# Stand Alone Report 3

# Baseline Radiological Investigation Report in Support of the Upton Rare Earth Processing Plant

# BASELINE RADIOLOGICAL INVESTIGATION REPORT

## BEAR LODGE PROJECT UPTON PLANT
## Weston County, Wyoming

**April 2015**

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## ACRONYMS AND ABBREVIATIONS

| Acronym | Definition |
|---|---|
| cm | centimeters |
| cpm | counts per minute |
| EPA | U.S. Environmental Protection Agency |
| ERG | Environmental Restoration Group, Inc. |
| GPS | Global Positioning System |
| HPIC | High Pressure Ion Chamber |
| in. | inch |
| IQR | interquartile range |
| km | kilometer |
| LLD | lower limit of detection |
| $\mu R\ hr^{-1}$ | microRoentgens per hour |
| m, $m\ s^{-1}$ | meter, meters per second |
| MDL | method detection limit |
| $mg\ kg^{-1}$ | milligrams per kilogram |
| n | number of observations |
| $pCi\ g^{-1}$ | picocuries per gram |
| $pCi\ m^{-2}\ s^{-1}$ | picocuries per meter squared per second |
| QA/QC | Quality Assurance/Quality Control |
| Ra-226 | radium-226 |
| Ra-228 | radium-228 |
| RER | Rare Element Resources, Inc. |
| RER | replicate error ratio |
| RL | reporting limit |
| Rn-222 | radon-222, or radon |
| RPD | relative percent difference |
| SAP | Sampling and Analysis and Quality Assurance Plans (Draft) |

## ACRONYMS AND ABBREVIATIONS (CONCLUDED)

| Acronym | Definition |
|---|---|
| TSF | tailings storage facility |
| Th-nat | natural thorium |
| UAMS | Upton air monitoring station |
| µCi $f^{-1}$ | microcuries per filter |
| µCi $ml^{-1}$ | microcuries per milliliter |
| µg $f^{-1}$ | micrograms per filter |
| µg $m^{-3}$ | micrograms per cubic meter |
| U-nat | natural uranium |

# 1.0 INTRODUCTION

Rare Element Resources, Inc. (RER) is proposing the construction of a rare earth element (REE) mine and hydrometallurgical (hydromet) processing plant, as part of its Bear Lodge Project. The mine will be located in Crook County, Wyoming, approximately 12 miles north of Sundance, Wyoming. Mine ore will be physically upgraded into a pre-concentrate and shipped to the Upton Plant that includes the hydromet facility and tailings storage facility (TSF) near Upton in Weston County, Wyoming. The hydromet will process the pre-concentrate through leaching, neutralization and precipitation to a final REE product. Tailings generated from the hydromet will be placed in the TSF.

Environmental Restoration Group, Inc. (ERG) conducted a baseline radiological investigation of the Upton Plant site in support of this proposed development, as requested by RER. The work described in this report was performed in accordance with applicable requirements in *Bear Lodge Project Upton Plant/TSF Environmental Sampling and Analysis and Quality Assurance Plans (Draft)* (SAP [RER, 2011]).

The objective of the radiological investigation —and monitoring program by extension— is to establish the baseline condition of the Upton Plant including 1) concentrations of radionuclides and lanthanides (cerium and lanthanum) in airborne particulates and gases (i.e. radon-222[radon]), surface soil, surface water, and groundwater, 2) gamma exposure rates, and 3) radon flux from soil surface to assess future potential impacts to human health and the environment during project construction, operation, and closure. Radiological impacts incurred during the development and operation of the Upton Plant, if any, will be evaluated in part by comparing the data sets of the baseline and operational monitoring. The monitoring of particulate matter (particles with diameters less than 10 ($PM_{10}$) and ($PM_{2.5}$) 2.5 microns —unrelated to radiological monitoring but relevant to pre-operational site conditions— is addressed in this investigation.

It is anticipated that radon, natural uranium and thorium, radium-226, and radium-228 will be the primary radionuclides of potential concern in assessments of exposure pathways.

Phase 1 of the work, conducted in June 2012 with continued air monitoring, addressed radon concentrations in air and baseline radionuclide concentrations in soils; and associated radon flux and gamma exposure rates. This report contains the results of baseline measurements of 1) radioactive and lanthanide (cerium and lanthanum) particulates and 2) $PM_{10}$ and $PM_{2.5}$ concentrations in air, all obtained from June 2012 to September 2014. Baseline radionuclide concentrations in groundwater and surface water are addressed and reported separately in the environmental report of RER's license application to the U.S. Nuclear Regulatory Commission (RER, 2015).

## 1.1 Description of the Project

The Project is located in Weston County, Wyoming; specifically Township 48 North, Range 65 West including all of Section 33 and parts of Sections 28, 29, and 32. Surface ownership within the Project is comprised of 850 acres of private land. Figure 1.1 shows the location of the Upton Plant.

## 1.2 Purpose and Scope

The objective of the investigation was to establish baseline concentrations of radon and radioactive, lanthanide, $PM_{10}$ and $PM_{2.5}$ particulates in air; and radionuclides in surface soil (0-15 centimeters [cm]) and related radon flux and exposure rates at the Upton Plant. This information will be used in part to assess future potential impacts to human health and the environment, if any, during construction, operation, and closure phases. The results from monitoring of radionuclides in groundwater and surface water have been investigated and are reported separately in the Environmental Report (ER) submitted to NRC as part of the license application (RER, 2015).

The collection of soil samples and other quality-affecting work performed in June 2012 were conducted in accordance with

- the requirements of Section 2.3 of the SAP;
- applicable ERG Standard Operating Procedures; and
- RER's Health and Safety Program and the *Bear Lodge Project Health and Safety Plan*, *Draft* (Knight Piésold, 2011).

## 1.3 Organization and Contents

Following this introduction, Section 2 summarizes the scope of the investigation and identifies any deviations from the SAP. Section 3 documents the results of the gamma survey and associated predictions of exposure rates. Section 4 documents the analytical results for soil samples and predictions of radium-226 and natural thorium concentrations in surface soil samples from gamma survey results. Section 5 discusses associated data quality issues. Section 6 presents the results of radon flux measurements. Section 7 presents a description of and the locations of passive radon track etch detectors. Section 8 presents the particulate concentrations (long-lived radionuclides, stable rare earth elements, and $PM_{10}$ and $PM_{2.5}$ fractions of particulate matter) in air. Section 9 presents the summary and conclusions, followed by references in Section 10.

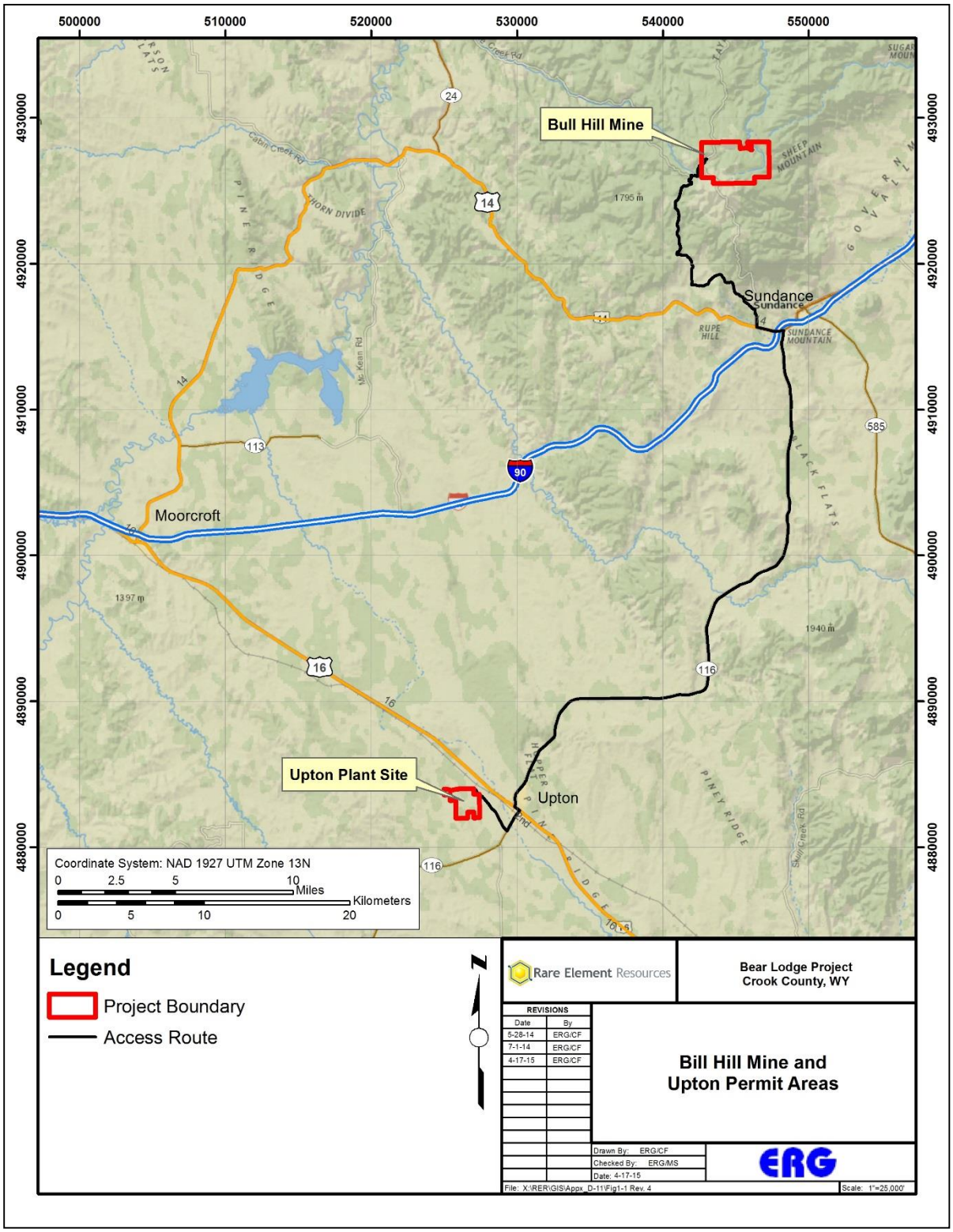



**Figure 1.1. Upton Plant Site Layout and Geographic Setting**

# 2.0 BASELINE FIELD INVESTIGATION SUMMARY AND SCOPE

## 2.1 Overall Scope of Project

The baseline radiological field investigation consisted of:

- a Global Positioning System (GPS)-based gamma survey conducted along transects, spaced at 100 meters (m), spanning the Upton Plant;
- co-located exposure and integrated gamma count rate measurements;
- deployment of passive radon track etch detectors at nine biased locations;
- collection of surface soil samples at 16 randomly selected locations;
- radon flux measurements at five of the soil sample locations; and
- collection of particulate concentrations (long-lived radionuclides, stable rare earth elements, and $PM_{10}$ and $PM_{2.5}$ fractions of particulate matter) in air at five Upton air monitoring stations (UAMS).

Table 2.1 summarizes the scope of the field program and the following section identifies deviations from the SAP.

*To assist the reader, it is important to note the following issues that are relevant to the scope of work:*

***Differences in scanning and integrated gamma-ray measurements.*** *Scanning measurements are those recorded during the walking survey, with the ratemeter/scaler in ratemeter mode. Count rate measurements are recorded every second in this method and stored individually, each with its own geoposition. Integrated measurements, on the other hand, are recorded, in the case of this investigation, at one location for one minute, with the ratemeter/scaler in scaler (integrating) mode. In this mode, the detector integrates the number of interactions (counts) within the one minute counting period. Both types of measurements are reported as counts per minute (cpm).*

***Presentation of the scanning data.*** *Project-wide exposure rates and radium-226 concentrations were predicted from linear correlations between integrated gamma count rates and co-located exposure rate measurements and soil samples, respectively. Because the predicted values are multiplicative and additive factors of gamma count rates, figures depicting Upton Plant-wide scanning gamma count rates; and predicted exposure rates and/or radium-226 concentrations will appear similar. Of these, we have chosen to display only the predicted exposure rates, because they are the most directly meaningful to worker and public safety.*

**Table 2.1. Summary of Radiological Investigation Scope**

| Survey Method/Endpoint | Baseline Investigation Scope | Parameters Evaluated |
|---|---|---|
| Gamma Survey | Scanning measurements of gamma count rates, tagged with x- and y- geopositions, taken every second at approximately 0.5 m. above ground surface along 100 m transects at less than 1.5 m $s^{-1}$. | Used to estimate exposure rates, surface soil radium-226 and natural thorium concentrations, and to identify anomalies and/or areas for biased sampling. |
| Random Soil Sampling | Random samples collected at 16 locations. All random samples were surface (0-15 cm) samples. Four duplicate samples were collected. | Th-nat and U-nat (ICP-MS); Ra-226 and Ra-228 (Gamma Spectroscopy) |
| Exposure Rate Monitoring | External dose rates were assessed by way of correlating exposure rate and co-located, integrated gamma count rate measurements. Given the strong linear correlation between the exposure rate and associated gamma survey measurements, ERG considers the interpolated exposure rates documented herein to be reliable estimates. | Exposure Rates |
| Radon Flux Measurements | Radon flux measurements at five locations (coinciding with random soil samples). Two duplicate measurements were made. | Rn-222 flux from soil |
| Radon Measurements in Air | Radon track etch measurements at nine locations. | Rn-222 in air |
| Airborne Particulate Measurements | Air sampling (total, stable rare earth elements, $PM_{2.5}$, and $PM_{10}$) at four locations from June 2102 to September 2014 at various intervals. A fifth location (UAMS-5) was added in May 2013. | Cerium, lanthanum, U-nat, and Th-nat (ICP-MS); Ra-226 (gas proportional counting), and Th-230 (alpha spectroscopy) |

Notes:
cm = centimeters
ERG = Environmental Restoration Group
HPIC = High Pressure Ion Chamber
ICP-MS = Inductively Coupled Plasma-Mass Spectroscopy
in. = inch
m = meter
m $s^{-1}$ = meters per second
Ra-226 = radium-226
Ra-228 = radium-228
RER = Rare Element Resources
Rn-222 = radon-222
Th-230 = thorium-230
Th-nat = natural thorium
U-nat = natural uranium

## 2.2 Deviations from the SAP

No deviations from the SAP were identified.

## 2.3 Future Work

The scope of work addressed in the SAP is ongoing. Baseline monitoring of air (ambient radon and particulates) will continue through 2015. Sampling of groundwater and surface water was performed in 2012, 2013, and 2014; and will continue throughout 2015.

# 3.0 GPS-BASED GAMMA (DIRECT RADIATION) SURVEY

This section documents the results of the baseline gamma radiation survey of the Upton Plant conducted in June 2012. The findings discussed in this section are reflected largely in the supporting figures; the text is limited to a discussion of trends and salient findings.

## 3.1 GPS Survey Methods

A GPS-based gamma survey was conducted at the Upton Plant on three days, between June 11 and 13, 2012. The detection systems were unshielded 2-in. by 2-in. sodium iodide detectors (Ludlum Model 44-10), each of which was coupled to a ratemeter/scaler (Ludlum Model 2221, set in ratemeter mode) and, in turn, a Trimble Pro XRS GPS Receiver with Trimble TSCe datalogger. Scanning was performed on north-south transects spaced at 100 m, at a speed less than 1.5 m $s^{-1}$ with differentially corrected x- and y-coordinates and gamma count rates recorded every second. The survey was conducted on foot while carrying the requisite equipment in backpacks. The detectors were held at approximately 0.5 m above ground surface in the walking survey.

The survey instruments were in calibration and function checked daily, before and after use. Calibration and function forms are provided in Appendix A.

## 3.2 Results of GPS-Based Gamma Survey

Data presented in the following sections indicate that the distribution of the Upton Plant gamma count rates is non-parametric. The data also indicate two statistically distinct populations. The data are first summarized collectively.

The gamma count rates were converted into exposure rates, using the method and linear correlations described in Section 3.3. The gamma count rates are displayed as exposure rates in Figure 3.3. All of the statistical analyses and summaries presented henceforth, including the illustrations, were developed using Minitab 15: a statistical software.

### 3.2.1 Upton Plant-Wide Gamma Count Rates

Table 3.1 provides a statistical summary of the gamma count rates recorded in the Upton Plant area.

**Table 3.1. Statistical Summary of Gamma Count Rates**

| Estimator/Endpoint | Gamma Data (cpm) |
|---|---|
| **Mean (arithmetic)** | **15,910** |
| Standard Deviation | 1,854 |
| **Median** | **16,091** |
| 1st quartile | 14,687 |
| 3rd quartile | 17,092 |
| IQR | 2,405 |
| Minimum | 8,637 |
| Maximum | 27,148 |
| Counts | 38,023 |

Notes:
cpm = counts per minute
IQR = interquartile range

Illustration 3.1 is a histogram of the frequency distribution of the gamma count rate data collected within the Upton Plant. A theoretical lognormal distribution is plotted as the smooth line on the illustration, for the purpose of reference. The distribution peaks at approximately 16,000 cpm and tails off at approximately 11,000 (low end) and 20,000 cpm (high end). In addition, the distribution appears to be bimodal and fails to approximate normal and/or lognormal statistical tests.

Illustration 3.2 is a probability distribution plot, with the theoretical distribution (blue line) set as normal. Approximately 99 percent of the points align with the theoretical normal distribution; however, it cannot be described as normal because 1) there is a discrepancy between the theoretical and actual distributions on the tails and 2) the data set does not pass the Anderson-Darling Normality Test at a 95 percent level of significance.

Illustration 3.3 is a probability distribution plot, with the theoretical distribution set as lognormal. The majority of points (approximately 99.5 percent) align with the theoretical lognormal distribution; however, the distribution of gamma count rates cannot be described as lognormal because there is a statistical discrepancy between the theoretical and actual distributions on the tails.

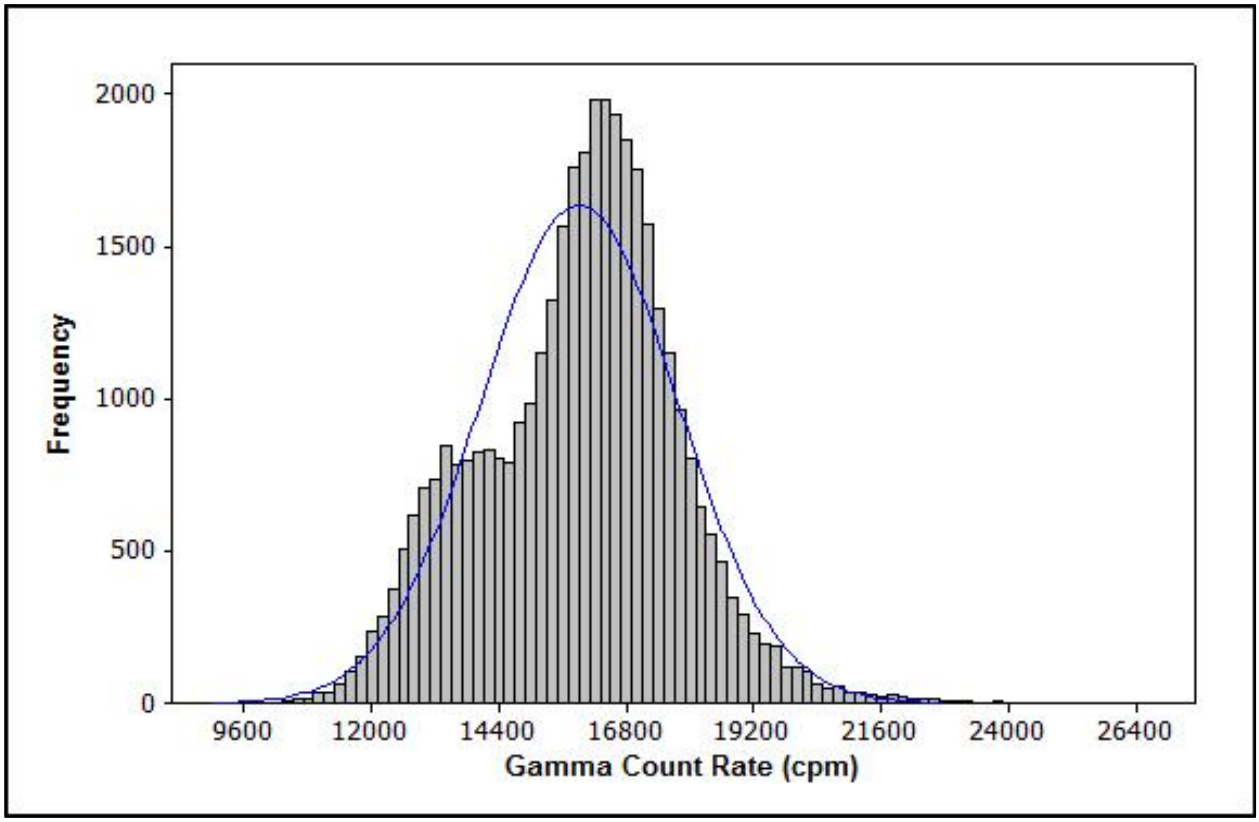



**Illustration 3.1. Histogram of Gamma Count Rates**

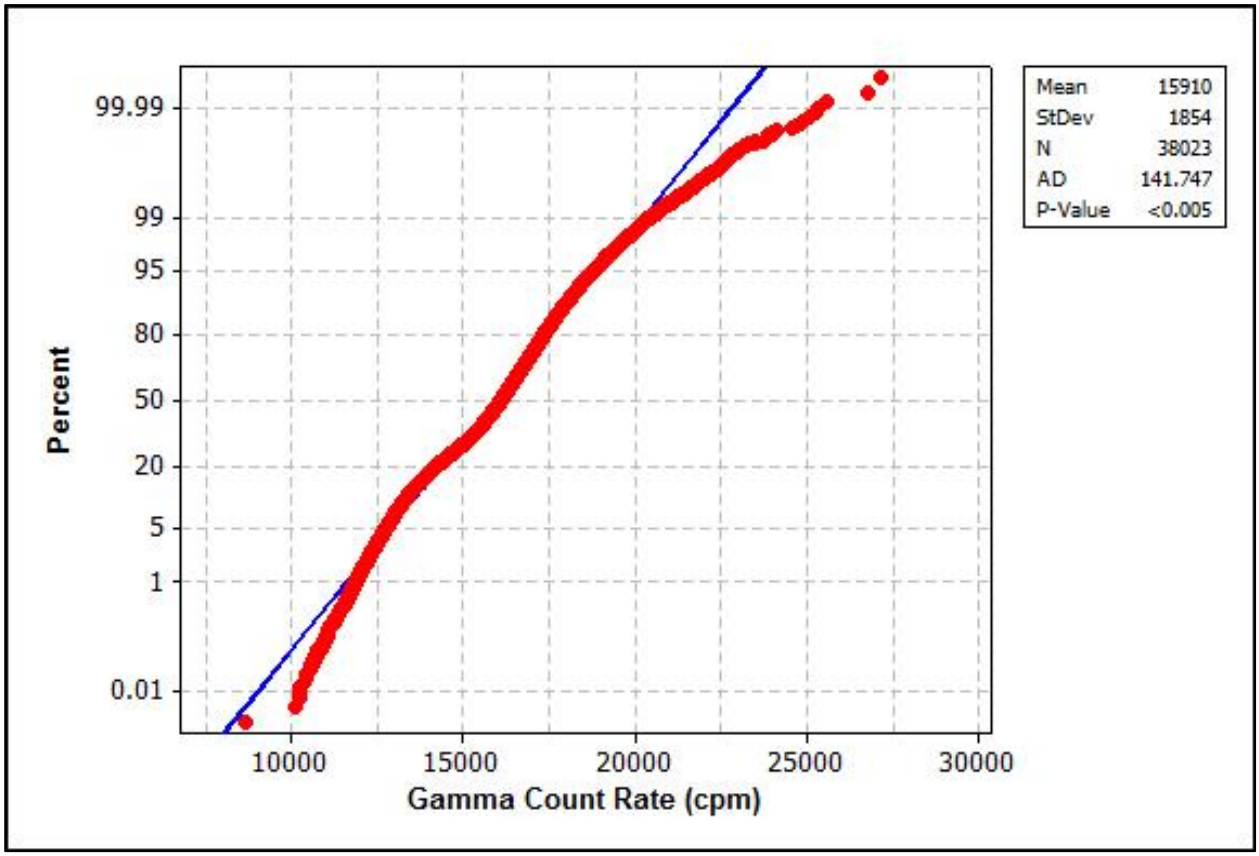



**Illustration 3.2. Normal Probability Plot of Gamma Count Rates**

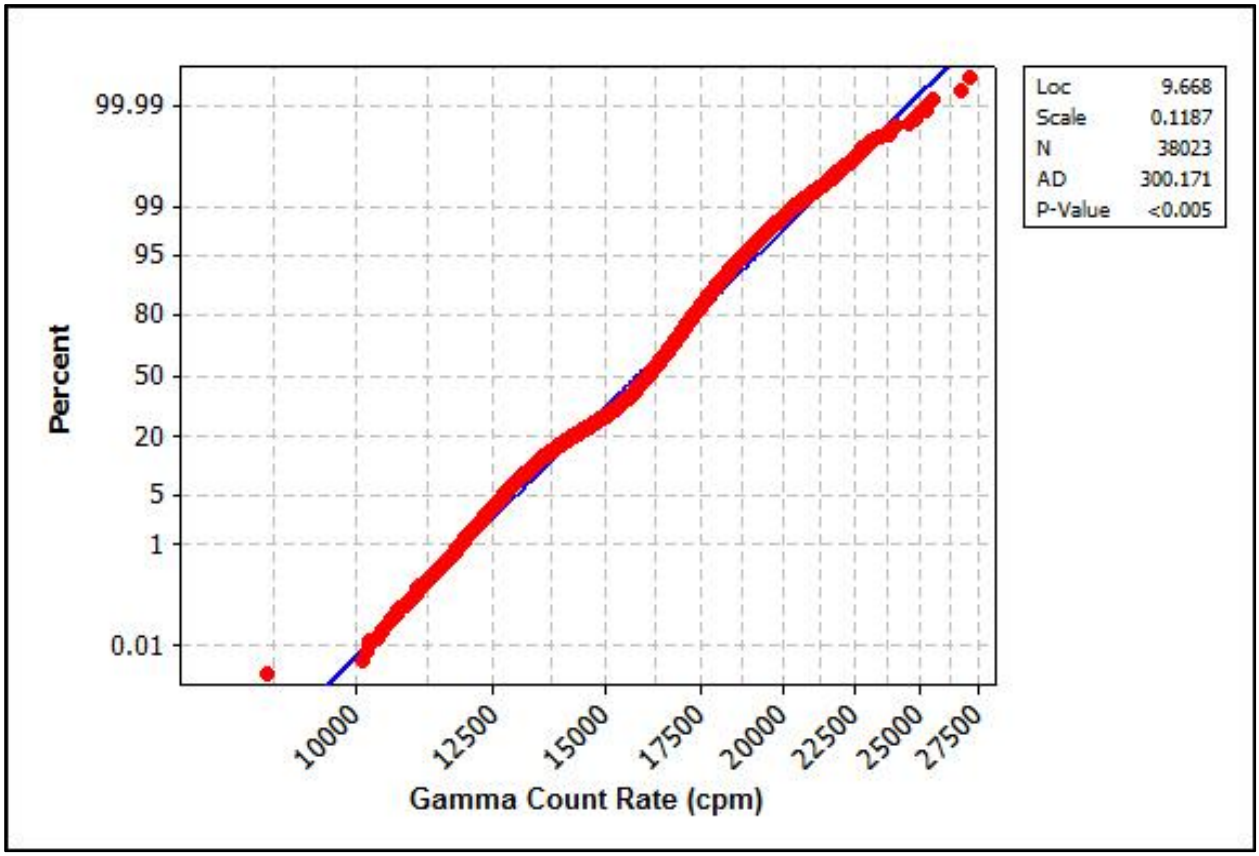



**Illustration 3.3. Lognormal Probability Plot of Gamma Count Rates**

Additional tests of the data sets (results not reported herein) indicated that none of them followed a parametric distribution. Because no underlying distribution could be defined, data analysis and summaries were performed using non-parametric statistical methods, which are less sensitive to extreme observations typical of skewed data distributions and assume no underlying distribution.

The central tendency and variability of non-parametric data can be described by the median and the interquartile range (IQR), respectively. The median of the population is 16,091 cpm. The IQR encompasses the range between the 1st quartile (the first 25 percent of ascending, ranked values) and 3rd quartile (the first 75 percent of ascending, ranked values). The IQR is 2,405 cpm (or 17,092 less 14,687 cpm).

### 3.2.1 Area-Specific Gamma Count Rates

A visual observation of the gamma count rates indicates that the data can be apportioned to two areas: 1) those west of a north-south trending ridge and 2) the remainder. The distributions of these data sets —each tested for normality and lognormality—are nonparametric. A Mann-Whitney test indicates that the distributions are statistically different, at a confidence level of 95 percent.

Gamma count rates west of the ridge average 13,583 cpm, with a median and standard deviation of 13,521 and 1,035 cpm, respectively. Those in the remainder of the Upton Plant average 16,604 cpm, with a median and standard deviation of 16,529 and 1,430 cpm, respectively.

## 3.3 Derivation of Exposure Rates Based on HPIC Correlation

One-minute integrated counts made using the sodium iodide detector were correlated to exposure rate measurements, made with a High Pressure Ion Chamber (HPIC) at eleven locations. Figure 3.1 shows the locations of the measurements. Table 3.2 presents the results of the paired measurements. Exposure rates are reported in microRoentgens per hour ($\mu R\ hr^{-1}$). Gamma measurements are reported as cpm.

The HPIC was in current calibration and function checked daily, before and after use. Calibration and function forms for the HPIC are provided in Appendix A.

The linear regression model for the eleven pairs of measurements is:

$$\text{Exposure rate } (\mu R\ hr^{-1}) = 5x10^{-4} \text{ x cpm} + 5.76$$

Plotting of the data from the HPIC and sodium iodide detector indicates that, with a correlation coefficient, $R^2$, of 0.99, the sodium iodide detector response explains 99 percent of the variance in the exposure rate; thus, the model strongly fits the data.

Figure 3.2 is a plot of the linear regression. This model was used to convert the gamma count rate data to exposure rates. Table 3.3 presents summary statistics for the exposure rates that are predicted from the population of scanning gamma count rates observed in the Upton Plant. Figure 3.3 presents the exposure rates predicted from all of the scanning gamma count rates observed within the Upton Plant. This figure also shows the two areas of differing gamma count rates. As stated in Section 2.1, the gamma survey results are expressed as exposure rates to allow a more meaningful context for interpretation than the relative magnitude of individual gamma readings. Each datum is assigned to one of three colors —from dark blue to green— based on its value.

**Table 3.2. Integrated Gamma Count Rates and High Pressure Ion Chamber Measurements**

| Measurement Location | Easting[a] | Northing[a] | Sodium Iodide Detector Response (cpm) | HPIC Response ($\mu R\ hr^{-1}$) |
|---|---|---|---|---|
| PIC-01 | 526635.3 | 4883935.2 | 15958 | 14.4 |
| PIC-02 | 525096.5 | 4883855.1 | 13915 | 13.2 |
| PIC-03 | 525987.9 | 4882773.8 | 13950 | 13.2 |
| PIC-04 | 527194.8 | 4883317.2 | 18367 | 15.6 |
| PIC-05 | 527179.8 | 4884002.4 | 22100 | 17.6 |

Notes:
[a] Coordinate system is NAD 1983, UTM Zone 13N, meters.
cpm = counts per minute
$\mu R\ hr^{-1}$ = microRoentgens per hour

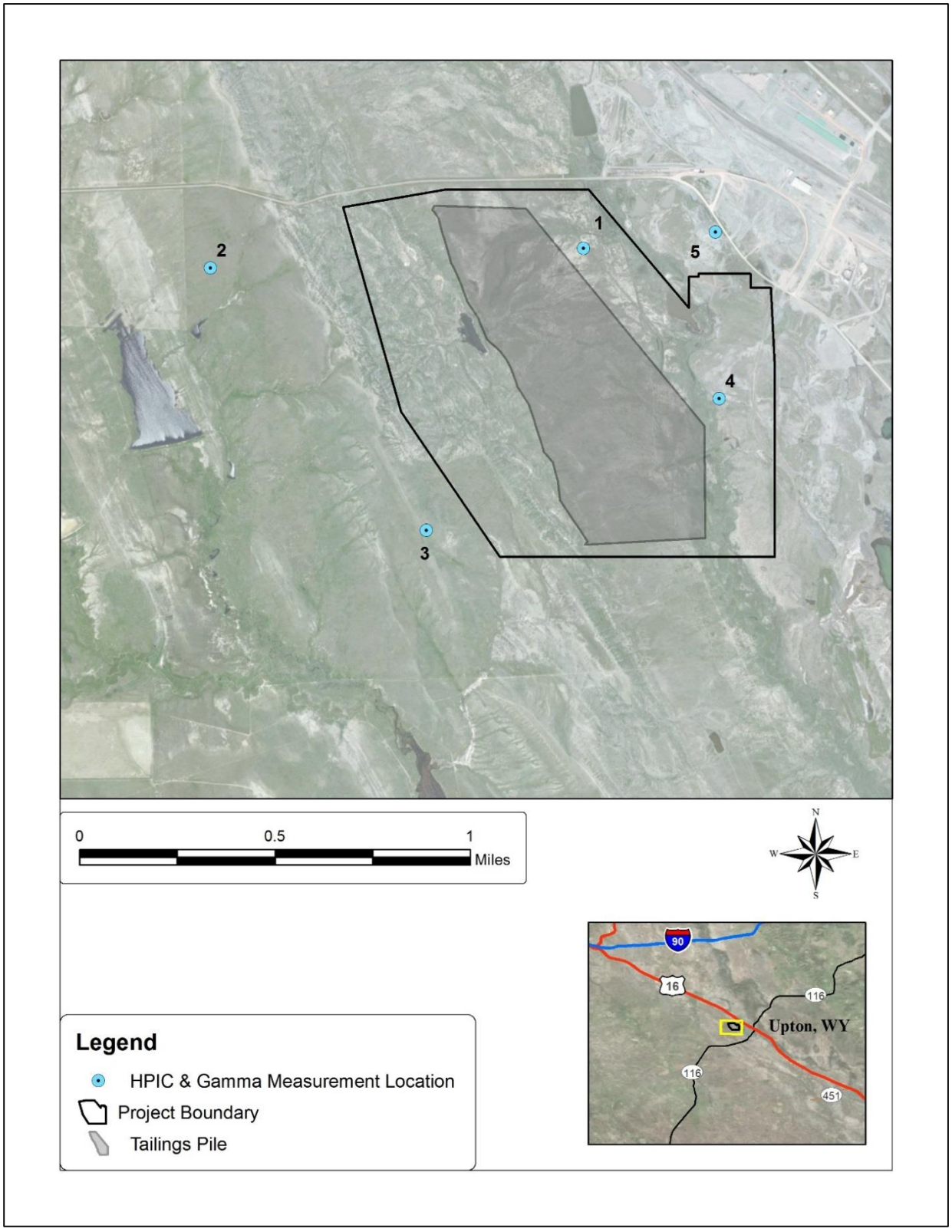



**Figure 3.1. High Pressure Ion Chamber and Gamma Count Rate Measurement Locations**

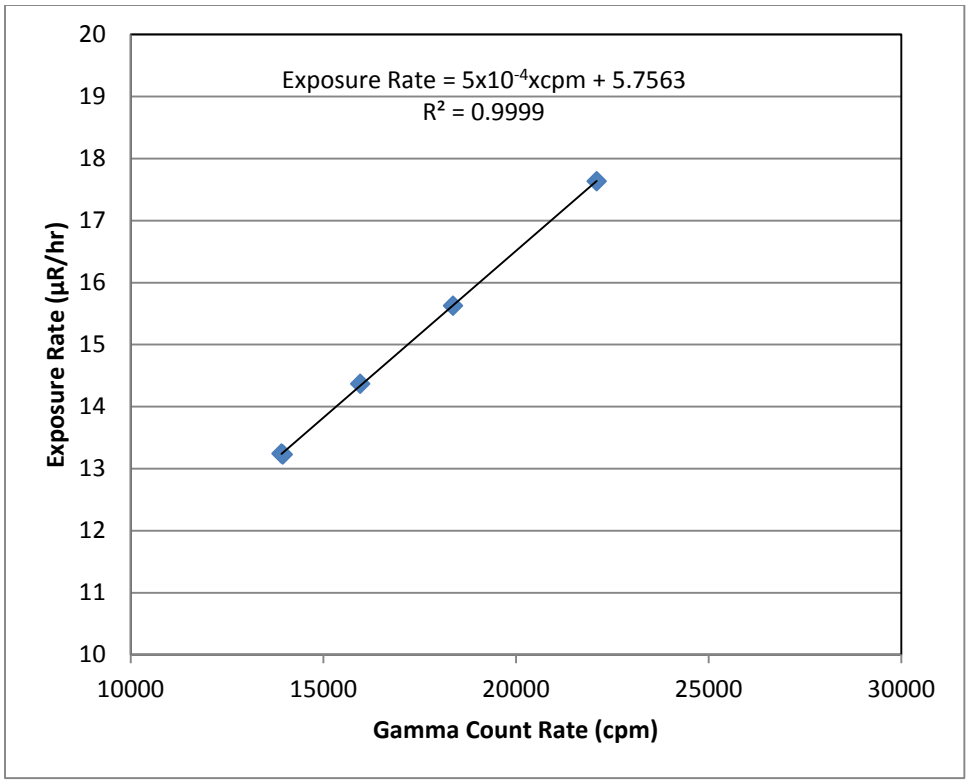



**Figure 3.2. High Pressure Ion Chamber and Gamma Count Rate Measurement Linear Regression Model**

**Table 3.3. Statistical Summary of Predicted Exposure Rates**

| Estimator/Endpoint | Exposure Rate ($\mu R\ hr^{-1}$) |
|---|---|
| **Mean (arithmetic)** | **13.7** |
| Standard Deviation | 0.9 |
| **Median** | **13.8** |
| 1st quartile | 13.1 |
| 3rd quartile | 14.3 |
| IQR | 1.2 |
| Minimum | 10.1 |
| Maximum | 19.3 |
| Count | 38,023 |

Notes:
cpm = counts per minute
IQR = interquartile range
$\mu R\ hr^{-1}$ = microRoentgens per hour

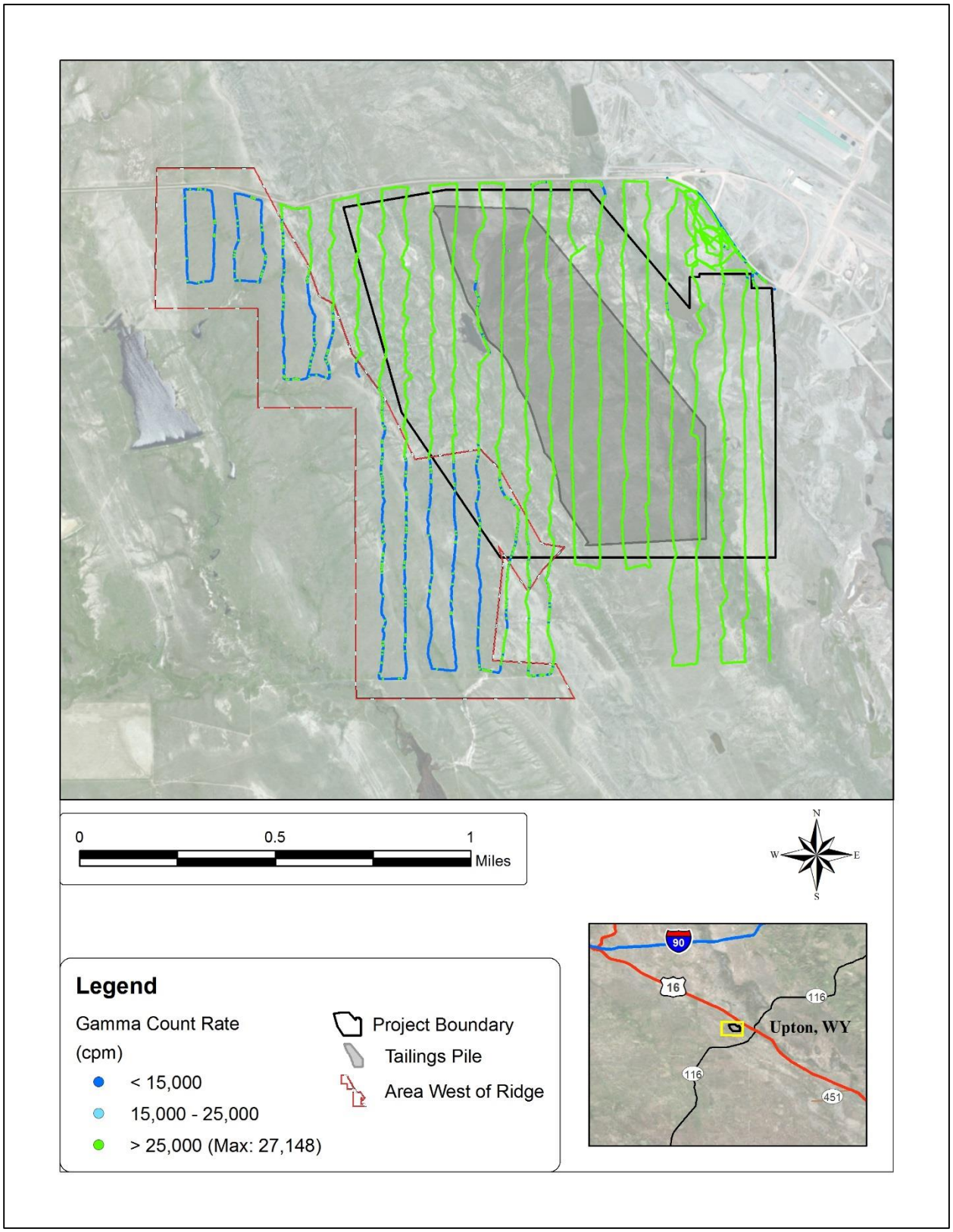



**Figure 3.3 Exposure Rates Predicted from Gamma Count Rates**

The predicted exposure rates at the Upton Plant can be summarized as follows:

- The range is 10.1 to 19.3 μR $hr^{-1}$. The IQR is 1.2 μR $hr^{-1}$ (14.3 less 13.1 μR $hr^{-1}$).
- There appear to be no elevated levels of radioactivity.
- There are two statistically distinct areas of exposure rates.

# 4.0 BASELINE RADIOLOGICAL INVESTIGATION SOIL SAMPLING

This section presents the results of the baseline soil sampling conducted in June 2012. Section 4.1 summarizes the soil sampling field approach, scope, and analytes. Section 4.2 discusses the results obtained for radium-226, the focus of the baseline soil sampling program. Section 4.3 addresses results for other radiological parameters. Section 4.5 discusses the correlation between radium-226 and natural thorium concentrations in soil and gamma count rates. The laboratory analytical reports for the soil analyses are provided in Appendix B.

## 4.1 Sampling Strategy and Approach

The soil sampling strategy for the Upton Plant consisted of random sampling at the 16 locations shown in Figure 4.1, in accordance with the strategy in the SAP. The identifiers in Figure 4.1 were truncated to facilitate presentation; e.g., Sample SS-05-SS-061412 was changed to 5. Table 4.1 lists the coordinates of the sample locations. Radon flux measurements were taken at five of the sample locations, as noted in Table 4.1.

The number and types of analytes for the surface soil samples were based on obtaining general knowledge of the distribution of the primary long-lived radionuclides in the uranium and thorium natural decay series. The sample locations were determined using Equation 4 of Section 2.3.3.4 in the SAP, which is:

$$N > \left( \frac{t}{r} cv \right)^2$$

Where:

N = number of samples
t = the t-statistic (1.645)
r = 0.2, the relative fraction error, or the mean minus the true mean, divided by the true mean
cv = coefficient of variation, or the standard deviation of the population divided by the mean

The coefficient of variation (standard deviation/mean= 0.67) was determined from the gamma survey data (see Table 3.1). In this case, N=16 samples, which were spaced on a systematic, triangular grid with a random start location, using Visual Sampling Plan Version 6.2d.

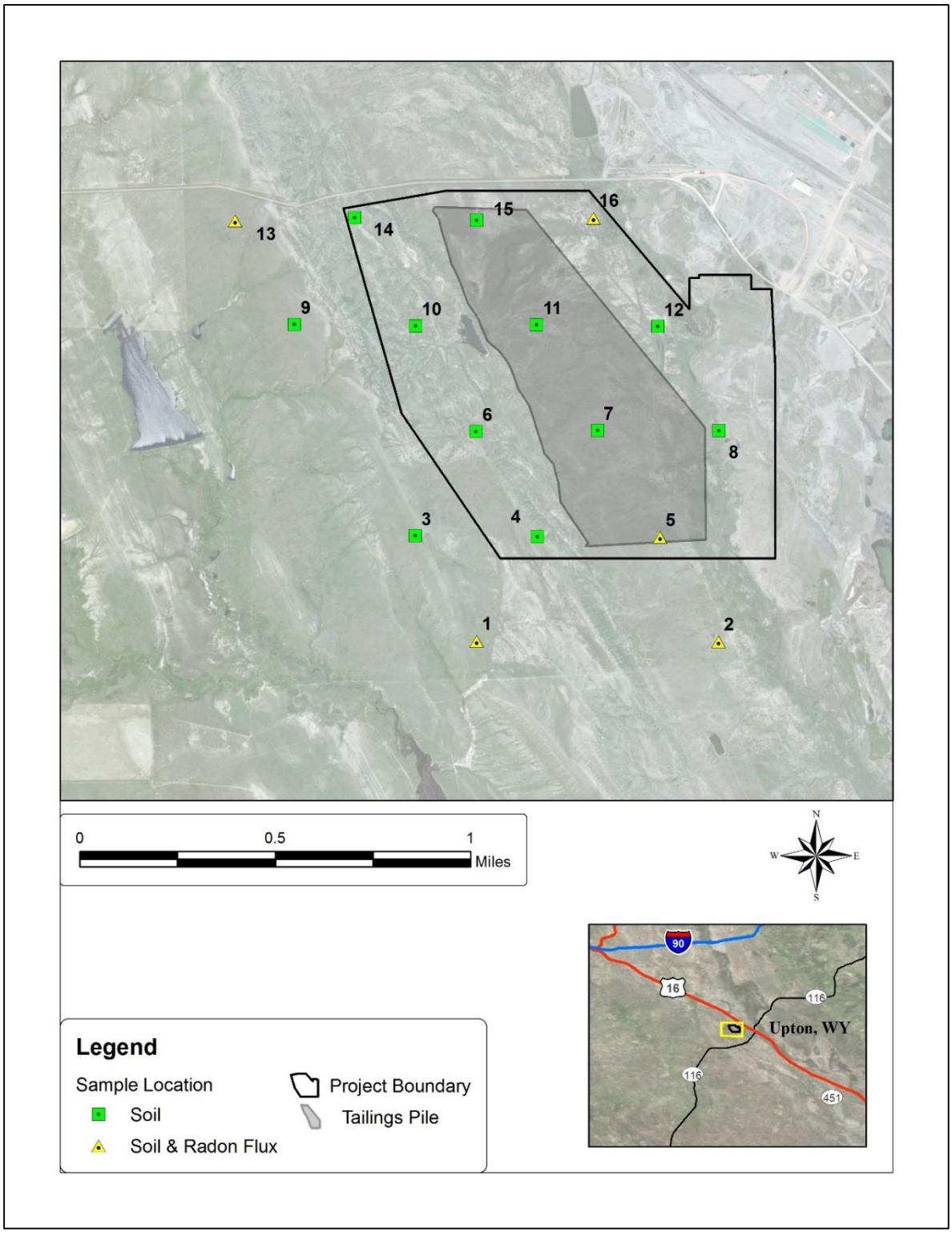



**Figure 4.1. Soil Sample and Radon Flux Locations**

**Table 4.1. Sample Location Coordinates**

| Sample Location | Easting | Northing |
|---|---|---|
| SS-01-SS-061412[a] | 526190.2 | 4882324.4 |
| SS-02-SS-061412[a] | 527186.7 | 4882322.7 |
| SS-03-SS-061412 | 525939.6 | 4882758.9 |
| SS-04-SS-061412 | 526442.5 | 4882754.4 |
| SS-05-SS-061412 | 526946.2 | 4882752.2 |
| SS-06-SS-061412 | 526190.6 | 4883187.8 |
| SS-07-SS-061412[a] | 526692.0 | 4883192.3 |
| SS-08-SS-061412 | 527191.1 | 4883190.4 |
| SS-09-SS-061412 | 525442.2 | 4883628.2 |
| SS-10-SS-061412 | 525941.4 | 4883622.4 |
| SS-11-SS-061412 | 526440.8 | 4883626.8 |
| SS-12-SS-061412 | 526940.4 | 4883619.6 |
| SS-13-SS-061412[a] | 525195.1 | 4884054.9 |
| SS-14-SS-061412 | 525690.7 | 4884066.1 |
| SS-15-SS-061412 | 526193.0 | 4884056.2 |
| SS-16-SS-061412[a] | 526671.0 | 4884065.0 |

Notes:
[a]Radon flux location.
[b]Coordinate system is NAD 1983, UTM Zone 13N, meters.

In accordance with the SAP, the baseline soil samples were collected from 0-15 cm and analyzed for radium-226 and -228, natural uranium and natural thorium. The corresponding U.S. Environmental Protection Agency (EPA) analytical methods are EPA M901.1 for the two radiums and EPA M 6020 (Inductively Coupled-Mass Spectroscopy) for natural uranium and thorium.

## 4.2 Radionuclide Concentrations in Surface Soils

Table 4.2 documents the results of the soil sampling. The soil sample results represent a baseline to compare results for soil samples collected at similar locations and depth during the construction, operational, and closure phases of the Upton Plant. It is recognized that topography and other features may change over time; however, some of the sample locations are expected to remain intact.

## Table 4.2. Laboratory Analytical Results for Soil Samples

| | Radium-226 (pCi $g^{-1}$) | | | Radium-228 (pCi $g^{-1}$) | | | U-nat (mg $kg^{-1}$) | | Th-nat (mg $kg^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Location** | **Result** | **Error ± 1σ** | **RL** | **Result** | **Error ± 1σ** | **RL** | **Result** | **MDL** | **Result** | **MDL** |
| SS-01-SS-061412 | 1.4 | 0.4 | 0.3 | 0.0U | 0.5 | 0.3 | 1 | 0.01 | 7 | 0.02 |
| SS-02-SS-061412 | 1.6 | 0.4 | 0.3 | 2.1 | 0.5 | 0.3 | 1 | 0.01 | 12 | 0.02 |
| SS-03-SS-061412 | 1.5 | 0.5 | 0.3 | 0.0U | 0.5 | 0.3 | 2 | 0.02 | 9 | 0.02 |
| SS-04-SS-061412 | 1.5 | 0.5 | 0.3 | 0.0U | 0.5 | 0.3 | ND | 0.01 | 8 | 0.02 |
| SS-05-SS-061412 | 1.6 | 0.6 | 0.3 | 1.9 | 0.7 | 0.3 | 2 | 0.01 | 12 | 0.02 |
| SS-06-SS-061412 | 1.6 | 0.4 | 0.3 | 2.3 | 0.8 | 0.3 | 2 | 0.01 | 13 | 0.02 |
| SS-07-SS-061412 | 1.8 | 0.5 | 0.3 | 0.0U | 0.5 | 0.3 | 2 | 0.01 | 13 | 0.02 |
| SS-08-SS-061412 | 2.3 | 0.5 | 0.3 | 2.4 | 0.8 | 0.3 | 2 | 0.01 | 14 | 0.02 |
| SS-09-SS-061412 | 1.5 | 0.6 | 0.3 | 0.0U | 0.5 | 0.3 | 1 | 0.01 | 8 | 0.02 |
| SS-10-SS-061412 | 1.8 | 0.6 | 0.3 | 0.0U | 0.5 | 0.3 | 3 | 0.01 | 15 | 0.02 |
| SS-11-SS-061412 | 1.9 | 0.6 | 0.3 | 2.4 | 0.6 | 0.3 | 2 | 0.01 | 10 | 0.02 |
| SS-12-SS-061412 | 1.0 | 0.3 | 0.3 | 2.2 | 0.6 | 0.3 | 2 | 0.01 | 11 | 0.02 |
| SS-13-SS-061412 | 1.0 | 0.3 | 0.3 | 0.0U | 0.5 | 0.3 | 1 | 0.01 | 6 | 0.02 |
| SS-14-SS-061412 | 2.2 | 0.7 | 0.3 | 0.0U | 0.5 | 0.3 | 2 | 0.01 | 13 | 0.02 |
| SS-15-SS-061412 | 1.6 | 0.5 | 0.3 | 0.0U | 0.5 | 0.3 | 2 | 0.01 | 13 | 0.02 |
| SS-16-SS-061412 | 2.3 | 0.6 | 0.3 | 0.0U | 0.5 | 0.3 | 2 | 0.01 | 10 | 0.02 |
| SS-17-SS-061412[a] | 1.4 | 0.5 | 0.3 | 2.4 | 0.9 | 0.3 | 2 | 0.01 | 11 | 0.02 |
| SS-18-SS-061412[a] | 1.8 | 0.5 | 0.3 | 2.3 | 0.7 | 0.3 | 3 | 0.01 | 14 | 0.02 |
| SS-19-SS-061412[a] | 1.5 | 0.5 | 0.3 | 0.0U | 0.5 | 0.3 | 3 | 0.01 | 14 | 0.02 |
| SS-20-SS-061412[a] | 1.6 | 0.5 | 0.3 | 0.0U | 0.5 | 0.3 | 2 | 0.01 | 7 | 0.02 |

Notes:
[a]Duplicate sample.
MDL = method detection limit
mg $kg^{-1}$ = milligrams per kilogram
pCi $g^{-1}$ = picocuries per gram
RL = reporting limit
σ = standard deviation
U = undetected
ND = not detected

## 4.3 Summary of Radium-226 Results

The following discussion is based largely upon the results and spatial distributions reflected in the supporting figures and tabular summaries.

Table 4.3 presents the summary statistics for radium-226 concentrations in surface soil.

**Table 4.3. Summary Statistics for Radium-226 Concentrations in Soil Samples**

| Estimator/Endpoint | Ra-226 (pCi $g^{-1}$) |
|---|---|
| **Mean (arithmetic)** | 1.7 |
| **Mean (geometric)** | 1.7 |
| **Standard deviation** | 0.3 |
| **Median** | 1.6 |
| **Minimum** | 1.3 |
| **Maximum** | 2.3 |
| **1st quartile** | 1.5 |
| **3rd quartile** | 1.8 |
| **IQR** | 0.3 |
| **Count** | 16 |

Notes:
IQR = interquartile range
pCi $g^{-1}$ = picocuries per gram

Statistical tests (results not shown) indicate that the distribution of the radium-226 concentrations is lognormal. The central tendency of a lognormal distribution is best described by a geometric mean, which in this case is 1.7 pCi $g^{-1}$. This result in central tendency is consistent with both the arithmetic mean and median.

## 4.4 Other Radionuclides

Table 4.4 presents summary statistics for radium-228, natural uranium, and natural thorium. Natural uranium and thorium results are reported in pCi $g^{-1}$, although the laboratory reported the results in (milligrams per kilogram) mg $kg^{-1}$. The conversion to activity concentrations (pCi $g^{-1}$=0.667 x mg $kg^{-1}$ for natural uranium and 0.22 x mg $kg^{-1}$ for natural thorium) was performed to provide a basis of directly comparing natural uranium and thorium to the other concentrations of long-lived radionuclides in the uranium and thorium series.

Trends in the radium-228 concentrations cannot be discussed, because detections are reported by the laboratory in 6 of 16 samples.

The distribution of natural thorium concentrations is normal, with a central tendency (mean) and standard deviation of 2.4 and 0.6 pCi $g^{-1}$, respectively. The range of natural thorium concentrations is 1.4 to 3.2 pCi $g^{-1}$.

The distribution of natural uranium concentrations is nonparametric, with a central tendency (median) and IQR of 1.4 and 0.1 pCi $g^{-1}$, respectively. The range of natural thorium concentrations is 0.7 to 2.0 pCi $g^{-1}$.

According to the laboratory results, the radium-226 concentrations are higher to those of natural uranium. However, assuming there is secular equilibrium in the uranium decay series, radium-226 concentrations should be about 48 percent of those of natural uranium (the concentration of uranium-238 based on the natural abundance of uranium isotopes). Thus, the laboratory results for radium-226 and/or natural uranium may be biased.

The laboratory results indicate that natural thorium concentrations are higher than those of the other primary radionuclides in soils at the Upton Plant.

**Table 4.4. Summary Statistics for Other Radionuclide Concentrations in Soil Samples**

| Estimator/Endpoint | Ra-228 (pCi $g^{-1}$)[a] | Th-nat (pCi $g^{-1}$)[a] | U-nat (pCi $g^{-1}$)[a] |
|---|---|---|---|
| **Mean (arithmetic)** | 0.9 | 2.4 | 1.3 |
| **Standard deviation** | 1.1 | 0.6 | 0.4 |
| **Median** | 0.0 | 2.5 | 1.4 |
| **Minimum** | 0.0 | 1.4 | 0.7 |
| **Maximum** | 2.4 | 3.2 | 2.0 |
| **1st quartile** | 0.0 | 1.9 | 1.2 |
| **3rd quartile** | 2.2 | 2.9 | 1.4 |
| **IQR** | 2.2 | 0.9 | 0.1 |
| **Count** | 16 | 16 | 16 |

Notes:
[a]Sample and duplicate results averaged.
IQR = interquartile range
pCi $g^{-1}$ = picocuries per gram

## 4.5 Surface Soil Radium-226 and Natural Thorium Estimates Based on Gamma-Soil Radium Correlation

Gamma-soil radium-226 and natural thorium correlations were established using the surface soil analytical results documented in Section 4.2 for all random soil sample locations where integrated gamma measurements were taken (n=16). The data were collected to estimate radium-226 and natural thorium concentrations corresponding to each of the gamma survey points shown in Figure 3.3.

One-minute integrated direct radiation measurements were collected at each of these 16 locations, using the same radiation detection equipment used in the GPS gamma survey. These measurements then were correlated to radium-226 and natural thorium concentrations in soil, as discussed below. Table 4.5 lists the observations.

Regression methods were employed to derive the correlations. It will be shown that radium-226 concentrations in soil do not reliably predict gamma count rates. However, natural thorium concentrations provide a reasonable prediction of gamma count rates.

The relationship between the entire data set (n=16) of radium-226 concentrations and gamma count rates yields a poor correlation coefficient ($R^2 = 0.35$) with poor residuals (i.e., predicted minus observed radium-226 concentrations). An iteration in which one of the observations (2.3 pCi $g^{-1}$/15,652 cpm [SS-16-SS-061412]) was omitted from the regression yielded an improved correlation coefficient ($R^2 = 0.45$) with poor residuals. Average residuals did not exhibit a bias (indicating a tendency to over- or under-estimate soil radium-226 concentrations).

**Table 4.5. Radium-226 Concentrations and Integrated Gamma Count Rates**

| Sample Location | Radium-226 (pCi $g^{-1}$) | Th-Nat (pCi $g^{-1}$) | Gamma Count Rate (cpm) |
|---|---|---|---|
| SS-01-SS-061412 | 1.4 | 1.5 | 13740 |
| SS-02-SS-061412 | 1.6 | 2.6 | 16634 |
| SS-03-SS-061412 | 1.5 | 2.0 | 13336 |
| SS-04-SS-061412 | 1.5 | 1.8 | 14519 |
| SS-05-SS-061412 | 1.6 | 2.6 | 16443 |
| SS-06-SS-061412 | 1.6 | 2.9 | 17727 |
| SS-07-SS-061412[a] | 1.8 | 3.0 | 16553 |
| SS-08-SS-061412 | 2.3 | 3.1 | 17833 |
| SS-09-SS-061412 | 1.5 | 1.8 | 12819 |
| SS-10-SS-061412[a] | 1.7 | 3.2 | 17388 |
| SS-11-SS-061412 | 1.9 | 2.2 | 16259 |
| SS-12-SS-061412[a] | 1.4 | 2.4 | 16056 |
| SS-13-SS-061412[a] | 1.3 | 1.4 | 12147 |
| SS-14-SS-061412 | 2.2 | 2.9 | 17463 |
| SS-15-SS-061412 | 1.6 | 2.9 | 15955 |
| SS-16-SS-061412 | 2.3 | 2.2 | 15652 |

Notes:
[a]Duplicate sample collected at this location. Ra-226 and Th-nat concentrations averaged for the calculation.
cpm = counts per minute
pCi $g^{-1}$ = picocuries per gram

The linear regression model for this iteration, which has the higher correlation coefficient of the two and was used to estimate radium-226 concentrations from the gamma survey data for the Upton Plant is:

$$\text{Concentration}_{\text{Ra-226}} = 1*10^{-4} \text{ x cpm} + 0.0221$$

A stepwise approach was not taken because it was clear, on cursory evaluation of the correlation plot of all observations, that the data were too few and variable from which to draw salient trends.

*It is important to acknowledge that discrepancies between measured soil radium-226 concentrations reported by the laboratory and corresponding radium-226 concentrations estimated by gamma surveys are inevitable in a characterization survey of this nature and magnitude, given the heterogeneity of the site (at least in some areas), differing detector-source geometry at various sample/survey locations, prominent gamma-ray emitters from the thorium decay series contributing to the instrument response, and uncertainty in the laboratory analytical results, especially at low concentrations.*

The relationship between the entire data set (n=16) of natural thorium concentrations and gamma count rates yields a strong correlation coefficient ($R^2 = 0.83$) with no unusual observations; that is, observations imparting large leverage on the analysis. The linear regression model for this iteration, which was used to estimate natural thorium concentrations from the gamma survey data for the Upton Plant is:

$$\text{Concentration}_{\text{Th-nat}} = 3*10^{-4} \text{ x cpm} - 2.17$$

Using these equations, radium-226 and natural thorium concentrations in soil were estimated for each discrete gamma survey measurement. Table 4.6 presents the resulting summary statistics for the radium-226 and natural thorium concentrations predicted by the linear regression model from the scanning gamma count rates observed in the Upton Plant.

**Table 4.6. Statistical Summary of Radium-226 and Natural Thorium Concentrations Predicted from Gamma Count Rates**

| Estimator/Endpoint | Radium-226, predicted (pCi $g^{-1}$)[a] | Th-nat, predicted (pCi $g^{-1}$)[a] |
|---|---|---|
| **Mean (arithmetic)** | **1.6** | **2.6** |
| Standard Deviation | 0.2 | 0.6 |
| **Median** | **1.6** | **2.7** |
| 1st quartile | 1.5 | 2.2 |
| 3rd quartile | 1.7 | 3.0 |
| IQR | 0.2 | 0.8 |
| Minimum | 0.9 | 0.4 |
| Maximum | 2.7 | 6.0 |
| Count (n) | 38,023 | 38,023 |

Notes:
[a] Measurements only within the Upton Plant.
IQR = interquartile range
pCi $g^{-1}$ = picocuries per gram

The median of the predicted concentrations of radium-226 is 1.6 pCi $g^{-1}$ and its IQR is 0.2 pCi $g^{-1}$ (1.7 less 1.5 pCi $g^{-1}$). This is equal to the median of the laboratory results.

The median of the predicted concentrations of natural thorium is 2.7 pCi $g^{-1}$ and IQR is 0.8 pCi $g^{-1}$ (3.0 less 2.2 pCi $g^{-1}$). The median of the predicted concentration of natural thorium is also in good agreement with the median of the laboratory results (2.4 pCi $g^{-1}$).

These observations indicate that gamma surveys can be an effective tool to predict radium-226 and natural thorium concentrations in soil at the Upton Plant.

# 5.0 DATA QUALITY ASSESSMENT

This section briefly summarizes the results of the quality control (QC) samples collected for the baseline soil sampling program. As indicated in Table 2.1, 25 percent of the soil samples were duplicated for QC purposes. The results of this QC effort are documented in Table 5.1, which lists the analytical results for each duplicate pair along with corresponding errors and reporting limits (RLs). Table 5.2 documents associated comparisons, presenting the corresponding Replicate Error Ratio (RER) or Relative Percent Difference (RPD), in the cases of Th-nat and U-nat) for each QC pair.

QC trends in the radium-228 concentrations cannot be discussed, because apparently erroneous non-detections are reported by the laboratory in 12 of 20 samples.

Examination of the results provided in Table 5.1 indicates that, in general, there is close agreement in the analytical results reported for each duplicate pair collected for all parameters. Because duplicate results are generally comparable for the majority of QC samples collected and the other parameters for this pair of soil samples were within acceptable ranges, no request to re-analyze the samples were made.

Table 5.2 presents the corresponding RER and, in the cases of Th-nat and U-nat, RPDs calculated for each duplicate pair. The calculation of RER and RPDs is a standard technique used to evaluate QC samples. Typically, an RER of < 2 and an RPD of <20 percent is used as a guideline in many data quality objective evaluations. This data set reveals no cases where either the RER or RPD was greater than 2 and 20, respectively. Thus, the laboratory performance on blind duplicates is satisfactory.

**Table 5.1. QA-QC Comparison Results**

| | | Radium-226 (pCi $g^{-1}$) | | | U-nat (mg $kg^{-1}$ ) | | Th-nat (mg $kg^{-1}$ ) | |
|---|---|---|---|---|---|---|---|---|
| Sample Pair | Sample Location | Result | Error ± 1σ | RL | Result | MDL | Result | MDL |
| 1 | SS-07-SS-061412 | 1.8 | 0.5 | 0.3 | 2 | 0.01 | 13 | 0.02 |
| | SS-18-SS-081311 | 1.8 | 0.5 | 0.3 | 3 | 0.01 | 14 | 0.02 |
| 2 | SS-10-SS-061412 | 1.8 | 0.6 | 0.3 | 3 | 0.01 | 15 | 0.02 |
| | SS-19-SS-081311 | 1.5 | 0.5 | 0.3 | 3 | 0.01 | 14 | 0.02 |
| 3 | SS-12-SS-081311 | 1.0 | 0.3 | 0.3 | 2 | 0.01 | 11 | 0.02 |
| | SS-17-SS-081311 | 1.4 | 0.5 | 0.3 | 2 | 0.01 | 11 | 0.02 |
| 4 | SS-13-SS-081311 | 1.0 | 0.3 | 0.3 | 1 | 0.01 | 6 | 0.02 |
| | SS-20-SS-061412 | 1.6 | 0.5 | 0.3 | 2 | 0.01 | 7 | 0.02 |

Notes:

MDL = method detection limit
mg $kg^{-1}$ = milligrams per kilogram
pCi $g^{-1}$ = picocuries per gram
σ = standard deviation

## Table 5.2. QA-QC Comparisons: RPD and RER Summary

| | | Radionuclide Concentrations | | | |
|---|---|---|---|---|---|
| **Sample ID** | **Type** | **Ra-226 (pCi $g^{-1}$)** | **Ra-226 Error ± 1σ** | **Uranium (mg $kg^{-1}$ )** | **Thorium (mg $kg^{-1}$ )** |
| SS-12-SS-061412 | Sample | 1 | 0.3 | 2 | 11 |
| SS-17-SS-061412 | Replicate | 1.4 | 0.5 | 2 | 11 |
| | **RER** | **0.7** | - | - | - |
| | **RPD** | **-** | - | **0** | **0** |
| | | | | | |
| SS-07-SS-061412 | Sample | 1.8 | 0.5 | 2 | 13 |
| SS-18-SS-061412 | Replicate | 1.8 | 0.5 | 3 | 14 |
| | **RER** | **0.0** | | | |
| | **RPD** | | | **10** | **1.9** |
| | | | | | |
| SS-10-SS-061412 | Sample | 1.8 | 0.6 | 3 | 15 |
| SS-19-SS-061412 | Replicate | 1.5 | 0.5 | 3 | 14 |
| | **RER** | **0.4** | | | |
| | **RPD** | | | **0** | **1.7** |
| | | | | | |
| SS-13-SS-061412 | Sample | 1 | 0.3 | 1 | 6 |
| SS-20-SS-061412 | Replicate | 1.6 | 0.5 | 2 | 7 |
| | **RER** | **1.0** | | | |
| | **RPD** | | | **16.7** | **3.8** |

In this table, RER corresponds to the Replicate Error Ratio and RPD corresponds to the relative percent difference, which is derived by dividing the difference between the two results by the average result.
mg $kg^{-1}$ = milligrams per kilogram
pCi $g^{-1}$ = picocuries per gram
σ = standard deviation

# 6.0 RADON FLUX MEASUREMENTS

This section summarizes the results of baseline radon-222 (Rn-222) flux measurements conducted in accordance with Section 2.3.5 of the SAP. Field data and analytical results supporting the Rn-222 flux data are contained in Appendix C.

In accordance with the SAP, radon flux rates were measured at five locations, which coincided with sample locations as shown on Figure 4.1. Five, plus two duplicate canisters were deployed and retrieved on June 13 and 14, 2012, respectively. These canisters were analyzed using EPA Test Method 115, *Monitoring for Radon-222 Emissions*.

Table 4.1 notes the five radon flux locations, all of which coincided with those for soil samples. Table 6.1 documents the results, and lists Ra-226 concentrations in corresponding soil samples. Radon flux rates ranged between 0.20 and 1.22 picocuries per meter squared second (pCi $m^{-2}$ $s^{-1}$). These values are below the National Emissions Standards for Hazardous Air Pollutants (NESHAPS) requirement of 20 pCi $m^{-2}$ $s^{-1}$ prescribed in 10 *Code of Federal Regulations* 40, Appendix A, Criterion 6. Although the latter requirement applies to tailings and thus is not directly germane to this characterization, it is useful as a context to demonstrate the relative magnitude of baseline radon flux levels measured in the areas where construction and mining activities are anticipated to occur. There are to be no trends in the radon fluxes, as compared to radium-226 concentrations in associated soil samples.

**Table 6.1. Radon Flux Results**

| | Radon-222 (pCi $m^{-2}$ $s^{-1}$) | | | | |
|---|---|---|---|---|---|
| **Sample Location** | **Flux** | **Flux Error (±1σ)** | **LLD** | **Average Flux** | **Ra-226 Concentration (pCi $g^{-1}$)** |
| **SS-01-SS-061412** | 1.22 | 0.05 | 0.1 | 1.22 | 1.4 |
| **SS-02-SS-061412** | 0.20 | 0.04 | 0.1 | 0.20 | 1.6 |
| **SS-07-SS-061412[a]** | 0.48 | 0.04 | 0.1 | 0.42 | 1.8 |
| | 0.35 | 0.05 | 0.1 | | |
| **SS-13-SS-061412[b]** | 0.93 | 0.05 | 0.1 | 0.93 | 1.4 |
| **SS-16-SS-061412[a]** | 0.57 | 0.04 | 0.1 | 0.66 | 2.3 |
| | 0.74 | 0.05 | 0.1 | | |

Notes:
[a]Duplicate canister deployed
[b]Duplicate sample collected. Radium-226 result is the average of the sample and duplicate results.

LLD = lower limit of detection
pCi $g^{-1}$ = picocuries per gram
pCi $m^{-2}$-s = picocuries per meter squared second
Ra-226 = radium-226
Rn-222 = radon-222
σ = standard deviation

# 7.0 AMBIENT RADON MEASUREMENTS

This section describes the placement of and data collection for the ambient radon track etch detectors.

## 7.1 Measurement Locations

Figure 7.1 and Table 7.1, respectively, show and list the locations of the track etch detectors. Five of the locations are air monitoring stations. One of the locations is in Upton.

Data collection at the Upton Plant started in February 2013 at will continue minimally in quarters: during plant construction, operation, and closure.

**Table 7.1. Ambient Radon Track Etch Detector Locations**

| Track Etch Location | Easting[a] | Northing[a] |
|---|---|---|
| 1[b] (UAMS-1) | 529472.7 | 4883375.4 |
| 2 | 526137.5 | 4883685.7 |
| 3[b] (UAMS-3) | 527044.4 | 4882981.1 |
| 4 | 527289.2 | 4882295.0 |
| 5 | 525942.1 | 4882349.1 |
| 6 | 525574.9 | 4883670.0 |
| 7[b] (UAMS-4) | 525027.1 | 4884122.5 |
| 8[b] (UAMS-2) | 526940.0 | 4884102.8 |
| 9 | 527236.6 | 4883434.9 |
| 10[b] (UAMS-5) | 529039.8 | 4882599.6 |

Notes:
[a]Coordinate systems is NAD1983, UTM Zone 13N, meters.
[b]Air monitoring station at this location, provided in parentheses.

## 7.2 Measurement Results

Table 7.2 lists the results obtained quarterly by location, between February 2013 and January 2015. Quarterly radon measurements ranged on average by location from 0.7 (Location 7) to 1.6 picocuries per liter (pCi $L^{-1}$: Locations 2, 4, and 9).

The laboratory analytical reports for the ambient radon analyses are provided in Appendix D.

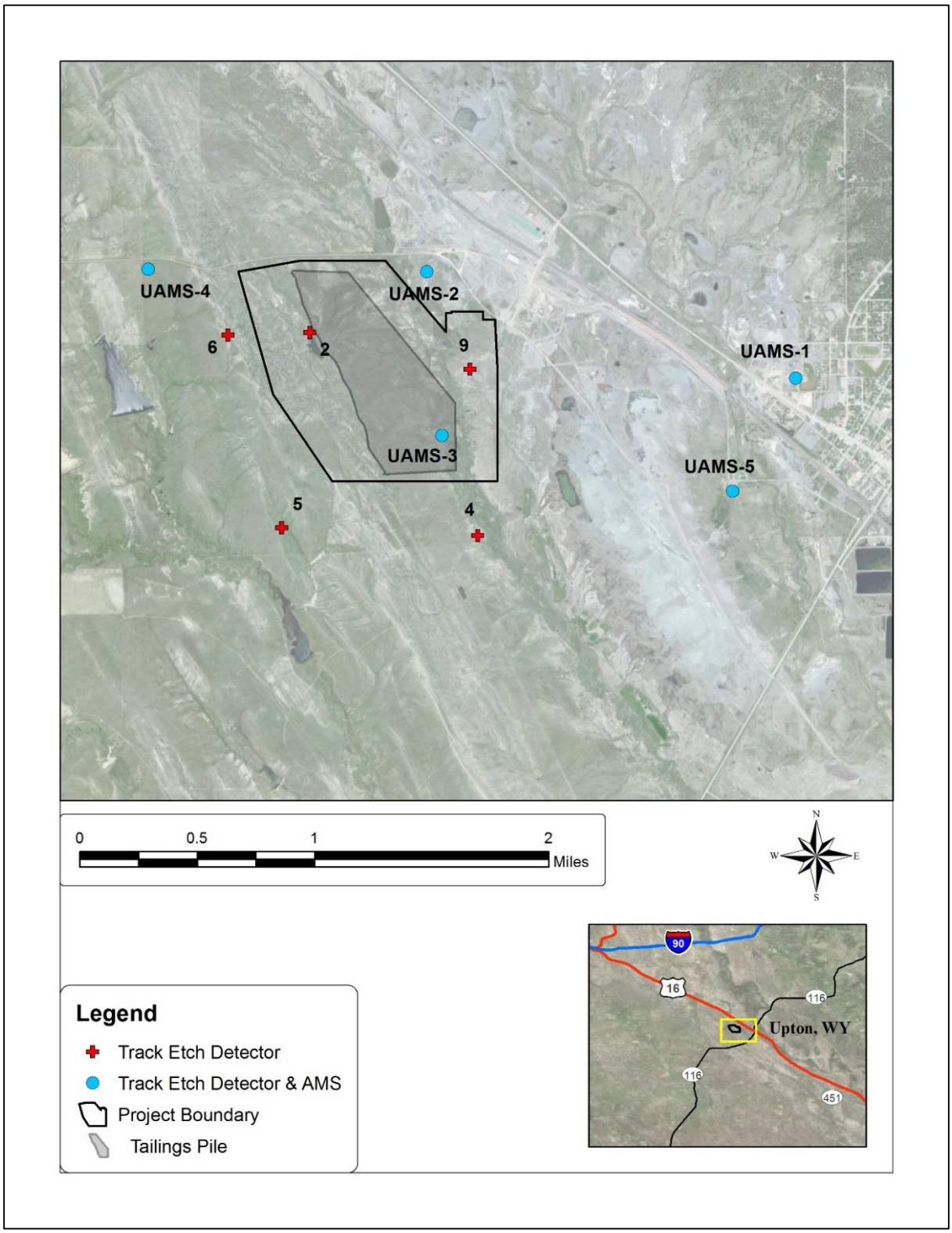



**Figure 7.1. Ambient Radon Track Etch Detector and Air Monitoring Station Locations**

## Table 7.2. Ambient Radon Track Etch Detector Results

| Location Number | Start Date | End Date | Radon Concentration (pCi $L^{-1}$) | Radon Error (± pCi $L^{-1}$) | Mean Concentration at Location (pCi $L^{-1}$) |
|---|---|---|---|---|---|
| 1 (UAMS-1) | 2/5/2013 | 3/25/2013 | 0.13 | 0.01 | 0.9 |
| | 3/25/2013 | 7/11/2013 | 0.8 | 0.05 | |
| | 7/11/2013 | 9/30/2013 | 0.4 | 0.03 | |
| | 9/30/2013 | 1/10/2014 | 0.5 | 0.04 | |
| | 1/10/2014 | 3/26/2014 | 0.3 | 0.02 | |
| | 3/26/2014 | 7/23/2014 | 0.6 | 0.04 | |
| | 7/23/14 | 10/28/14 | 3.2 | 0.13 | |
| | 10/28/14 | 1/4/15 | 1.1 | 0.08 | |
| 2 | 2/7/2013 | 3/25/2013 | 1 | 0.08 | 1.6 |
| | 3/23/2013 | 7/11/2013 | 1.4 | 0.07 | |
| | 7/11/2013 | 9/30/2013 | 1.8 | 0.1 | |
| | 9/30/2013 | 1/10/2014 | 2.7 | 0.11 | |
| | 1/10/2014 | 3/26/2014 | 0.1 | 0.01 | |
| | 3/26/2014 | 7/18/2014 | 0.8 | 0.05 | |
| | 7/18/14 | 10/28/14 | 4.3 | 0.15 | |
| | 10/28/14 | 1/4/15 | 1.0 | 0.07 | |
| 3 (UAMS-3) | 2/5/2013 | 3/25/2013 | 0.3[a] | 0.03[a] | 1.2 |
| | 3/25/2013 | 7/11/2013 | 1.3[a] | 0.07[a] | |
| | 7/11/2013 | 9/30/2013 | 1.1[a] | 0.07[a] | |
| | 9/30/2013 | 1/10/2014 | 1.0[a] | 0.06[a] | |
| | 1/10/2014 | 3/26/2014 | 0.1[a] | 0.01[a] | |
| | 3/26/2014 | 7/18/2014 | 0.9[a] | 0.06[a] | |
| | 7/18/14 | 10/28/14 | 3.7 | 0.14 | |
| | 10/28/14 | 1/4/15 | 1.1[a] | 0.08[a] | |

## Table 7.2. Ambient Radon Track Etch Detector Results (continued)

| Location Number | Start Date | End Date | Radon Concentration (pCi $L^{-1}$) | Radon Error (± pCi $L^{-1}$) | Mean Concentration at Location (pCi $L^{-1}$) |
|---|---|---|---|---|---|
| 4 | 2/5/2013 | 3/25/2013 | 0.13 | 0.01 | 1.6 |
| | 3/25/2013 | 7/11/2013 | 1.4 | 0.08 | |
| | 7/11/2013 | 9/30/2013 | 1.4 | NA | |
| | 9/30/2013 | 1/10/2014 | 1.3 | 0.07 | |
| | 3/26/2014 | 7/18/2014 | 1.1 | 0.06 | |
| | 7/18/14 | 10/28/14 | 4.8 | 0.16 | |
| | 10/28/14 | 1/4/15 | 1.3 | 0.09 | |
| 5 | 2/7/2013 | 3/26/2013 | 1 | 0.08 | 1.1 |
| | 3/26/2013 | 7/11/2013 | 0.9 | 0.06 | |
| | 7/11/2013 | 9/30/2013 | 1.1 | 0.07 | |
| | 9/30/2013 | 1/10/2014 | 0.7 | 0.05 | |
| | 1/10/2014 | 3/26/2014 | 0.08 | 0.01 | |
| | 3/26/2014 | 7/18/2014 | 0.6 | 0.04 | |
| | 7/18/14 | 10/28/14 | 3.7 | 0.14 | |
| | 10/28/14 | 1/4/15 | 1.0 | 0.07 | |
| 6 | 2/5/13 | 3/25/13 | 0.5 | 0.04 | 1.3 |
| | 3/25/2013 | 7/11/2013 | 0.7 | 0.05 | |
| | 7/11/2013 | 9/30/2013 | 0.6 | 0.04 | |
| | 9/30/2013 | 1/10/2014 | 0.9 | 0.05 | |
| | 3/26/2014 | 7/18/2014 | 0.6 | 0.04 | |
| | 7/18/14 | 10/28/14 | 4.3 | 0.15 | |
| | 10/28/14 | 1/4/15 | 1.7 | 0.1 | |
| 7 (UAMS-4) | 2/5/2013 | 3/26/2013 | 0.6 | 0.05 | 0.7 |
| | 3/26/2013 | 7/11/2013 | 0.8 | 0.05 | |
| | 7/11/2013 | 9/30/2013 | 0.8 | 0.06 | |
| | 9/30/2013 | 1/10/2014 | 1 | 0.06 | |
| | 1/10/2014 | 3/26/2014 | 0.08 | 0.01 | |
| | 3/26/2014 | 7/18/2014 | 0.7 | 0.04 | |
| | 10/28/14 | 1/4/15 | 1.2 | 0.08 | |
| 8 (UAMS-2) | 2/5/2013 | 3/25/2013 | 0.13 | 0.01 | 0.9 |
| | 3/25/2013 | 7/11/2013 | 1.2 | 0.07 | |
| | 7/11/2013 | 9/30/2013 | 1.1 | 0.07 | |
| | 1/10/2014 | 3/26/2014 | 0.3 | 0.02 | |
| | 3/26/2014 | 7/23/2014 | 1.1 | 0.06 | |
| | 10/28/14 | 1/4/15 | 1.6 | 0.09 | |

## Table 7.2. Ambient Radon Track Etch Detector Results (concluded)

| Location Number | Start Date | End Date | Radon Concentration (pCi $L^{-1}$) | Radon Error (± pCi $L^{-1}$) | Mean Concentration at Location (pCi $L^{-1}$) |
|---|---|---|---|---|---|
| 9 | 2/5/2013 | 3/25/2013 | 0.13 | 0.01 | 1.6 |
| | 3/25/2013 | 7/17/2013 | 1.6 | 0.08 | |
| | 7/17/2013 | 9/30/2013 | 1.5 | 0.09 | |
| | 9/30/2013 | 1/10/2014 | 1.5 | 0.08 | |
| | 1/10/2014 | 3/26/2014 | 0.4 | 0.03 | |
| | 3/26/2014 | 7/18/2014 | 1.3 | 0.07 | |
| | 7/18/14 | 10/28/14 | 4.6 | 0.15 | |

Notes:
[a]Average of sample and duplicate result
pCi $L^{-1}$ = picocuries per liter

# 8.0 ENVIRONMENTAL DOSIMETER MEASUREMENTS

This section describes the placement of and data collection for the environmental dosimeters.

## 8.1 Measurement Locations

Environmental dosimeters were placed at Locations 1, 3, 7, 8 and 10 shown on Figure 7.1 and listed in Table 7.1. A dosimeter also was placed in the RER office in Sundance, Wyoming.

Data collection at the Upton Plant started in April 2013 and continued through December 2014.

## 8.2 Measurement Results

Table 8.1 lists the results obtained quarterly by location, between February 2013 and March 2014. Quarterly dosimetry measurements ranged on average from 23.9 (Location 7) to 29.5 millirem (mrem) (Location 8).

The quarterly response at each location was calculated as follows:

$$X = \frac{R}{T} \times 90$$

Where:

X= Quarterly exposure rate (mrem per quarter)
R= Dosimeter response (mrem)
T= time between shipment and receipt by dosimeter provider (days)
90= average number of days in quarter

The laboratory analytical reports for the environmental dosimeter analyses are provided in Appendix E.

## Table 8.1. Environmental Dosimeter Results

| Location | Year | Quarter | Dose for Quarter (mrem) | Average Dose per Quarter (mrem) |
|---|---|---|---|---|
| 1 (UAMS-1) | 2013 | 2 | 27.4[a] | 24.3 |
| | | 3 | 22.8[a] | |
| | | 4 | 21.3[a] | |
| | 2014 | 1 | 30.7[a] | |
| | | 3 | 21.8[a] | |
| | | 4 | 21.9[a] | |
| 3 (UAMS-3) | 2013 | 2 | 26.5 | 25.6 |
| | | 3 | 24.8 | |
| | | 4 | 21.9 | |
| | 2014 | 1 | 35.6 | |
| | | 3 | 21.9 | |
| | | 4 | 23.0 | |
| 7 (UAMS-4) | 2013 | 2 | 27.2[a] | 23.9 |
| | | 3 | 22.1[a] | |
| | | 4 | 20.7[a] | |
| | 2014 | 1 | 29.2 | |
| | | 3 | 21.0 | |
| | | 4 | 23.3 | |
| 8 (UAMS-2) | 2013 | 2 | 30.0 | 29.5 |
| | | 3 | 28.3 | |
| | 2014 | 1 | 38.2 | |
| | | 3 | 24.0 | |
| | | 4 | 27.2 | |
| 10 (UAMS-5) | 2013 | 3 | 25.1 | 25.0 |
| | | 4 | 22.5 | |
| | 2014 | 1 | 34.2[a] | |
| | | 3 | 21.5[a] | |
| | | 4 | 21.8[a] | |

Notes:
[a]Average of sample and duplicate result
mrem = millirem

# 9.0 AIRBORNE PARTICULATES

RER collected samples of airborne particulates at five locations (UAMS-1 through UAMS-5) using high volume air samplers. The samplers were operated at various intervals, depending on the parameter of interest and field or sampler conditions. The samples were analyzed for total particulates (long-lived radionuclides and lanthanides) and particle size fractions.

## 9.1 Total Particulates

The samplers were used periodically, from June 2012 to December 2014 to collect total particulates. The locations of the air samplers are shown on Figure 7.1, as UAMS-1 through UAMS-5.

Each high volume air sampler was equipped with an 8-in. by 10-in. 0.8 micron glass fiber filter paper. The air filters were collected at various intervals, prior to saturation. Sample collection periods lasted from 3 to 49 days, averaging 30 days. Flow rate and total flow data were recorded at the time of sample collection.

The filters were sent to and digested by the external analytical laboratory. The samples were analyzed for cerium, lanthanum; natural thorium and uranium, thorium-230, and radium-226 using EPA Methods 200.8 (cerium, lanthanum, natural thorium and uranium), 908.0 (thorium-230) and 903.0 (radium-226).

The laboratory data were reported in units of picocuries per filter (pC $f^{-1}$) or micrograms per filter (µg $f^{-1}$, for natural thorium and uranium; cerium, and lanthanum). The radiological data were converted to units of microcuries per milliliter (µCi $ml^{-1}$), as follows:

$$Concentration, \mu Ci\ ml^{-1} = \frac{Filter\ Concentration}{Total\ Flow}(10^{-12})$$

The units of total flow and filter concentration in the equation are cubic meters ($m^3$) and pCi $f^{-1}$, respectively. The laboratory-reported concentrations of natural thorium and uranium were converted to pCi $g^{-1}$ by multiplying the value in µg $f^{-1}$ by their respective specific activities ($2.22x10^{-7}$ and $6.77x10^{-7}$ Ci $g^{-1}$, respectively) and $1x10^6$.

Airborne concentrations of cerium and lanthanum were determined by dividing the laboratory reported concentration (in µg $f^{-1}$) by the volume of air sampled (in standard cubic meters).

Appendix F presents the laboratory analytical reports for particulates.

### *9.1.1 Radioactive Particulates*

The resulting concentrations for each radionuclide and high volume sampler were compared to effluent concentrations listed in Table 2 of 10 CFR 20 Appendix B and reported in Table 9.1 as percentages of the respective effluent concentrations. The most conservative effluent concentration was applied to thorium-230 ($2x10^{-14}$ µCi $ml^{-1}$). The Class D and W effluent concentrations were applied to natural uranium ($3x10^{-12}$ µCi $ml^{-1}$) and radium-226 ($9x10^{-13}$ µCi $ml^{-1}$), respectively. There is no 10 CFR 20 concentration for natural thorium; thus one was calculated for this baseline investigation, by assuming equal activities of the constituents of natural thorium (thorium-228 and thorium-232) and Class W effluent concentrations for thorium-228 ($3x10^{-14}$ µCi $ml^{-1}$) and thorium-232 ($4x10^{-15}$ µCi $ml^{-1}$). The unity rule is $1/((0.5/(3x10^{-14})+ 0.5/4x10^{-15})) = 7x10^{-15}$ µCi $ml^{-1}$.

To date, there have been 12 to 16 effective monitoring events at UAMS-1, UAMS-2, UAMS-3, and UAMS-4. There were seven events at UAMS-5. The data are summarized in Table 9.2, according to location, averages, standard deviations and ranges.

Site-wide, the data can be summarized as follows:

- Natural uranium concentrations ranged from not detected to $1.2x10^{-16}$ µCi $ml^{-1}$ and averaged $3.6x10^{-17}$ µCi $ml^{-1}$.
- Thorium-230 concentrations ranged from not detected to $1.7x10^{-16}$ µCi $ml^{-1}$ and averaged $2.6x10^{-17}$ µCi $ml^{-1}$.
- Radium-226 concentrations ranged from not detected to $3.5x10^{-15}$ µCi $ml^{-1}$ and averaged $1.0x10^{-16}$ µCi $ml^{-1}$.
- Natural thorium concentrations ranged from not detected to $2.4x10^{-16}$ µCi $ml^{-1}$ and averaged $4.1x10^{-17}$ µCi $ml^{-1}$.

## Table 9.1. Radionuclide Concentrations in Air

| | | | Concentration (µCi ml$^{-1}$) | | | | % Effluent Concentration | | | | Lower Limit of Detection (µCi ml$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | **Start Date** | **Stop Date** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** |
| UAMS-1 | 12-Jun-12 | 15-Jun-12 | 1.2E-16 | 1.7E-16 | 1.8E-16 | 2.4E-16 | 4.1E-03 | 5.7E-03 | 2.0E-02 | 3.0E-02 | 1.2E-16 | 9.9E-17 | 9.0E-17 | 4.0E-17 |
| | 21-Jun-12 | 05-Jul-12 | 1.1E-16 | 1.2E-16 | 1.6E-16 | 1.3E-16 | 3.6E-03 | 4.1E-03 | 1.7E-02 | 1.6E-02 | 3.6E-17 | 3.5E-17 | 3.2E-17 | 1.2E-17 |
| | 12-Jul-12 | 26-Jul-12 | 6.3E-17 | 6.0E-17 | 9.7E-17 | 6.1E-17 | 2.1E-03 | 2.0E-03 | 1.1E-02 | 7.6E-03 | 3.1E-17 | 2.3E-17 | 3.2E-17 | 1.0E-17 |
| | 31-Aug-12 | 04-Oct-12 | 2.5E-18 | 2.3E-18 | 2.4E-18 | 2.4E-18 | 8.3E-05 | 7.7E-05 | 2.7E-04 | 3.0E-04 | 6.2E-19 | 4.7E-19 | 1.3E-18 | 2.0E-19 |
| | 11-Oct-12 | 07-Nov-12 | 6.6E-17 | 4.9E-17 | 8.7E-17 | 7.5E-17 | 2.2E-03 | 1.6E-03 | 9.7E-03 | 9.3E-03 | 1.6E-17 | 1.4E-18 | 5.2E-18 | 5.3E-18 |
| | 16-Nov-12 | 03-Jan-13 | ND | 2.9E-18 | 1.3E-16 | ND | NA | 9.8E-05 | 1.4E-02 | NA | 2.2E-16 | 1.0E-16 | 1.0E-16 | 7.7E-17 |
| | 10-Jan-13 | 05-Feb-13 | ND | 4.9E-17 | 7.3E-18 | ND | NA | 1.6E-03 | 8.1E-04 | NA | 3.1E-16 | 1.0E-16 | 1.0E-16 | 1.1E-16 |
| | 12-Feb-13 | 15-Mar-13 | ND | 2.3E-17 | 7.6E-18 | ND | NA | 7.6E-04 | 8.4E-04 | NA | 2.6E-16 | 1.0E-16 | 1.0E-16 | 9.1E-17 |
| | 21-Mar-13 | 18-Apr-13 | ND | ND | 1.9E-17 | ND | NA | NA | 2.1E-03 | NA | 2.9E-16 | 1.0E-16 | 1.0E-16 | 1.0E-16 |
| | 21-Nov-13 | 07-Jan-14 | ND | ND | ND | ND | NA | NA | NA | NA | 2.9E-16 | 1.0E-16 | 1.0E-16 | 1.0E-16 |
| | 04-Mar-14 | 07-Apr-14 | ND | ND | 2.1E-17 | ND | NA | NA | 2.4E-03 | NA | 2.1E-16 | 1.0E-16 | 1.0E-16 | 7.2E-17 |
| | 14-Apr-14 | 16-May-14 | ND | 5.8E-17 | 4.5E-17 | ND | NA | 1.9E-03 | 5.0E-03 | NA | 2.8E-16 | 1.0E-16 | 1.0E-16 | 9.7E-17 |
| | 22-May-14 | 27-Jun-14 | ND | 1.3E-17 | 2.5E-17 | ND | NA | 4.2E-04 | 2.8E-03 | NA | 2.4E-16 | 1.0E-16 | 1.0E-16 | 8.4E-17 |
| | 09-Jul-14 | 18-Aug-14 | ND | 1.1E-17 | 9.8E-17 | ND | NA | 3.6E-04 | 1.1E-02 | NA | 2.4E-16 | 1.0E-16 | 1.0E-16 | 8.1E-17 |
| | 26-Aug-14 | 01-Oct-14 | ND | 2.0E-17 | 6.6E-17 | ND | NA | 6.6E-04 | 7.3E-03 | NA | 2.4E-16 | 1.0E-16 | 1.0E-16 | 8.5E-17 |
| | 13-Oct-14 | 12-Dec-14 | ND | 7.2E-17 | 3.5E-15 | ND | NA | 2.4E-03 | 3.9E-01 | NA | 1.0E-11 | 1.0E-16 | 1.0E-16 | 3.5E-12 |

## Table 9.1. Radionuclide Concentrations in Air (continued)

| | | | Concentration (µCi ml$^{-1}$) | | | | % Effluent Concentration | | | | Lower Limit of Detection (µCi ml$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | **Start Date** | **Stop Date** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** |
| UAMS-2 | 12-Jun-12 | 21-Jun-12 | 4.6E-17 | 8.1E-17 | 7.4E-17 | 4.5E-17 | 1.5E-03 | 2.7E-03 | 8.3E-03 | 5.6E-03 | 4.6E-17 | 4.4E-17 | 3.4E-17 | 1.5E-17 |
| | 28-Jun-12 | 12-Jul-12 | 5.9E-17 | 5.7E-17 | 5.3E-17 | 5.8E-17 | 2.0E-03 | 1.9E-03 | 5.8E-03 | 7.2E-03 | 3.0E-17 | 2.3E-17 | 2.6E-17 | 9.6E-18 |
| | 09-Aug-12 | 02-Sep-12 | 1.0E-18 | 1.5E-18 | 9.0E-19 | 9.8E-19 | 3.4E-05 | 5.0E-05 | 9.9E-05 | 1.2E-04 | 5.0E-19 | 4.8E-19 | 9.0E-19 | 1.6E-19 |
| | 19-Jul-12 | 02-Aug-12 | 8.4E-19 | 8.4E-19 | 7.4E-19 | 8.2E-19 | 2.8E-05 | 2.8E-05 | 8.2E-05 | 1.0E-04 | 8.4E-19 | 6.9E-19 | 1.5E-18 | 2.7E-19 |
| | 09-Sep-12 | 11-Oct-12 | 4.9E-17 | 3.9E-17 | 2.2E-17 | 3.7E-17 | 1.6E-03 | 1.3E-03 | 2.4E-03 | 4.7E-03 | 1.6E-17 | 3.2E-19 | 9.7E-19 | 5.3E-18 |
| | 16-Oct-12 | 16-Nov-12 | 7.6E-19 | 6.7E-19 | 1.9E-18 | 6.2E-19 | 2.5E-05 | 2.2E-05 | 2.1E-04 | 7.7E-05 | 3.8E-19 | 3.2E-19 | 1.7E-18 | 1.2E-19 |
| | 28-Nov-12 | 10-Jan-13 | 2.7E-19 | 4.8E-19 | 6.5E-19 | 7.1E-19 | 9.1E-06 | 1.6E-05 | 7.2E-05 | 8.9E-05 | 2.7E-19 | 1.9E-19 | 3.2E-19 | 8.9E-20 |
| | 16-Jan-13 | 19-Feb-13 | ND | 5.6E-18 | 2.3E-18 | ND | NA | 1.9E-04 | 2.5E-04 | NA | 1.8E-16 | 1.0E-16 | 1.0E-16 | 6.4E-17 |
| | 26-Feb-13 | 21-Mar-13 | ND | 7.8E-18 | ND | ND | NA | 2.6E-04 | NA | NA | 2.7E-16 | 1.0E-16 | 1.0E-16 | 9.4E-17 |
| | 27-Mar-13 | 25-Apr-13 | ND | 2.7E-18 | 1.1E-17 | ND | NA | 9.0E-05 | 1.3E-03 | NA | 2.1E-16 | 1.0E-16 | 1.0E-16 | 7.4E-17 |
| | 03-Dec-13 | 10-Jan-14 | ND | ND | ND | ND | NA | NA | NA | NA | 1.6E-16 | 1.0E-16 | 1.0E-16 | 5.7E-17 |
| | 20-Jan-14 | 25-Feb-14 | ND | 1.6E-18 | 5.3E-18 | ND | NA | 5.3E-05 | 5.9E-04 | NA | 1.7E-16 | 1.0E-16 | 1.0E-16 | 6.0E-17 |
| | 11-Mar-14 | 14-Apr-14 | ND | ND | ND | ND | NA | NA | NA | NA | 1.8E-16 | 1.0E-16 | 1.0E-16 | 6.3E-17 |
| | 22-Apr-14 | 22-May-14 | ND | ND | ND | ND | NA | NA | NA | NA | 2.1E-16 | 1.0E-16 | 1.0E-16 | 7.1E-17 |

## Table 9.1. Radionuclide Concentrations in Air (continued)

| | | | Concentration (µCi ml$^{-1}$) | | | | % Effluent Concentration | | | | Lower Limit of Detection (µCi ml$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | **Start Date** | **Stop Date** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** |
| UAMS-3 | 24-Jul-12 | 09-Aug-12 | 2.2E-18 | 3.2E-18 | 3.2E-18 | 2.1E-18 | 7.3E-05 | 1.1E-04 | 3.6E-04 | 2.7E-04 | 2.2E-18 | 2.1E-18 | 3.6E-18 | 7.1E-19 |
| | 17-Sep-12 | 19-Oct-12 | 1.6E-17 | 2.3E-17 | 5.6E-17 | 2.7E-17 | 5.5E-04 | 7.7E-04 | 6.2E-03 | 3.3E-03 | 1.6E-17 | 3.1E-19 | 1.1E-18 | 5.3E-18 |
| | 30-Oct-12 | 28-Nov-12 | ND | 1.5E-18 | 2.2E-18 | 8.2E-19 | NA | 5.0E-05 | 2.5E-04 | 1.0E-04 | 6.3E-19 | 4.8E-19 | 2.8E-18 | 2.1E-19 |
| | 28-Jan-13 | 26-Feb-13 | ND | 5.3E-18 | 3.1E-18 | ND | NA | 1.8E-04 | 3.5E-04 | NA | 2.2E-16 | 1.0E-16 | 1.0E-16 | 7.5E-17 |
| | 10-Mar-13 | 27-Mar-13 | ND | ND | 2.1E-17 | ND | NA | NA | 2.3E-03 | NA | 3.7E-16 | 1.0E-16 | 1.0E-16 | 1.3E-16 |
| | 20-Dec-13 | 20-Jan-14 | ND | 7.6E-18 | 6.5E-18 | ND | NA | 2.5E-04 | 7.2E-04 | NA | 3.9E-16 | 1.0E-16 | 1.0E-16 | 1.4E-16 |
| | 03-Feb-14 | 19-Mar-14 | ND | 7.0E-18 | 1.1E-17 | ND | NA | 2.3E-04 | 1.2E-03 | NA | 2.2E-16 | 1.0E-16 | 1.0E-16 | 7.7E-17 |
| | 26-Mar-14 | 02-May-14 | ND | 2.0E-17 | 0.0E+00 | ND | NA | 6.5E-04 | NA | NA | 2.3E-16 | 1.0E-16 | 1.0E-16 | 7.9E-17 |
| | 13-May-14 | 13-Jun-14 | ND | 2.5E-17 | 0.0E+00 | ND | NA | 8.5E-04 | NA | NA | 2.2E-16 | 1.0E-16 | 1.0E-16 | 7.6E-17 |
| | 20-Jun-14 | 04-Aug-14 | ND | 5.7E-18 | 3.2E-17 | ND | NA | 1.9E-04 | 3.6E-03 | NA | 1.6E-16 | 1.0E-16 | 1.0E-16 | 5.4E-17 |
| | 12-Aug-14 | 12-Sep-14 | ND | ND | 2.8E-17 | ND | NA | NA | 3.1E-03 | NA | 2.4E-16 | 1.0E-16 | 1.0E-16 | 8.3E-17 |
| | 19-Sep-14 | 07-Nov-14 | ND | 4.0E-18 | 5.9E-17 | ND | NA | 1.3E-04 | 6.6E-03 | NA | 1.0E-11 | 1.0E-16 | 1.0E-16 | 3.5E-12 |

## Table 9.1. Radionuclide Concentrations in Air (concluded)

| | | | Concentration (µCi ml$^{-1}$) | | | | % Effluent Concentration | | | | Lower Limit of Detection (µCi ml$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | **Start Date** | **Stop Date** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** | **U-nat** | **Th-230** | **Ra-226** | **Th-nat** |
| UAMS-4 | 12-Jun-12 | 28-Jun-12 | 5.2E-17 | 2.8E-17 | 6.1E-17 | 3.4E-17 | 1.7E-03 | 9.3E-04 | 6.8E-03 | 4.2E-03 | 2.6E-17 | 2.4E-17 | 2.3E-17 | 8.4E-18 |
| | 05-Jul-12 | 19-Jul-12 | 3.0E-17 | 5.3E-17 | 5.7E-17 | 2.9E-17 | 9.9E-04 | 1.8E-03 | 6.3E-03 | 3.6E-03 | 3.0E-17 | 2.0E-17 | 2.6E-17 | 9.7E-18 |
| | 26-Aug-12 | 27-Sep-12 | 9.3E-19 | 1.2E-18 | 6.1E-19 | 1.2E-18 | 3.1E-05 | 4.1E-05 | 6.8E-05 | 1.5E-04 | 4.6E-19 | 5.4E-19 | 9.6E-19 | 1.5E-19 |
| | 28-Nov-12 | 16-Jan-13 | ND | 1.3E-18 | 1.5E-18 | ND | NA | 4.4E-05 | 1.7E-04 | NA | 1.3E-16 | 1.0E-16 | 1.0E-16 | 4.4E-17 |
| | 24-Jan-13 | 08-Mar-13 | ND | 1.6E-18 | 2.7E-18 | ND | NA | 5.3E-05 | 3.0E-04 | NA | 1.4E-16 | 1.0E-16 | 1.0E-16 | 5.0E-17 |
| | 15-Mar-13 | 12-Apr-13 | ND | 3.7E-17 | 1.8E-16 | ND | NA | 1.2E-03 | 2.0E-02 | NA | 2.2E-15 | 1.0E-16 | 1.0E-16 | 7.7E-16 |
| | 30-Dec-13 | 03-Feb-14 | ND | 3.8E-18 | 1.7E-17 | ND | NA | 1.3E-04 | 1.9E-03 | NA | 1.8E-16 | 1.0E-16 | 1.0E-16 | 6.2E-17 |
| | 17-Feb-14 | 11-Mar-14 | ND | 2.9E-18 | 1.3E-17 | ND | NA | 9.5E-05 | 1.5E-03 | NA | 2.9E-16 | 1.0E-16 | 1.0E-16 | 9.9E-17 |
| | 19-Mar-14 | 22-Apr-14 | ND | ND | 1.9E-17 | ND | NA | NA | 2.1E-03 | NA | 1.9E-16 | 1.0E-16 | 1.0E-16 | 6.5E-17 |
| | 02-May-14 | 03-Jun-14 | ND | ND | 1.7E-17 | ND | NA | NA | 1.9E-03 | NA | 1.9E-16 | 1.0E-16 | 1.0E-16 | 6.7E-17 |
| | 13-Jun-14 | 18-Jul-14 | ND | 1.3E-16 | 1.8E-16 | ND | NA | 4.5E-03 | 2.0E-02 | NA | 1.9E-16 | 1.0E-16 | 1.0E-16 | 6.5E-17 |
| | 04-Aug-14 | 29-Aug-14 | ND | 1.5E-17 | 4.2E-17 | ND | NA | 5.0E-04 | 4.7E-03 | NA | 2.6E-16 | 1.0E-16 | 1.0E-16 | 9.0E-17 |
| | 09-Sep-14 | 09-Sep-14 | ND | 5.4E-18 | 6.2E-17 | ND | NA | 1.8E-04 | 6.8E-03 | NA | 1.0E-11 | 1.0E-16 | 1.0E-16 | 3.5E-12 |
| | 04-Nov-14 | 04-Nov-14 | ND | 9.1E-19 | 1.5E-17 | ND | NA | 3.0E-05 | 1.7E-03 | NA | 1.0E-11 | 1.0E-16 | 1.0E-16 | 3.5E-12 |
| UAMS-5 | 07-Jan-14 | 17-Feb-14 | ND | 4.4E-18 | 3.8E-17 | ND | NA | 1.5E-04 | 4.3E-03 | NA | 1.5E-16 | 1.0E-16 | 1.0E-16 | 5.3E-17 |
| | 25-Feb-14 | 26-Mar-14 | ND | 1.0E-17 | 2.2E-17 | ND | NA | 3.5E-04 | 2.5E-03 | NA | 2.1E-16 | 1.0E-16 | 1.0E-16 | 7.4E-17 |
| | 07-Apr-14 | 13-May-14 | ND | 1.1E-17 | 4.1E-17 | ND | NA | 3.6E-04 | 4.6E-03 | NA | 1.8E-16 | 1.0E-16 | 1.0E-16 | 6.3E-17 |
| | 16-May-14 | 20-Jun-14 | ND | 4.3E-17 | 4.3E-17 | ND | NA | 1.4E-03 | 4.8E-03 | NA | 1.8E-16 | 1.0E-16 | 1.0E-16 | 6.1E-17 |
| | 27-Jun-14 | 12-Aug-14 | ND | 2.0E-17 | 1.0E-16 | ND | NA | 6.5E-04 | 1.2E-02 | NA | 1.6E-16 | 1.0E-16 | 1.0E-16 | 5.6E-17 |
| | 18-Aug-14 | 19-Sep-14 | ND | 1.7E-17 | 6.9E-17 | ND | NA | 5.8E-04 | 7.7E-03 | NA | 2.1E-16 | 1.0E-16 | 1.0E-16 | 7.3E-17 |
| | 01-Oct-14 | 01-Oct-14 | ND | 1.3E-17 | 1.1E-16 | ND | NA | 4.4E-04 | 1.2E-02 | NA | 1.0E-11 | 1.0E-16 | 1.0E-16 | 3.5E-12 |

Notes:
[a]Reporting limit not reported by analytical laboratory
[b]Volume not reported. Calculation not performed.
NA = Not applicable
ND = Result below detection limit
NR = not reported
Ra-226 = radium-226
Th-230 = thorium-230
Th-nat = natural thorium
U-nat = natural uranium
µCi ml$^{-1}$ = microcuries per milliliter

## Table 9.2. Summary Statistics for Radionuclide Concentrations in Air

| Location | U-nat Concentration (µC ml$^{-1}$) | | | | | Th-230 Concentration (µC ml$^{-1}$) | | | | Ra-226 Concentration (µC ml$^{-1}$) | | | | Th-nat Concentration (µC ml$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | Avg | σ | Min | Max | Avg | σ | Min | Max | Avg | σ | Min | Max | Avg | σ | Min | Max |
| UAMS-1 | 16 | 7.2E-17 | 4.7E-17 | 2.5E-18 | 1.2E-16 | 5.0E-17 | 5.0E-17 | 2.3E-18 | 1.7E-16 | 3.0E-16 | 9.0E-16 | 2.4E-18 | 3.5E-15 | 1.0E-16 | 8.8E-17 | 2.4E-18 | 2.4E-16 |
| UAMS-2 | 14 | 2.2E-17 | 2.7E-17 | 2.7E-19 | 5.9E-17 | 1.8E-17 | 2.8E-17 | 4.8E-19 | 8.1E-17 | 1.7E-17 | 2.6E-17 | 6.5E-19 | 7.4E-17 | 2.0E-17 | 2.5E-17 | 6.2E-19 | 5.8E-17 |
| UAMS-3 | 12 | 9.3E-18 | 1.0E-17 | 2.2E-18 | 1.6E-17 | 1.0E-17 | 8.9E-18 | 1.5E-18 | 2.5E-17 | 2.2E-17 | 2.1E-17 | 2.2E-18 | 5.9E-17 | 9.9E-18 | 1.5E-17 | 8.2E-19 | 2.7E-17 |
| UAMS-4 | 14 | 2.7E-17 | 2.5E-17 | 9.3E-19 | 5.2E-17 | 2.4E-17 | 3.9E-17 | 9.1E-19 | 1.3E-16 | 4.7E-17 | 5.9E-17 | 6.1E-19 | 1.8E-16 | 2.1E-17 | 1.8E-17 | 1.2E-18 | 3.4E-17 |
| UAMS-5 | 7 | A | NA | NA | NA | 1.7E-17 | 1.3E-17 | 4.4E-18 | 4.3E-17 | 6.2E-17 | 3.5E-17 | 2.2E-17 | 1.1E-16 | NA | NA | NA | NA |
| Site Wide | 63 | 3.6E-17 | 3.9E-17 | 2.7E-19 | 1.2E-16 | 2.7E-17 | 3.8E-17 | 4.8E-19 | 1.7E-16 | 1.2E-16 | 5.1E-16 | 6.1E-19 | 3.5E-15 | 4.1E-17 | 6.0E-17 | 6.2E-19 | 2.4E-16 |

Notes:
NA = not applicable
Ra-226 = radium-226
σ = standard deviation
Th-230 = thorium-230
Th-nat = natural thorium
U-nat = natural uranium
µCi ml$^{-1}$ = microcuries per milliliter

The values determined above are similar to U.S. background concentrations reported in the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) Report to the General Assembly, Sources and Effects of Ionizing Radiation, Annex B (UNSCEAR, 2000). The regional concentrations reported in this reference document are: uranium-238 ($2.4x10^{-17}$ to $1.4x10^{-16}$ µCi $ml^{-1}$), natural thorium ($1.9x10^{-17}$µCi $ml^{-1}$ based on an average of thorium-228 and thorium-232 regional concentrations), thorium-230 ($1.6x10^{-17}$ µCi $ml^{-1}$), and radium-226 ($1.6x10^{-17}$ µCi $ml^{-1}$).

The ranges of airborne radioactive particulate concentrations were the following percentages of their respective 10 CFR 20 Appendix B effluent concentrations:

- Natural uranium: not detected to 0.004 percent.
- Natural thorium: not detected to 0.009 percent.
- Thorium-230: not detected to 0.4 percent.
- Radium-226: not detected to 0.03 percent.

### *9.1.2 Lanthanide Particulates*

Table 9.3 presents the concentrations of lanthanides in sample filters and in air. Table 9.4 lists summary statistics for the lanthanides.

Site-wide average cerium and lanthanum particulate concentrations in air are $9.0x10^{-4}$ and $4.5x10^{-4}$ µg $m^{-3}$, respectively. The range of cerium concentrations is $6.5x10^{-6}$ to $4.0x10^{-3}$ µg $m^{-3}$. The range of lanthanum concentrations is $3.6x10^{-6}$ to $2.0x10^{-3}$ µg $m^{-3}$.

## Table 9.3. Lanthanide Concentrations in Air

| | | | Lanthanum (µg $m^{-3}$) | | Cerium (µg $m^{-3}$) | |
|---|---|---|---|---|---|---|
| **Location** | **Start Date** | **Stop Date** | **Result** | **Reporting Limit** | **Result** | **Reporting Limit** |
| UAMS-1 | 12-Jun-12 | 15-Jun-12 | 2.0E-03 | 1.8E-04 | 4.0E-03 | 1.8E-04 |
| | 21-Jun-12 | 05-Jul-12 | 1.6E-03 | 5.4E-05 | 3.3E-03 | 5.4E-05 |
| | 12-Jul-12 | 26-Jul-12 | 8.8E-04 | 4.6E-05 | 1.8E-03 | 4.6E-05 |
| | 31-Aug-12 | 04-Oct-12 | 3.1E-05 | 9.2E-07 | 6.3E-05 | 9.2E-07 |
| | 11-Oct-12 | 07-Nov-12 | 7.3E-04 | 2.4E-05 | 1.5E-03 | 2.4E-05 |
| | 16-Nov-12 | 03-Jan-13 | 5.4E-04 | 3.5E-04 | 1.0E-03 | 3.5E-04 |
| | 10-Jan-13 | 05-Feb-13 | ND | 4.9E-04 | ND | 4.9E-04 |
| | 12-Feb-13 | 15-Mar-13 | ND | 4.1E-04 | 4.6E-04 | 4.1E-04 |
| | 21-Mar-13 | 18-Apr-13 | ND | 4.5E-04 | ND | 4.5E-04 |
| | 21-Nov-13 | 07-Jan-14 | ND | 4.6E-04 | ND | 4.6E-04 |
| | 04-Mar-14 | 07-Apr-14 | ND | 3.3E-04 | ND | 3.3E-04 |
| | 14-Apr-14 | 16-May-14 | ND | 4.4E-04 | ND | 4.4E-04 |
| | 22-May-14 | 27-Jun-14 | ND | 3.8E-04 | ND | 3.8E-04 |
| | 09-Jul-14 | 18-Aug-14 | ND | 3.7E-04 | ND | 3.7E-04 |
| | 26-Aug-14 | 01-Oct-14 | ND | 3.8E-04 | ND | 3.8E-04 |
| | 13-Oct-14 | 13-Oct-14 | ND | 1.6E+01 | ND | 1.6E+01 |
| UAMS-2 | 12-Jun-12 | 21-Jun-12 | 6.1E-04 | 6.8E-05 | 1.2E-03 | 6.8E-05 |
| | 28-Jun-12 | 12-Jul-12 | 7.4E-04 | 4.4E-05 | 1.5E-03 | 4.4E-05 |
| | 19-Jul-12 | 02-Aug-12 | 1.1E-05 | 1.2E-06 | 2.3E-05 | 1.2E-06 |
| | 09-Aug-12 | 02-Sep-12 | 1.3E-05 | 7.5E-07 | 2.5E-05 | 7.5E-07 |
| | 09-Sep-12 | 11-Oct-12 | 3.9E-04 | 2.4E-05 | 7.8E-04 | 2.4E-05 |
| | 16-Oct-12 | 16-Nov-12 | 5.6E-06 | 5.6E-07 | 1.1E-05 | 5.6E-07 |
| | 28-Nov-12 | 10-Jan-13 | 3.6E-06 | 4.0E-07 | 6.5E-06 | 4.0E-07 |
| | 16-Jan-13 | 19-Feb-13 | ND | 2.9E-04 | ND | 2.9E-04 |
| | 26-Feb-13 | 21-Mar-13 | ND | 4.3E-04 | ND | 4.3E-04 |
| | 27-Mar-13 | 25-Apr-13 | ND | 3.4E-04 | ND | 3.4E-04 |
| | 03-Dec-13 | 10-Jan-14 | ND | 2.6E-04 | ND | 2.6E-04 |
| | 20-Jan-14 | 25-Feb-14 | ND | 2.7E-04 | ND | 2.7E-04 |
| | 11-Mar-14 | 14-Apr-14 | ND | 2.9E-04 | ND | 2.9E-04 |
| | 22-Apr-14 | 22-May-14 | ND | 3.2E-04 | ND | 3.2E-04 |

## Table 9.3. Lanthanide Concentrations in Air (concluded)

| | | | Lanthanum (µg $m^{-3}$) | | Cerium (µg $m^{-3}$) | |
|---|---|---|---|---|---|---|
| **Location** | **Start Date** | **Stop Date** | **Result** | **Reporting Limit** | **Result** | **Reporting Limit** |
| UAMS-3 | 24-Jul-12 | 09-Aug-12 | 2.9E-05 | 3.2E-06 | 6.2E-05 | 3.2E-06 |
| | 17-Sep-12 | 19-Oct-12 | 2.7E-04 | 2.4E-05 | 5.6E-04 | 2.4E-05 |
| | 30-Oct-12 | 28-Nov-12 | 4.7E-06 | 9.3E-07 | 9.3E-06 | 9.3E-07 |
| | 28-Jan-13 | 26-Feb-13 | ND | 3.4E-04 | ND | 3.4E-04 |
| | 10-Mar-13 | 27-Mar-13 | ND | 5.8E-04 | ND | 5.8E-04 |
| | 20-Dec-13 | 20-Jan-14 | ND | 6.2E-04 | ND | 6.2E-04 |
| | 03-Feb-14 | 19-Mar-14 | ND | 3.5E-04 | ND | 3.5E-04 |
| | 26-Mar-14 | 02-May-14 | ND | 3.6E-04 | ND | 3.6E-04 |
| | 13-May-14 | 13-Jun-14 | ND | 3.4E-04 | ND | 3.4E-04 |
| | 20-Jun-14 | 04-Aug-14 | ND | 2.5E-04 | ND | 2.5E-04 |
| | 12-Aug-14 | 12-Sep-14 | ND | 3.8E-04 | ND | 3.8E-04 |
| | 19-Sep-14 | 19-Sep-14 | ND | 1.6E+01 | ND | 1.6E+01 |
| UAMS-4 | 12-Jun-12 | 28-Jun-12 | 5.7E-04 | 3.8E-05 | 1.2E-03 | 3.8E-05 |
| | 05-Jul-12 | 19-Jul-12 | 4.4E-04 | 4.4E-05 | 9.2E-04 | 4.4E-05 |
| | 26-Aug-12 | 27-Sep-12 | 1.6E-05 | 6.8E-07 | 3.4E-05 | 6.8E-07 |
| | 28-Nov-12 | 16-Jan-13 | 2.0E-04 | 2.0E-04 | 5.0E-04 | 2.0E-04 |
| | 24-Jan-13 | 08-Mar-13 | ND | 2.3E-04 | ND | 2.3E-04 |
| | 15-Mar-13 | 12-Apr-13 | ND | 3.5E-03 | ND | 3.5E-03 |
| | 30-Dec-13 | 03-Feb-14 | ND | 2.8E-04 | ND | 2.8E-04 |
| | 17-Feb-14 | 11-Mar-14 | ND | 4.5E-04 | ND | 4.5E-04 |
| | 13-Jun-14 | 18-Jul-14 | ND | 3.0E-04 | ND | 3.0E-04 |
| | 04-Aug-14 | 29-Aug-14 | ND | 4.1E-04 | ND | 4.1E-04 |
| | 09-Sep-14 | 09-Sep-14 | ND | 1.6E+01 | ND | 1.6E+01 |
| | 04-Nov-14 | 04-Nov-14 | ND | 1.6E+01 | ND | 1.6E+01 |
| UAMS-5 | 07-Jan-14 | 17-Feb-14 | ND | 2.4E-04 | ND | 2.4E-04 |
| | 25-Feb-14 | 26-Mar-14 | ND | 3.4E-04 | ND | 3.4E-04 |
| | 07-Apr-14 | 13-May-14 | ND | 2.9E-04 | ND | 2.9E-04 |
| | 16-May-14 | 20-Jun-14 | ND | 2.8E-04 | ND | 2.8E-04 |
| | 27-Jun-14 | 12-Aug-14 | ND | 2.6E-04 | ND | 2.6E-04 |
| | 18-Aug-14 | 19-Sep-14 | ND | 3.3E-04 | ND | 3.3E-04 |
| | 01-Oct-14 | 01-Oct-14 | ND | 1.6E+01 | ND | 1.6E+01 |

Notes:
Ce = cerium
La = lanthanum
ND = not detected
NA = not applicable
µg $m^{-3}$ = micrograms per cubic meter

## Table 9.4. Summary Statistics for Lanthanide Concentrations in Air

| | | Lanthanide Concentration ($\mu g\ m^{-3}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Average | | Standard Deviation | | Minimum | | Maximum | |
| Location | n | Lanthanum | Cerium | Lanthanum | Cerium | Lanthanum | Cerium | Lanthanum | Cerium |
| UAMS-1 | 16 | 9.6E-04 | 1.7E-03 | 7.1E-04 | 1.8E+00 | 3.1E-05 | 6.3E-05 | 2.0E-03 | 5.0E+00 |
| UAMS-2 | 14 | 2.5E-04 | 5.1E-04 | 3.2E-04 | 6.5E-04 | 3.6E-06 | 6.5E-06 | 7.4E-04 | 1.5E-03 |
| UAMS-3 | 12 | 1.0E-04 | 2.1E-04 | 1.4E-04 | 3.0E-04 | 4.7E-06 | 9.3E-06 | 2.7E-04 | 5.6E-04 |
| UAMS-4 | 12 | 3.1E-04 | 6.6E-04 | 2.5E-04 | 5.0E-04 | 1.6E-05 | 3.4E-05 | 5.7E-04 | 1.2E-03 |
| UAMS-5 | 7 | NA | NA | NA | NA | NA | NA | NA | NA |
| Site-Wide | 61 | 4.5E-04 | 9.0E-04 | 5.5E-04 | 1.1E-03 | 3.6E-06 | 6.5E-06 | 2.0E-03 | 4.0E-03 |

Notes:
Ce = cerium
La = lanthanum
$\mu g\ m^{-3}$ = micrograms per cubic meter

## 9.2 Particulate Matter Fractions

RER conducted Particulate Matter 2.5 ($PM_{2.5}$: particles with a nominal diameter less than 2.5 microns) and Particulate Matter 10 ($PM_{10}$: particles with a nominal diameter less than 10 microns) measurements for 24 hours at each of the four AMS locations, to further characterize particulates in air.

Tables 9.5 and 9.6 list the individual concentrations of the $PM_{10}$ and $PM_{2.5}$ filters, respectively. $PM_{10}$ and $PM_{2.5}$ concentrations were determined by dividing the laboratory-reported mass by the volume of air sampled in the 24-hr period. The concentrations are compared there to their respective 40 CFR 50 standards.

For the purpose of reference, the $PM_{10}$ standard is met when the expected number of days per calendar year with a 24-hr average concentration above 150 $\mu g\ m^{-3}$ is equal to or less than one.

The $PM_{10}$ standard has been meet at each of the five air monitoring stations. The concentrations range from 7.4 (UAMS-3) to 17.4 percent (UAMS-1) of the $PM_{10}$ standard.

The $PM_{2.5}$ standard is met when:

- The annual arithmetic mean concentration (averaged over three years) is less than or equal to 15 $\mu g\ m^{-3}$, or

- The $98^{th}$ percentile 24-hr concentration is less than or equal to 65 $\mu g\ m^{-3}$.

The $98^{th}$ percentile is defined in 40 CFR 50 Appendix N as the daily value out of a year of $PM_{2.5}$ monitoring data below which 98 percent of all daily values fall.

Three years of data are needed to compare site measurements to applicable $PM_{2.5}$ standards.

## Table 9.5. $PM_{10}$ Concentrations Measured at Upton Air Monitoring Stations

| Location | Start Date | End Date | Filter No. | Filter Weight (g) | Volume (scm) | Concentration (µg m-3) | Mean (µg $m^{-3}$) | Maximum (µg $m^{-3}$) | % of Standard (Mean)[a] |
|---|---|---|---|---|---|---|---|---|---|
| UAMS-1 | 17-Jun-12 | 18-Jun-12 | 58683 | 0.0293 | 1115 | 26 | 26 | 78 | 17.4 |
| | 10-Jul-12 | 11-Jul-12 | 58697 | 0.084 | 1076 | 78 | | | |
| | 29-Jul-12 | 30-Jul-12 | 58757 | 0.0242 | 1042 | 23 | | | |
| | 29-Aug-12 | 30-Aug-12 | 58776 | 0.0758 | 1089 | 70 | | | |
| | 08-Oct-12 | 09-Oct-12 | 58784 | 0.0172 | 1344 | 13 | | | |
| | 07-Nov-12 | 08-Nov-12 | 58790 | 0.0546 | 1300 | 42 | | | |
| | 07-Jan-13 | 08-Jan-13 | 58794 | 0.0279 | 1363 | 20 | | | |
| | 06-Feb-13 | 07-Feb-13 | 514597 | 0.012 | 1470 | 8 | | | |
| | 16-Mar-13 | 17-Mar-13 | 514605 | 0.0088 | 1475 | 6 | | | |
| | 18-Apr-13 | 19-Apr-13 | 514613 | 0.0174 | 1415 | 12 | | | |
| | 14-Jun-13 | 15-Jun-13 | 514622 | 0.0319 | 1394 | 23 | | | |
| | 25-Jul-13 | 26-Jul-13 | 514633 | 0.0197 | 1434 | 14 | | | |
| | 12-Nov-13 | 13-Nov-13 | 515959 | 0.0268 | 1559 | 17 | | | |
| | 07-Apr-14 | 08-Apr-14 | 515986 | 0.0512 | 1573 | 33 | | | |
| | 20-May-14 | 21-May-14 | 515997 | 0.0183 | 1537 | 12 | | | |
| | 27-Jun-14 | 28-Jun-14 | 516006 | 0.0235 | 1499 | 16 | | | |
| | 18-Aug-14 | 19-Aug-14 | 516015 | 0.0755 | 1531 | 49 | | | |
| | 01-Oct-14 | 02-Oct-14 | 516023 | 0.0124 | 1867 | 7 | | | |

## Table 9.5. $PM_{10}$ Concentrations Measured at Upton Air Monitoring Stations (continued)

| Location | Start Date | End Date | Filter No. | Filter Weight (g) | Volume (scm) | Concentration (µg m-3) | Mean (µg $m^{-3}$) | Maximum (µg $m^{-3}$) | % of Standard (Mean)[a] |
|---|---|---|---|---|---|---|---|---|---|
| UAMS-2 | 26-May-12 | 27-May-12 | 58688 | 0.0515 | 1343 | 38 | 12 | 38 | 8.1 |
| | 07-Aug-12 | 08-Aug-12 | 58699 | 0.0307 | 1528 | 20 | | | |
| | 07-Aug-12 | 08-Aug-12 | 58765 | 0.0116 | 1623 | 7 | | | |
| | 02-Sep-12 | 03-Sep-12 | 58777 | 0.0552 | 1639 | 34 | | | |
| | 11-Oct-12 | 12-Oct-12 | 58785 | 0.0245 | 1633 | 15 | | | |
| | 21-Nov-12 | 22-Nov-12 | 58793 | 0.0077 | 1636 | 5 | | | |
| | 10-Jan-13 | 11-Jan-13 | 58795 | 0.0468 | 1633 | 29 | | | |
| | 22-Feb-13 | 23-Feb-13 | 514600 | 0.0167 | 2668 | 6 | | | |
| | 26-Mar-13 | 27-Mar-13 | 514608 | 0.0333 | 2429 | 14 | | | |
| | 29-Apr-13 | 29-Apr-13 | 514618 | 0.0175 | 1855 | 9 | | | |
| | 21-Jun-13 | 22-Jun-13 | 514623 | 0.0237 | 1947 | 12 | | | |
| | 09-Aug-13 | 10-Aug-13 | 514637 | 0.0163 | 1954 | 8 | | | |
| | 30-Sep-13 | 02-Oct-13 | 514646 | 0.0045 | 3687 | 1 | | | |
| | 25-Nov-13 | 26-Nov-13 | 515962 | 0.0207 | 3432 | 6 | | | |
| | 12-Jan-14 | 13-Jan-14 | 515970 | 0.0063 | 1965 | 3 | | | |
| | 25-Feb-14 | 26-Feb-14 | 515978 | 0.0045 | 3205 | 1 | | | |
| | 17-Apr-14 | 18-Apr-14 | 515989 | 0.0073 | 1852 | 4 | | | |
| | 22-May-14 | 23-May-14 | 515998 | 0.011 | 1921 | 6 | | | |

## Table 9.5. $PM_{10}$ Concentrations Measured at Upton Air Monitoring Stations (continued)

| Location | Start Date | End Date | Filter No. | Filter Weight (g) | Volume (scm) | Concentration (µg m-3) | Mean (µg $m^{-3}$) | Maximum (µg $m^{-3}$) | % of Standard (Mean)[a] |
|---|---|---|---|---|---|---|---|---|---|
| UAMS-3 | 12-Aug-12 | 13-Aug-12 | 58767 | 0.0231 | 1386 | 17 | 11 | 42 | 7.4 |
| | 11-Sep-12 | 12-Sep-12 | 58779 | 0.062 | 1464 | 42 | | | |
| | 28-Oct-12 | 29-Oct-12 | 58789 | 0.0146 | 1609 | 9 | | | |
| | 28-Nov-12 | 28-Nov-12 | 58772 | 0.0122 | 1433 | 9 | | | |
| | 27-Feb-13 | 28-Feb-13 | 514601 | 0.0071 | 2061 | 3 | | | |
| | 28-Mar-13 | 29-Mar-13 | 514609 | 0.0107 | 1795 | 6 | | | |
| | 30-Apr-13 | 01-May-13 | 514619 | 0.0094 | 1750 | 5 | | | |
| | 02-Jul-13 | 03-Jul-13 | 514628 | 0.031 | 1547 | 20 | | | |
| | 19-Aug-13 | 20-Aug-13 | 514638 | 0.0495 | 1661 | 30 | | | |
| | 18-Oct-13 | 19-Oct-13 | 515954 | 0.0099 | 1833 | 5 | | | |
| | 11-Dec-13 | 12-Dec-13 | 515964 | 0.0265 | 2738 | 10 | | | |
| | 27-Jan-14 | 28-Jan-14 | 515973 | 0.0096 | 2962 | 3 | | | |
| | 19-Mar-14 | 20-Mar-14 | 515982 | 0.0114 | 1788 | 6 | | | |
| | 06-May-14 | 07-May-14 | 515993 | 0.0032 | 1800 | 2 | | | |
| | 13-Jun-14 | 14-Jun-14 | 516002 | 0.0099 | 1867 | 5 | | | |
| | 04-Aug-14 | 05-Aug-14 | 516011 | 0.045 | 1768 | 25 | | | |
| | 18-Nov-14 | 18-Nov-14 | 516029 | 0.0064 | 1730 | 4 | | | |

## Table 9.5. $PM_{10}$ Concentrations Measured at Upton Air Monitoring Stations (continued)

| Location | Start Date | End Date | Filter No. | Filter Weight (g) | Volume (scm) | Concentration (µg m-3) | Mean (µg $m^{-3}$) | Maximum (µg $m^{-3}$) | % of Standard (Mean)[a] |
|---|---|---|---|---|---|---|---|---|---|
| UAMS-4 | 01-Jul-12 | 02-Jul-12 | 58691 | 0.1417 | 1502 | 94 | 21 | 94 | 13.9 |
| | 24-Jul-12 | 25-Jul-12 | 58755 | 0.0193 | 1634 | 12 | | | |
| | 22-Aug-12 | 23-Aug-12 | 58771 | 0.0456 | 1631 | 28 | | | |
| | 27-Sep-12 | 28-Sep-12 | 58781 | 0.0357 | 1633 | 22 | | | |
| | 21-Jan-13 | 22-Jan-13 | 58798 | 0.0217 | 1632 | 13 | | | |
| | 15-Mar-13 | 16-Mar-13 | 514604 | 0.0219 | 1829 | 12 | | | |
| | 16-Apr-13 | 17-Apr-13 | 514612 | 0.0175 | 1681 | 10 | | | |
| | 14-May-13 | 15-May-13 | 514624 | 0.0607 | 1760 | 34 | | | |
| | 12-Jul-13 | 13-Jul-13 | 514629 | 0.0319 | 1790 | 18 | | | |
| | 03-Sep-13 | 04-Sep-13 | 514641 | 0.0437 | 1809 | 24 | | | |
| | 22-Oct-13 | 23-Oct-13 | 515955 | 0.0133 | 1797 | 7 | | | |
| | 23-Dec-13 | 24-Dec-13 | 515967 | 0.0085 | 1966 | 4 | | | |
| | 03-Feb-14 | 04-Feb-14 | 515974 | 0.0141 | 4308 | 3 | | | |
| | 17-Mar-14 | 18-Mar-14 | 515981 | 0.0065 | 1730 | 4 | | | |
| | 22-Apr-14 | 23-Apr-14 | 515990 | 0.0352 | 1853 | 19 | | | |
| | 10-Jun-14 | 11-Jun-14 | 516001 | 0.0135 | 1817 | 7 | | | |
| | 04-Sep-14 | 05-Sep-14 | 516018 | 0.019 | 1626 | 12 | | | |
| | 28-Oct-14 | 29-Oct-14 | 516027 | 0.1282 | 1749 | 73 | | | |

## Table 9.5. $PM_{10}$ Concentrations Measured at Upton Air Monitoring Stations (concluded)

| Location | Start Date | End Date | Filter No. | Filter Weight (g) | Volume (scm) | Concentration (µg m-3) | Mean (µg $m^{-3}$) | Maximum (µg $m^{-3}$) | % of Standard (Mean)[a] |
|---|---|---|---|---|---|---|---|---|---|
| UAMS-5 | 25-May-13 | 27-May-13 | 513262 | 0.0453 | 3767 | 12 | 17 | 48 | 11.0 |
| | 23-Jul-13 | 24-Jul-13 | 514632 | 0.0633 | 1938 | 33 | | | |
| | 10-Sep-13 | 11-Sep-13 | 514642 | 0.091 | 1879 | 48 | | | |
| | 05-Nov-13 | 06-Nov-13 | 515958 | 0.0083 | 1745 | 5 | | | |
| | 30-Dec-13 | 31-Dec-13 | 515968 | 0.0068 | 1863 | 4 | | | |
| | 21-Feb-14 | 22-Feb-14 | 515977 | 0.0094 | 2209 | 4 | | | |
| | 04-Apr-14 | 05-Apr-14 | 515985 | 0.0386 | 1820 | 21 | | | |
| | 13-May-14 | 14-May-14 | 515994 | 0.0416 | 1798 | 23 | | | |
| | 24-Jun-14 | 25-Jun-14 | 516005 | 0.0254 | 1914 | 13 | | | |
| | 09-Dec-14 | 10-Dec-14 | 519703 | 0.0625 | 1778 | 35 | | | |

Notes:
[a]$PM_{10}$ standard is met when the expected number of days per calendar year with a 24-hr average concentration above 150 µg $m^{-3}$ is equal to or less than one.
g = grams
NA = not applicable
NR = not reported
$PM_{10}$ = particulate matter, diameter less than 10 microns
scm = standard cubic meters
µg $m^{-3}$ = micrograms per cubic meter

## Table 9.6. $PM_{2.5}$ Concentrations Measured at Upton Air Monitoring Stations

| Location | Start Date | End Date | Filter No. | Filter Weight (g) | Volume (scm) | Concentration (µg m-3) | Mean (µg $m^{-3}$) | Maximum (µg $m^{-3}$) | % of Standard (Mean)[a] |
|---|---|---|---|---|---|---|---|---|---|
| UAMS-1 | 19-Jun-12 | 20-Jun-12 | 58685 | 0.0038 | 795.1 | 4.8 | 10 | 47 | 64.2 |
| | 08-Jul-12 | 09-Jul-12 | 58694 | 0.0509 | 1088.0 | 46.8 | | | |
| | 31-Jul-12 | 01-Aug-12 | 58761 | 0.0138 | 1014.3 | 13.6 | | | |
| | 26-Aug-12 | 27-Aug-12 | 58775 | 0.0146 | 1095.0 | 13.3 | | | |
| | 04-Oct-12 | 05-Oct-12 | 58783 | 0.0097 | 1302.7 | 7.4 | | | |
| | 12-Nov-12 | 13-Nov-12 | 58791 | 0.0151 | 1323.5 | 11.4 | | | |
| | 03-Jan-13 | 04-Jan-13 | 58774 | 0.0139 | 1300.2 | 10.7 | | | |
| | 08-Feb-13 | 09-Feb-13 | 514598 | 0.0054 | 1324.0 | 4.0 | | | |
| | 19-Mar-13 | 20-Mar-13 | 514606 | 0.0029 | 1307.0 | 2.0 | | | |
| | 23-Apr-13 | 24-Apr-13 | 514614 | 0.0099 | 1294.0 | 8.0 | | | |
| | 11-Jun-13 | 12-Jun-13 | 513265 | 0.0167 | 1446.0 | 12.0 | | | |
| | 05-Aug-13 | 06-Aug-13 | 514635 | 0.0105 | | 0.0 | | | |
| | 18-Sep-13 | 19-Sep-13 | 514644 | 0.0107 | 1329.0 | 8.0 | | | |
| | 15-Nov-13 | 16-Nov-13 | 515960 | 0.016 | 1384.0 | 12.0 | | | |
| | 10-Apr-14 | 11-Apr-14 | 515987 | 0.0132 | 1462.0 | 9.0 | | | |
| | 16-May-14 | 17-May-14 | 515996 | 0.022 | 1571.0 | 14.0 | | | |
| | 08-Jul-14 | | 516008 | 0 | | 0.0 | | | |
| | 22-Aug-14 | | 516016 | 0 | | 0.0 | | | |
| | 06-Oct-14 | 07-Oct-14 | 516024 | 0.0108 | 1795.0 | 6.0 | | | |

## Table 9.6. $PM_{2.5}$ Concentrations Measured at Upton Air Monitoring Stations (continued)

| Location | Start Date | End Date | Filter No. | Filter Weight (g) | Volume (scm) | Concentration (µg m-3) | Mean (µg $m^{-3}$) | Maximum (µg $m^{-3}$) | % of Standard (Mean)[a] |
|---|---|---|---|---|---|---|---|---|---|
| UAMS-2 | 24-Jun-12 | 25-Jun-12 | 58686 | 0.0179 | 1252.3 | 14.3 | 5 | 14 | 36.1 |
| | 17-Jul-12 | 18-Jul-12 | 58752 | 0.0113 | 1639.3 | 6.9 | | | |
| | 05-Aug-12 | 06-Aug-12 | 58763 | 0.0125 | 1359.8 | 9.2 | | | |
| | 05-Sep-12 | 06-Sep-12 | 58778 | 0.0186 | 1635.2 | 11.4 | | | |
| | 13-Oct-12 | 14-Oct-12 | 58786 | 0.0137 | 1634.6 | 8.4 | | | |
| | 16-Nov-12 | 17-Nov-12 | 58792 | 0.011 | 1636.0 | 6.7 | | | |
| | 14-Jan-13 | 15-Jan-13 | 58796 | 0.0057 | 1634.2 | 3.5 | | | |
| | 21-Feb-13 | 22-Feb-13 | 514599 | 0.0053 | 1964.0 | 3.0 | | | |
| | 22-Mar-13 | 22-Mar-13 | 514607 | 0.0019 | 1774.0 | 1.0 | | | |
| | 25-Apr-13 | 26-Apr-13 | 514616 | 0.0106 | 1880.0 | 6.0 | | | |
| | 24-Jun-13 | 25-Jun-13 | 514626 | 0.0107 | 1957.0 | 5.0 | | | |
| | 07-Aug-13 | 08-Aug-13 | 514636 | 0.0109 | 1971.0 | 6.0 | | | |
| | 09-Oct-13 | 10-Oct-13 | 515952 | 0.008 | 1818.0 | 4.0 | | | |
| | 21-Nov-13 | 22-Nov-13 | 515961 | 0.007 | 3150.0 | 2.0 | | | |
| | 16-Jan-14 | 17-Jan-14 | 515971 | 0.0034 | 2052.0 | 2.0 | | | |
| | 04-Mar-14 | 05-Mar-14 | 515979 | 0.0044 | 1759.0 | 3.0 | | | |
| | 14-Apr-14 | 15-Apr-14 | 515988 | 0.0041 | 1803.0 | 2.0 | | | |
| | 27-May-14 | 28-May-14 | 515999 | 0.006 | 1950.0 | 3.0 | | | |

## Table 9.6. $PM_{2.5}$ Concentrations Measured at Upton Air Monitoring Stations (continued)

| Location | Start Date | End Date | Filter No. | Filter Weight (g) | Volume (scm) | Concentration (µg m-3) | Mean (µg $m^{-3}$) | Maximum (µg $m^{-3}$) | % of Standard (Mean)[a] |
|---|---|---|---|---|---|---|---|---|---|
| UAMS-3 | 15-Aug-12 | 16-Aug-12 | 58789 | 0.0065 | 1279.2 | 5.1 | 6 | 13 | 40.0 |
| | 13-Sep-12 | 14-Sep-12 | 58780 | 0.0162 | 1361.9 | 11.9 | | | |
| | 16-Oct-12 | 17-Oct-12 | 58787 | 0.009 | 1480.3 | 6.1 | | | |
| | 07-Dec-12 | 08-Dec-12 | 58773 | NR | 1038.3 | NA | | | |
| | 06-Mar-13 | 07-Mar-13 | 514602 | 0.0041 | 1728.0 | 2.0 | | | |
| | 01-Apr-13 | 02-Apr-13 | 514610 | 0.0094 | 1724.0 | 5.0 | | | |
| | 07-May-13 | 08-May-13 | 514620 | 0.0109 | 1549.0 | 7.0 | | | |
| | 27-Jun-13 | 28-Jun-13 | 514627 | 0.0085 | 1655.0 | 5.0 | | | |
| | 22-Aug-13 | 23-Aug-13 | 514639 | 0.0152 | 1440.0 | 11.0 | | | |
| | 16-Oct-13 | 17-Oct-13 | 515953 | 0.0116 | 1765.0 | 7.0 | | | |
| | 16-Dec-13 | 17-Dec-13 | 515965 | 0.0077 | 2825.0 | 3.0 | | | |
| | 20-Jan-14 | 21-Jan-14 | 515972 | 0.0036 | 2415.0 | 1.0 | | | |
| | 24-Mar-14 | 25-Mar-14 | 515983 | 0.0077 | 1747.0 | 4.0 | | | |
| | 06-May-14 | 07-May-14 | 515992 | 0.0081 | 1766.0 | 5.0 | | | |
| | 17-Jun-14 | 18-Jun-14 | 516003 | 0.0082 | 1794.0 | 5.0 | | | |
| | 08-Aug-14 | 09-Aug-14 | 516012 | 0.0155 | 1640.0 | 9.0 | | | |
| | 16-Sep-14 | 17-Sep-14 | 516020 | 0.021 | 1665.0 | 13.0 | | | |
| | 02-Dec-14 | 03-Dec-14 | 516031 | 0.0039 | 2541.0 | 2.0 | | | |

## Table 9.6. $PM_{2.5}$ Concentrations Measured at Upton Air Monitoring Stations (continued)

| Location | Start Date | End Date | Filter No. | Filter Weight (g) | Volume (scm) | Concentration (µg m-3) | Mean (µg $m^{-3}$) | Maximum (µg $m^{-3}$) | % of Standard (Mean)[a] |
|---|---|---|---|---|---|---|---|---|---|
| UAMS-4 | 03-Jul-12 | 04-Jul-12 | 58693 | 0.0269 | 1478.6 | 18.2 | 6 | 18 | 43.2 |
| | 22-Jul-12 | 23-Jul-12 | 58754 | 0.0142 | 1464.7 | 9.7 | | | |
| | 20-Aug-12 | 21-Aug-12 | 58770 | 0.0143 | 1584.5 | 9.0 | | | |
| | 30-Sep-12 | 01-Oct-12 | 58782 | 0.0265 | 1632.9 | 16.2 | | | |
| | 16-Jan-13 | 17-Jan-13 | 58797 | 0.0078 | 1598.4 | 4.9 | | | |
| | 09-Mar-13 | 10-Mar-13 | 514603 | 0.0075 | 1726.0 | 4.0 | | | |
| | 12-Apr-13 | 13-Apr-13 | 514611 | 0.0107 | 1721.0 | 6.0 | | | |
| | 09-May-13 | 10-May-13 | 514621 | 0.0103 | 1799.0 | 6.0 | | | |
| | 16-Jul-13 | 17-Jul-13 | 514630 | 0.0109 | 1734.0 | 6.0 | | | |
| | 28-Aug-13 | 29-Aug-13 | 514640 | 0.0186 | 1792.0 | 10.0 | | | |
| | 28-Oct-13 | 29-Oct-13 | 515956 | 0.0039 | 1725.0 | 2.0 | | | |
| | 20-Dec-13 | 21-Dec-13 | 515966 | 0.0075 | 2319.0 | 3.0 | | | |
| | 06-Feb-14 | 07-Feb-14 | 515975 | 0.0142 | 3705.0 | 4.0 | | | |
| | 11-Mar-14 | 12-Mar-14 | 515980 | 0.0012 | 1745.0 | 1.0 | | | |
| | 25-Apr-14 | 26-Apr-14 | 515991 | 0.0071 | 1766.0 | 4.0 | | | |
| | 03-Jun-14 | 04-Jun-14 | 516000 | 0.0102 | 1819.0 | 6.0 | | | |
| | 18-Jul-14 | NR | 516009 | NR | NA | NA | | | |
| | 29-Aug-14 | 30-Aug-14 | 516017 | 0.015 | 1721.0 | 9.0 | | | |
| | 13-Oct-14 | 14-Oct-14 | 516025 | 0.0073 | 1810.0 | 4.0 | | | |

## Table 9.6. $PM_{2.5}$ Concentrations Measured at Upton Air Monitoring Stations (concluded)

| Location | Start Date | End Date | Filter No. | Filter Weight (g) | Volume (scm) | Concentration (µg m-3) | Mean (µg $m^{-3}$) | Maximum (µg $m^{-3}$) | % of Standard (Mean)[a] |
|---|---|---|---|---|---|---|---|---|---|
| UAMS-5 | 11-Jun-13 | 12-Jun-13 | 513264 | 0.0144 | 1841.0 | 8.0 | 7 | 15 | 45.6 |
| | 18-Jul-13 | 19-Jul-13 | 514631 | 0.0142 | 1936.0 | 7.0 | | | |
| | 12-Sep-13 | 13-Sep-13 | 514643 | 0.0123 | 1869.0 | 7.0 | | | |
| | 31-Oct-13 | 01-Nov-13 | 515957 | 0.0079 | 1785.0 | 4.0 | | | |
| | 02-Jan-14 | 03-Jan-14 | 515969 | 0.0037 | 2099.0 | 2.0 | | | |
| | 17-Feb-14 | 18-Feb-14 | 515976 | 0.0037 | 1785.0 | 2.0 | | | |
| | 26-Mar-14 | 27-Mar-14 | 515984 | 0.0116 | 1798.0 | 6.0 | | | |
| | 14-May-14 | 15-May-14 | 515995 | 0.0205 | 1828.0 | 11.0 | | | |
| | 20-Jun-14 | 21-Jun-14 | 516004 | 0.0233 | 1921.0 | 12.0 | | | |
| | 13-Aug-14 | 14-Aug-14 | 516013 | 0.0265 | 1791.0 | 15.0 | | | |
| | 19-Sep-14 | | 516021 | 0 | | 0.0 | | | |
| | 04-Dec-14 | 05-Dec-14 | 516032 | 0.0135 | 1763.0 | 8.0 | | | |

Notes:
[a]$PM_{2.5}$ standard is less than or equal to 15 µg $m^{-3}$, as an annual arithmetic mean concentration averaged over three years.
g = grams
$PM_{2.5}$ = particulate matter, diameter less than 2.5 microns
scm = standard cubic meters
µg $m^{-3}$ = micrograms per cubic meter

# 10.0 SUMMARY AND CONCLUSIONS

The baseline information presented in this report, coupled with environmental data collected once the mine is operational, will be used as a basis to evaluate its potential environmental impacts. The results of the baseline field investigation documented herein indicate the following at the Upton Plant:

- The central tendency and variability of measured gamma count rates can be described non-parametrically by the median and the interquartile range (IQR), respectively. The median of the population is 16,091 cpm. The IQR encompasses the range between the 1st quartile (the first 25 percent of ascending, ranked values) and 3rd quartile (the first 75 percent of ascending, ranked values). The IQR is 2,405 cpm (or 17,092 less 14,687 cpm).

- The relationship between gamma count and exposure rates is highly predictable. The range of predicted exposure rates is 10.1 and 19.3 $\mu R\ hr^{-1}$, with a central tendency of 13.8 $\mu R\ hr^{-1}$.

- The medians of the predicted concentrations (1.6 pCi $g^{-1}$) of radium-226 and natural thorium (2.7 pCi $g^{-1}$) are in good agreement with the median of the laboratory results (1.6 and 2.4 pCi $g^{-1}$, respectively). This indicates that gamma surveys can effectively predict radium-226 and natural thorium concentrations in soil.

- The largely homogeneous distribution of radium-226 and natural thorium concentrations is indicated by the low variability in gamma count rates at the Upton Plant.

- Because applicable NRC soil cleanup criteria are likely to be based both on radium-226 and radium-228, both radionuclides should be considered in investigations conducted during operation and closure.

- The measured radon flux rates range from 0.20 to 1.22 pCi $m^{-2}\ s^{-1}$. For comparison purposes, these values are below the NESHAPS requirement of 20 pCi $m^{-2}\ s^{-1}$ specified in 10 CFR 40, Appendix A, Criterion 6. Although the requirement applies to uranium mill tailings and thus is not directly germane to this characterization, it is useful as a context to demonstrate the magnitude of baseline radon flux levels measured at the Site.

- Quarterly dosimetry measurements ranged on average from 23.9 to 29.5 mrem.

- Quarterly radon measurements ranged on average from 0.7 to 1.6 pCi $L^{-1}$.

- Particulate radionuclide concentrations in air across the site are consistently low and at levels at least 99 % below their respective 10 CFR 20 Appendix B effluent concentrations.

- Site-wide average cerium and lanthanum particulate concentrations in air are $9.0x10^{-4}$ and $4.5x10^{-4}$ µg $m^{-3}$, respectively. The range of cerium concentrations is $6.5x10^{-6}$ to $4.0x10^{-3}$ µg $m^{-3}$. The range of lanthanum concentrations is $3.6x10^{-6}$ to $2.0x10^{-3}$ µg $m^{-3}$.

- $PM_{10}$ and $PM_{2.5}$ measurements continue to be collected at the Upton Plant. $PM_{10}$ concentrations range from 7.4 (UAMS-3) to 17.4 percent (UAMS-1) of the respective standard. Three years of data are needed to compare site measurements to the applicable $PM_{2.5}$ standard.

- Radiological impacts incurred during the development and operation of the Plant and TSF, if any, will be determined by comparing the data sets of this baseline and future surveys.

## 11.0 REFERENCES


Knight Piésold, 2011. *Bear Lodge Project Upton Project/TSF Environmental Sampling and Analysis and Quality Assurance Plans,* December.

Rare Element Resources, Inc. (RER), 2015. *Environmental Report in Support of the Radioactive Materials License Application for the Upton Plant Site*. Anticipated publication in May.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 2000. *UNSCEAR Report to the General Assembly, Sources and Effects of Ionizing Radiation, Annex B*.

U.S. Environmental Protection Agency (EPA), Test Method 115: *Monitoring for Radon-222 Emissions*.

# Appendix A

# Instrument Calibration and Function Check Forms

# 1

ERG

## Function Check Form
## Single Channel Detector

Ratemeter: LUDLUM 2221 Serial No. 254772 Cal. Due Date: 2/15/13

Detector: LUDLUM 44-10 Serial No. PR118372 Cal. Due Date: 2/15/13

Source: Cs-137 Activity: 4 μCi on 4/12/96 Serial No. 544-96

Comments: FUNCTION CHECKS IN BACK OF VEHICLE @ SAME LOCATION CUCKY DTY. LOCATION @ UPTON SITE NEXT TO POST w/ ORANGE CAP.

| Date | Time | Battery | High Voltage | Threshold | Gross Counts | Background | Net Counts | Efficiency | Initial |
|---|---|---|---|---|---|---|---|---|---|
| 6/11/12 | 8:15 | 5.4 | 1150 | 101 | 44222 | 9610 | 34,612 | | cf |
| 6/11/12 | 18:35 | 5.1 | 1147 | 101 | 43632 | 8847 | 34,785 | | cf |
| 6/12/12 | 8:15 | 5.2 | 1151 | 101 | 45511 | 10551 | 34,960 | | cf |
| 6/12/12 | 12:55 | 5.1 | 1147 | 101 | 44929 | 9887 | 35,042 | | cf |
| 6/13/12 | 07:45 | 5.2 | 1154 | 101 | 44918 | 10758 | 34,160 | N/A | cf |
| 6/13/12 | 15:30 | 5.1 | 1146 | 101 | 45683 | 10048 | 35635 | | cf |
| 6/14/12 | 08:30 | 4.9 | 1150 | 101 | 44963 | 10117 | 34846 | | cf |
| 6/14/12 | 13:30 | 5.0 | 1147 | 101 | 46161 | 10481 | 35680 | | cf |
| | | | | | | | | | |
| | | | | | | | | | |

Reviewed By: [signature] Date: 11-15-12

ERG Form 1.30A

ERG

# Function Check Form
## Single Channel Detector

Ratemeter: LUDLUM 2221 Serial No. ~~254757~~ 254757 MW 11-15-12 Cal. Due Date: 4/30/12

Detector: LUDLUM 44-10 Serial No. PR199131 Cal. Due Date: 4/30/12

Source: Cs-137 Activity: 4 µCi on 4/12/96 Serial No. 544-96

Comments: _____

| Date | Time | Battery | High Voltage | Threshold | Gross Counts | Background | Net Counts | Efficiency | Initial |
|---|---|---|---|---|---|---|---|---|---|
| ~~6/11/12~~ MW | | | | | | | | | |
| 6/11/12 | 8:20 | 6.2 | 1051 | 101 | 43948 | 9171 | 34,777 | N/A | cf |
| 6/11/12 | 16:30 | 5.8 | 1046 | 100 | 42810 | 8340 | 34,470 | | cf |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

Reviewed By: _____ Date: 11-15-12

ERG Form 1.30A

# Certificate of Calibration

## Calibration and Voltage Plateau

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

Meter: Manufacturer: Ludlum Model Number: 2221r Serial Number: 254757

Detector: Manufacturer: Ludlum Model Number: 44-10 Serial Number: PR199131

☑ Mechanical Check ☑ Geotropism ☑ THR/WIN Operation ☑ Audio Check ☑ Battery Check (Min 4.4 VDC)

☑ F/S Response Check ☑ Meter Zeroed ☑ Reset Check HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V

Source Distance: ☐ Contact ☑ 6 inches ☐ Other: Cable Length: ☐ 39-inch ☑ 72-inch ☐ Other:

Source Geometry: ☑ Side ☐ Below ☐ Other: Temperature: 73 °F Relative Humidity 20 %

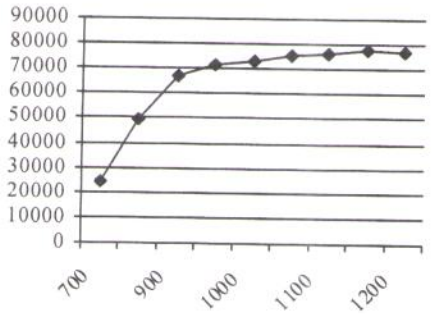
Threshold: 10 mV Window: Barometric Pressure: 24.45 inches Hg

Instrument found within tolerance: ☑ Yes ☐ No

| Range/Multiplier | Reference Setting | "As Found Reading" | Meter Reading | Integrated 1-Min. Count | Log Scale Count |
|---|---|---|---|---|---|
| x 1000 | 400 | 400 | 400 | 399405 | 400 |
| x 1000 | 100 | 100 | 100 | | 100 |
| x 100 | 40 | 400 | 400 | 39930 | 400 |
| x 100 | 10 | 100 | 100 | | 100 |
| x 10 | 4 | 400 | 400 | 3993 | 400 |
| x 10 | 1 | 100 | 100 | | 100 |
| x 1 | 400 | 400 | 400 | 400 | 400 |
| x 1 | 100 | 100 | 100 | | 100 |

| High Voltage | Source Counts | Background |
|---|---|---|
| 700 | 24387 | |
| 800 | 49746 | |
| 900 | 67033 | |
| 950 | 71599 | |
| 1000 | 73102 | |
| 1050 | 75406 | 12197 |
| 1100 | 76537 | |
| 1150 | 77927 | |
| 1200 | 76995 | |

Voltage Plateau




Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV =1050

**Reference Instruments and/or Sources:**

Ludlum pulser serial number: ☐ 97743 ☑ 201932

☐ Alpha Source: Th-230 @ 12,800 dpm (1/4/12) sn: 4098-03

☐ Beta Source: Tc-99 @ 17,700 dpm (1/4/12) sn: 4099-03

Fluke multimeter serial number: ☐ 8749012

☑ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03

☐ Other Source:

Calibrated By: [signature] Calibration Date: 4-30-12 Calibration Due: 4-30-13

Reviewed By: [signature] Review Date: 4/30/12

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997.
NMRCB Registration No. 921-3 * Calibration of Radiation Detection Instrument Devices

# Certificate of Calibration

**Calibration and Voltage Plateau**

Environmental Restoration Group, Inc.
8809 Washington St NE, Suite 150
Albuquerque, NM 87113
(505) 298-4224
www.ERGoffice.com

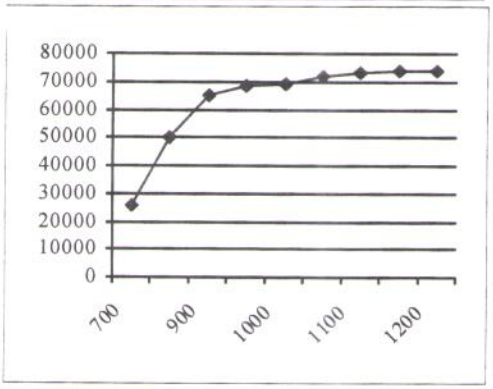
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Meter: | Manufacturer: | Ludlum | Model Number: | 2221r | Serial Number: | 254772 |
| Detector: | Manufacturer: | Ludlum | Model Number: | 44-10 | Serial Number: | PR118372 |

☑ Mechanical Check ☑ Geotropism ☑ THR/WIN Operation ☑ Audio Check ☑ Battery Check (Min 4.4 VDC)
☑ F/S Response Check ☑ Meter Zeroed ☑ Reset Check HV Check (+/- 2.5%): ☑ 500 V ☑ 1000 V ☑ 1500 V
Source Distance: ☐ Contact ☑ 6 inches ☐ Other: Cable Length: ☐ 39-inch ☑ 72-inch ☐ Other:
Source Geometry: ☑ Side ☐ Below ☐ Other: Temperature: 76 °F Relative Humidity 20 %
Threshold: 10 mV Window: Barometric Pressure: 24.48 inches Hg
Instrument found within tolerance: ☑ Yes ☐ No

| Range/Multiplier | Reference Setting | "As Found Reading" | Meter Reading | Integrated 1-Min. Count | Log Scale Count |
|---|---|---|---|---|---|
| x 1000 | 400 | 400 | 400 | 399841 | 400 |
| x 1000 | 100 | 100 | 100 | | 100 |
| x 100 | 40 | 400 | 400 | 39987 | 400 |
| x 100 | 10 | 100 | 100 | | 100 |
| x 10 | 4 | 400 | 400 | 3999 | 400 |
| x 10 | 1 | 100 | 100 | | 100 |
| x 1 | 400 | 400 | 400 | 400 | 400 |
| x 1 | 100 | 100 | 100 | | 100 |

| High Voltage | Source Counts | Background |
|---|---|---|
| 700 | 25860 | |
| 800 | 50025 | |
| 900 | 64773 | |
| 950 | 68236 | |
| 1000 | 69331 | |
| 1050 | 71661 | |
| 1100 | 73320 | |
| 1150 | 74127 | 11930 |
| 1200 | 74051 | |

Voltage Plateau




Comments: HV Plateau Scaler Count Time = 1-min. Recommended HV =1150

**Reference Instruments and/or Sources:**

Ludlum pulser serial number: ☐ 97743 ☑ 201932 Fluke multimeter serial number: ☐ 8749012
☐ Alpha Source: Th-230 @ 12,800 dpm (1/4/12) sn: 4098-03 ☑ Gamma Source Cs-137 @ 5.2 uCi (1/4/12) sn: 4097-03
☐ Beta Source: Tc-99 @ 17,700 dpm (1/4/12) sn: 4099-03 ☐ Other Source:

Calibrated By: Calibration Date: 2-15-12 Calibration Due: 2-15-13

Reviewed By: Review Date: 02/16/12

This calibration conforms to the requirements and acceptable calibration conditions of ANSI N323A - 1997.
NMRCB Registration No. 921-3 * Calibration of Radiation Detection Instrument Devices

RSCS
Radiation Safety & Control Services

# Calibration Certificate

**ID Number:** 07J00KM148952-0

**Customer:** Scott Heronimus
**ERG**
8809 Washington Street, NE
Suite 150
Albuquerque, NM 87113

**Instrument**
Reuter-Stokes Model RSS-131

**Serial Number**
07J00KM1

## Precision Check

| Test 1 | Test 2 | Test 3 | Mean | Results |
|---|---|---|---|---|
| 7.65 mR/hr | 7.64 mR/hr | 7.65 mR/hr | 7.65 mR/hr | Satisfactory |

## Accuracy Check

| Range | Target Value | As Found | As Left |
|---|---|---|---|
| AUTO | 80 mR/Hr | 78.50 mR/Hr | 75.10 mR/Hr |
| AUTO | 8 mR/Hr | 7.69 mR/Hr | 7.65 mR/Hr |
| AUTO | 2 mR/Hr | 1.92 mR/Hr | 1.83 mR/Hr |
| AUTO | 0.8 mR/Hr | 0.69 mR/Hr | 0.78 mR/Hr |
| AUTO | 0.2 mR/Hr | 0.202 mR/Hr | 0.194 mR/Hr |
| AUTO | 0.08 mR/Hr | 0.0894 mR/Hr | 0.0820 mR/Hr |

Readings with * indicate ranges where As-Found readings are >20% of Target value. Readings with ** indicate As-left readings are >10.00% of Target value

Outer Physical Check: *Pass*
Tap Test: *Pass*

Comments: calibration factor AF - 2.210E-8 AL- 2.310E-8

Calibrated by: _____ QA Review: _____ Calibration Date: 07/05/2011
Expires: 07/05/2012

Atmospheric Conditions - Temperature: 760°F Humidity: 48% Barometric Pressure: 29.78"hg
This calibration was performed by RSCS Inc. 91 Portsmouth ave, Stratham NH 03885 using a NIST Traceable radiation source (Cs-137 Beam Source SN: S-1110), in conformance to the following standards: ANSI N323A (1997). RSCS New Hampshire Radioactive Material License Number: 381R. RSCS calibration services are performed in accordance with the RSCS Radiation Protection Program Manual and Standard Operating Procedure . This calibration certificate shall not be reproduced except in full without the express written consent of RSCS, Inc

# Appendix B

# Laboratory Analytical Data: Soils

# ANALYTICAL SUMMARY REPORT

July 23, 2012

Environmental Restoration Group Inc
8809 Washington St NE
Albuquerque, NM 87113

Workorder No.: G12060386

Project Name: Upton

Energy Laboratories Inc. Gillette WY received the following 20 samples for Environmental Restoration Group Inc on 6/14/2012 for analysis.

| Sample ID | Client Sample ID | Collect Date | Receive Date | Matrix | Test |
|---|---|---|---|---|---|
| G12060386-001 | SS-01-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Metals by ICP/ICPMS, Total or Soluble<br>Digestion, Total Metals<br>Gamma Sample Preparation<br>Gross Gamma |
| G12060386-002 | SS-02-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-003 | SS-03-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-004 | SS-04-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-005 | SS-05-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-006 | SS-06-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-007 | SS-07-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-008 | SS-08-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-009 | SS-09-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-010 | SS-10-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-011 | SS-11-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-012 | SS-12-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-013 | SS-13-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-014 | SS-14-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-015 | SS-15-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-016 | SS-16-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-017 | SS-17-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-018 | SS-18-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-019 | SS-19-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |
| G12060386-020 | SS-20-SS-061412 | 06/14/12 0:00 | 06/14/12 | Soil | Same As Above |

The analyses presented in this report were performed by Energy Laboratories, Inc., 400 W. Boxelder Rd., Gillette, WY 82718, unless otherwise noted.

As appropriate, any exceptions or problems with the analyses are noted in the Laboratory Analytical Report, the QA/QC Summary Report, or the Case Narrative.

The results as reported relate only to the item(s) submitted for testing.

If you have any questions regarding these tests results, please call.

# ANALYTICAL SUMMARY REPORT

Report Approved By:

**CLIENT:** Environmental Restoration Group Inc
**Project:** Upton
**Sample Delivery Group:** G12060386

**Report Date:** 07/23/12

# CASE NARRATIVE

Tests associated with analyst identified as ELI-CA were subcontracted to Energy Laboratories, 2393 Salt Creek Hwy., Casper, WY, EPA Number WY00002 and WY00937.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-001
**Client Sample ID** SS-01-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.4 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.4 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 7 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 09:45 / eli-c |
| Uranium | 1 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 09:45 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-002
**Client Sample ID** SS-02-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.6 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.4 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 2.1 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 12 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 10:25 / eli-c |
| Uranium | 1 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 10:25 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-003
**Client Sample ID** SS-03-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.6 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 9 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 10:33 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 10:33 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-004
**Client Sample ID** SS-04-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.5 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 8 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 10:37 / eli-c |
| Uranium | ND | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 10:37 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-005
**Client Sample ID** SS-05-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.6 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.6 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 1.9 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.7 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 12 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 10:42 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 10:42 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-006
**Client Sample ID** SS-06-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.6 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.4 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 2.3 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.8 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 13 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 10:46 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 10:46 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-007
**Client Sample ID** SS-07-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.8 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 13 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 11:08 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 11:08 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-008
**Client Sample ID** SS-08-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 2.3 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 2.4 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.8 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 14 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 11:12 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 11:12 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-009
**Client Sample ID** SS-09-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.5 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.6 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 8 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 11:25 / eli-c |
| Uranium | 1 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 11:25 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-010
**Client Sample ID** SS-10-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.8 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.6 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 15 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 11:29 / eli-c |
| Uranium | 3 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 11:29 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-011
**Client Sample ID** SS-11-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.9 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.6 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 2.4 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.6 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 10 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 11:33 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 11:33 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-012
**Client Sample ID** SS-12-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.0 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.3 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 2.2 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.6 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 11 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 11:37 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 11:37 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-013
**Client Sample ID** SS-13-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.0 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.3 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 6 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 11:42 / eli-c |
| Uranium | 1 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 11:42 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-014
**Client Sample ID** SS-14-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 2.2 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.7 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 13 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/26/12 11:46 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/26/12 11:46 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-015
**Client Sample ID** SS-15-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.6 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 13 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/28/12 05:46 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/28/12 05:46 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-016
**Client Sample ID** SS-16-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 2.3 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.6 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 10 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/28/12 05:55 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/28/12 05:55 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-017
**Client Sample ID** SS-17-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.4 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 2.4 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.9 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 11 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/28/12 05:59 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/28/12 05:59 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-018
**Client Sample ID** SS-18-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.8 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 2.3 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.7 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 14 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/28/12 06:03 / eli-c |
| Uranium | 3 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/28/12 06:03 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-019
**Client Sample ID** SS-19-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.5 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 14 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/28/12 06:25 / eli-c |
| Uranium | 3 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/28/12 06:25 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# LABORATORY ANALYTICAL REPORT

Prepared by Gillette, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton
**Lab ID:** G12060386-020
**Client Sample ID** SS-20-SS-061412

**Report Date:** 07/23/12
**Collection Date:** 06/14/12
**DateReceived:** 06/14/12
**Matrix:** Soil

| Analyses | Result | Units | Qualifiers | RL | MDL | Method | Analysis Date / By |
|---|---|---|---|---|---|---|---|
| **RADIONUCLIDES - GAMMA** | | | | | | | |
| Radium 226 | 1.6 | pCi/g-dry | | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 226 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 | 0.0 | pCi/g-dry | U | 0.3 | | E901.1 | 07/10/12 08:50 / eli-c |
| Radium 228 precision (±) | 0.5 | pCi/g-dry | | | | E901.1 | 07/10/12 08:50 / eli-c |
| **METALS, TOTAL** | | | | | | | |
| Thorium | 7 | mg/kg-dry | | 1 | 0.02 | SW6020 | 06/28/12 06:29 / eli-c |
| Uranium | 2 | mg/kg-dry | | 1 | 0.01 | SW6020 | 06/28/12 06:29 / eli-c |

**Report Definitions:**
RL - Analyte reporting limit.
MCL - Maximum contaminant level.
ND - Not detected at the reporting limit.
MDL - Method detection limit
QCL - Quality control limit.
U - Not detected at minimum detectable concentration

# QA/QC Summary Report

Prepared by Casper, WY Branch

**Client:** Environmental Restoration Group Inc
**Report Date:** 07/22/12
**Project:** Upton site
**Work Order:** G12060386

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method: E901.1** | | | | | | | | | Batch: R161853 |
| **Sample ID: LCS-R161853** | Laboratory Control Sample | | | | Run: GAM-HPGE_120710B | | | | 07/10/12 08:50 |
| Bismuth 214 | 2.6 | pCi/g-dry | 0.3 | 100 | 70 | 130 | | | |
| - LCS sample uses Bi214 for Ra226. | | | | | | | | | |
| **Sample ID: MB-R161853** | Method Blank | | | | Run: GAM-HPGE_120710B | | | | 07/10/12 08:50 |
| Radium 226 | ND | pCi/g-dry | | | | | | | U |
| Radium 226 precision (±) | ND | pCi/g-dry | | | | | | | |
| Radium 228 | ND | pCi/g-dry | | | | | | | U |
| Radium 228 precision (±) | ND | pCi/g-dry | | | | | | | |
| **Sample ID: G12060386-020ADUP** | Sample Duplicate | | | | Run: GAM-HPGE_120710B | | | | 07/10/12 08:50 |
| Radium 226 | 1.4 | pCi/g-dry | 0.3 | | | | 13 | 20 | |
| Radium 226 precision (±) | 0.4 | pCi/g-dry | | | | | | | |
| Radium 228 | ND | pCi/g-dry | 0.3 | | | | | 20 | U |
| Radium 228 precision (±) | ND | pCi/g-dry | | | | | | | |
| **Sample ID: G12060386-006ADUP** | Sample Duplicate | | | | Run: GAM-HPGE_120710B | | | | 07/10/12 08:50 |
| Radium 226 | 1.8 | pCi/g-dry | 0.3 | | | | 12 | 20 | |
| Radium 226 precision (±) | 0.5 | pCi/g-dry | | | | | | | |
| Radium 228 | ND | pCi/g-dry | 0.3 | | | | | 20 | U |
| Radium 228 precision (±) | ND | pCi/g-dry | | | | | | | |

**Qualifiers:**

RL - Analyte reporting limit.
ND - Not detected at the reporting limit.
U - Not detected at minimum detectable concentration

# QA/QC Summary Report

Prepared by Casper, WY Branch

**Client:** Environmental Restoration Group Inc
**Project:** Upton site

**Report Date:** 07/22/12
**Work Order:** G12060386

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** SW6020 | | | | | | | | Analytical Run: ICPMS4-C_120625A | |
| **Sample ID:** ICV | Initial Calibration Verification Standard | | | | | | | 06/25/12 16:28 | |
| Thorium | 0.0499 | mg/L | 0.050 | 100 | 80 | 120 | | | |
| Uranium | 0.0500 | mg/L | 0.00030 | 100 | 90 | 110 | | | |
| **Sample ID:** ICSA | Interference Check Sample A | | | | | | | 06/25/12 16:55 | |
| Thorium | 9.71E-05 | mg/L | 0.0010 | | | | | | |
| Uranium | 5.80E-06 | mg/L | 0.00030 | | | | | | |
| **Sample ID:** ICSAB | Interference Check Sample AB | | | | | | | 06/25/12 17:00 | |
| Thorium | 5.60E-05 | mg/L | 0.0010 | | | | | | |
| Uranium | 2.50E-06 | mg/L | 0.00030 | | | | | | |
| **Method:** SW6020 | | | | | | | | Batch: 34037 | |
| **Sample ID:** MB-34037 | Method Blank | | | | Run: ICPMS4-C_120625A | | | 06/26/12 08:50 | |
| Thorium | 0.05 | mg/kg | 0.002 | | | | | | |
| Uranium | 0.002 | mg/kg | 0.001 | | | | | | |
| **Sample ID:** LFB-34037 | Laboratory Fortified Blank | | | | Run: ICPMS4-C_120625A | | | 06/26/12 09:12 | |
| Thorium | 27 | mg/kg | 1.0 | 107 | 80 | 120 | | | |
| Uranium | 27 | mg/kg | 1.0 | 109 | 80 | 120 | | | |
| **Sample ID:** C12060577-001AMS3 | Sample Matrix Spike | | | | Run: ICPMS4-C_120625A | | | 06/26/12 09:28 | |
| Thorium | 8.1 | mg/kg-dry | 1.0 | 13 | 75 | 125 | | | S |
| Uranium | 52 | mg/kg-dry | 1.0 | 91 | 75 | 125 | | | |
| **Sample ID:** C12060577-001AMSD3 | Sample Matrix Spike Duplicate | | | | Run: ICPMS4-C_120625A | | | 06/26/12 09:32 | |
| Thorium | 6.2 | mg/kg-dry | 1.0 | 10 | 75 | 125 | 27 | 20 | SR |
| Uranium | 52 | mg/kg-dry | 1.0 | 91 | 75 | 125 | 0.2 | 20 | |
| **Sample ID:** G12060386-001AMS3 | Sample Matrix Spike | | | | Run: ICPMS4-C_120625A | | | 06/26/12 10:07 | |
| Thorium | 34 | mg/kg-dry | 1.0 | 100 | 75 | 125 | | | |
| Uranium | 30 | mg/kg-dry | 1.0 | 108 | 75 | 125 | | | |
| **Sample ID:** G12060386-001AMSD3 | Sample Matrix Spike Duplicate | | | | Run: ICPMS4-C_120625A | | | 06/26/12 10:11 | |
| Thorium | 35 | mg/kg-dry | 1.0 | 103 | 75 | 125 | 2.0 | 20 | |
| Uranium | 31 | mg/kg-dry | 1.0 | 110 | 75 | 125 | 2.0 | 20 | |
| **Sample ID:** G12060386-002ADIL | Serial Dilution | | | | Run: ICPMS4-C_120625A | | | 06/26/12 10:29 | |
| Thorium | 7.4 | mg/kg-dry | 1.0 | | 0 | 0 | 45 | 10 | R |
| Uranium | 0.94 | mg/kg-dry | 1.0 | | 0 | 0 | | 10 | |

**Qualifiers:**

RL - Analyte reporting limit.
ND - Not detected at the reporting limit.
R - RPD exceeds advisory limit.
S - Spike recovery outside of advisory limits.

# QA/QC Summary Report

Prepared by Casper, WY Branch

**Client:** Environmental Restoration Group Inc
**Report Date:** 07/22/12
**Project:** Upton site
**Work Order:** G12060386

| Analyte | Result | Units | RL | %REC | Low Limit | High Limit | RPD | RPDLimit | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Method:** **SW6020** | | | | | | | | Analytical Run: ICPMS4-C_120627A | |
| **Sample ID:** **ICV** | Initial Calibration Verification Standard | | | | | | | 06/27/12 16:27 | |
| Thorium | 0.0494 | mg/L | 0.0010 | 99 | 90 | 110 | | | |
| Uranium | 0.0505 | mg/L | 0.00030 | 101 | 90 | 110 | | | |
| **Sample ID:** **ICSA** | Interference Check Sample A | | | | | | | 06/27/12 16:31 | |
| Thorium | 0.000135 | mg/L | 0.0010 | | | | | | |
| Uranium | 3.25E-05 | mg/L | 0.00030 | | | | | | |
| **Sample ID:** **ICSAB** | Interference Check Sample AB | | | | | | | 06/27/12 16:35 | |
| Thorium | 5.10E-05 | mg/L | 0.0010 | | | | | | |
| Uranium | 8.30E-06 | mg/L | 0.00030 | | | | | | |
| **Method:** **SW6020** | | | | | | | | Batch: 34055 | |
| **Sample ID:** **MB-34055** | Method Blank | | | | Run: ICPMS4-C_120627A | | | 06/28/12 05:30 | |
| Thorium | 0.04 | mg/kg | 0.002 | | | | | | |
| Uranium | 0.005 | mg/kg | 0.001 | | | | | | |
| **Sample ID:** **LFB-34055** | Laboratory Fortified Blank | | | | Run: ICPMS4-C_120627A | | | 06/28/12 05:34 | |
| Thorium | 27 | mg/kg | 1.0 | 110 | 80 | 120 | | | |
| Uranium | 28 | mg/kg | 1.0 | 114 | 80 | 120 | | | |
| **Sample ID:** **G12060386-015ADIL** | Serial Dilution | | | | Run: ICPMS4-C_120627A | | | 06/28/12 05:51 | |
| Thorium | 9.3 | mg/kg-dry | 1.0 | | 0 | 0 | 31 | 10 | R |
| Uranium | 1.6 | mg/kg-dry | 1.0 | | 0 | 0 | 25 | 10 | R |
| **Sample ID:** **C12060844-002BMS3** | Sample Matrix Spike | | | | Run: ICPMS4-C_120627A | | | 06/28/12 06:42 | |
| Thorium | 38 | mg/kg-dry | 1.0 | 109 | 75 | 125 | | | |
| Uranium | 35 | mg/kg-dry | 1.0 | 113 | 75 | 125 | | | |
| **Sample ID:** **C12060844-002BMSD3** | Sample Matrix Spike Duplicate | | | | Run: ICPMS4-C_120627A | | | 06/28/12 06:47 | |
| Thorium | 38 | mg/kg-dry | 1.0 | 109 | 75 | 125 | 0.1 | 20 | |
| Uranium | 35 | mg/kg-dry | 1.0 | 113 | 75 | 125 | 0.2 | 20 | |

**Qualifiers:**

RL - Analyte reporting limit.
ND - Not detected at the reporting limit.
R - RPD exceeds advisory limit.

# Standard Reporting Procedures

Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH, Dissolved Oxygen and Residual Chlorine, are qualified as being analyzed outside of recommended holding time.

Solid/soil samples are reported on a wet weight basis (as received) unless specifically indicated. If moisture corrected, data units are typically noted as –dry. For agricultural and mining soil parameters/characteristics, all samples are dried and ground prior to sample analysis.

# Workorder Receipt Checklist

## Environmental Restoration Group Inc

## G12060386

Login completed by: Alyson T. Degnan
Date Received: 6/14/2012

Reviewed by: BL2000\kscottruff
Received by: atd

Reviewed Date: 6/15/2012
Carrier name: Hand Del

| | | | |
|---|---|---|---|
| Shipping container/cooler in good condition? | Yes ☑ | No ☐ | Not Present ☐ |
| Custody seals intact on shipping container/cooler? | Yes ☐ | No ☐ | Not Present ☑ |
| Custody seals intact on sample bottles? | Yes ☐ | No ☐ | Not Present ☑ |
| Chain of custody present? | Yes ☑ | No ☐ | |
| Chain of custody signed when relinquished and received? | Yes ☑ | No ☐ | |
| Chain of custody agrees with sample labels? | Yes ☑ | No ☐ | |
| Samples in proper container/bottle? | Yes ☑ | No ☐ | |
| Sample containers intact? | Yes ☑ | No ☐ | |
| Sufficient sample volume for indicated test? | Yes ☑ | No ☐ | |
| All samples received within holding time? (Exclude analyses that are considered field parameters such as pH, DO, Res Cl, Sulfite, Ferrous Iron, etc.) | Yes ☑ | No ☐ | |
| Container/Temp Blank temperature: | NA°C Soil | | |
| Water - VOA vials have zero headspace? | Yes ☐ | No ☐ | No VOA vials submitted ☑ |
| Water - pH acceptable upon receipt? | Yes ☐ | No ☐ | Not Applicable ☑ |

Contact and Corrective Action Comments:

None

# Chain of Custody and Analytical Request Record



**PLEASE PRINT- Provide as much information as possible.**

| | | | |
|---|---|---|---|
| Company Name: Environmental Restoration Group | Project Name, PWS, Permit, Etc.: Upton site | Sample Origin State: Wy | EPA/State Compliance: Yes ☑ No ☐ |
| Report Mail Address: 8809 Washington St. NE, Suite 150, Albuquerque NM 87113 | Contact Name: Mike Schierman; Phone/Fax: 505-298-4224; Email: MIKESCHIERMAN@ERGOFF.COM | | Sampler: (Please Print) cfm |
| Invoice Address: Same as above | Invoice Contact & Phone: Fidela Farr 505-298-4224 | Purchase Order: - | Quote/Bottle Order: - |

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

☐ DW ☐ A2LA
☐ GSA ☐ EDD/EDT(Electronic Data)
☐ POTW/WWTP Format: _____
☐ State: _____ ☐ LEVEL IV
☐ Other: _____ ☐ NELAC

Number of Containers
Sample Type: A Air W Water S Soils/Solids V Vegetation B Bioassay O Other

ANALYSIS REQUESTED

| SAMPLE IDENTIFICATION (Name, Location, Interval, etc.) | Collection Date | Collection Time | MATRIX | Radium-226 (gamma Spec) | Radium-228 (gamma spec) | Natural Uranium (ICP-MS) | Natural Thorium (ICP-MS) | SEE ATTACHED | Normal Turnaround (TAT) | RUSH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 SS-01-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 2 SS-02-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 3 SS-03-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 4 SS-04-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 5 SS-05-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 6 SS-06-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 7 SS-07-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 8 SS-08-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 9 SS-9-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 10 SS-10-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |

Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments: Hand delivered to ~~AES~~-Gillette ELI

Shipped by: na
Cooler ID(s):
Receipt Temp: 5.1 °C
On Ice: Yes (No)
Custody Seal Y N
Intact Y N
Signature Match Y N

LABORATORY USE ONLY 612060386

**Custody Record MUST be Signed**

| | | |
|---|---|---|
| Relinquished by (print): CHUCK FARR | Date/Time: 6/14/12 16:29 | Signature: |
| Relinquished by (print): | Date/Time: | Signature: |
| Sample Disposal: Return to Client: _____ Lab Disposal: _____ | | |

| | | |
|---|---|---|
| Received by (print): | Date/Time: | Signature: |
| Received by (print): | Date/Time: | Signature: |
| Received by Laboratory: | Date/Time: 6/14/12 1629 | Signature: |

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

# Chain of Custody and Analytical Request Record



**PLEASE PRINT- Provide as much information as possible.**

| | | | |
|---|---|---|---|
| Company Name: Environmental Restoration Group | Project Name, PWS, Permit, Etc.: Upton site | Sample Origin State: Wy | EPA/State Compliance: Yes ☑ No ☐ |
| Report Mail Address: 8809 Washington St. NE, Suite 150, Albuquerque NM 87113 | Contact Name: Mike Schierman | Phone/Fax: 505-298-4224 | Email: mikeschierman@ergoffic |
| | | | Sampler: (Please Print) cf/rf |
| Invoice Address: Same as above | Invoice Contact & Phone: Fidela Farr 505-298-4224 | Purchase Order: - | Quote/Bottle Order: - |

Special Report/Formats – ELI must be notified prior to sample submittal for the following:

☐ DW ☐ A2LA
☐ GSA ☐ EDD/EDT (Electronic Data) Format:
☐ POTW/WWTP ☐ LEVEL IV
☐ State: ☐ NELAC
☐ Other:

Number of Containers
Sample Type: A Air, W Water, S Soils/Solids, V Vegetation, B Bioassay, O Other

ANALYSIS REQUESTED

| SAMPLE IDENTIFICATION (Name, Location, Interval, etc.) | Collection Date | Collection Time | MATRIX | Radium-226 (gamma Spec) | Radium-228 (gamma spec) | Natural Uranium (ICP-MS) | Natural Thorium (ICP-MS) | SEE ATTACHED | Normal Turnaround (TAT) | RUSH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 SS-11-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 2 SS-12-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 3 SS-13-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 4 SS-14-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 5 SS-15-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 6 SS-16-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 7 SS-17-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 8 SS-18-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 9 SS-19-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |
| 10 SS-20-SS-061412 | 06/14/12 | | soil | X | X | X | X | | | | 0-15 cm |

RUSH: Contact ELI prior to **RUSH** sample submittal for charges and scheduling – See Instruction Page

Comments: ~~Hand~~ delivered to ~~ALS~~ Gillette ELI

Shipped by: na
Cooler ID(s):
Receipt Temp: 5.1 °C
On Ice: Yes (No)
Custody Seal Y N
Intact Y N
Signature Match Y N

LABORATORY USE ONLY: 206586

**Custody Record MUST be Signed**

| | | | |
|---|---|---|---|
| Relinquished by (print): Chuck Farr | Date/Time: 6/14/12 16:30 | Signature: | Received by (print): / Date/Time: / Signature: |
| Relinquished by (print): | Date/Time: | Signature: | Received by (print): / Date/Time: / Signature: |
| Sample Disposal: Return to Client: ____ Lab Disposal: ____ | | | Received by Laboratory: Date/Time: 6/14/12 1629 Signature: |

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested.
This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.
Visit our web site at www.energylab.com for additional information, downloadable fee schedule, forms, and links.

# Appendix C

# Radon Flux Measurement Documentation

ERG Environmental Restoration Group, Inc.
8809 Washington St. NE, Suite 150
Albuquerque, NM 87113

**Radon Flux Measurements for RER Upton, WY Site**

| Location | Location Number | Duplicate Type | Canister Number | Lab Date (mm/dd/yy) | Start Count Time (24:00) | Deploy Date (mm/dd/yy) | Deploy Time (24:00) | Retrieve Date (mm/dd/yy) | Retreive Time (24:00) | Deployment Duration (sec) | Count Duration (sec) | Sample Counts | BKG Counts | Detector Efficiency (cps/dps) | Canister Activity (pCi) | Flux ($pCi/m^2s$) | Flux Error (1.00 SD) | LLD ($pCi/m^2s$) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Upton #13 | 1 | | 255 | 6/15/2012 | 15:45 | 6/13/2012 | 9:19 | 6/14/2012 | 12:10 | 95280 | 1200 | 4481 | 2766.5 | 1.17E-02 | 3.31E+03 | 0.93 | 0.05 | 0.1 | OK |
| Upton #16 | 2 | | 42 | 6/15/2012 | 16:06 | 6/13/2012 | 9:08 | 6/14/2012 | 11:55 | 95880 | 1200 | 3819 | 2766.5 | 1.17E-02 | 2.03E+03 | 0.57 | 0.04 | 0.1 | OK |
| Upton #1 | 3 | | 48 | 6/15/2012 | 16:28 | 6/13/2012 | 9:33 | 6/14/2012 | 10:40 | 96360 | 1200 | 5016 | 2766.5 | 1.17E-02 | 4.34E+03 | 1.22 | 0.05 | 0.1 | OK |
| Upton #2 | 3 | | 87 | 6/15/2012 | 16:49 | 6/13/2012 | 10:07 | 6/14/2012 | 11:15 | 96360 | 1200 | 3136 | 2766.5 | 1.17E-02 | 7.13E+02 | 0.20 | 0.04 | 0.1 | OK |
| Upton #16 | 4 | Dup | 44 | 6/15/2012 | 17:10 | 6/13/2012 | 9:08 | 6/14/2012 | 11:55 | 96060 | 1200 | 4116 | 2766.5 | 1.17E-02 | 2.60E+03 | 0.74 | 0.05 | 0.1 | OK |
| Upton #7 | 5 | | 82 | 6/15/2012 | 17:30 | 6/13/2012 | 8:50 | 6/14/2012 | 9:50 | 96060 | 1200 | 3632 | 2766.5 | 1.17E-02 | 1.67E+03 | 0.48 | 0.04 | 0.1 | OK |
| Upton #7 | 5 | CD | 82B | 6/15/2012 | 17:50 | 6/13/2012 | 8:50 | 6/14/2012 | 9:50 | 96120 | 1200 | 3527 | 2766.5 | 1.17E-02 | 1.47E+03 | 0.42 | 0.04 | 0.1 | OK |
| TB | 6 | | 40 | 6/15/2012 | 18:12 | 6/13/2012 | 12:00 | 6/14/2012 | 12:00 | 96120 | 1200 | 2728 | 2766.5 | 1.17E-02 | -7.43E+01 | -0.02 | 0.04 | 0.1 | OK |
| TB | 7 | | 94 | 6/15/2012 | 18:43 | 6/13/2012 | 12:00 | 6/14/2012 | 12:00 | 96300 | 1200 | 2765 | 2766.5 | 1.17E-02 | -2.89E+00 | 0.00 | 0.04 | 0.1 | OK |
| Upton #7 | 8 | Dup | 84 | 6/15/2012 | 19:05 | 6/13/2012 | 8:50 | 6/14/2012 | 9:50 | 93240 | 1200 | 3376 | 2766.5 | 1.17E-02 | 1.18E+03 | 0.35 | 0.05 | 0.1 | OK |

Reviewed by CFam 6/18/12

# ERG Radon Flux Canister Data Log

Site: Upton WY



| Location Number | Canister Number | Deployment Date (mm/dd/yy) | Deployment Time (24:00) | Retrieval Date (mm/dd/yy) | Retrieval Time (24:00) | Notes/Comments |
|---|---|---|---|---|---|---|
| 1 | 84 | 06/13/12 | 0850 | 6/14/12 | 09:50 | Soil location #7 |
| 2 | 82 | " | " | 6/14/12 | 09:50 | " |
| 3 | 42 | " | 0909 | 6/14/12 | 11:55 | Near roadway |
| 4 | 44 | " | 0908 | 6/14/12 | 11:55 | Soil location 16 |
| 5 | 255 | " | 0919 | 6/14/12 | 12:10 | Soil location #13 |
| 6 | 48 | " | 0933 | 6/14/12 | 10:40 | Soil location #1 |
| 7 | 87 | 06/13/12 | 1007 | 6/14/12 | 11:15 | Soil location #2 |
| 8 | | | | | | |
| 9 | | | | | | |
| 10 | | | | | | |
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| 25 | | | | | | |

Environmental Restoration Group, Inc.
8809 Washington St. NE * Suite 150
Albuquerque, NM 87113

Environmental Restoration Group, Inc.
8809 Washington NE, Ste 150
Albuquerque, NM 87113

Site KIRTLAND (CUPTON)

| Location | Canister | Date | Start | Count time(s) | Peak Total | |
|---|---|---|---|---|---|---|
| STD 3 | | 6/15/12 | 1438 | 1200 | 41911 | |
| STD 1 | | | 1500 | 1200 | 46216 | |
| BKG1 | | | 1522 | 1200 | 2738 | |
| | 255 | | 1545 | 1200 | 4481 | |
| | 42 | | 1606 | 1200 | 3819 | |
| | 48 | | 1628 | 1200 | 5016 | |
| | 87 | | 1649 | 1200 | 3136 | |
| | 44 | | 1710 | 1200 | 4116 | |
| | 82 | | 1730 | 1200 | 3672 | |
| | 82B | | 1750 | 1200 | 3527 | |
| | 40 | | 1812 | 1200 | 2728 | TB |
| | 44 | | 1843 | 1200 | 2765 | TB |
| | 84 | | 1905 | 1200 | 3376 | |
| BKG2 | | | 1930 | 1200 | 2795 | |
| STD 1 | | | 2000 | 1200 | 46245 | |
| STD 3 | | | 2021 | 1200 | 41415 | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

11-15-12

# Appendix D

# Laboratory Analytical Data:
# Ambient Radon Concentrations

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

# Radon Monitoring Report

LICENSES: 101146AL,100584RT

**Acct. No.** 0410058

LANDAUER®
Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800)528-8327 Facsimile: (708) 755-7048

PROGRAM NAME: UPTON

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4844738 | DRNF | 05-FEB-13 | 25-MAR-13 | * - LESS THAN INDICATED VALUE<br>LOCATION #1/UAMS #1<br>CALIB FACT= N/A<br>DAYS EXPOSED: 48 | * 6.0 | * 0.13<br>±0.01 | 104 | 63.8 A | 1.96 | 091201-065 |
| 4844739 | DRNF | 05-FEB-13 | 25-MAR-13 | * - LESS THAN INDICATED VALUE<br>LOCATION #8/UAMS #2<br>CALIB FACT= 34.1<br>DAYS EXPOSED: 48 | * 6.0 | * 0.13<br>±0.01 | 126 | 63.8 A | 1.96 | 091201-065 |
| 4844741 | DRNF | 05-FEB-13 | 25-MAR-13 | LOCATION #3/UAMS #3<br>CALIB FACT= 34.1 STD DEV= 7.7<br>DAYS EXPOSED: 48 | 22.8<br>±1.76 | 0.5<br>±0.04 | 168 | 63.8 A | 1.96 | 091201-065 |
| 4844742 | DRNF | 05-FEB-13 | 25-MAR-13 | * - LESS THAN INDICATED VALUE<br>LOCATION #3/UAMS #3<br>CALIB FACT= 34.1<br>DAYS EXPOSED: 48 | * 6.0 | * 0.13<br>±0.01 | 127 | 63.8 A | 1.96 | 091201-065 |
| 4844743 | DRNF | 05-FEB-13 | 25-MAR-13 | * - LESS THAN INDICATED VALUE<br>LOCATION #4/USMW #3<br>CALIB FACT= 34.1<br>DAYS EXPOSED: 48 | * 6.0 | * 0.13<br>±0.01 | 126 | 63.8 A | 1.96 | 091201-065 |
| 4844744 | DRNF | 05-FEB-13 | 25-MAR-13 | * - LESS THAN INDICATED VALUE<br>LOCATION #9/MIDSITE S. OF UAMS #2<br>CALIB FACT= 34.1<br>DAYS EXPOSED: 48 | * 6.0 | * 0.13<br>±0.01 | 136 | 63.8 A | 1.96 | 091201-065 |

① ② ③ ④ ⑤ ⑥ ⑦ ⑧

RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER. RADON IN AIR BY ALPHA TRACK - EPA 402-R92-004.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A22631 | 10-APR-13 | 28-MAR-13 |

Mark Solasky
Radon Measurement Specialist

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

# Radon Monitoring Report

LICENSES: 101146AL,100584RT

**Acct. No.** 0410058

LANDAUER®
Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800)528-8327 Facsimile: (708) 755-7048

PROGRAM NAME: UPTON

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4869513 | DRNF | 05-FEB-13 | 25-MAR-13 | LOCATION #6/MIDSITE E. RIDGE UAMS #4<br>CALIB FACT= 36.2 STD DEV= 9.4<br>DAYS EXPOSED: 48 | 22.8<br>±2.14 | 0.5<br>±0.04 | 114 | 63.8 A | 1.16 | 101201-052 |
| 4869514 | DRNF | 05-FEB-13 | 26-MAR-13 | LOCATION #7/UAMS #4<br>CALIB FACT= 36.3 STD DEV= 8.9<br>DAYS EXPOSED: 49 | 30.2<br>±2.68 | 0.6<br>±0.05 | 127 | 63.8 A | 1.16 | 101201-052 |
| 4869515 | DRNF | 07-FEB-13 | 25-MAR-13 | LOCATION #2/SOUTH OF MET STATION<br>CALIB FACT= 36.3 STD DEV= 8.1<br>DAYS EXPOSED: 46 | 45.0<br>±3.64 | 1.0<br>±0.08 | 153 | 63.8 A | 1.16 | 101201-052 |
| 4869516 | DRNF | 07-FEB-13 | 26-MAR-13 | LOCATION #5/SW CORNER<br>CALIB FACT= 36.3 STD DEV= 7.9<br>DAYS EXPOSED: 47 | 49.0<br>±3.87 | 1.0<br>±0.08 | 160 | 63.8 A | 1.16 | 101201-052 |

① ② ③ ④ ⑤ ⑥ ⑦ ⑧

RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER. RADON IN AIR BY ALPHA TRACK - EPA 402-R92-004.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A22631 | 10-APR-13 | 28-MAR-13 |

Mark Solasky
Radon Measurement Specialist

The United States Environmental Protection Agency recommends fixing your home if the results of one long-term test or the average of two short-term tests taken in the lowest lived-in level of the home show radon levels of 4.0 pCi/l or higher. A short term test remains in your home for two days to 90 days, whereas a long-term test remains in your home for more than 90 days under these guidelines.

Column 7 of this report indicates the radon test result, i.e., the average radon concentration in pCi/l for the test period. If you did not provide us the starting and ending dates (days the detector was exposed) we are unable to calculate the average radon concentration. To calculate the average radon concentration, divide the total exposure in pCi/l-days (column 6) by the number of days the detector was exposed.

For more information about the interpretation of your test result or about other radon related issues we suggest you contact your state radon office. Your state radon office should have available the following EPA publications:

- A Citizen's Guide to Radon
- Home Buyer's and Seller's Guide to Radon
- Consumer's Guide to Radon Reduction

## DISCLAIMER



LANDAUER®

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586 Telephone: (800) 528-8327 Facsimile: (708) 755-7048
Email: radon@landauer.com Website: www.landauer.com

# Radon Monitoring Report

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

Acct. No. 0410058

LANDAUER

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800) 528-8327 Facsimile: (708) 755-7048

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4894229 | DRNF | 25-MAR-13 | 11-JUL-13 | CALIB FACT= 36.1 STD DEV= 5.3<br>DAYS EXPOSED: 108 | 153.0<br>±8.2 | 1.4<br>±0.08 | 351 | 63.8 | A 1.26 | 120119-015 |
| 4894230 | DRNF | 25-MAR-13 | 11-JUL-13 | CALIB FACT= 36.0 STD DEV= 5.7<br>DAYS EXPOSED: 108 | 130.8<br>±7.4 | 1.2<br>±0.07 | 312 | 63.8 | A 1.26 | 120119-015 |
| 4894231 | DRNF | 25-MAR-13 | 11-JUL-13 | CALIB FACT= 36.0 STD DEV= 5.6<br>DAYS EXPOSED: 108 | 135.4<br>±7.6 | 1.3<br>±0.07 | 320 | 63.8 | A 1.26 | 120119-015 |
| 4894232 | DRNF | 25-MAR-13 | 17-JUL-13 | CALIB FACT= 36.1 STD DEV= 4.9<br>DAYS EXPOSED: 114 | 187.1<br>±9.2 | 1.6<br>±0.08 | 411 | 63.8 | A 1.26 | 120119-015 |
| 4894233 | DRNF | 25-MAR-13 | 11-JUL-13 | CALIB FACT= 36.0 STD DEV= 5.6<br>DAYS EXPOSED: 108 | 132.0<br>±7.4 | 1.2<br>±0.07 | 314 | 63.8 | A 1.26 | 120119-015 |
| 4894234 | DRNF | 25-MAR-13 | 11-JUL-13 | CALIB FACT= 36.0 STD DEV= 6.6<br>DAYS EXPOSED: 108 | 86.1<br>±5.64 | 0.8<br>±0.05 | 233 | 63.8 | A 1.26 | 120119-015 |
| 4894324 | DRNF | 23-MAR-13 | 11-JUL-13 | CALIB FACT= 36.1 STD DEV= 5.3<br>DAYS EXPOSED: 110 | 154.1<br>±8.2 | 1.4<br>±0.07 | 353 | 63.8 | A 1.26 | 120119-015 |
| 4894326 | DRNF | 25-MAR-13 | 11-JUL-13 | CALIB FACT= 36.0 STD DEV= 6.9<br>DAYS EXPOSED: 108 | 74.2<br>±5.10 | 0.7<br>±0.05 | 212 | 63.8 | A 1.26 | 120119-015 |
| 4894328 | DRNF | 26-MAR-13 | 11-JUL-13 | CALIB FACT= 36.0 STD DEV= 6.3<br>DAYS EXPOSED: 107 | 95.1<br>±6.03 | 0.9<br>±0.06 | 249 | 63.8 | A 1.26 | 120119-015 |
| 4894329 | DRNF | 26-MAR-13 | 11-JUL-13 | CALIB FACT= 36.0 STD DEV= 6.6<br>DAYS EXPOSED: 107 | 85.5<br>±5.61 | 0.8<br>±0.05 | 232 | 63.8 | A 1.26 | 120119-015 |
| ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | | | |

RESULTS RELATED ONLY TO MONITORS
AS RECEIVED BY LANDAUER.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A22814 | 15-OCT-13 | 07-OCT-13 |

# Radon Monitoring Report

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

Acct. No. 0410058

LANDAUER

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800) 528-8327 Facsimile: (708) 755-7048

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4894470 | DRNF | 11-JUL-13 | 30-SEP-13 | CALIB FACT= 36.0 STD DEV= 6.5<br>DAYS EXPOSED: 81 | 86.6<br>±5.66 | 1.1<br>±0.07 | 234 | 63.8 | A 1.26 | 120119-015 |
| 4894471 | DRNF | 11-JUL-13 | 30-SEP-13 | CALIB FACT= 35.9 STD DEV= 7.9<br>DAYS EXPOSED: 81 | 45.4<br>±3.58 | 0.6<br>±0.04 | 161 | 63.8 | A 1.26 | 120119-015 |
| 4894472 | DRNF | 17-JUL-13 | 30-SEP-13 | CALIB FACT= 36.0 STD DEV= 6.0<br>DAYS EXPOSED: 75 | 111.0<br>±6.7 | 1.5<br>±0.09 | 277 | 63.8 | A 1.26 | 120119-015 |
| 4894478 | DRNF | NOT GIVEN | NOT GIVEN | NO DATES PROVIDED<br>CALIB FACT= 35.9 STD DEV= 7.8 | 47.1<br>±3.68 | | 164 | 63.8 | A 1.26 | 120119-015 |
| 4894575 | DRNF | 11-JUL-13 | 30-SEP-13 | CALIB FACT= 36.0 STD DEV= 6.5<br>DAYS EXPOSED: 81 | 88.3<br>±5.74 | 1.1<br>±0.07 | 237 | 63.8 | A 1.26 | 120119-015 |
| 4894576 | DRNF | 11-JUL-13 | 30-SEP-13 | CALIB FACT= 36.0 STD DEV= 6.7<br>DAYS EXPOSED: 81 | 79.3<br>±5.33 | 1.0<br>±0.07 | 221 | 63.8 | A 1.26 | 120119-015 |
| 4895386 | DRNF | 11-JUL-13 | NOT GIVEN | NO END DATE PROVIDED<br>CALIB FACT= 35.8 STD DEV= 6.0 | 111.4<br>±6.7 | | 279 | 63.8 | A 1.26 | 120119-020 |
| 4895387 | DRNF | 11-JUL-13 | 30-SEP-13 | CALIB FACT= 35.9 STD DEV= 5.4<br>DAYS EXPOSED: 81 | 145.3<br>±7.9 | 1.8<br>±0.10 | 339 | 63.8 | A 1.26 | 120119-020 |
| 4895388 | DRNF | 11-JUL-13 | 30-SEP-13 | CALIB FACT= 35.8 STD DEV= 6.4<br>DAYS EXPOSED: 81 | 92.3<br>±5.90 | 1.1<br>±0.07 | 245 | 63.8 | A 1.26 | 120119-020 |
| 4895389 | DRNF | 11-JUL-13 | 30-SEP-13 | CALIB FACT= 35.7 STD DEV= 8.6<br>DAYS EXPOSED: 81 | 31.1<br>±2.67 | 0.4<br>±0.03 | 136 | 63.8 | A 1.26 | 120119-020 |

① ② ③ ④ ⑤ ⑥ ⑦ ⑧

RESULTS RELATED ONLY TO MONITORS
AS RECEIVED BY LANDAUER.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A22814 | 15-OCT-13 | 07-OCT-13 |

# Radon Monitoring Report

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

Acct. No. 0410058

LANDAUER

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800) 528-8327 Facsimile: (708) 755-7048

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4895390 | DRNF | 11-JUL-13 | 30-SEP-13 | CALIB FACT= 35.8 STD DEV= 7.2<br>DAYS EXPOSED: 81 | 62.5<br>±4.51 | 0.8<br>±0.06 | 192 | 63.8 A | 1.26 | 120119-020 |
| 4905908 | DRN | 19-AUG-13 | 30-SEP-13 | EE STORAGE<br>CALIB FACT= 34.0 STD DEV= 7.1<br>DAYS EXPOSED: 42 | 145.4<br>±10.3 | 3.5<br>±0.24 | 200 | 37.2 A | 1.09 | 120119-051 |
| 4905916 | DRN | 19-AUG-13 | 30-SEP-13 | EE SPLITTING<br>CALIB FACT= 33.9 STD DEV= 9.0<br>DAYS EXPOSED: 42 | 75.9<br>±6.81 | 1.8<br>±0.16 | 124 | 37.2 A | 1.09 | 120119-051 |
| 4905922 | DRN | 19-AUG-13 | 30-SEP-13 | EE LOGGING<br>CALIB FACT= 34.2 STD DEV= 5.2<br>DAYS EXPOSED: 42 | 303.3<br>±15.7 | 7.2<br>±0.37 | 371 | 37.2 A | 1.09 | 120119-051 |
| 4905925 | DRN | 19-AUG-13 | 30-SEP-13 | EE SCOPE<br>CALIB FACT= 33.9 STD DEV= 9.1<br>DAYS EXPOSED: 42 | 72.2<br>±6.59 | 1.7<br>±0.16 | 120 | 37.2 A | 1.09 | 120119-051 |
| 4905930 | DRN | 19-AUG-13 | 30-SEP-13 | REE WAREHOUSE<br>CALIB FACT= 35.2 STD DEV= 3.0<br>DAYS EXPOSED: 42 | 1041.8<br>±30.8 | 24.8<br>±0.73 | 1144 | 37.2 A | 1.09 | 120119-051 |
| 4905936 | DRN | 19-AUG-13 | 30-SEP-13 | AU WAREHOUSE<br>CALIB FACT= 34.2 STD DEV= 5.0<br>DAYS EXPOSED: 42 | 333.1<br>±16.6 | 7.9<br>±0.40 | 403 | 37.2 A | 1.09 | 120119-051 |

① ② ③ ④ ⑤ ⑥ ⑦ ⑧

RESULTS RELATED ONLY TO MONITORS
AS RECEIVED BY LANDAUER.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A22814 | 15-OCT-13 | 07-OCT-13 |

# Radon Monitoring Report

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

Acct. No. 0410058

LANDAUER

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800) 528-8327 Facsimile: (708) 755-7048

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4905937 | DRN | 19-AUG-13 | 30-SEP-13 | TERRY'S/Q-LUBE<br>CALIB FACT= 33.9 STD DEV= 7.9<br>DAYS EXPOSED: 42 | 107.8<br>±8.6 | 2.6<br>±0.20 | 159 | 37.2 A | 1.09 | 120119-051 |
| 4905941 | DRN | 19-AUG-13 | 30-SEP-13 | * - LESS THAN INDICATED VALUE<br>OFFICE<br>CALIB FACT= 33.8<br>DAYS EXPOSED: 42 | * 30.0 | * 0.7<br>±0.08 | 73 | 37.2 A | 1.09 | 120119-051 |
| 4905946 | DRN | 19-AUG-13 | 30-SEP-13 | * - LESS THAN INDICATED VALUE<br>VISTA WEST MAIN<br>CALIB FACT= 33.8<br>DAYS EXPOSED: 42 | * 30.0 | * 0.7<br>±0.09 | 68 | 37.2 A | 1.09 | 120119-051 |
| 4905950 | DRN | 19-AUG-13 | 30-SEP-13 | * - LESS THAN INDICATED VALUE<br>VISTA WEST BARN<br>CALIB FACT= 33.8<br>DAYS EXPOSED: 42 | * 30.0 | * 0.7<br>±0.10 | 49 | 37.2 A | 1.09 | 120119-051 |

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RESULTS RELATED ONLY TO MONITORS
AS RECEIVED BY LANDAUER.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A22814 | 15-OCT-13 | 07-OCT-13 |

# Radon Monitoring Report

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

LICENSES: 101146AL,100584RT

Acct. No. 0410058

LANDAUER

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800) 528-8327 Facsimile: (708) 755-7048

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4910591 | DRNF | 10-OCT-13 | 07-JAN-14 | CALIB FACT= 33.9 STD DEV= 7.1<br>DAYS EXPOSED: 89 | 60.9<br>±4.30 | 0.7<br>±0.05 | 201 | 63.8 | A 1.35 | 120119-063 |
| 4910592 | DRNF | 10-OCT-13 | 07-JAN-14 | CALIB FACT= 33.9 STD DEV= 6.8<br>DAYS EXPOSED: 89 | 70.5<br>±4.77 | 0.8<br>±0.05 | 219 | 63.8 | A 1.35 | 120119-063 |
| 4910593 | DRNF | 10-OCT-13 | 07-JAN-14 | CALIB FACT= 33.9 STD DEV= 6.8<br>DAYS EXPOSED: 89 | 70.5<br>±4.77 | 0.8<br>±0.05 | 219 | 63.8 | A 1.35 | 120119-063 |
| 4910594 | DRNF | 10-OCT-13 | 07-JAN-14 | CALIB FACT= 33.9 STD DEV= 7.0<br>DAYS EXPOSED: 89 | 62.5<br>±4.38 | 0.7<br>±0.05 | 204 | 63.8 | A 1.35 | 120119-063 |
| 4910595 | DRNF | 10-OCT-13 | 07-JAN-14 | CALIB FACT= 33.9 STD DEV= 7.3<br>DAYS EXPOSED: 89 | 52.9<br>±3.88 | 0.6<br>±0.04 | 186 | 63.8 | A 1.35 | 120119-063 |
| 4910596 | DRNF | 01-OCT-13 | 07-JAN-14 | CALIB FACT= 33.8 STD DEV= 10.1<br>DAYS EXPOSED: 98 | 6.2<br>±0.63 | 0.1<br>±0.01 | 98 | 63.8 | A 1.35 | 120119-063 |
| 4910597 | DRNF | 02-OCT-13 | NOT GIVEN | NO END DATE PROVIDED<br>CALIB FACT= 33.9 STD DEV= 7.8 | 40.7<br>±3.19 | | 163 | 63.8 | A 1.35 | 120119-063 |
| 4910598 | DRNF | 02-OCT-13 | 07-JAN-14 | CALIB FACT= 34.3 STD DEV= 3.6<br>DAYS EXPOSED: 97 | 376.5<br>±13.4 | 3.9<br>±0.14 | 786 | 63.8 | A 1.35 | 120119-063 |
| 4910599 | DRNF | 02-OCT-13 | 07-JAN-14 | CALIB FACT= 34.5 STD DEV= 3.1<br>DAYS EXPOSED: 97 | 518.1<br>±16.0 | 5.3<br>±0.17 | 1044 | 63.8 | A 1.35 | 120119-063 |
| 4910600 | DRNF | 10-OCT-13 | 07-JAN-14 | CALIB FACT= 33.9 STD DEV= 8.1<br>DAYS EXPOSED: 89 | 35.9<br>±2.89 | 0.4<br>±0.03 | 154 | 63.8 | A 1.35 | 120119-063 |

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RESULTS RELATED ONLY TO MONITORS
AS RECEIVED BY LANDAUER.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A22886 | 26-FEB-14 | 07-FEB-14 |

# Radon Monitoring Report

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

LICENSES: 101146AL,100584RT

Acct. No. 0410058

LANDAUER

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800) 528-8327 Facsimile: (708) 755-7048

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4910740 | DRNF | 30-SEP-13 | 10-JAN-14 | CALIB FACT= 33.9 STD DEV= 5.4<br>DAYS EXPOSED: 102 | 135.1<br>±7.3 | 1.3<br>±0.07 | 339 | 63.8 A | 1.33 | 120119-064 |
| 4910743 | DRNF | 30-SEP-13 | 10-JAN-14 | CALIB FACT= 33.9 STD DEV= 5.5<br>DAYS EXPOSED: 102 | 127.6<br>±7.1 | 1.3<br>±0.07 | 325 | 63.8 A | 1.33 | 120119-064 |
| 4910744 | DRNF | 30-SEP-13 | 10-JAN-14 | CALIB FACT= 33.9 STD DEV= 6.0<br>DAYS EXPOSED: 102 | 104.1<br>±6.2 | 1.0<br>±0.06 | 281 | 63.8 A | 1.33 | 120119-064 |
| 4910746 | DRNF | 30-SEP-13 | 10-JAN-14 | CALIB FACT= 33.9 STD DEV= 6.3<br>DAYS EXPOSED: 102 | 87.6<br>±5.54 | 0.9<br>±0.05 | 250 | 63.8 A | 1.33 | 120119-064 |
| 4910747 | DRNF | 30-SEP-13 | 10-JAN-14 | CALIB FACT= 34.0 STD DEV= 5.2<br>DAYS EXPOSED: 102 | 152.7<br>±7.9 | 1.5<br>±0.08 | 372 | 63.8 A | 1.33 | 120119-064 |
| 4911225 | DRNF | 30-SEP-13 | 10-JAN-14 | CALIB FACT= 33.6 STD DEV= 7.4<br>DAYS EXPOSED: 102 | 51.3<br>±3.80 | 0.5<br>±0.04 | 182 | 63.8 A | 1.33 | 120119-065 |
| 4911226 | DRNF | 30-SEP-13 | 10-JAN-14 | CALIB FACT= 33.6 STD DEV= 6.8<br>DAYS EXPOSED: 102 | 68.1<br>±4.66 | 0.7<br>±0.05 | 214 | 63.8 A | 1.33 | 120119-065 |
| 4911227 | DRNF | 30-SEP-13 | 10-JAN-14 | CALIB FACT= 33.9 STD DEV= 4.1<br>DAYS EXPOSED: 102 | 274.2<br>±11.2 | 2.7<br>±0.11 | 601 | 63.8 A | 1.33 | 120119-065 |
| 4911228 | DRNF | 30-SEP-13 | 10-JAN-14 | CALIB FACT= 33.6 STD DEV= 6.7<br>DAYS EXPOSED: 102 | 72.9<br>±4.88 | 0.7<br>±0.05 | 223 | 63.8 A | 1.33 | 120119-065 |

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RESULTS RELATED ONLY TO MONITORS
AS RECEIVED BY LANDAUER.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A22886 | 26-FEB-14 | 07-FEB-14 |

# Radon Monitoring Report

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

LICENSES: 101146AL,100584RT

Acct. No. 0410058

LANDAUER

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800) 528-8327 Facsimile: (708) 755-7048

PROGRAM NAME: RER/UPTON

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4911559 | DRNF | 10-JAN-14 | 26-MAR-14 | UAMS#2<br>CALIB FACT= 33.5 STD DEV= 8.6<br>DAYS EXPOSED: 75 | 21.5<br>±1.85 | 0.3<br>±0.02 | 135 | 63.8 A | 1.48 | 120119-066 |
| 4911560 | DRNF | 10-JAN-14 | 26-MAR-14 | SOUTH OF UAMS #2<br>CALIB FACT= 33.6 STD DEV= 8.0<br>DAYS EXPOSED: 75 | 32.0<br>±2.57 | 0.4<br>±0.03 | 155 | 63.8 A | 1.48 | 120119-066 |
| 4911561 | DRNF | 10-JAN-14 | 26-MAR-14 | * - LESS THAN INDICATED VALUE<br>UAMS #3<br>CALIB FACT= N/A<br>DAYS EXPOSED: 75 | * 6.0 | * 0.08<br>±0.01 | 81 | 63.8 A | 1.48 | 120119-066 |
| 4911562 | DRNF | 10-JAN-14 | 26-MAR-14 | UAMS#3<br>DUPLICATE<br>CALIB FACT= 33.5 STD DEV= 9.5<br>DAYS EXPOSED: 75 | 8.8<br>±0.84 | 0.1<br>±0.01 | 111 | 63.8 A | 1.48 | 120119-066 |
| 4911563 | DRNF | 10-JAN-14 | 26-MAR-14 | USMW #3<br>FOUND ON THE GRAVEL<br>CALIB FACT= 33.6 STD DEV= 6.6<br>DAYS EXPOSED: 75 | 71.0<br>±4.69 | 0.9<br>±0.06 | 229 | 63.8 A | 1.48 | 120119-066 |
| 4911570 | DRNF | 10-JAN-14 | 26-MAR-14 | SOUTH OF MET<br>CALIB FACT= 33.5 STD DEV= 9.6<br>DAYS EXPOSED: 75 | 7.8<br>±0.75 | 0.1<br>±0.01 | 109 | 63.8 A | 1.48 | 120119-066 |

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RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A22923 | 23-APR-14 | 10-APR-14 |

# Radon Monitoring Report

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

LICENSES: 101146AL,100584RT

Acct. No. 0410058

LANDAUER

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800) 528-8327 Facsimile: (708) 755-7048

PROGRAM NAME: RER/UPTON

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4911571 | DRNF | 10-JAN-14 | 26-MAR-14 | * - LESS THAN INDICATED VALUE<br>UAMS#4<br>CALIB FACT= N/A<br>DAYS EXPOSED: 75 | * 6.0 | * 0.08<br>±0.01 | 91 | 63.8 A | 1.48 | 120119-066 |
| 4911572 | DRNF | 10-JAN-14 | 26-MAR-14 | * - LESS THAN INDICATED VALUE<br>SW CORNER<br>CALIB FACT= 33.5<br>DAYS EXPOSED: 75 | * 6.0 | * 0.08<br>±0.01 | 98 | 63.8 A | 1.48 | 120119-066 |
| 4911573 | DRNF | 10-JAN-14 | 26-MAR-14 | RIDGE E.OF UAMS #4<br>CALIB FACT= 33.5 STD DEV= 9.6<br>DAYS EXPOSED: 75 | 7.8<br>±0.75 | 0.1<br>±0.01 | 109 | 63.8 A | 1.48 | 120119-066 |
| 4911574 | DRNF | 10-JAN-14 | 26-MAR-14 | UAMS#1<br>CALIB FACT= 33.5 STD DEV= 8.7<br>DAYS EXPOSED: 75 | 19.9<br>±1.73 | 0.3<br>±0.02 | 132 | 63.8 A | 1.48 | 120119-066 |

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RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A22923 | 23-APR-14 | 10-APR-14 |

# Radon Monitoring Report

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

LICENSES: 101146AL,100584RT

Acct. No. 0410058

LANDAUER

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800) 528-8327 Facsimile: (708) 755-7048

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4929486 | DRNF | 26-MAR-14 | 18-JUL-14 | CALIB FACT= 35.7 STD DEV= 5.9<br>DAYS EXPOSED: 114 | 89.8<br>±5.32 | 0.8<br>±0.05 | 285 | 63.8 A | 1.95 | 121128-016 |
| 4929487 | DRNF | 26-MAR-14 | 18-JUL-14 | CALIB FACT= 35.7 STD DEV= 5.4<br>DAYS EXPOSED: 114 | 120.1<br>±6.5 | 1.1<br>±0.06 | 339 | 63.8 A | 1.95 | 121128-016 |
| 4929488 | DRNF | 26-MAR-14 | 18-JUL-14 | CALIB FACT= 35.7 STD DEV= 6.0<br>DAYS EXPOSED: 114 | 88.1<br>±5.25 | 0.8<br>±0.05 | 282 | 63.8 A | 1.95 | 121128-016 |
| 4929489 | DRNF | 26-MAR-14 | 18-JUL-14 | CALIB FACT= 35.6 STD DEV= 6.4<br>DAYS EXPOSED: 114 | 68.5<br>±4.36 | 0.6<br>±0.04 | 247 | 63.8 A | 1.95 | 121128-016 |
| 4929506 | DRNF | 08-APR-14 | 17-JUL-14 | CALIB FACT= 35.6 STD DEV= 7.1<br>DAYS EXPOSED: 100 | 40.0<br>±2.86 | 0.4<br>±0.03 | 196 | 63.8 A | 1.95 | 121128-016 |
| 4929508 | DRNF | 08-APR-14 | 17-JUL-14 | CALIB FACT= 35.6 STD DEV= 6.4<br>DAYS EXPOSED: 100 | 68.0<br>±4.33 | 0.7<br>±0.04 | 246 | 63.8 A | 1.95 | 121128-016 |
| 4929509 | DRNF | 08-APR-14 | 17-JUL-14 | CALIB FACT= 35.7 STD DEV= 5.6<br>DAYS EXPOSED: 100 | 110.0<br>±6.1 | 1.1<br>±0.06 | 321 | 63.8 A | 1.95 | 121128-016 |
| 4929510 | DRNF | 08-APR-14 | 17-JUL-14 | CALIB FACT= 35.6 STD DEV= 6.2<br>DAYS EXPOSED: 100 | 75.8<br>±4.70 | 0.8<br>±0.05 | 260 | 63.8 A | 1.95 | 121128-016 |
| 4929545 | DRNF | 08-APR-14 | 17-JUL-14 | CALIB FACT= 35.7 STD DEV= 5.9<br>DAYS EXPOSED: 100 | 90.9<br>±5.37 | 0.9<br>±0.05 | 287 | 63.8 A | 1.95 | 121128-016 |
| 4929546 | DRNF | 08-APR-14 | 17-JUL-14 | CALIB FACT= 35.6 STD DEV= 6.1<br>DAYS EXPOSED: 100 | 80.8<br>±4.93 | 0.8<br>±0.05 | 269 | 63.8 A | 1.95 | 121128-016 |

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RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER. RADON IN AIR BY ALPHA TRACK - EPA 402-R92-004

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A23083 | 05-SEP-14 | 02-SEP-14 |

# Radon Monitoring Report

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

LICENSES: 101146AL,100584RT

**Acct. No.** 0410058

LANDAUER

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800) 528-8327 Facsimile: (708) 755-7048

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4929547 | DRNF | 08-APR-14 | 17-JUL-14 | CALIB FACT= 35.7 STD DEV= 5.2<br>DAYS EXPOSED: 100 | 140.4<br>±7.2 | 1.4<br>±0.07 | 375 | 63.8 A | 1.95 | 121128-016 |
| 4929548 | DRNF | 08-APR-14 | 17-JUL-14 | CALIB FACT= 35.6 STD DEV= 6.9<br>DAYS EXPOSED: 100 | 47.8<br>±3.30 | 0.5<br>±0.03 | 210 | 63.8 A | 1.95 | 121128-016 |
| 4929605 | DRNF | 26-MAR-14 | 18-JUL-14 | CALIB FACT= 35.6 STD DEV= 6.4<br>DAYS EXPOSED: 114 | 68.0<br>±4.33 | 0.6<br>±0.04 | 246 | 63.8 A | 1.95 | 121128-016 |
| 4929606 | DRNF | 26-MAR-14 | 18-JUL-14 | CALIB FACT= 35.6 STD DEV= 6.2<br>DAYS EXPOSED: 114 | 76.4<br>±4.73 | 0.7<br>±0.04 | 261 | 63.8 A | 1.95 | 121128-016 |
| 4929607 | DRNF | 26-MAR-14 | 23-JUL-14 | CALIB FACT= 35.7 STD DEV= 5.3<br>DAYS EXPOSED: 119 | 128.5<br>±6.8 | 1.1<br>±0.06 | 354 | 63.8 A | 1.95 | 121128-016 |
| 4929608 | DRNF | 26-MAR-14 | 18-JUL-14 | CALIB FACT= 35.8 STD DEV= 5.0<br>DAYS EXPOSED: 114 | 153.9<br>±7.7 | 1.3<br>±0.07 | 399 | 63.8 A | 1.95 | 121128-016 |
| 4929610 | DRNF | 26-MAR-14 | 23-JUL-14 | CALIB FACT= 35.6 STD DEV= 6.4<br>DAYS EXPOSED: 119 | 67.4<br>±4.31 | 0.6<br>±0.04 | 245 | 63.8 A | 1.95 | 121128-016 |
| 4931077 | DRNF | 26-MAR-14 | 18-JUL-14 | CALIB FACT= 35.6 STD DEV= 5.6<br>DAYS EXPOSED: 114 | 115.2<br>±6.4 | 1.0<br>±0.06 | 321 | 63.8 A | 1.79 | 121128-020 |
| 4931108 | DRNF | 08-APR-14 | 17-JUL-14 | CALIB FACT= 36.1 STD DEV= 3.1<br>DAYS EXPOSED: 100 | 523.1<br>±16.2 | 5.2<br>±0.16 | 1039 | 63.8 A | 1.79 | 121128-020 |
| 4931109 | DRNF | 08-APR-14 | 17-JUL-14 | CALIB FACT= 36.3 STD DEV= 2.8<br>DAYS EXPOSED: 100 | 654.7<br>±18.4 | 6.5<br>±0.18 | 1266 | 63.8 A | 1.79 | 121128-020 |

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RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER. RADON IN AIR BY ALPHA TRACK - EPA 402-R92-004

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A23083 | 05-SEP-14 | 02-SEP-14 |

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

# Radon Monitoring Report

LICENSES: 101146AL,100584RT

**Acct. No.** 0410058

LANDAUER®

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800)528-8327 Facsimile: (708) 755-7048

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | COUNTED (SQ MM) | BACK GRND | LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4927919 | DRN | 22-SEP-14 | 21-OCT-14 | EE STORAGE<br>CALIB FACT= 35.6 STD DEV= 4.4<br>DAYS EXPOSED: 29 | 417.4<br>±18.5 | 14.4<br>±0.64 | 510 | 37.2 A | 1.97 | 121128-012 |
| 4927922 | DRN | 22-SEP-14 | 21-OCT-14 | EE SPLITING<br>CALIB FACT= 35.6 STD DEV= 4.4<br>DAYS EXPOSED: 29 | 434.9<br>±18.9 | 15.0<br>±0.65 | 528 | 37.2 A | 1.97 | 121128-012 |
| 4927925 | DRN | 22-SEP-14 | 21-OCT-14 | EE LOGGING<br>CALIB FACT= 35.5 STD DEV= 4.9<br>DAYS EXPOSED: 29 | 321.6<br>±15.9 | 11.1<br>±0.55 | 411 | 37.2 A | 1.97 | 121128-012 |
| 4927927 | DRN | 22-SEP-14 | 21-OCT-14 | SCOPE<br>CALIB FACT= 35.5 STD DEV= 4.7<br>DAYS EXPOSED: 29 | 353.4<br>±16.8 | 12.2<br>±0.58 | 444 | 37.2 A | 1.97 | 121128-012 |
| 4927929 | DRN | 22-SEP-14 | 21-OCT-14 | AU WAREHOUSE<br>CALIB FACT= 35.7 STD DEV= 4.1<br>DAYS EXPOSED: 29 | 507.0<br>±20.7 | 17.5<br>±0.71 | 602 | 37.2 A | 1.97 | 121128-012 |
| 4927952 | DRN | 22-SEP-14 | 21-OCT-14 | TERRY'S/Q LUBE<br>CALIB FACT= 35.5 STD DEV= 4.9<br>DAYS EXPOSED: 29 | 333.2<br>±16.2 | 11.5<br>±0.56 | 423 | 37.2 A | 1.97 | 121128-012 |
| 4927971 | DRN | 22-SEP-14 | 21-OCT-14 | OFFICE<br>CALIB FACT= 35.4 STD DEV= 5.1<br>DAYS EXPOSED: 29 | 295.6<br>±15.1 | 10.2<br>±0.52 | 384 | 37.2 A | 1.97 | 121128-012 |

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RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER. RADON IN AIR BY ALPHA TRACK - EPA 402-R92-004.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| KJT | A23158 | 06-JAN-15 | 24-DEC-14 |

Mark Solosky
Radon Measurement Specialist

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

# Radon Monitoring Report

LICENSES: 101146AL,100584RT

**Acct. No.** 0410058

LANDAUER®
Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800)528-8327 Facsimile: (708) 755-7048

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4928028 | DRN | 22-SEP-14 | 21-OCT-14 | VISTA WEST MAIN<br>CALIB FACT= 35.4 STD DEV= 5.0<br>DAYS EXPOSED: 29 | 311.0<br>±15.5 | 10.7<br>±0.54 | 400 | 37.2 A | 1.97 | 121128-012 |
| 4944246 | DRNF | 18-JUL-14 | 28-OCT-14 | CALIB FACT= 34.7 STD DEV= 3.6<br>DAYS EXPOSED: 102 | 381.2<br>±13.8 | 3.7<br>±0.14 | 764 | 63.8 A | 0.99 | 121128-063 |
| 4944247 | DRNF | 23-JUL-14 | 28-OCT-14 | CALIB FACT= 34.7 STD DEV= 3.8<br>DAYS EXPOSED: 97 | 350.3<br>±13.2 | 3.6<br>±0.14 | 708 | 63.8 A | 0.99 | 121128-063 |
| 4944248 | DRNF | 18-JUL-14 | 28-OCT-14 | CALIB FACT= 34.6 STD DEV= 3.8<br>DAYS EXPOSED: 102 | 334.9<br>±12.8 | 3.3<br>±0.13 | 680 | 63.8 A | 0.99 | 121128-063 |
| 4944250 | DRNF | 18-JUL-14 | 28-OCT-14 | CALIB FACT= 34.6 STD DEV= 4.1<br>DAYS EXPOSED: 102 | 291.5<br>±11.9 | 2.9<br>±0.12 | 601 | 63.8 A | 0.99 | 121128-063 |
| 4944251 | DRNF | 23-JUL-14 | 28-OCT-14 | CALIB FACT= 34.6 STD DEV= 4.0<br>DAYS EXPOSED: 97 | 311.8<br>±12.3 | 3.2<br>±0.13 | 638 | 63.8 A | 0.99 | 121128-063 |
| 4944294 | DRNF | 18-JUL-14 | 28-OCT-14 | CALIB FACT= 34.7 STD DEV= 3.6<br>DAYS EXPOSED: 102 | 380.6<br>±13.8 | 3.7<br>±0.14 | 763 | 63.8 A | 0.99 | 121128-063 |
| 4944295 | DRNF | 18-JUL-14 | 28-OCT-14 | CALIB FACT= 34.8 STD DEV= 3.4<br>DAYS EXPOSED: 102 | 434.8<br>±14.8 | 4.3<br>±0.15 | 861 | 63.8 A | 0.99 | 121128-063 |
| 4944296 | DRNF | 18-JUL-14 | 28-OCT-14 | CALIB FACT= 34.8 STD DEV= 3.3<br>DAYS EXPOSED: 102 | 464.2<br>±15.4 | 4.6<br>±0.15 | 914 | 63.8 A | 0.99 | 121128-063 |

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RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER. RADON IN AIR BY ALPHA TRACK - EPA 402-R92-004.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| KJT | A23158 | 06-JAN-15 | 24-DEC-14 |

Mark Solasky
Radon Measurement Specialist

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

# Radon Monitoring Report

LICENSES: 101146AL,100584RT

**Acct. No.** 0410058

LANDAUER®

Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800)528-8327 Facsimile: (708) 755-7048

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4944297 | DRNF | 18-JUL-14 | 28-OCT-14 | CALIB FACT= 34.8 STD DEV= 3.4<br>DAYS EXPOSED: 102 | 439.2<br>±14.9 | 4.3<br>±0.15 | 869 | 63.8 | A 0.99 | 121128-063 |
| 4944298 | DRNF | 18-JUL-14 | 28-OCT-14 | CALIB FACT= 34.9 STD DEV= 3.2<br>DAYS EXPOSED: 102 | 492.0<br>±15.8 | 4.8<br>±0.16 | 964 | 63.8 | A 0.99 | 121128-063 |
| 4951370 | DRN | 22-SEP-14 | 21-OCT-14 | VISTA WEST BARN<br>CALIB FACT= 34.0 STD DEV= 5.3<br>DAYS EXPOSED: 29 | 317.4<br>±16.7 | 10.9<br>±0.58 | 361 | 37.2 | A 0.35 | 131029-013 |
| ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | | | |

RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER. RADON IN AIR BY ALPHA TRACK - EPA 402-R92-004.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| KJT | A23158 | 06-JAN-15 | 24-DEC-14 |

Mark Solasky
Radon Measurement Specialist

The United States Environmental Protection Agency recommends fixing your home if the results of one long-term test or the average of two short-term tests taken in the lowest lived-in level of the home show radon levels of 4.0 pCi/l or higher. A short term test remains in your home for two days to 90 days, whereas a long-term test remains in your home for more than 90 days under these guidelines.

Column 7 of this report indicates the radon test result, i.e., the average radon concentration in pCi/l for the test period. If you did not provide us the starting and ending dates (days the detector was exposed) we are unable to calculate the average radon concentration. To calculate the average radon concentration, divide the total exposure in pCi/l-days (column 6) by the number of days the detector was exposed.

For more information about the interpretation of your test result or about other radon related issues we suggest you contact your state radon office. Your state radon office should have available the following EPA publications:

- A Citizen's Guide to Radon
- Home Buyer's and Seller's Guide to Radon
- Consumer's Guide to Radon Reduction

## DISCLAIMER



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Email: radon@landauer.com Website: www.landauer.com

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

# Radon Monitoring Report

LICENSES: 101146AL,100584RT

**Acct. No.** 0410058

LANDAUER®
Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800)528-8327 Facsimile: (708) 755-7048

PROGRAM NAME: UPTON

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | COUNTED (SQ MM) | BACK GRND | LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4956140 | DRN | 28-OCT-14 | 14-JAN-15 | LOCATION#4/USMW#3<br>CALIB FACT= 33.1 STD DEV= 6.5<br>DAYS EXPOSED: 78 | 105.2<br>±6.8 | 1.3<br>±0.09 | 240 | 63.8 A | 0.58 | 131029-028 |
| 4956141 | DRN | 28-OCT-14 | 14-JAN-15 | LOCATION#10/UAMS#5<br>CALIB FACT= 33.1 STD DEV= 6.5<br>DAYS EXPOSED: 78 | 103.1<br>±6.7 | 1.3<br>±0.09 | 236 | 63.8 A | 0.58 | 131029-028 |
| 4956142 | DRN | 28-OCT-14 | 14-JAN-15 | LOCATION#8/UAMS#2<br>CALIB FACT= 33.2 STD DEV= 6.1<br>DAYS EXPOSED: 78 | 122.4<br>±7.4 | 1.6<br>±0.09 | 273 | 63.8 A | 0.58 | 131029-028 |
| 4956143 | DRN | 28-OCT-14 | 14-JAN-15 | LOCATION #2/SOUTH OF MET<br>CALIB FACT= 33.1 STD DEV= 7.4<br>DAYS EXPOSED: 78 | 76.6<br>±5.63 | 1.0<br>±0.07 | 185 | 63.8 A | 0.58 | 131029-028 |
| 4956144 | DRN | 28-OCT-14 | 14-JAN-15 | LOCATION#1/UAMS#1<br>CALIB FACT= 33.1 STD DEV= 7.0<br>DAYS EXPOSED: 78 | 87.0<br>±6.07 | 1.1<br>±0.08 | 205 | 63.8 A | 0.58 | 131029-028 |
| 4956147 | DRN | 28-OCT-14 | 14-JAN-15 | LOCATION#7/UAMS#4<br>CALIB FACT= 33.1 STD DEV= 6.8<br>DAYS EXPOSED: 78 | 92.2<br>±6.29 | 1.2<br>±0.08 | 215 | 63.8 A | 0.58 | 131029-028 |
| 4956148 | DRN | 28-OCT-14 | 14-JAN-15 | LOCATION#6/RIDGE E. OF UAMS#4<br>CALIB FACT= 33.2 STD DEV= 5.9<br>DAYS EXPOSED: 78 | 129.7<br>±7.7 | 1.7<br>±0.10 | 287 | 63.8 A | 0.58 | 131029-028 |

① ② ③ ④ ⑤ ⑥ ⑦ ⑧

RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER. RADON IN AIR BY ALPHA TRACK - EPA 402-R92-004.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A23194 | 26-FEB-15 | 18-FEB-15 |

Mark Solasky
Radon Measurement Specialist

ENVIRONMENTAL RESTORATION GRP
ATTN: MIKE SCHIERMAN
8809 WASHINGTON STREET NE
SUITE 150
ALBUQUERQUE, NM 87113

# Radon Monitoring Report

LICENSES: 101146AL,100584RT

**Acct. No.** 0410058

LANDAUER®
Landauer, Inc. 2 Science Road Glenwood, Illinois 60425-1586
Telephone: (800)528-8327 Facsimile: (708) 755-7048

PROGRAM NAME: UPTON

| Detector Number | Detector Type | Starting Date | Ending Date | Field Data / Comments | Exposure pCi/l-days | Avg. Radon Conc. pCi/l | AREA GROSS COUNT | AREA COUNTED (SQ MM) | AREA BACK GRND | AREA LOT NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| 4956149 | DRN | 28-OCT-14 | 14-JAN-15 | LOCATION#5/SW CORNER<br>CALIB FACT= 33.1 STD DEV= 7.2<br>DAYS EXPOSED: 78 | 81.2<br>±5.83 | 1.0<br>±0.07 | 194 | 63.8 A | 0.58 | 131029-028 |
| 4956150 | DRN | 28-OCT-14 | 14-JAN-15 | LOCATION#3/UAMS#3<br>CALIB FACT= 33.1 STD DEV= 6.7<br>DAYS EXPOSED: 78 | 97.9<br>±6.51 | 1.3<br>±0.08 | 226 | 63.8 A | 0.58 | 131029-028 |
| 4956151 | DRN | 28-OCT-14 | 14-JAN-15 | LOCATION#3/UAMS#3<br>CALIB FACT= 33.1 STD DEV= 7.0<br>DAYS EXPOSED: 78 | 85.9<br>±6.03 | 1.1<br>±0.08 | 203 | 63.8 A | 0.58 | 131029-028 |

① ② ③ ④ ⑤ ⑥ ⑦ ⑧

RESULTS RELATED ONLY TO MONITORS AS RECEIVED BY LANDAUER. RADON IN AIR BY ALPHA TRACK - EPA 402-R92-004.

| Q.C. Release | Process No. | Report Date | Date Received |
|---|---|---|---|
| LMR | A23194 | 26-FEB-15 | 18-FEB-15 |

Mark Solasky
Radon Measurement Specialist

The United States Environmental Protection Agency recommends fixing your home if the results of one long-term test or the average of two short-term tests taken in the lowest lived-in level of the home show radon levels of 4.0 pCi/l or higher. A short term test remains in your home for two days to 90 days, whereas a long-term test remains in your home for more than 90 days under these guidelines.

Column 7 of this report indicates the radon test result, i.e., the average radon concentration in pCi/l for the test period. If you did not provide us the starting and ending dates (days the detector was exposed) we are unable to calculate the average radon concentration. To calculate the average radon concentration, divide the total exposure in pCi/l-days (column 6) by the number of days the detector was exposed.

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- Home Buyer's and Seller's Guide to Radon
- Consumer's Guide to Radon Reduction

## DISCLAIMER



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Email: radon@landauer.com Website: www.landauer.com

# Appendix E

# Laboratory Analytical Data:
# Environmental Dosimeters

ENVIROMENTAL
RESTORATION GROUP
SUITE 150
8809 WASHINGTON ST NE
ALBUQERQUE, NM 87113

| | |
|---|---|
| Report Date (YYYY-MM-DD) | 2013-07-29 |
| Page | 1 of 1 |
| Dosimeter Received | 2013-07-29 |
| QC Release | LCA |
| Analytical Work Order | 1320711339 |

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Customer Service: (800) 323-8830
Technical: (800) 438-3241

# Environmental Dosimetry Report

**Account : 291406 Subaccount : 1420532 Series: REC**

| Location ID Number | Dosimeter Type | Identifier (Client Supplied) | Exposure (Ambient Dose mrem) | | Net Cumulative Totals (mrem) | | | Inception Date (YYYY-MM) | Serial Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | Gross | Net | Quarter to Date | Year to Date | Permanent | | |
| Monitoring Period: | | | 2013-04-01 to | 2013-06-30 | Q2 | 2013 | | | |
| 00000 | V03NH | Deploy Control | | | | | | 2013-01 | EX00057972H |
| | V03NH | Control Dose Used | 36.3 | | | | | | |
| 00119 | V03NH | UPTON 1 | 41.8 | 5.5 | 5.5 | 5.5 | 5.5 | 2013-01 | EX00021436Z |
| 00120 | V03NH | UPTON 2 | 46.3 | 10.0 | 10.0 | 10.0 | 10.0 | 2013-01 | EX00009149U |
| 00121 | V03NH | UPTON 3 | 40.9 | 4.6 | 4.6 | 4.6 | 4.6 | 2013-01 | EX000231280 |
| 00122 | V03NH | UPTON 4 | 40.8 | 4.5 | 4.5 | 4.5 | 4.5 | 2013-01 | EX00012378U |
| 00123 | V03NH | UPTON 5 | 36.0 | -0.3 | -0.3 | -0.3 | -0.3 | 2013-01 | EX00058736G |
| 00124 | V03NH | UPTON 6 | 42.7 | 6.4 | 6.4 | 6.4 | 6.4 | 2013-01 | EX00011666U |
| 00125 | V03NH | UPTON 7 | 37.9 | 1.7 | 1.7 | 1.7 | 1.7 | 2013-01 | EX00013794R |
| 00126 | V03NH | UPTON 8 | 43.1 | 6.8 | 6.8 | 6.8 | 6.8 | 2013-01 | EX00025525W |

## General Information

The Environmental dosimeter is for both indoor and outdoor use, and is designed to withstand extremes of temperature, humidity, precipitation, and other environmental conditions. InLight dosimeters are built on an assembly of a case component with copper and plastic filters along with a four-positioned aluminum oxide detector slide component. Both the case and slide are uniquely bar coded with serial numbers for chain of custody and sensitivity identification. The InLight dosimeter is sealed within a heavy-duty vinyl tamper resistant pouch that has multiple slots to permit several methods of attachment for easy deployment.

### Technical Specifications

- Fully meets ANSI N545-1977, NRC Regulatory Guide 4.13, and HPS Draft Standard N13.29 for environmental dosimetry.

- Minimum Detectable Dose - nominally 0.1 mrem (1 μSv), reporting to tenths of a millirem ambient dose equivalent.

- Detection Capabilities:

  Photons (x and gamma rays) with energies above 15 keV nominally: 0.1 mrem to 1000 rem (1 μSv to 10 Sv).

  Beta particles with energies greater than approximately 500 keV average energy: 20 mrem to 1000 rem (200 μSv to 10 Sv).

### Control Dosimeter

A minimum of two control dosimeters are provided per shipment. The first is for field deployment/retrieval used to measure exposure during shipment and placement/collection. The second is for transit used to measure exposure during shipment only. Both control dosimeters assigned to a shipment should accompany that shipment both from and to Landauer. Do not use the control dosimeters for any other purpose. Store dosimeters away from radiation when not in use along with the control dosimeter(s) of the same use date.

Dosimetry reports show gross and net dosage. Gross dosage includes the dosage to the controls. Landauer's background subtraction protocol is:

1. Subtract the deployment/retrieval control; or if not returned to Landauer
2. Subtract the transit control.

## Dosimetry Report Information

**Location ID Number**
Unique number assigned by Landauer.

**Dosimeter Type**

| Dosimeter Type | Analytical Sensitivity | Minimum Detectable Dose Level (mrem) |
|---|---|---|
| V03NH | High | 0.1 |
| V03NN | Standard | 5.0 |
| V06NH | High | 0.1 |
| V06NN | Standard | 5.0 |

**Identifier**
Location name supplied by customer.

**Exposure Ambient Dose (mrem)**
Gross: Gross exposure before control subtraction.
Net: Net exposure after control subtraction.

**Net Cumulative Totals (mrem)**
Quarter to Date, Year to Date, and Permanent are accumulated net ambient exposure.

**Inception Date**
The date Landauer began keeping dosimeter records for a given dosimeter for a monitoring location on the current account.

**Serial Number**
Dosimeter serial number.

### U.S. Patents

6,316,782; 6,127,685; 5,892,234

Landauer, Inc.
2 Science Road
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www.landauer.com
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Technical: (800) 438-3241

LANDAUER®

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8809 WASHINGTON ST NE
ALBUQERQUE, NM 87113

| | |
|---|---|
| Report Date (YYYY-MM-DD) | 2013-10-15 |
| Page | 1 of 1 |
| Dosimeter Received | 2013-10-10 |
| QC Release | JJG |
| Analytical Work Order | 1328310049 |

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Customer Service: (800) 323-8830
Technical: (800) 438-3241

# Environmental Dosimetry Report

**Account : 291406 Subaccount : 1420532 Series: REC**

| Location ID Number | Dosimeter Type | Identifier (Client Supplied) | Exposure (Ambient Dose mrem) | | Net Cumulative Totals (mrem) | | | Inception Date (YYYY-MM) | Serial Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | Gross | Net | Quarter to Date | Year to Date | Permanent | | |
| Monitoring Period: | | | 2013-07-01 to | 2013-09-30 | Q3 | 2013 | | | |
| | V03NH | Average Control Dose | 25.0 | | | | | | |
| 00126 | V03NH | UPTON 8 | 26.9 | 1.5 | 1.5 | 8.3 | 8.3 | 2013-01 | EX00060355U |

## General Information

The Environmental dosimeter is for both indoor and outdoor use, and is designed to withstand extremes of temperature, humidity, precipitation, and other environmental conditions. InLight dosimeters are built on an assembly of a case component with copper and plastic filters along with a four-positioned aluminum oxide detector slide component. Both the case and slide are uniquely bar coded with serial numbers for chain of custody and sensitivity identification. The InLight dosimeter is sealed within a heavy-duty vinyl tamper resistant pouch that has multiple slots to permit several methods of attachment for easy deployment.

### Technical Specifications

- Fully meets ANSI N545-1977, NRC Regulatory Guide 4.13, and HPS Draft Standard N13.29 for environmental dosimetry.

- Minimum Detectable Dose - nominally 0.1 mrem (1 μSv), reporting to tenths of a millirem ambient dose equivalent.

- Detection Capabilities:

  Photons (x and gamma rays) with energies above 15 keV nominally: 0.1 mrem to 1000 rem (1 μSv to 10 Sv).

  Beta particles with energies greater than approximately 500 keV average energy: 20 mrem to 1000 rem (200 μSv to 10 Sv).

### Control Dosimeter

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Dosimetry reports show gross and net dosage. Gross dosage includes the dosage to the controls. Landauer's background subtraction protocol is:

1. Subtract the deployment/retrieval control; or if not returned to Landauer
2. Subtract the transit control.

## Dosimetry Report Information

**Location ID Number**
Unique number assigned by Landauer.

**Dosimeter Type**

| Dosimeter Type | Analytical Sensitivity | Minimum Detectable Dose Level (mrem) |
|---|---|---|
| V03NH | High | 0.1 |
| V03NN | Standard | 5.0 |
| V06NH | High | 0.1 |
| V06NN | Standard | 5.0 |

**Identifier**
Location name supplied by customer.

**Exposure Ambient Dose (mrem)**
Gross: Gross exposure before control subtraction.
Net: Net exposure after control subtraction.

**Net Cumulative Totals (mrem)**
Quarter to Date, Year to Date, and Permanent are accumulated net ambient exposure.

**Inception Date**
The date Landauer began keeping dosimeter records for a given dosimeter for a monitoring location on the current account.

**Serial Number**
Dosimeter serial number.

### U.S. Patents

6,316,782; 6,127,685; 5,892,234

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LANDAUER®

ENVIROMENTAL
RESTORATION GROUP
SUITE 150
8809 WASHINGTON ST NE
ALBUQERQUE, NM 87113

| | |
|---|---|
| Report Date (YYYY-MM-DD) | 2014-01-09 |
| Page | 1 of 1 |
| Dosimeter Received | 2014-01-07 |
| QC Release | SBA |
| Analytical Work Order | 1400610700 |

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Customer Service: (800) 323-8830
Technical: (800) 438-3241

# Environmental Dosimetry Report

**Account : 291406 Subaccount : 1420532 Series: REC**

| Location ID Number | Dosimeter Type | Identifier (Client Supplied) | Exposure (Ambient Dose mrem) | | Net Cumulative Totals (mrem) | | | Inception Date (YYYY-MM) | Serial Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | Gross | Net | Quarter to Date | Year to Date | Permanent | | |
| Monitoring Period: | | | 2013-07-01 to | 2013-09-30 | Q3 | 2013 | | | |
| 00000 | V03NH | Deploy Control | | | | | | 2013-01 | EX00065367K |
| | V03NH | Control Dose Used | 52.6 | | | | | | |
| 00119 | V03NH | UPTON 1 | 52.1 | -0.5 | -0.5 | 5.0 | 5.0 | 2013-01 | EX00060374U |
| 00120 | V03NH | UPTON 2 | 66.6 | 13.9 | 13.9 | 24.0 | 24.0 | 2013-01 | EX00058660R |
| 00121 | V03NH | UPTON 3 | 58.5 | 5.9 | 5.9 | 10.5 | 10.5 | 2013-01 | EX00013114B |
| 00122 | V03NH | UPTON 4 | 57.6 | 5.0 | 5.0 | 9.5 | 9.5 | 2013-01 | EX00064093W |
| 00123 | V03NH | UPTON 5 | 59.1 | 6.5 | 6.5 | 6.2 | 6.2 | 2013-01 | EX00064489D |
| 00124 | V03NH | UPTON 6 | 55.4 | 2.8 | 2.8 | 9.2 | 9.2 | 2013-01 | EX00056660T |
| 00125 | V03NH | UPTON 7 | 48.4 | -4.2 | -4.2 | -2.6 | -2.6 | 2013-01 | EX000097103 |

## General Information

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### Technical Specifications

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- Minimum Detectable Dose - nominally 0.1 mrem (1 μSv), reporting to tenths of a millirem ambient dose equivalent.

- Detection Capabilities:

  Photons (x and gamma rays) with energies above 15 keV nominally: 0.1 mrem to 1000 rem (1 μSv to 10 Sv).

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2. Subtract the transit control.

## Dosimetry Report Information

**Location ID Number**
Unique number assigned by Landauer.

**Dosimeter Type**

| Dosimeter Type | Analytical Sensitivity | Minimum Detectable Dose Level (mrem) |
|---|---|---|
| V03NH | High | 0.1 |
| V03NN | Standard | 5.0 |
| V06NH | High | 0.1 |
| V06NN | Standard | 5.0 |

**Identifier**
Location name supplied by customer.

**Exposure Ambient Dose (mrem)**
Gross: Gross exposure before control subtraction.
Net: Net exposure after control subtraction.

**Net Cumulative Totals (mrem)**
Quarter to Date, Year to Date, and Permanent are accumulated net ambient exposure.

**Inception Date**
The date Landauer began keeping dosimeter records for a given dosimeter for a monitoring location on the current account.

**Serial Number**
Dosimeter serial number.

### U.S. Patents

6,316,782; 6,127,685; 5,892,234

Landauer, Inc.
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| | |
|---|---|
| Report Date (YYYY-MM-DD) | 2014-02-13 |
| Page | 1 of 1 |
| Dosimeter Received | 2014-02-07 |
| QC Release | SBA |
| Analytical Work Order | 1403810155 |

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# Environmental Dosimetry Report

**Account : 291406 Subaccount : 1420532 Series: REC**

| Location ID Number | Dosimeter Type | Identifier (Client Supplied) | Exposure (Ambient Dose mrem) | | Net Cumulative Totals (mrem) | | | Inception Date (YYYY-MM) | Serial Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | Gross | Net | Quarter to Date | Year to Date | Permanent | | |
| Monitoring Period: | | | 2013-10-01 to | 2013-12-31 | Q4 | 2013 | | | |
| 00000 | V03NH | Deploy Control | | | | | | 2013-01 | EX00060258Q |
| | V03NH | Control Dose Used | 36.8 | | | | | | |
| 00119 | V03NH | UPTON 1 | 36.2 | -0.6 | -0.6 | 4.4 | 4.4 | 2013-01 | EX00063454R |
| 00121 | V03NH | UPTON 3 | 36.7 | -0.1 | -0.1 | 10.3 | 10.3 | 2013-01 | EX000620061 |
| 00122 | V03NH | UPTON 4 | 35.6 | -1.2 | -1.2 | 8.3 | 8.3 | 2013-01 | EX000611614 |
| 00123 | V03NH | UPTON 5 | 37.8 | 1.0 | 1.0 | 7.1 | 7.1 | 2013-01 | EX00063208S |
| 00124 | V03NH | UPTON 6 | 35.0 | -1.8 | -1.8 | 7.4 | 7.4 | 2013-01 | EX00063706M |
| 00125 | V03NH | UPTON 7 | 35.2 | -1.7 | -1.7 | -4.3 | -4.3 | 2013-01 | EX00046393S |
| 00126 | V03NH | UPTON 8 | 33.8 | -3.0 | -3.0 | 5.3 | 5.3 | 2013-01 | EX00046219Q |

## General Information

The Environmental dosimeter is for both indoor and outdoor use, and is designed to withstand extremes of temperature, humidity, precipitation, and other environmental conditions. InLight dosimeters are built on an assembly of a case component with copper and plastic filters along with a four-positioned aluminum oxide detector slide component. Both the case and slide are uniquely bar coded with serial numbers for chain of custody and sensitivity identification. The InLight dosimeter is sealed within a heavy-duty vinyl tamper resistant pouch that has multiple slots to permit several methods of attachment for easy deployment.

### Technical Specifications

- Fully meets ANSI N545-1977, NRC Regulatory Guide 4.13, and HPS Draft Standard N13.29 for environmental dosimetry.

- Minimum Detectable Dose - nominally 0.1 mrem (1 μSv), reporting to tenths of a millirem ambient dose equivalent.

- Detection Capabilities:

  Photons (x and gamma rays) with energies above 15 keV nominally: 0.1 mrem to 1000 rem (1 μSv to 10 Sv).

  Beta particles with energies greater than approximately 500 keV average energy: 20 mrem to 1000 rem (200 μSv to 10 Sv).

### Control Dosimeter

A minimum of two control dosimeters are provided per shipment. The first is for field deployment/retrieval used to measure exposure during shipment and placement/collection. The second is for transit used to measure exposure during shipment only. Both control dosimeters assigned to a shipment should accompany that shipment both from and to Landauer. Do not use the control dosimeters for any other purpose. Store dosimeters away from radiation when not in use along with the control dosimeter(s) of the same use date.

Dosimetry reports show gross and net dosage. Gross dosage includes the dosage to the controls. Landauer's background subtraction protocol is:

1. Subtract the deployment/retrieval control; or if not returned to Landauer
2. Subtract the transit control.

## Dosimetry Report Information

**Location ID Number**
Unique number assigned by Landauer.

**Dosimeter Type**

| Dosimeter Type | Analytical Sensitivity | Minimum Detectable Dose Level (mrem) |
|---|---|---|
| V03NH | High | 0.1 |
| V03NN | Standard | 5.0 |
| V06NH | High | 0.1 |
| V06NN | Standard | 5.0 |

**Identifier**
Location name supplied by customer.

**Exposure Ambient Dose (mrem)**
Gross: Gross exposure before control subtraction.
Net: Net exposure after control subtraction.

**Net Cumulative Totals (mrem)**
Quarter to Date, Year to Date, and Permanent are accumulated net ambient exposure.

**Inception Date**
The date Landauer began keeping dosimeter records for a given dosimeter for a monitoring location on the current account.

**Serial Number**
Dosimeter serial number.

### U.S. Patents

6,316,782; 6,127,685; 5,892,234

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| | |
|---|---|
| Report Date (YYYY-MM-DD) | 2014-05-12 |
| Page | 1 of 1 |
| Dosimeter Received | 2014-05-08 |
| QC Release | LCA |
| Analytical Work Order | 1412810116 |

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# Environmental Dosimetry Report

**Account : 291406 Subaccount : 1420532 Series: REC**

| Location ID Number | Dosimeter Type | Identifier (Client Supplied) | Exposure (Ambient Dose mrem) | | Net Cumulative Totals (mrem) | | | Inception Date (YYYY-MM) | Serial Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | Gross | Net | Quarter to Date | Year to Date | Permanent | | |
| Monitoring Period: | | | 2014-01-01 to | 2014-03-31 | Q1 | 2014 | | | |
| 00000 | V03NH | Deploy Control | | | | | | 2013-01 | EX000533040 |
| | V03NH | Control Dose Used | 47.3 | | | | | | |
| 00119 | V03NH | UPTON 1 | 45.9 | -1.4 | -1.4 | -1.4 | 3.0 | 2013-01 | EX000023950 |
| 00120 | V03NH | UPTON 2 | 54.8 | 7.5 | 7.5 | 7.5 | 31.4 | 2013-01 | EX00069904G |
| 00121 | V03NH | UPTON 3 | 51.0 | 3.7 | 3.7 | 3.7 | 14.1 | 2013-01 | EX00070892K |
| 00122 | V03NH | UPTON 4 | 41.9 | -5.4 | -5.4 | -5.4 | 2.9 | 2013-01 | EX000202570 |
| 00123 | V03NH | UPTON 5 | 50.7 | 3.4 | 3.4 | 3.4 | 10.5 | 2013-01 | EX000211183 |
| 00124 | V03NH | UPTON 6 | 42.2 | -5.1 | -5.1 | -5.1 | 2.3 | 2013-01 | EX00070000D |
| 00125 | V03NH | UPTON 7 | 47.1 | -0.2 | -0.2 | -0.2 | -4.4 | 2013-01 | EX00025067Y |
| 00126 | V03NH | UPTON 8 | 45.2 | -2.1 | -2.1 | -2.1 | 3.2 | 2013-01 | EX00070029T |

## General Information

The Environmental dosimeter is for both indoor and outdoor use, and is designed to withstand extremes of temperature, humidity, precipitation, and other environmental conditions. InLight dosimeters are built on an assembly of a case component with copper and plastic filters along with a four-positioned aluminum oxide detector slide component. Both the case and slide are uniquely bar coded with serial numbers for chain of custody and sensitivity identification. The InLight dosimeter is sealed within a heavy-duty vinyl tamper resistant pouch that has multiple slots to permit several methods of attachment for easy deployment.

### Technical Specifications

- Fully meets ANSI N545-1977, NRC Regulatory Guide 4.13, and HPS Draft Standard N13.29 for environmental dosimetry.

- Minimum Detectable Dose - nominally 0.1 mrem (1 μSv), reporting to tenths of a millirem ambient dose equivalent.

- Detection Capabilities:

  Photons (x and gamma rays) with energies above 15 keV nominally: 0.1 mrem to 1000 rem (1 μSv to 10 Sv).

  Beta particles with energies greater than approximately 500 keV average energy: 20 mrem to 1000 rem (200 μSv to 10 Sv).

### Control Dosimeter

A minimum of two control dosimeters are provided per shipment. The first is for field deployment/retrieval used to measure exposure during shipment and placement/collection. The second is for transit used to measure exposure during shipment only. Both control dosimeters assigned to a shipment should accompany that shipment both from and to Landauer. Do not use the control dosimeters for any other purpose. Store dosimeters away from radiation when not in use along with the control dosimeter(s) of the same use date.

Dosimetry reports show gross and net dosage. Gross dosage includes the dosage to the controls. Landauer's background subtraction protocol is:

1. Subtract the deployment/retrieval control; or if not returned to Landauer
2. Subtract the transit control.

## Dosimetry Report Information

**Location ID Number**
Unique number assigned by Landauer.

**Dosimeter Type**

| Dosimeter Type | Analytical Sensitivity | Minimum Detectable Dose Level (mrem) |
|---|---|---|
| V03NH | High | 0.1 |
| V03NN | Standard | 5.0 |
| V06NH | High | 0.1 |
| V06NN | Standard | 5.0 |

**Identifier**
Location name supplied by customer.

**Exposure Ambient Dose (mrem)**
Gross: Gross exposure before control subtraction.
Net: Net exposure after control subtraction.

**Net Cumulative Totals (mrem)**
Quarter to Date, Year to Date, and Permanent are accumulated net ambient exposure.

**Inception Date**
The date Landauer began keeping dosimeter records for a given dosimeter for a monitoring location on the current account.

**Serial Number**
Dosimeter serial number.

### U.S. Patents

6,316,782; 6,127,685; 5,892,234

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8809 WASHINGTON ST NE
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| | |
|---|---|
| Report Date (YYYY-MM-DD) | 2014-11-19 |
| Page | 1 of 1 |
| Dosimeter Received | 2014-11-17 |
| QC Release | LCA |
| Analytical Work Order | 1431811680 |

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# Environmental Dosimetry Report

**Account : 291406 Subaccount : 1420532 Series: REC**

| Location ID Number | Dosimeter Type | Identifier (Client Supplied) | Exposure (Ambient Dose mrem) | | Net Cumulative Totals (mrem) | | | Inception Date (YYYY-MM) | Serial Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | Gross | Net | Quarter to Date | Year to Date | Permanent | | |
| Monitoring Period: | | | 2014-07-01 to | 2014-09-30 | Q3 | 2014 | | | |
| 00000 | V03NH | Deploy Control | | | | | | 2013-01 | EX00062020B |
| | V03NH | Control Dose Used | 28.2 | | | | | | |
| 00119 | V03NH | UPTON 1 | 26.3 | -2.0 | -2.0 | -3.4 | 1.0 | 2013-01 | EX00053329O |
| 00120 | V03NH | UPTON 2 | 29.3 | 1.1 | 1.1 | 8.6 | 32.5 | 2013-01 | EX000083053 |
| 00121 | V03NH | UPTON 3 | 26.8 | -1.4 | -1.4 | 2.3 | 12.6 | 2013-01 | EX00069224S |
| 00122 | V03NH | UPTON 4 | 25.7 | -2.5 | -2.5 | -8.0 | 0.4 | 2013-01 | EX00026692S |
| 00123 | V03NH | UPTON 5 | 25.9 | -2.3 | -2.3 | 1.1 | 8.2 | 2013-01 | EX00060561X |
| 00124 | V03NH | UPTON 6 | 27.0 | -1.2 | -1.2 | -6.3 | 1.1 | 2013-01 | EX00062881N |
| 00125 | V03NH | UPTON 7 | 26.7 | -1.5 | -1.5 | -1.7 | -5.9 | 2013-01 | EX000532810 |
| 00126 | V03NH | UPTON 8 | 28.0 | -0.2 | -0.2 | -2.3 | 2.9 | 2013-01 | EX00062730W |

## General Information

The Environmental dosimeter is for both indoor and outdoor use, and is designed to withstand extremes of temperature, humidity, precipitation, and other environmental conditions. InLight dosimeters are built on an assembly of a case component with copper and plastic filters along with a four-positioned aluminum oxide detector slide component. Both the case and slide are uniquely bar coded with serial numbers for chain of custody and sensitivity identification. The InLight dosimeter is sealed within a heavy-duty vinyl tamper resistant pouch that has multiple slots to permit several methods of attachment for easy deployment.

### Technical Specifications

- Fully meets ANSI N545-1977, NRC Regulatory Guide 4.13, and HPS Draft Standard N13.29 for environmental dosimetry.

- Minimum Detectable Dose - nominally 0.1 mrem (1 μSv), reporting to tenths of a millirem ambient dose equivalent.

- Detection Capabilities:

  Photons (x and gamma rays) with energies above 15 keV nominally: 0.1 mrem to 1000 rem (1 μSv to 10 Sv).

  Beta particles with energies greater than approximately 500 keV average energy: 20 mrem to 1000 rem (200 μSv to 10 Sv).

### Control Dosimeter

A minimum of two control dosimeters are provided per shipment. The first is for field deployment/retrieval used to measure exposure during shipment and placement/collection. The second is for transit used to measure exposure during shipment only. Both control dosimeters assigned to a shipment should accompany that shipment both from and to Landauer. Do not use the control dosimeters for any other purpose. Store dosimeters away from radiation when not in use along with the control dosimeter(s) of the same use date.

Dosimetry reports show gross and net dosage. Gross dosage includes the dosage to the controls. Landauer's background subtraction protocol is:

1. Subtract the deployment/retrieval control; or if not returned to Landauer
2. Subtract the transit control.

## Dosimetry Report Information

**Location ID Number**
Unique number assigned by Landauer.

**Dosimeter Type**

| Dosimeter Type | Analytical Sensitivity | Minimum Detectable Dose Level (mrem) |
|---|---|---|
| V03NH | High | 0.1 |
| V03NN | Standard | 5.0 |
| V06NH | High | 0.1 |
| V06NN | Standard | 5.0 |

**Identifier**
Location name supplied by customer.

**Exposure Ambient Dose (mrem)**
Gross: Gross exposure before control subtraction.
Net: Net exposure after control subtraction.

**Net Cumulative Totals (mrem)**
Quarter to Date, Year to Date, and Permanent are accumulated net ambient exposure.

**Inception Date**
The date Landauer began keeping dosimeter records for a given dosimeter for a monitoring location on the current account.

**Serial Number**
Dosimeter serial number.

### U.S. Patents

6,316,782; 6,127,685; 5,892,234

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| | |
|---|---|
| Report Date (YYYY-MM-DD) | 2015-01-02 |
| Page | 1 of 1 |
| Dosimeter Received | 2014-12-29 |
| QC Release | CHA |
| Analytical Work Order | 1435810165 |

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# Environmental Dosimetry Report

**Account : 291406 Subaccount : 1420532 Series: REC**

| Location ID Number | Dosimeter Type | Identifier (Client Supplied) | Exposure (Ambient Dose mrem) | | Net Cumulative Totals (mrem) | | | Inception Date (YYYY-MM) | Serial Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | Gross | Net | Quarter to Date | Year to Date | Permanent | | |
| Monitoring Period: | | | 2014-10-01 to | 2014-12-31 | Q4 | 2014 | | | |
| | V03NH | Historical Customer Avg Control Dose | 32.0 | | | | | | |
| 00122 | V03NH | UPTON 4 | 30.0 | -2.0 | -2.0 | -10.0 | -1.7 | 2013-01 | EX00064824L |

## General Information

The Environmental dosimeter is for both indoor and outdoor use, and is designed to withstand extremes of temperature, humidity, precipitation, and other environmental conditions. InLight dosimeters are built on an assembly of a case component with copper and plastic filters along with a four-positioned aluminum oxide detector slide component. Both the case and slide are uniquely bar coded with serial numbers for chain of custody and sensitivity identification. The InLight dosimeter is sealed within a heavy-duty vinyl tamper resistant pouch that has multiple slots to permit several methods of attachment for easy deployment.

### Technical Specifications

- Fully meets ANSI N545-1977, NRC Regulatory Guide 4.13, and HPS Draft Standard N13.29 for environmental dosimetry.

- Minimum Detectable Dose - nominally 0.1 mrem (1 μSv), reporting to tenths of a millirem ambient dose equivalent.

- Detection Capabilities:

  Photons (x and gamma rays) with energies above 15 keV nominally: 0.1 mrem to 1000 rem (1 μSv to 10 Sv).

  Beta particles with energies greater than approximately 500 keV average energy: 20 mrem to 1000 rem (200 μSv to 10 Sv).

### Control Dosimeter

A minimum of two control dosimeters are provided per shipment. The first is for field deployment/retrieval used to measure exposure during shipment and placement/collection. The second is for transit used to measure exposure during shipment only. Both control dosimeters assigned to a shipment should accompany that shipment both from and to Landauer. Do not use the control dosimeters for any other purpose. Store dosimeters away from radiation when not in use along with the control dosimeter(s) of the same use date.

Dosimetry reports show gross and net dosage. Gross dosage includes the dosage to the controls. Landauer's background subtraction protocol is:

1. Subtract the deployment/retrieval control; or if not returned to Landauer
2. Subtract the transit control.

## Dosimetry Report Information

**Location ID Number**
Unique number assigned by Landauer.

**Dosimeter Type**

| Dosimeter Type | Analytical Sensitivity | Minimum Detectable Dose Level (mrem) |
|---|---|---|
| V03NH | High | 0.1 |
| V03NN | Standard | 5.0 |
| V06NH | High | 0.1 |
| V06NN | Standard | 5.0 |

**Identifier**
Location name supplied by customer.

**Exposure Ambient Dose (mrem)**
Gross: Gross exposure before control subtraction.
Net: Net exposure after control subtraction.

**Net Cumulative Totals (mrem)**
Quarter to Date, Year to Date, and Permanent are accumulated net ambient exposure.

**Inception Date**
The date Landauer began keeping dosimeter records for a given dosimeter for a monitoring location on the current account.

**Serial Number**
Dosimeter serial number.

### U.S. Patents

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| | |
|---|---|
| Report Date (YYYY-MM-DD) | 2015-02-24 |
| Page | 1 of 1 |
| Dosimeter Received | 2015-02-23 |
| QC Release | LCA |
| Analytical Work Order | 1504811234 |

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# Environmental Dosimetry Report

**Account : 291406 Subaccount : 1420532 Series: REC**

| Location ID Number | Dosimeter Type | Identifier (Client Supplied) | Exposure (Ambient Dose mrem) | | Net Cumulative Totals (mrem) | | | Inception Date (YYYY-MM) | Serial Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | Gross | Net | Quarter to Date | Year to Date | Permanent | | |
| Monitoring Period: | | | 2014-10-01 to | 2014-12-31 | Q4 | 2014 | | | |
| 00000 | V03NH | Deploy Control | | | | | | 2013-01 | EX000678298 |
| | V03NH | Control Dose Used | 39.6 | | | | | | |
| 00119 | V03NH | UPTON 1 | 43.6 | 4.0 | 4.0 | 0.6 | 5.0 | 2013-01 | EX00001080I |
| 00120 | V03NH | UPTON 2 | 51.9 | 12.3 | 12.3 | 20.9 | 44.9 | 2013-01 | EX00054399G |
| 00121 | V03NH | UPTON 3 | 44.0 | 4.4 | 4.4 | 6.7 | 17.0 | 2013-01 | EX00069822K |
| 00123 | V03NH | UPTON 5 | 42.6 | 3.0 | 3.0 | 4.1 | 11.2 | 2013-01 | EX00012797M |
| 00124 | V03NH | UPTON 6 | 39.9 | 0.3 | 0.3 | -5.9 | 1.4 | 2013-01 | EX00062698C |
| 00125 | V03NH | UPTON 7 | 40.6 | 1.0 | 1.0 | -0.6 | -4.9 | 2013-01 | EX00063723Q |
| 00126 | V03NH | UPTON 8 | 40.3 | 0.7 | 0.7 | -1.6 | 3.7 | 2013-01 | EX00061117X |

## General Information

The Environmental dosimeter is for both indoor and outdoor use, and is designed to withstand extremes of temperature, humidity, precipitation, and other environmental conditions. InLight dosimeters are built on an assembly of a case component with copper and plastic filters along with a four-positioned aluminum oxide detector slide component. Both the case and slide are uniquely bar coded with serial numbers for chain of custody and sensitivity identification. The InLight dosimeter is sealed within a heavy-duty vinyl tamper resistant pouch that has multiple slots to permit several methods of attachment for easy deployment.

### Technical Specifications

- Fully meets ANSI N545-1977, NRC Regulatory Guide 4.13, and HPS Draft Standard N13.29 for environmental dosimetry.

- Minimum Detectable Dose - nominally 0.1 mrem (1 μSv), reporting to tenths of a millirem ambient dose equivalent.

- Detection Capabilities:

  Photons (x and gamma rays) with energies above 15 keV nominally: 0.1 mrem to 1000 rem (1 μSv to 10 Sv).

  Beta particles with energies greater than approximately 500 keV average energy: 20 mrem to 1000 rem (200 μSv to 10 Sv).

### Control Dosimeter

A minimum of two control dosimeters are provided per shipment. The first is for field deployment/retrieval used to measure exposure during shipment and placement/collection. The second is for transit used to measure exposure during shipment only. Both control dosimeters assigned to a shipment should accompany that shipment both from and to Landauer. Do not use the control dosimeters for any other purpose. Store dosimeters away from radiation when not in use along with the control dosimeter(s) of the same use date.

Dosimetry reports show gross and net dosage. Gross dosage includes the dosage to the controls. Landauer's background subtraction protocol is:

1. Subtract the deployment/retrieval control; or if not returned to Landauer
2. Subtract the transit control.

## Dosimetry Report Information

**Location ID Number**
Unique number assigned by Landauer.

**Dosimeter Type**

| Dosimeter Type | Analytical Sensitivity | Minimum Detectable Dose Level (mrem) |
|---|---|---|
| V03NH | High | 0.1 |
| V03NN | Standard | 5.0 |
| V06NH | High | 0.1 |
| V06NN | Standard | 5.0 |

**Identifier**
Location name supplied by customer.

**Exposure Ambient Dose (mrem)**
Gross: Gross exposure before control subtraction.
Net: Net exposure after control subtraction.

**Net Cumulative Totals (mrem)**
Quarter to Date, Year to Date, and Permanent are accumulated net ambient exposure.

**Inception Date**
The date Landauer began keeping dosimeter records for a given dosimeter for a monitoring location on the current account.

**Serial Number**
Dosimeter serial number.

### U.S. Patents

6,316,782; 6,127,685; 5,892,234

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# Appendix F

# Laboratory Analytical Data: Particulates

*(Provided Separately on CD)*