations Since 2019

## 4.0 Data Assessment

Radon detectors, thermoluminescent dosimeters used for continuous dose measurements, and radioparticulate sample filters were sent to qualified 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 Quality Assurance/Quality Control samples.

### 4.1 Quality Assurance/Quality Control Sampling

Duplicate samples for radon were collected at Moab locations 0102, 0108, and 0111, and at Crescent Junction locations 0303 and 0308. In addition, duplicate direct gamma samples were collected at Moab locations 0102, 0108, and 0129 and Crescent Junction locations 0301 and 0305. All results associated with the duplicate sampling are provided in Table 7. No duplicate samples were collected for radioparticulate samples, per the SAP.

As Table 7 displays, the five locations that included duplicate radon samples were within 0.1 pCi/L of each other. The five locations equipped with duplicate gamma detectors were all within two mrem of each other. These radon and gamma duplicate results are within the acceptable ranges, and the data are considered valid based on these results.

Table 7. Duplicate Results for Fourth Quarter 2021

Location	Result	Duplicate Result
<b>Moab</b>		
Radon:	pCi/L	pCi/L
0102	2.5	2.5
0108	4.7	4.8
0111	0.6	0.51
Gamma:	mrem	mrem
0102	29	28
0108	49	50
0129	33	31
<b>Crescent Junction</b>		
Radon:	pCi/L	pCi/L
0308	3.1	3.0
0310	0.7	0.7
Gamma:	mrem	mrem
0301	28	29
0305	30	31

Control samples measured the dose for gamma and radon while being shipped from the site to the respective analytical laboratories. Transit values for direct gamma was at or below background levels. The Radonova lab subtracts the average transit exposure from the reported radon concentrations. The radon transit values are shown in Table 8.

Table 8. Shipment Control Sample Results for Fourth Quarter 2021

Sample	Result
Radon:	pCi/L
In-transit 1	18 +/- 11
In-transit 2	23 +/- 14
In-transit 3	12 +/- 14

## 4.2 Suspected Anomalies

All 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 this quarter.

## 4.3 Summary

Data collected during the fourth quarter of 2021 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. 4, "Radiation Protection of the Public and the Environment.