

*Office of Environmental Management – Grand Junction*



Environmental Air Monitoring Data  
Quarterly Report for the Moab and  
Crescent Junction, Utah, Sites  
Second Quarter 2019  
(April through June 2019)

November 2019



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 Second Quarter 2019  
(April – June 2019)**

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**Revision 0**

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**Review and Approval**

10/30/2019

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10/30/2019

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## Revision History

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| 0        | October 2019 | 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 second quarter of 2019. 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 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 that exceeds 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 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 highest radiation dose based on exposure pathways and parameters. The Project established an MEI for each of the Project sites.

## **3.0 Results for April through June 2019**

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**

A total of 15 air monitoring stations are equipped with radon and gamma detectors located on site, and another 12 off-site stations have these detectors. Of these 27 stations, three on-site and six off-site stations are also equipped with air sampling pumps to measure air radioparticulates. Location 0114 was established the beginning of the 2018 fourth quarter to measure the air radioparticulate concentration, gamma doses, and the radon concentration in the vicinity of the IA well field (near groundwater extraction well 0810). Only the first, second, and third rounds of data from this new location are presented in this Report. Gamma detectors and radon cups from locations 0106, 0107, 0114, 0119, 0124, 0125, 0126, and 0128, and radioparticulate sampling equipment from station 0114 were removed early by authorized personnel due to potential river flooding in the area. Those detectors and radon cups were only exposed for 66 days out of the 91 days for second quarter (data has been flagged accordingly).

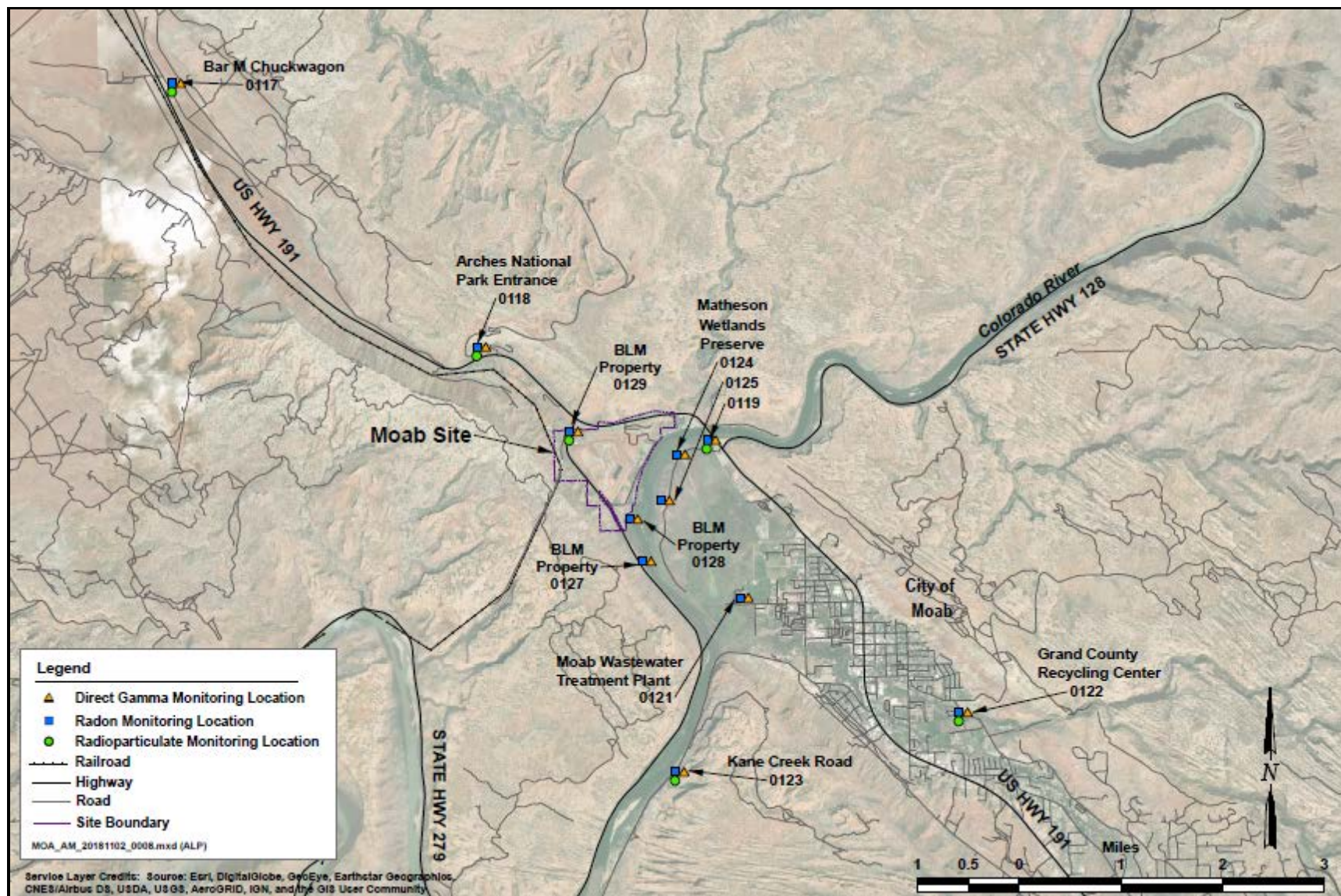


Figure 1. Moab Off-site Environmental Air Monitoring Locations

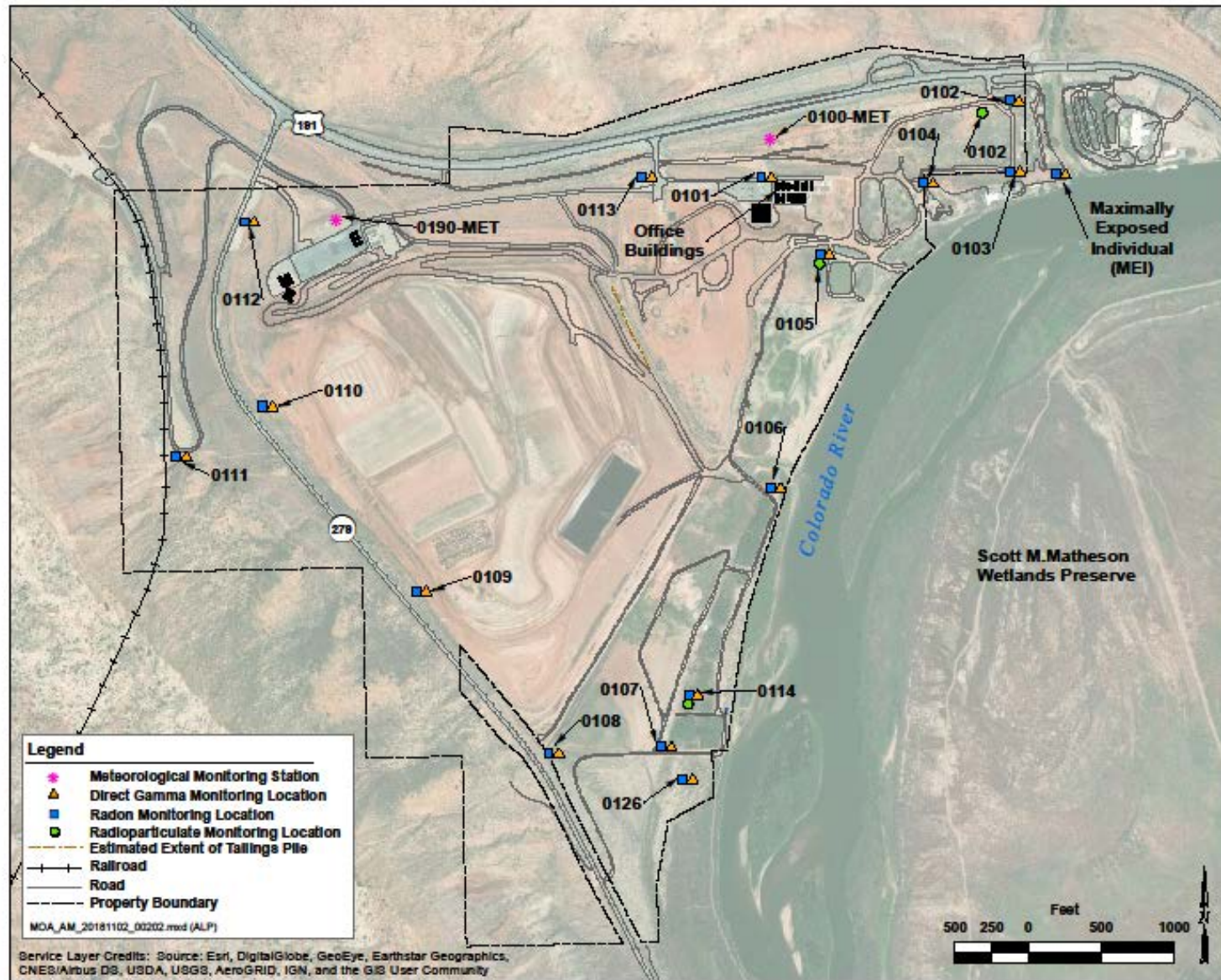


Figure 2. Moab On-site and Maximally Exposed Individual Environmental Air Monitoring Locations

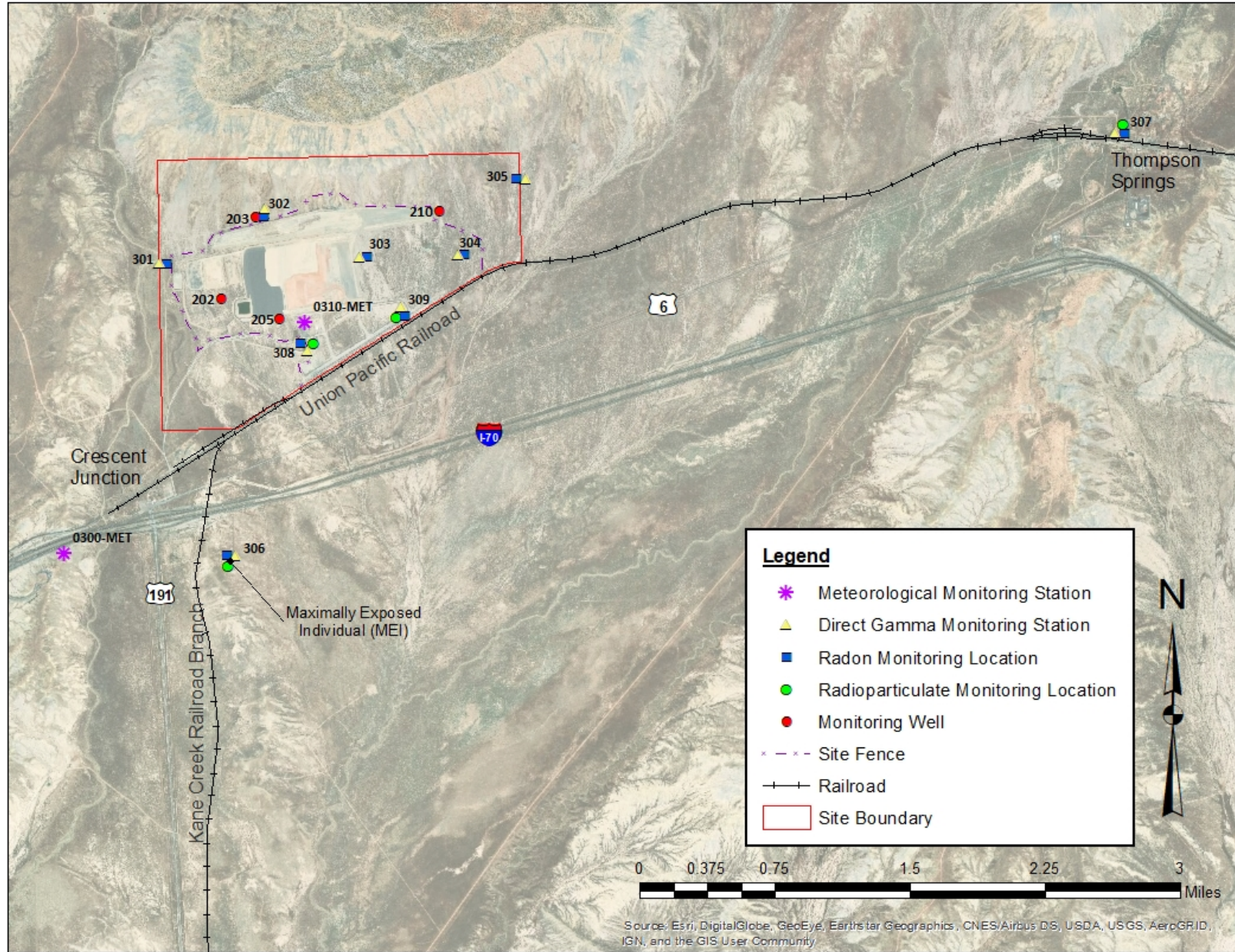


Figure 3. Crescent Junction Site Environmental Air Monitoring Locations

### 3.1.1 Meteorological Analysis

Data were collected from the on-site meteorology station (northwest portion of the site) and downloaded from the Vista Data Vision online database where the meteorological data are uploaded from the site. Hourly averages were analyzed. In the second quarter 2019, the primary wind direction for the quarter ranged from north to east, making up 43 percent of the wind direction at the Moab site. The site received 1.65 inches of rain during second quarter 2019. Figure 4 displays the wind rose for this quarter.

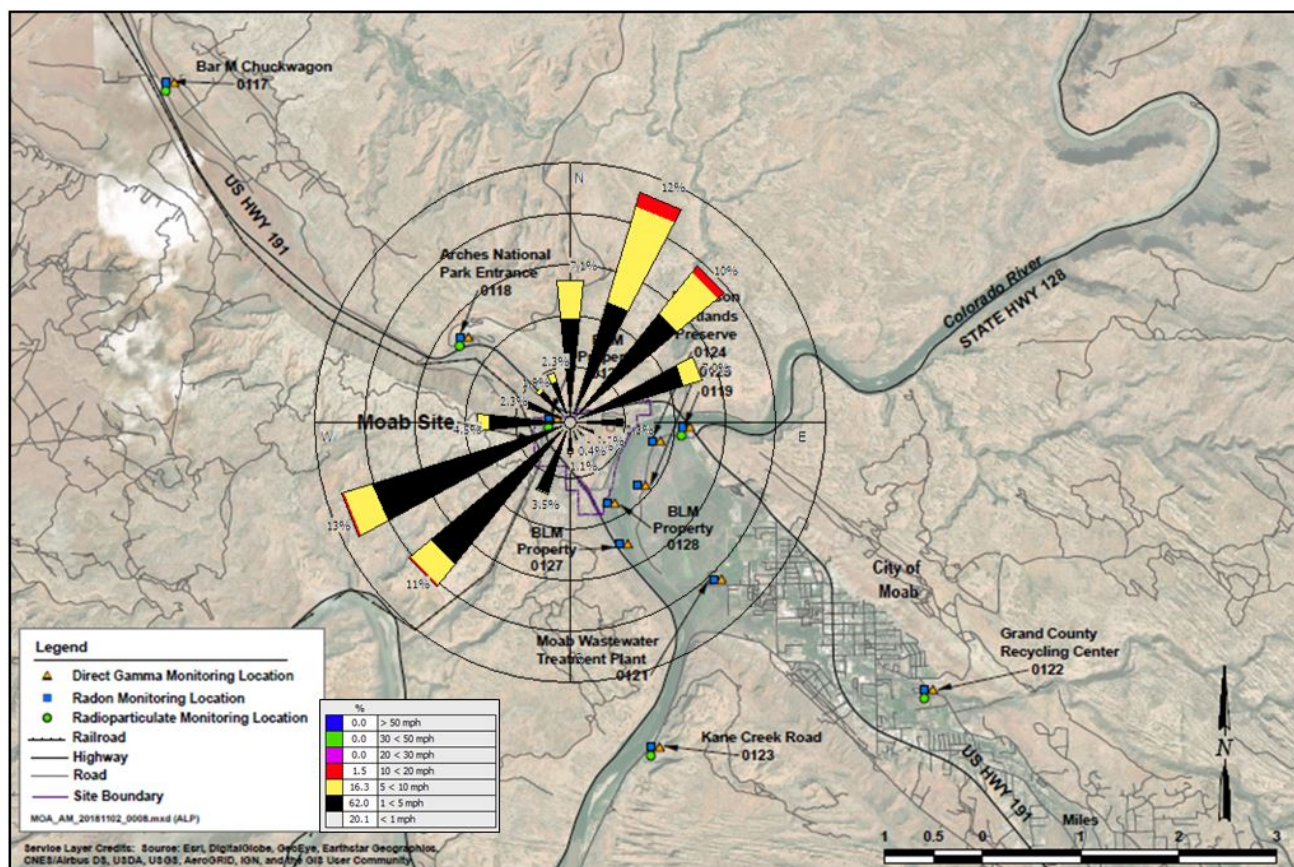


Figure 4. Moab Wind Rose for Second Quarter 2019

### 3.1.2 Radon

Based on five years of data 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, none of which exceeded the 3.7 pCi/L annual average.

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

| Station Number            | 3rd Quarter 2018 (pCi/L) | 4th Quarter 2018 (pCi/L) | 1st Quarter 2019 (pCi/L) | 2nd Quarter 2019 (pCi/L) | Annual Average Concentration Based on Four Quarters (pCi/L) |
|---------------------------|--------------------------|--------------------------|--------------------------|--------------------------|-------------------------------------------------------------|
| <b>On-site Locations</b>  |                          |                          |                          |                          |                                                             |
| <b>0101</b>               | 1.9                      | 4.2                      | 1.8                      | 1.5                      | <b>2.4</b>                                                  |
| <b>0102</b>               | 0.9                      | 2.8                      | 1.7                      | 1.4                      | <b>1.7</b>                                                  |
| <b>0103</b>               | 1.0                      | 2.7                      | 1.4                      | 0.8                      | <b>1.5</b>                                                  |
| <b>0104</b>               | 1.4                      | 3.8                      | 2.2                      | 1.2                      | <b>2.2</b>                                                  |
| <b>0105</b>               | 1.7                      | 4.2                      | 2.5                      | 1.4                      | <b>2.5</b>                                                  |
| <b>0106</b>               | 1.7                      | 5.4                      | 3.2                      | 2.6*                     | <b>3.2</b>                                                  |
| <b>0107</b>               | 1.8                      | 5.1                      | 3.1                      | 2.1*                     | <b>3.0</b>                                                  |
| <b>0108</b>               | 2.8                      | 5.9                      | 3.3                      | 1.8                      | <b>3.4</b>                                                  |
| <b>0109</b>               | 2.0                      | 2.4                      | 1.7                      | 1.3                      | <b>1.9</b>                                                  |
| <b>0110</b>               | 1.7                      | 2.0                      | 1.6                      | 1.2                      | <b>1.6</b>                                                  |
| <b>0111</b>               | 0.7                      | 0.9                      | 0.7                      | 0.7                      | <b>0.8</b>                                                  |
| <b>0112</b>               | 2.0                      | 3.3                      | 1.6                      | 1.6                      | <b>2.1</b>                                                  |
| <b>0113</b>               | 2.8                      | 4.4                      | 2.2                      | 1.7                      | <b>2.8</b>                                                  |
| <b>0114</b>               | NS                       | 5.3                      | 3.5                      | 2.3*                     | <b>NA</b>                                                   |
| <b>0126</b>               | 1.4                      | 4.4                      | 2.9                      | 2.0*                     | <b>2.7</b>                                                  |
| <b>Off-site Locations</b> |                          |                          |                          |                          |                                                             |
| <b>0117</b>               | <0.4                     | 0.6                      | 0.8                      | 0.4                      | <b>0.6</b>                                                  |
| <b>0118</b>               | 0.5                      | 0.7                      | 1.1                      | 0.7                      | <b>0.8</b>                                                  |
| <b>0119</b>               | 0.5                      | 1.4                      | 1.2                      | 1.0*                     | <b>1.0</b>                                                  |
| <b>0121</b>               | <0.4                     | NS                       | 0.7                      | 0.3                      | <b>NA</b>                                                   |
| <b>0122</b>               | <0.4                     | 0.4                      | 0.8                      | <.27                     | <b>0.5</b>                                                  |
| <b>0123</b>               | <0.4                     | 0.4                      | 0.6                      | <.24                     | <b>0.4</b>                                                  |
| <b>0124</b>               | 0.6                      | 2.1                      | 1.2                      | 2.0*                     | <b>1.5</b>                                                  |
| <b>0125</b>               | 0.8                      | 2.3                      | 1.7                      | 1.2*                     | <b>1.5</b>                                                  |
| <b>0127</b>               | 0.8                      | 1.5                      | 1.1                      | 0.7                      | <b>1.0</b>                                                  |
| <b>0128</b>               | 1.4                      | 4.0                      | 2.6                      | 1.4*                     | <b>2.4</b>                                                  |
| <b>0129</b>               | 1.9                      | 3.0                      | 1.8                      | 1.2                      | <b>2.0</b>                                                  |
| <b>MEI</b>                | 0.6                      | 2.4                      | 1.5                      | 1.0                      | <b>1.4</b>                                                  |

NS = No Sample collected from this location

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

\*=Removed early due to flooding, timeframe limited to 66 days

The five Moab locations with the highest annual average radon concentrations as of the second quarter of 2019 and the annual average concentrations (since first quarter 2016) are displayed on Figure 5.

Locations 0106, 0107, 0108, and 0113 continue to have the highest annual average from the last quarter, despite having a shorter exposure period of 66 days. However, none of the locations for this quarter were above the 3.7 pCi/L limit. Radon concentrations have historically peaked during the fourth quarter of any year. When compared to the previous quarter, the results indicate second quarter 2019 concentrations decreased at all 15 on-site locations (as much as 1.5 pCi/L), and decreased at all of the 12 off-site locations (as much as 1.2 pCi/L) except for location 0124, which saw an increase of 0.8 pCi/L.

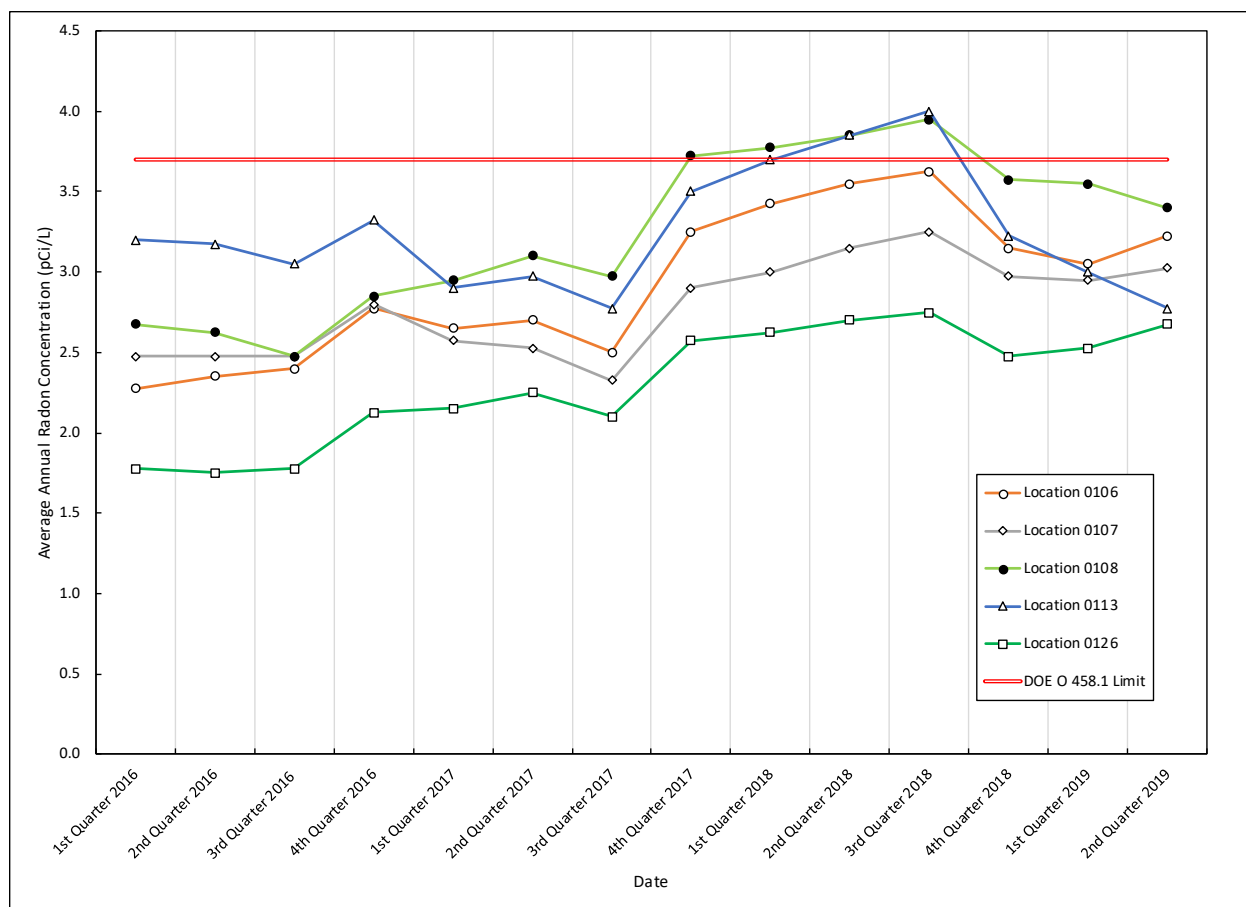


Figure 5. Moab Locations with Highest Second Quarter 2019 Average Annual Radon Concentrations

### 3.1.3 Direct Gamma Radiation

The average annual background (based on five years of data between 2003 and 2008) 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.

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

| Station Number           | 3rd Quarter 2018 (mrem) | 4th Quarter 2018 (mrem) | 1st Quarter 2019 (mrem) | 2nd Quarter 2019 (mrem) | Annual Dose Based on Four Quarters (mrem) |
|--------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------------------------|
| <b>On-site Locations</b> |                         |                         |                         |                         |                                           |
| <b>0101</b>              | 46                      | 43                      | 41                      | 44                      | 174                                       |
| <b>0102</b>              | 28                      | 26                      | 27                      | 31                      | 112                                       |
| <b>0103</b>              | 27                      | 27                      | 28                      | 30                      | 112                                       |
| <b>0104</b>              | 30                      | 29                      | 30                      | 32                      | 121                                       |
| <b>0105</b>              | 30                      | 28                      | 29                      | 32                      | 119                                       |
| <b>0106</b>              | 38                      | 35                      | 36                      | 36*                     | 145                                       |
| <b>0107</b>              | 31                      | 31                      | 31                      | 33*                     | 126                                       |
| <b>0108</b>              | 46                      | 44                      | 42                      | 49                      | 181                                       |
| <b>0109</b>              | 120                     | 113                     | 102                     | 111                     | 446                                       |

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

| Station Number            | 3rd Quarter 2018 (mrem) | 4th Quarter 2018 (mrem) | 1st Quarter 2019 (mrem) | 2nd Quarter 2019 (mrem) | Annual Dose Based on Four Quarters (mrem) |
|---------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------------------------|
| 0110                      | 113                     | 99                      | 88                      | 103                     | 403                                       |
| 0111                      | 42                      | 38                      | 43                      | 43                      | 166                                       |
| 0112                      | 54                      | 49                      | 49                      | 55                      | 207                                       |
| 0113                      | 48                      | 42                      | 41                      | 43                      | 174                                       |
| 0114                      | NS                      | 35                      | 35                      | 34*                     | NA                                        |
| 0126                      | 32                      | 30                      | 31                      | 32                      | 125                                       |
| <b>Off-site Locations</b> |                         |                         |                         |                         |                                           |
| 0117                      | 28                      | 27                      | 29                      | 31                      | 115                                       |
| 0118                      | 27                      | 26                      | 28                      | 30                      | 111                                       |
| 0119                      | 26                      | 26                      | 27                      | 30*                     | 109                                       |
| 0121                      | 25                      | NS                      | 26                      | 29                      | NA                                        |
| 0122                      | 24                      | 22                      | 25                      | 27                      | 98                                        |
| 0123                      | 24                      | 22                      | 25                      | 25                      | 96                                        |
| 0124                      | 29                      | 27                      | 29                      | 27*                     | 112                                       |
| 0125                      | 31                      | 30                      | NS                      | 31*                     | NA                                        |
| 0127                      | 29                      | 28                      | 29                      | 33                      | 119                                       |
| 0128                      | 28                      | 29                      | 29                      | 32*                     | 118                                       |
| 0129                      | 35                      | 33                      | 33                      | 39                      | 140                                       |
| MEI                       | 27                      | 27                      | 27                      | 30                      | 111                                       |

NS = No sample collected from this location

NA = Not applicable, insufficient data to calculate a representative annual average

\*Removed early due to flooding, timeframe limited to 66 days

These readings represent the gamma dose an individual would receive from occupying a location for an entire year. The second quarter 2019 analytical results indicated the dose increased up to 15 mrem at 22 of the 26 locations compared to first quarter 2019. The dose decreased at on-site locations 0114 and 0124 up to 2 mrem from the previous quarter. There was no change observed for on-site locations 0106 and 0111, and off-site location 0123.

### 3.1.4 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 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. Samples were collected at or near the Moab site to measure the 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). These analytical results are used to calculate the effective dose from the inhalation of radioparticulates.

As previously mentioned, the location 0114 air particulate sampling equipment was installed at the beginning of the fourth quarter, and the results provided in Table 3 only display the dose for three quarters (the annual dose cannot be calculated). In addition, due to river flooding on- and off-site, radioparticulate station 0114 was removed by authorized personnel. Results from location 0114 reflect only 66 out of the 91 days of the quarter, and have not been adjusted to reflect the full quarter. Therefore, only 73 percent of the data for the quarter is reflected in the results and is excluded from analysis due to incomplete data.

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

| Station Number     | Isotope          | 3rd Quarter 2018 (mrem) | 4th Quarter 2018 (mrem) | 1st Quarter 2019 (mrem) | 2nd Quarter 2019 (mrem) | Annual Total Dose Based on Four Quarters (mrem) |
|--------------------|------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------------------------------|
| On-site Locations  |                  |                         |                         |                         |                         |                                                 |
| 0102-RP (MEI)      | Total Uranium    | 0.004                   | 0.003                   | 0.002                   | 0.002                   | 3.73                                            |
|                    | Thorium-230      | 0.043                   | 0.043                   | 0.019                   | 0.035                   |                                                 |
|                    | Radium-226       | 0.036                   | 0.053                   | 0.048                   | 0.020                   |                                                 |
|                    | Polonium-210     | 0.488                   | 0.716                   | 0.765                   | 0.464                   |                                                 |
|                    | Actinium-227     | 0.149                   | 0.466                   | 0.186                   | ND                      |                                                 |
|                    | Protactinium-231 | 0.034                   | 0.107                   | 0.043                   | ND                      |                                                 |
| 0105-RP            | Total Uranium    | 0.006                   | 0.004                   | 0.002                   | 0.004                   | 6.98                                            |
|                    | Thorium-230      | 0.109                   | 0.085                   | 0.051                   | 0.072                   |                                                 |
|                    | Radium-226       | 0.029                   | 0.079                   | 0.034                   | 0.128                   |                                                 |
|                    | Polonium-210     | 0.513                   | 0.814                   | 0.895                   | 0.431                   |                                                 |
|                    | Actinium-227     | 1.352                   | 0.490                   | 0.746                   | 0.443                   |                                                 |
|                    | Protactinium-231 | 0.311                   | 0.113                   | 0.172                   | 0.102                   |                                                 |
| 0114-RP            | Total Uranium    | NS                      | 0.006                   | 0.002                   | 0.003*                  | NA                                              |
|                    | Thorium-230      | NS                      | 0.192                   | 0.049                   | 0.101*                  |                                                 |
|                    | Radium-226       | NS                      | 0.354                   | 0.092                   | 0.141*                  |                                                 |
|                    | Polonium-210     | NS                      | 0.792                   | 1.106                   | 0.391*                  |                                                 |
|                    | Actinium-227     | NS                      | 0.691                   | 0.489                   | 0.699*                  |                                                 |
|                    | Protactinium-231 | NS                      | 0.159                   | 0.113                   | 0.161*                  |                                                 |
| Off-site Locations |                  |                         |                         |                         |                         |                                                 |
| 0117-RP            | Total Uranium    | 0.003                   | 0.003                   | 0.002                   | 0.003                   | 2.56                                            |
|                    | Thorium-230      | 0.021                   | 0.021                   | 0.016                   | 0.019                   |                                                 |
|                    | Radium-226       | 0.003                   | 0.185                   | 0.000                   | 0.011                   |                                                 |
|                    | Polonium-210     | 0.472                   | 0.554                   | 0.757                   | 0.358                   |                                                 |
|                    | Actinium-227     | 0.280                   | 0.098                   | 0.420                   | 0.049                   |                                                 |
|                    | Protactinium-231 | 0.064                   | 0.023                   | 0.097                   | 0.011                   |                                                 |
| 0118-RP            | Total Uranium    | 0.004                   | 0.002                   | 0.002                   | 0.003                   | 3.46                                            |
|                    | Thorium-230      | 0.067                   | 0.019                   | 0.027                   | 0.051                   |                                                 |
|                    | Radium-226       | 0.021                   | 0.066                   | 0.031                   | 0.041                   |                                                 |
|                    | Polonium-210     | 0.529                   | 0.529                   | 0.741                   | 0.366                   |                                                 |
|                    | Actinium-227     | 0.280                   | 0.200                   | 0.303                   | ND                      |                                                 |
|                    | Protactinium-231 | 0.064                   | 0.046                   | 0.070                   | ND                      |                                                 |
| 0119-RP            | Total Uranium    | 0.003                   | 0.002                   | 0.002                   | 0.002                   | 3.92                                            |
|                    | Thorium-230      | 0.029                   | 0.021                   | 0.015                   | 0.018                   |                                                 |
|                    | Radium-226       | 0.014                   | 0.030                   | 0.018                   | 0.016                   |                                                 |
|                    | Polonium-210     | 0.529                   | 0.578                   | 0.814                   | 0.383                   |                                                 |
|                    | Actinium-227     | 0.172                   | 0.396                   | 0.256                   | 0.256                   |                                                 |
|                    | Protactinium-231 | 0.040                   | 0.091                   | 0.059                   | 0.080                   |                                                 |

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

| Station Number                        | Isotope          | 3rd Quarter 2018 (mrem) | 4th Quarter 2018 (mrem) | 1st Quarter 2019 (mrem) | 2nd Quarter 2019 (mrem) | Annual Total Dose Based on Four Quarters (mrem) |
|---------------------------------------|------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------------------------------|
| <b>Off-site Locations (continued)</b> |                  |                         |                         |                         |                         |                                                 |
| <b>0122-RP</b>                        | Total Uranium    | 0.003                   | 0.002                   | 0.002                   | 0.002                   | <b>3.06</b>                                     |
|                                       | Thorium-230      | 0.011                   | 0.016                   | 0.010                   | 0.012                   |                                                 |
|                                       | Radium-226       | 0.015                   | 0.026                   | 0.024                   | 0.010                   |                                                 |
|                                       | Polonium-210     | 0.423                   | 0.472                   | 0.741                   | 0.334                   |                                                 |
|                                       | Actinium-227     | 0.217                   | 0.303                   | ND                      | 0.256                   |                                                 |
|                                       | Protactinium-231 | 0.050                   | 0.070                   | ND                      | 0.059                   |                                                 |
| <b>0123-RP</b>                        | Total Uranium    | 0.003                   | 0.002                   | 0.002                   | 0.002                   | <b>3.21</b>                                     |
|                                       | Thorium-230      | 0.015                   | 0.022                   | 0.015                   | 0.018                   |                                                 |
|                                       | Radium-226       | 0.026                   | 0.026                   | 0.029                   | 0.004                   |                                                 |
|                                       | Polonium-210     | 0.423                   | 0.554                   | 0.741                   | 0.383                   |                                                 |
|                                       | Actinium-227     | 0.131                   | 0.280                   | 0.170                   | 0.191                   |                                                 |
|                                       | Protactinium-231 | 0.030                   | 0.064                   | 0.039                   | 0.044                   |                                                 |
| <b>0129-RP</b>                        | Total Uranium    | 0.009                   | 0.004                   | 0.003                   | 0.005                   | <b>8.72</b>                                     |
|                                       | Thorium-230      | 0.346                   | 0.125                   | 0.093                   | 0.200                   |                                                 |
|                                       | Radium-226       | 0.070                   | 0.211                   | 0.097                   | 0.198                   |                                                 |
|                                       | Polonium-210     | 0.602                   | 0.627                   | 0.814                   | 0.472                   |                                                 |
|                                       | Actinium-227     | 1.585                   | 0.606                   | 0.559                   | 1.189                   |                                                 |
|                                       | Protactinium-231 | 0.365                   | 0.139                   | 0.129                   | 0.274                   |                                                 |

\*=Removed early due to flooding, timeframe limited to 66 days

NS = No Sample collected from this location

ND = Not Detected, analyte concentration below detection limit

NA = Not Applicable, insufficient data available to calculate Annual Dose

The annual dose associated with the stations closest to the site operations (0102, 0105, and 0129) is higher, as expected, compared to the remaining stations. The annual dose associated with seven of the eight locations being analyzed decreased an average of 0.48 mrem (with a maximum of 0.72 mrem at location 0105). Location 0129 saw an increase of 0.64 mrem in annual dose for this quarter.

The results indicate the dose associated with uranium did not significantly change (on average only 0.001 mrem) at all locations compared to the previous quarter. The dose associated with thorium-230 increased (an average of 0.025 mrem) at seven out of eight locations, while radium-226 decreased at five locations (on average of only 0.048 mrem) and increased at three locations (an average of 0.068).

The dose associated with polonium-210 decreased (an average of 0.36 mrem) at all eight locations. The dose associated with actinium-227 (and also protactinium-230) decreased at half the locations while the other half increased. All four sites that had an increase in actinium-227 and protactinium-230 were off-site locations. Whereas the on-site locations decreased in actinium-227 and protactinium-230.

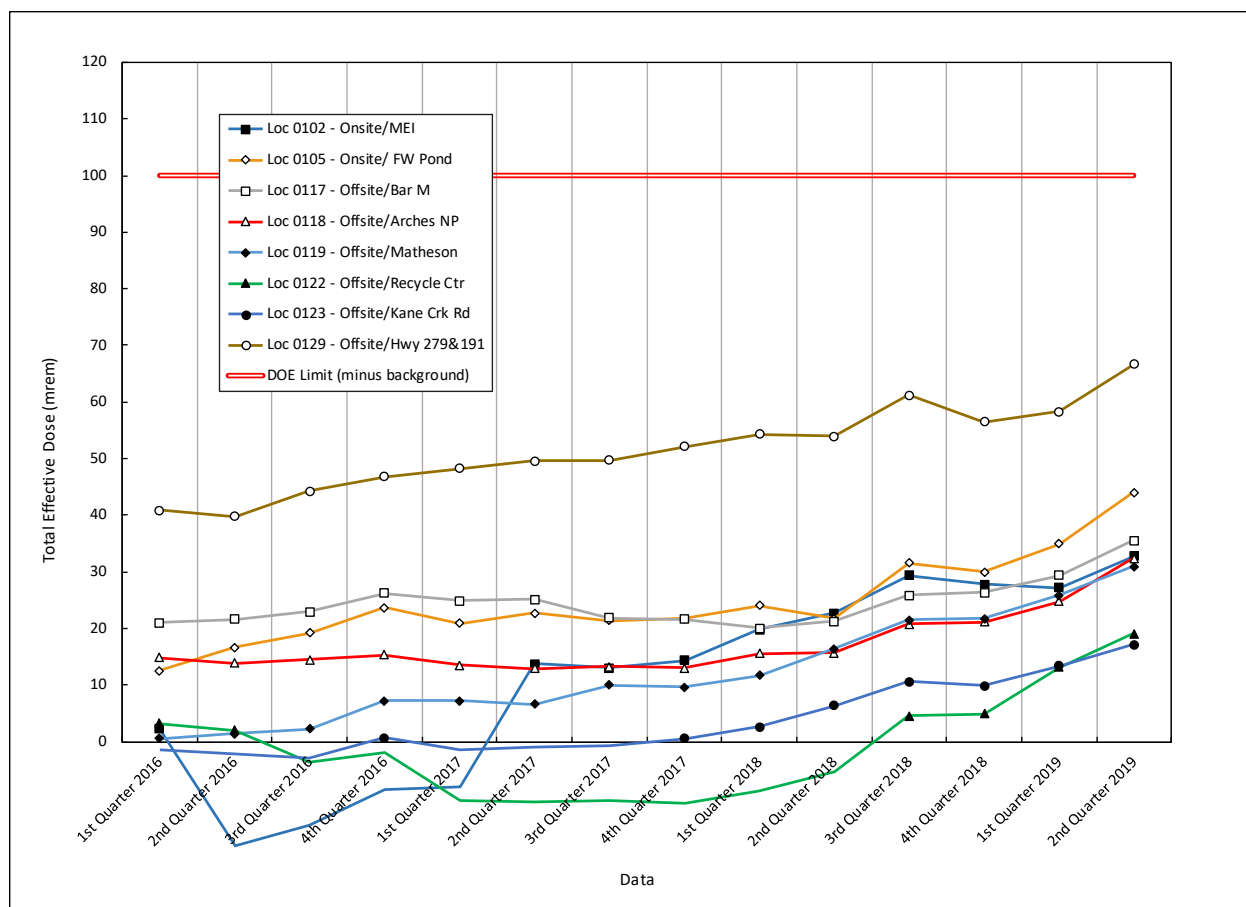


Figure 6. Total Effective Dose Measured at the Moab Locations Since 2016

### 3.1.5 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 32.57 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 111 mrem and then adding the radioparticulate total dose of 3.57 mrem for location 0102, the closest radioparticulate station to the MEI. Figure 6 shows the total effective dose measured at the Moab locations since 2016.

## 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, and two of the on-site and the two off-site stations are equipped with air sampling pumps to measure air radioparticulates. After mill tailings disposal began in the second quarter of 2009, Crescent Junction monitoring location 0306 became the MEI.

### 3.2.1 Meteorological Analysis

Data were collected from the on-site meteorology station and downloaded from the Vista Data Vision online database where meteorological data are uploaded from the site, and hourly averages are analyzed.

For the second quarter 2019 in Crescent Junction, the primary wind direction for the quarter ranged from west to north, making up 44 percent of the wind direction. The Crescent Junction site received more precipitation than the Moab site with 4.83 inches during second quarter 2019. Figure 7 displays a wind rose for this quarter.

### 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.

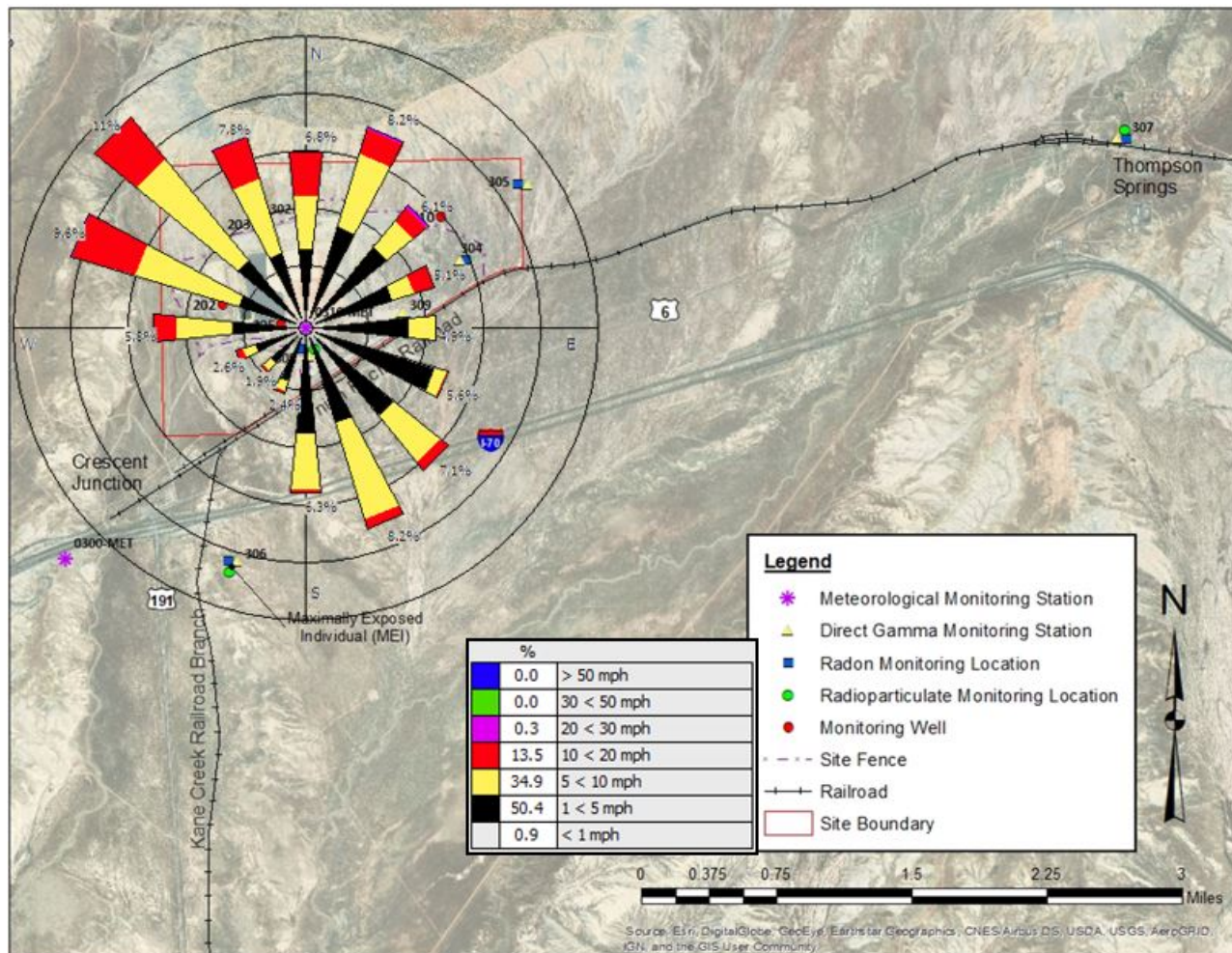


Figure 7. Crescent Junction Wind Rose for Second Quarter 2019

The five Crescent Junction locations that had the highest annual average radon concentrations during the second quarter are shown on Figure 8, which displays the annual average concentrations for these locations since the first quarter of 2016. None of the on- or off-site stations exceeded the limit of 3.9 pCi/L. Compared to the previous quarter, the radon concentrations decreased as much as 0.8 pCi/L or saw no change at all of the nine locations. Locations 0301, 0305, and 0309 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.

### 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 from 2006 to 2009. Table 5 shows quarterly and annual results for the past year, including background, for on- and off-site locations. These results represent the gamma dose an individual would receive from occupying a location for an entire year.

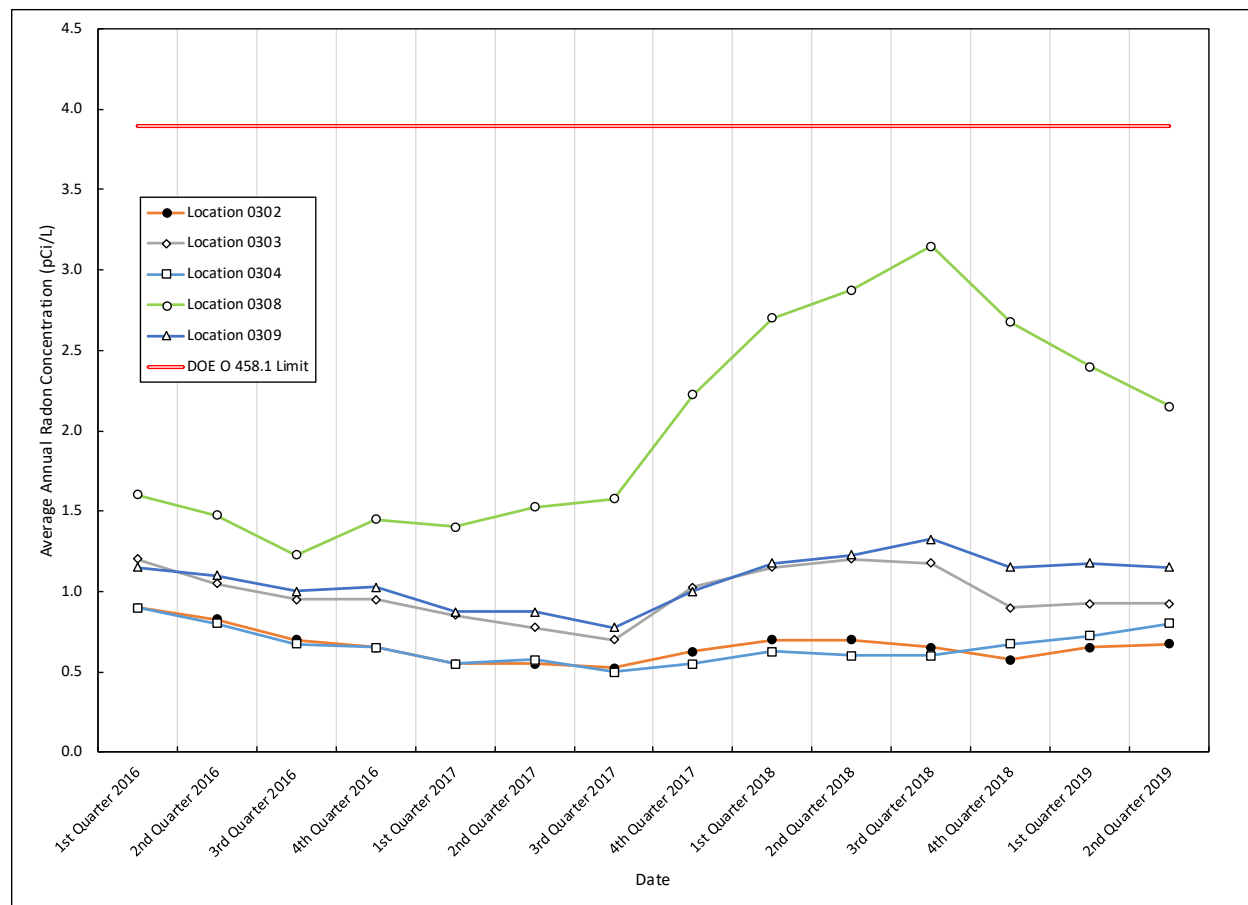


Figure 8. Crescent Junction Locations with Highest Second Quarter 2019 Average Annual Radon Concentrations

Analytical results for the second quarter 2019 indicated the gamma radiation dose increased six of the seven Crescent Junction locations (up to 6 mrem) compared to the previous quarter. For locations 0301 and 0305, the gamma detectors were found damaged on the ground, so the lab was unable to retrieve the data. For location 0301, the duplicate was reported in Table 5.

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

| Station Number            | 3rd Quarter 2018 (pCi/L) | 4th Quarter 2018 (pCi/L) | 1st Quarter 2019 (pCi/L) | 2nd Quarter 2019 (pCi/L) | Annual Average Concentration Based on Four Quarters (pCi/L) |
|---------------------------|--------------------------|--------------------------|--------------------------|--------------------------|-------------------------------------------------------------|
| <b>On-site Locations</b>  |                          |                          |                          |                          |                                                             |
| <b>0301</b>               | 0.4                      | 0.7                      | 0.8                      | 0.4                      | <b>0.6</b>                                                  |
| <b>0302</b>               | <0.4                     | 0.8                      | 1.0                      | 0.5                      | <b>0.7</b>                                                  |
| <b>0303</b>               | 0.5                      | 1.3                      | 1.2                      | 0.7                      | <b>0.9</b>                                                  |
| <b>0304</b>               | 0.4                      | 1.2                      | 0.9                      | 0.7                      | <b>0.8</b>                                                  |
| <b>0305</b>               | <0.4                     | 1.1                      | 0.6                      | 0.6                      | <b>0.7</b>                                                  |
| <b>0308</b>               | 2.6                      | 3.0                      | 1.9                      | 1.1                      | <b>2.2</b>                                                  |
| <b>0309</b>               | 1.0                      | 1.5                      | 1.4                      | 0.7                      | <b>1.2</b>                                                  |
| <b>Off-site Locations</b> |                          |                          |                          |                          |                                                             |
| <b>0306 (MEI)</b>         | <0.4                     | 0.9                      | 0.6                      | 0.5                      | <b>0.6</b>                                                  |
| <b>0307</b>               | <0.4                     | 0.6                      | 0.6                      | 0.4                      | <b>0.5</b>                                                  |

### 3.2.4 Radioparticulates

As with the Moab sampling results, the effective background dose from inhalation of radioparticulates at the Crescent Junction site was not determined, so 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).

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

| Station Number            | 3rd Quarter 2018 (mrem) | 4th Quarter 2018 (mrem) | 1st Quarter 2019 (mrem) | 2nd Quarter 2019 (mrem) | Annual Total Dose Based on Four Quarters (mrem) |
|---------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------------------------------|
| <b>On-site Locations</b>  |                         |                         |                         |                         |                                                 |
| <b>0301</b>               | 28                      | 27                      | 29                      | 33                      | 117                                             |
| <b>0302</b>               | 28                      | 28                      | 30                      | 35                      | 121                                             |
| <b>0303</b>               | 34                      | 33                      | 35                      | 41                      | 143                                             |
| <b>0304</b>               | 29                      | 27                      | 30                      | 32                      | 118                                             |
| <b>0305</b>               | 29                      | 29                      | 31                      | NS                      | NA                                              |
| <b>0308</b>               | 30                      | 28                      | 30                      | 32                      | 120                                             |
| <b>0309</b>               | 36                      | 27                      | 30                      | 33                      | 126                                             |
| <b>Off-site Locations</b> |                         |                         |                         |                         |                                                 |
| <b>0306 (MEI)</b>         | 28                      | 27                      | 29                      | 34                      | 118                                             |
| <b>0307</b>               | 31                      | 28                      | 30                      | 33                      | 122                                             |

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

Compared to the previous quarter, the results indicate that the dose measured at the off-site locations 0306 (the MEI) and 0307 (Thompson Springs) decreased by 0.38 mrem and 0.47 mrem, respectively. On site, the dose measured from the samples collected from location 0308 (at the guard shack) and 0309 (eastern end of the rail bench) increased by 0.17 mrem and 0.08 mrem, respectively.

Similar to the results associated with the Moab site, the data indicate that from the first quarter 2019 to the second quarter 2019, the dose associated with polonium-210 decreased at all four sampling locations (an average of 0.29 mrem), while the dose from uranium saw little to no change. The dose associated with radium-226 increased at three locations (on average 0.005 mrem), while location 0309 saw a decrease of 0.004 mrem.

Doses calculated from the actinium-227 and protactinium-231 results increased at locations 0306, 0308, and 0309, but decreased at location 0307. Lastly, dose from thorium-230 at locations 0307, 0308, and 0309 increased an average of 0.011 mrem, while location 0306 dose saw a 0.01 mrem decrease.

### 3.2.5 Total Effective Dose

The annual total effective dose to the Crescent Junction MEI was 26.16 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 116 mrem and then adding the radioparticulate dose of 2.66 mrem for the MEI.

The total effective dose to the MEI increased 8.9 mrem compared to the first quarter 2019. Figure 9 is a plot of the total effective dose from for the four Crescent Junction locations since 2016. As shown in Figure 5, the background was subtracted from the gamma data to provide more detail; therefore, the DOE Limit is shown as 100 mrem.

As Figure 9 displays, there has been a gradual increase in the total effective dose since late 2017, and this trend has continued in the second quarter of 2019. The total effective dose increased as much as 9.3 mrem (location 0309) since the last quarter. 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          | 3rd Quarter 2018 (mrem) | 4th Quarter 2018 (mrem) | 1st Quarter 2019 (mrem) | 2nd Quarter 2019 (mrem) | Annual Total Dose Based on Four Quarters (mrem) |
|--------------------------|------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------------------------------|
| <b>On-site Locations</b> |                  |                         |                         |                         |                         |                                                 |
| <b>0308-RP</b>           | Total Uranium    | 0.004                   | 0.002                   | 0.002                   | 0.002                   | <b>2.66</b>                                     |
|                          | Thorium-230      | 0.077                   | 0.037                   | 0.035                   | 0.037                   |                                                 |
|                          | Radium-226       | 0.048                   | 0.066                   | 0.053                   | 0.062                   |                                                 |
|                          | Polonium-210     | 0.554                   | 0.505                   | 0.578                   | 0.374                   |                                                 |
|                          | Actinium-227     | 0.629                   | 0.326                   | 0.105                   | 0.396                   |                                                 |
|                          | Protactinium-231 | 0.145                   | 0.075                   | 0.024                   | 0.091                   |                                                 |
| <b>0309-RP</b>           | Total Uranium    | 0.003                   | 0.003                   | 0.002                   | 0.002                   | <b>3.36</b>                                     |
|                          | Thorium-230      | 0.064                   | 0.080                   | 0.061                   | 0.091                   |                                                 |
|                          | Radium-226       | 0.026                   | 0.167                   | 0.114                   | 0.110                   |                                                 |
|                          | Polonium-210     | 0.488                   | 0.537                   | 0.692                   | 0.407                   |                                                 |
|                          | Actinium-227     | 0.233                   | 0.466                   | 0.396                   | 0.676                   |                                                 |
|                          | Protactinium-231 | 0.054                   | 0.107                   | 0.091                   | 0.156                   |                                                 |

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

| Station Number            | Isotope          | 3rd Quarter 2018 (mrem) | 4th Quarter 2018 (mrem) | 1st Quarter 2019 (mrem) | 2nd Quarter 2019 (mrem) | Annual Total Dose Based on Four Quarters (mrem) |
|---------------------------|------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------------------------------|
| <b>Off-site Locations</b> |                  |                         |                         |                         |                         |                                                 |
| <b>0306-RP MEI</b>        | Total Uranium    | 0.002                   | 0.002                   | 0.002                   | 0.003                   | <b>4.23</b>                                     |
|                           | Thorium-230      | 0.009                   | 0.014                   | 0.016                   | 0.006                   |                                                 |
|                           | Radium-226       | 0.003                   | 0.037                   | 0.000                   | 0.002                   |                                                 |
|                           | Polonium-210     | 0.472                   | 0.529                   | 0.700                   | 0.317                   |                                                 |
|                           | Actinium-227     | 0.070                   | 0.089                   | 0.140                   | 0.145                   |                                                 |
|                           | Protactinium-231 | 0.016                   | 0.020                   | 0.032                   | 0.033                   |                                                 |
| <b>0307-RP</b>            | Total Uranium    | 0.003                   | 0.003                   | 0.002                   | 0.002                   | <b>5.03</b>                                     |
|                           | Thorium-230      | 0.014                   | 0.021                   | 0.011                   | 0.012                   |                                                 |
|                           | Radium-226       | 0.000                   | 0.009                   | 0.000                   | 0.008                   |                                                 |
|                           | Polonium-210     | 0.529                   | 0.472                   | 0.602                   | 0.277                   |                                                 |
|                           | Actinium-227     | 0.326                   | 0.373                   | 0.280                   | 0.154                   |                                                 |
|                           | Protactinium-231 | 0.075                   | 0.086                   | 0.064                   | 0.035                   |                                                 |

## 4.0 Data Assessment

Radon detectors, thermoluminescent dosimeters 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 Quality Assurance/Quality Control samples.

Location 0114 was established in the beginning of the fourth quarter 2018 to measure the radioparticulate and gamma doses and the radon concentration in the vicinity of the IA well field, near groundwater extraction well 0810. Because this station was recently established, only quarterly results are presented in this Report, and the annual average radon concentration, annual total gamma dose, and annual dose associated with radioparticulates for this location were not included in this Report.

In addition, due to flooding on and off site, gamma detectors, radon cups, and their respective duplicates were removed by authorized personnel from locations 0106, 0107, 0114, 0119, 0124, 0125, 0126, and 0128. Results from the specified locations reflect only 66 out of the 91 days of the quarter. Radioparticulate station 0114 was also removed at this time, and results only reflect nine out of the standard 13 weeks.

## 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.

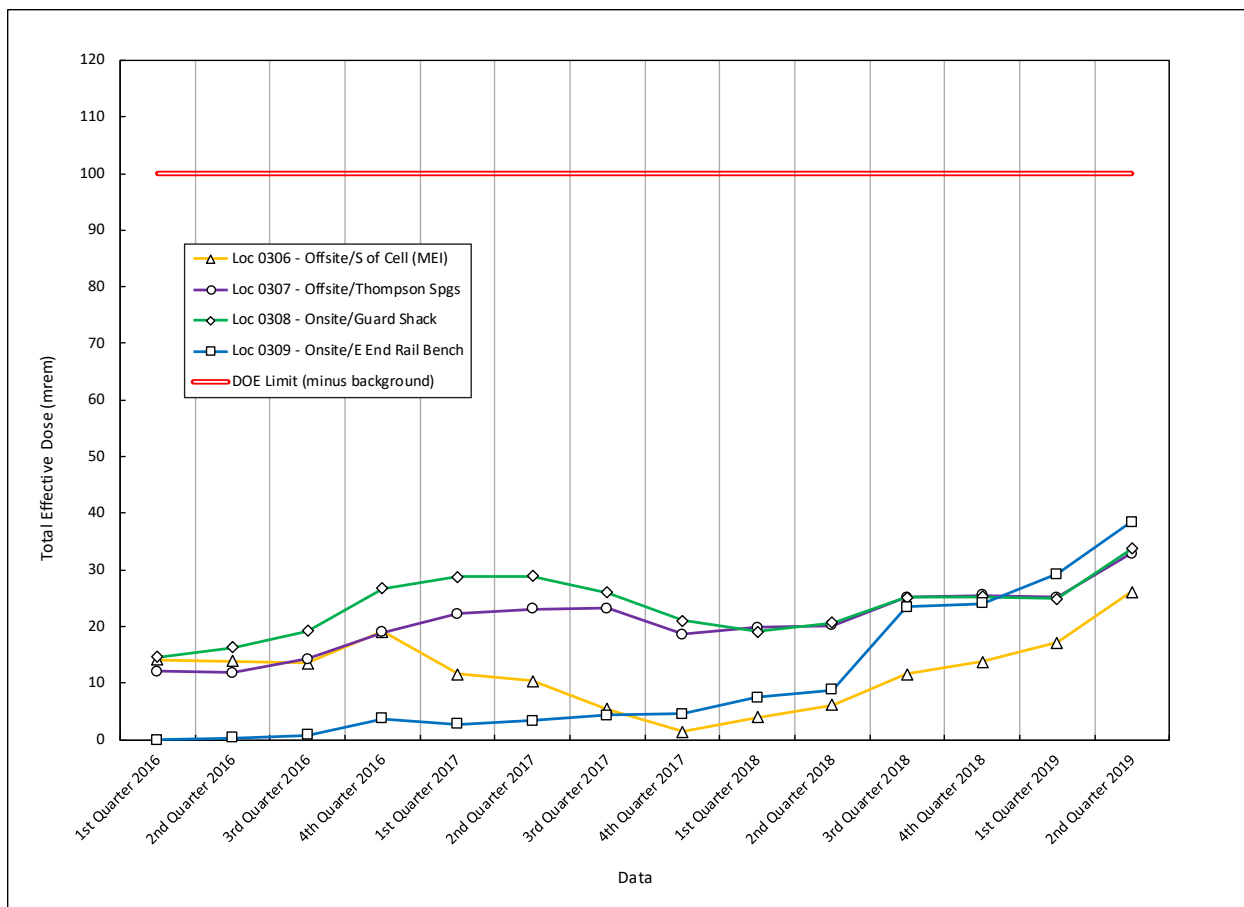


Figure 9. Total Effective Dose Measured at the Crescent Junction Locations Since 2016

As Table 7 displays, the five locations that included duplicate radon samples were within 0.4 pCi/L of each other. The five locations that were equipped with duplicate gamma detectors were all within 2 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. Both gamma detectors at Crescent Junctions location 0305 were damaged when collected. The lab was not able to retrieve the data.

A different radon detector was tested during the second quarter 2019 to determine if there was a significant difference between the detectors historically used (Radtrak2) compared to a new model that has been designed with a higher sensitivity for outdoor use (Rapidos).

Ten of the Rapidos detectors were placed in the same locations where Radtrak2 detectors were placed and exposed for the same amount of time.

Table 8 provides the results of this comparison. Figure 10 is a graphical display of the results. The Radtrak2 results are on the x-axis, and the Rapidos results on the y-axis. Also shown is the 1:1 line, which represents the point on the graph if the results from the two different detectors were identical, and of the 10 test locations, six are below this line which suggests the Radtrak2 detectors generally provide comparable results. On average, the detectors were within 0.04 pCi/L of each other.

Table 7. Duplicate Results for Second Quarter 2019

| Location                 | Result | Duplicate Result |
|--------------------------|--------|------------------|
| <b>Moab</b>              |        |                  |
| Radon:                   | pCi/L  | pCi/L            |
| 0102                     | 1.4    | 1                |
| 0108                     | 1.8    | 1.8              |
| 0111                     | 0.65   | 0.62             |
| Gamma:                   | mrem   | mrem             |
| 0102                     | 31     | 31               |
| 0108                     | 49     | 50               |
| 0129                     | 39     | 37               |
| <b>Crescent Junction</b> |        |                  |
| Radon:                   | pCi/L  | pCi/L            |
| 0303                     | 0.70   | 0.65             |
| 0308                     | 1.1    | 1                |
| Gamma:                   | mrem   | mrem             |
| 0301                     | NS     | 33               |
| 0305                     | NS     | NS               |

NS = No Sample collected from this location (detectors damaged)

Table 8. Comparison of Radon Detector Results for Second Quarter 2019

| Location | Radtrak2 Conc.(pci/L) |             | Rapiods Conc. (pCi/L) |             |
|----------|-----------------------|-------------|-----------------------|-------------|
|          | Results               | Range (+/-) | Results               | Range (+/-) |
| 0101     | 1.5                   | 0.25        | 1.5                   | 0.25        |
| 0106*    | 2.6                   | 0.5         | 2.5                   | 0.38        |
| 0108*    | 1.8                   | 0.33        | 2.2                   | 0.33        |
| 0113     | 1.7                   | 0.33        | 1.9                   | 0.3         |
| 0119*    | 1.0                   | 0.41        | 1.1                   | 0.25        |
| 0126*    | 2.0                   | 0.41        | 1.9                   | 0.3         |
| 0129     | 1.2                   | 0.28        | 1.4                   | 0.22        |
| MEI      | 1.0                   | 0.25        | 0.86                  | 0.17        |
| 0308     | 1.1                   | 0.3         | 1.0                   | 0.28        |
| 0309     | 0.73                  | 0.25        | 0.7                   | 0.14        |

\*Removed early due to potential flooding, to 66

## 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 the second quarter of 2019.

## 4.3 Summary

Data collected during the second quarter of 2019 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.

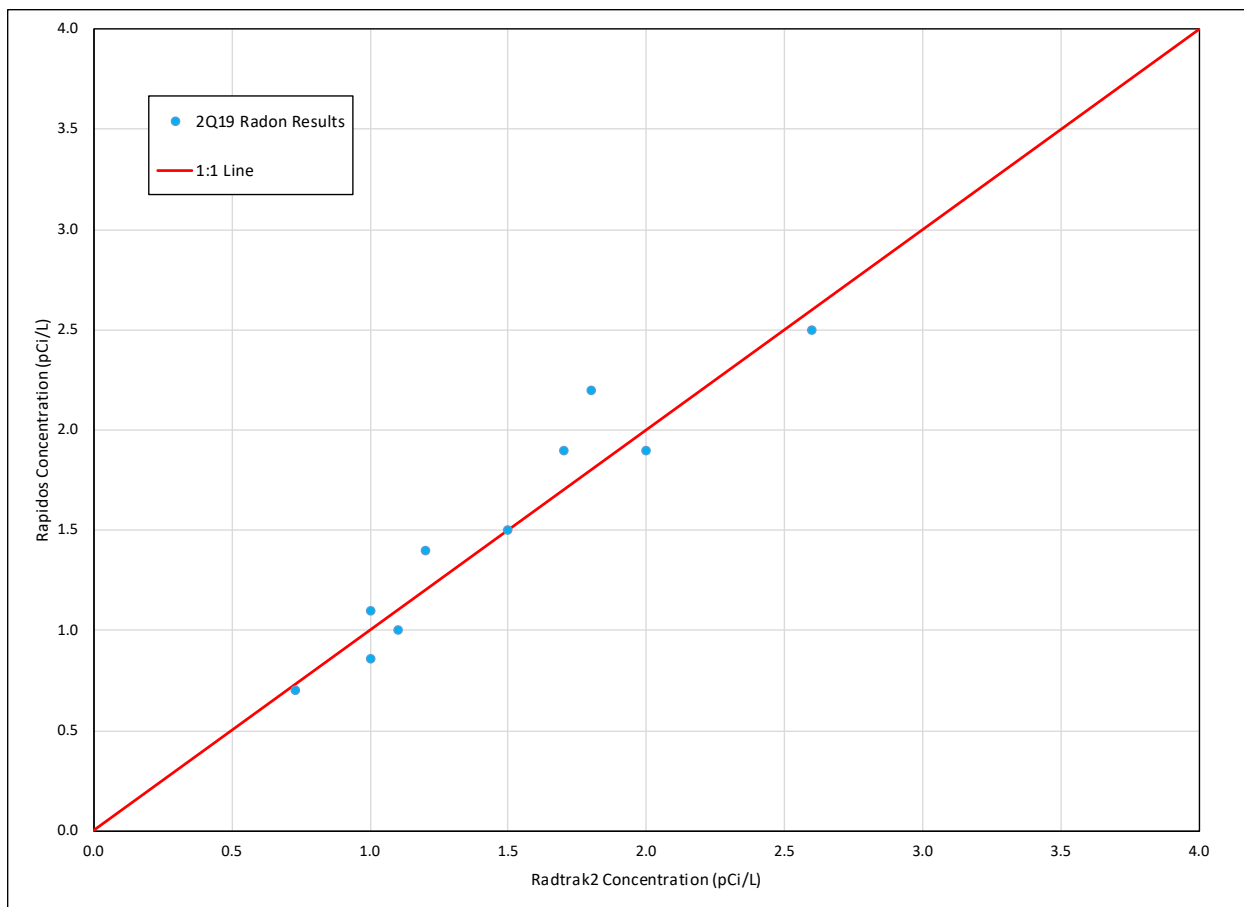


Figure 10. Graphical Display of the Results for the Radon Detector Comparison

## 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."