Idaho National Laboratory Site Offsite Environmental Surveillance Program Report: First Quarter 2014

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Contributors:
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Under Contract DE-NE0000300

By Gonzales Stoller Surveillance, LLC
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EXECUTIVE SUMMARY

None of the radionuclides detected in samples collected during the first quarter of 2014 could be directly linked with INL Site activities. Levels of detected radionuclides were no different than values measured at other locations across the western United States. All detected radionuclide concentrations were well below standards set by the U.S. Department of Energy (DOE) and regulatory standards established by the U.S. Environmental Protection Agency (EPA) for protection of the public.

This report for the first quarter of 2014 contains results from the Environmental Surveillance, Education, and Research (ESER) Program’s monitoring of the Department of Energy’s Idaho National Laboratory (INL) Site’s offsite environment, January 1 through March 31, 2014. All sample types (media) and the sampling schedule followed during 2014 are listed in Appendix A. Specifically, this report contains the results for the following:

- Air sampling, including particulate air filters, charcoal cartridges, and atmospheric moisture
- Precipitation sampling
- Milk sampling

Table E-1  Summary of results for the First Quarter of 2014.

<table>
<thead>
<tr>
<th>Media</th>
<th>Sample Type</th>
<th>Analysis</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Filters</td>
<td>Gross alpha, gross beta</td>
<td>Gross alpha and gross beta concentrations were statistically the same for Distant, Boundary, and INL Site sample groups for the quarter and each month of the quarter. A few statistical differences were found in gross alpha and gross beta concentrations during some weeks. The differences appeared due to normal variability in the data rather than an INL Site impact. No result exceeded the DCS for gross alpha or gross beta activity in air.</td>
</tr>
<tr>
<td>Gamma-emitting radionuclides, $^{90}$Sr, actinides (americium and plutonium)</td>
<td></td>
<td></td>
<td>No human-made radionuclides were detected.</td>
</tr>
<tr>
<td>Charcoal Cartridge</td>
<td>Iodine-131</td>
<td></td>
<td>Iodine-131 was not detected in any of the 24 batches counted during the quarter.</td>
</tr>
<tr>
<td>Atmospheric Moisture</td>
<td>Liquid</td>
<td>Tritium</td>
<td>Two of the ten sample results showed tritium concentrations</td>
</tr>
</tbody>
</table>
Executive Summary

greater than the 3s uncertainty during the quarter. No sample result exceeded the DCS for tritium in air. Results were consistent at all four sample locations.

<table>
<thead>
<tr>
<th>Precipitation</th>
<th>Liquid</th>
<th>Tritium</th>
<th>Nine samples were collected. Three of the results were greater than the 3s uncertainty. The concentrations were consistent with those reported across the region by the Environmental Protection Agency and with previous results.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Liquid</td>
<td>Iodine-131, other gamma-emitting radionuclides</td>
<td>No Iodine-131 or other human-made gamma emitting radionuclides were detected.</td>
</tr>
<tr>
<td>Large Game Animals</td>
<td>Tissue</td>
<td>Gamma-emitting radionuclides</td>
<td>No large game animals were sampled in the first quarter.</td>
</tr>
</tbody>
</table>
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEC</td>
<td>Atomic Energy Commission</td>
</tr>
<tr>
<td>CFA</td>
<td>Central Facilities Area</td>
</tr>
<tr>
<td>DCS</td>
<td>Derived Concentration Standard</td>
</tr>
<tr>
<td>DOE</td>
<td>Department of Energy</td>
</tr>
<tr>
<td>DOE – ID</td>
<td>Department of Energy Idaho Operations Office</td>
</tr>
<tr>
<td>EAL</td>
<td>Environmental Assessment Laboratory</td>
</tr>
<tr>
<td>EFS</td>
<td>Experimental Field Station</td>
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<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>ERAMS</td>
<td>Environmental Radiation Ambient Monitoring System</td>
</tr>
<tr>
<td>ESER</td>
<td>Environmental Surveillance, Education, and Research</td>
</tr>
<tr>
<td>GSS</td>
<td>Gonzales Stoller Surveillance, LLC</td>
</tr>
<tr>
<td>ICP</td>
<td>Idaho Cleanup Project</td>
</tr>
<tr>
<td>INL</td>
<td>Idaho National Laboratory</td>
</tr>
<tr>
<td>INEL</td>
<td>Idaho National Engineering Laboratory</td>
</tr>
<tr>
<td>INEEL</td>
<td>Idaho National Engineering and Environmental Laboratory</td>
</tr>
<tr>
<td>ISU</td>
<td>Idaho State University</td>
</tr>
<tr>
<td>MDC</td>
<td>minimum detectable concentration</td>
</tr>
<tr>
<td>NRTS</td>
<td>National Reactor Testing Station</td>
</tr>
</tbody>
</table>
LIST OF UNITS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bq</td>
<td>becquerel</td>
</tr>
<tr>
<td>Ci</td>
<td>curie</td>
</tr>
<tr>
<td>g</td>
<td>gram</td>
</tr>
<tr>
<td>L</td>
<td>liter</td>
</tr>
<tr>
<td>µCi</td>
<td>microcurie</td>
</tr>
<tr>
<td>mL</td>
<td>milliliter</td>
</tr>
<tr>
<td>pCi</td>
<td>picocurie</td>
</tr>
</tbody>
</table>
1. ESER PROGRAM DESCRIPTION

Operations at the Idaho National Laboratory (INL) Site are conducted under requirements imposed by the U.S. Department of Energy (DOE) under authority of the Atomic Energy Act and the U.S. Environmental Protection Agency (EPA) under a number of acts (e.g. the Clean Air Act and Safe Drinking Water Act). The requirements imposed by DOE are specified in DOE Orders. These requirements include those to monitor the effects of DOE activities both inside and outside the boundaries of DOE facilities (DOE 2003). During calendar year 2014, environmental monitoring within the INL Site boundaries was primarily the responsibility of the INL and Idaho Cleanup Project (ICP) contractors, while monitoring outside the INL Site boundaries was conducted under the Environmental Surveillance, Education, and Research (ESER) Program. At the beginning of the first quarter of 2011, the ESER Program became led by a new partnership between S.M. Stoller and Jerome Gonzales Management Systems, Inc. with the support of the previous team members. This partnership is named Gonzales Stoller Surveillance, LLC (GSS). The ESER Program was led by GSS in cooperation with its team members, including the University of Idaho, Idaho State University (ISU), and ALS Environmental.

This report contains monitoring results from the ESER Program for samples collected during the first quarter of 2014 (January 1-March 31, 2014).

The surveillance portion of the ESER Program is designed to satisfy the following program objectives:

- Verify compliance with applicable environmental laws, regulations, and DOE Orders
- Characterize and define trends in the physical, chemical, and biological condition of environmental media on and around the INL Site
- Assess the potential radiation dose to members of the public from INL Site effluents
- Present program results clearly and concisely through the use of reports, presentations, newsletter articles and press releases.

The goal of the surveillance program is to monitor different media at a number of potential exposure points within the various exposure pathways, including air, water, agricultural products, wildlife, and soil that could possibly contribute to the radiation dose received by the public.

Environmental samples collected include:

- air at 16 locations on and around the INL Site
- moisture in air at four locations around the INL Site
- precipitation from three locations on and around the INL Site
- drinking water from eight locations and surface water from three locations around the INL Site
- agricultural products, including milk at seven dairies around the INL Site, potatoes from at least six local producers, alfalfa from a local producer, wheat/barley from approximately 10 local producers, and lettuce from approximately nine home-owned and portable gardens on and around the INL
- soil from 13 locations around the INL Site biennially
- environmental dosimeters from 17 locations semi-annually
- various numbers of wildlife including big game (pronghorn, mule deer, and elk) and waterfowl sampled on and near the INL Site.
Table A-1 in Appendix A lists samples, sampling locations, and collection frequency for the ESER Program.

The ESER Program used two laboratories to perform analyses on routine environmental samples collected during the quarter reported here. The ISU Environmental Assessment Laboratory (EAL) performed routine gross alpha, gross beta, tritium, and gamma spectrometry analyses. Analyses requiring radiochemistry including strontium-90 ($^{90}$Sr), plutonium-238 ($^{238}$Pu), plutonium-239/240 ($^{239/240}$Pu), and americium-241 ($^{241}$Am) were performed by ALS Environmental of Fort Collins, Colorado.

In the event of non-routine occurrences, such as suspected releases of radioactive material, the ESER Program may increase the frequency of sampling and/or the number of sampling locations based on the nature of the release and wind distribution patterns. Any data found to be outside historical norms in the ESER Program is thoroughly investigated to determine if an INL Site origin is likely. Investigation may include re-sampling and/or re-analysis of prior samples.

In the event of any suspected worldwide nuclear incidents, like the 1986 Chernobyl accident or the 2011 Fukushima accident, the EPA may request additional sampling be performed through RadNet [previously known as the Environmental Radiation Ambient Monitoring System (ERAMS) network] (EPA 2013). The EPA established the ERAMS network in 1973 with an emphasis on identifying trends in the accumulation of long-lived radionuclides in the environment. ERAMS was renamed RadNet in 2005 to reflect a new mission. RadNet is comprised of a nationwide network of sampling stations that provide air, precipitation, drinking water, and milk samples. The ESER Program currently operates a high-volume air sampler and collects precipitation and drinking water in Idaho Falls for this national program and routinely sends samples to EPA’s Eastern Environmental Radiation Facility for analyses. The RadNet data collected at Idaho Falls are not reported by the ESER Program but are available through the EPA RadNet website (http://www.epa.gov/narel/radnet/).

Once samples have been collected and analyzed, the ESER Program has the responsibility for quality control of the data and for preparing quarterly reports on results from the environmental surveillance program. The quarterly reports are then consolidated into the INL Site Environmental Report for each calendar year. These annual reports also include data collected by other INL Site contractors.

The results reported in the quarterly and annual reports are assessed in terms of data quality and statistical significance with respect to laboratory analytical uncertainties, sample locations, reported INL Site releases, meteorological data, and worldwide events that might conceivably have an effect on the INL Site environment. First, field collection and laboratory information are reviewed to determine identifiable errors that would invalidate or limit use of the data. Examples of such limitations include insufficient sample volume, torn filters, evidence of laboratory cross-contamination or quality control issues. Data that pass initial screening are further evaluated using statistical methods. Statistical tools are necessary for data evaluation particularly since environmental measurements typically involve the determination of minute concentrations, which are difficult to detect and even more difficult to distinguish from other measurements.

Results are presented in this report with an analytical uncertainty term, $s$, where “$s$” is the estimated sample standard deviation ($\sigma$), assuming a Gaussian or normal distribution. All results are reported in this document, even those that do not necessarily represent detections. The term "detected", as used for the discussion of results in this report, does not imply any degree of risk to the public or environment, but rather indicates that the radionuclide was measured at a concentration sufficient for the analytical instrument to record a value that is
statistically different from background. The ESER has adopted guidelines developed by the United States Geological Survey (Bartholomay, et al. 2003), based on an extension of a method proposed by Currie (1984), to interpret analytical results and make decisions concerning detection. Most of the following discussion is taken from Bartholomay et al (2003).

Laboratory measurements involve the analysis of a target sample and the analysis of a prepared laboratory blank (i.e., a sample which is identical to the sample collected in the environment, except that the radionuclide of interest is absent). Instrument signals for the target and blank vary randomly about the true signals and may overlap making it difficult to distinguish between radionuclide activities in blank and in environmental samples (Figure 1). That is, the variability around the sample result may substantially overlap the variability around a net activity of zero for samples with no radioactivity. In order to conclude that a radionuclide has been detected, it is essential to consider two fundamental aspects of the problem of detection: (1) the instrument signal for the sample must be greater than that observed for the blank before the decision can be made that the radionuclide has been detected; and (2) an estimate must be made of the minimum radionuclide concentration that will yield a sufficiently large observed signal before the correct decision can be made for detection or non-detection.

Figure 1. Example of overlap of blank and sample measurement distributions.

In the laboratory, instrument signals must exceed a critical level of 1.6s before the qualitative decision can be made as to whether the radionuclide was detected in a sample. At 1.6s there is about a 95-percent probability that the correct conclusion—not detected—will be made. Given a large number of samples, approximately 5 percent of the samples with measured concentrations greater than or equal to 1.6s, which were concluded as being detected, might not contain the radionuclide. These are referred to as false positives. For purposes of simplicity and consistency with past reporting, the ESER has rounded the 1.6s critical level estimate to 2s.

Once the critical level has been defined, the minimum detectable concentration may be determined. Concentrations that equal 3s represent a measurement at the detection level or minimum detectable concentration. For true concentrations of 3s or greater, there is a greater than 99-percent probability that the radionuclide was detected in the target sample. In a large number of samples, the conclusion—not detected—will be made in less than one percent of the samples with true concentrations at the minimum detectable concentration of 3s. These
measurements are known as false negatives. The ESER reports measured radionuclide concentrations greater than or equal to their respective 3σ uncertainties as being “detected with confidence.”

Concentrations between 2σ and 3σ are reported as “questionably detected”. That is, the radionuclide may be present in the sample; however, the detection may not be reliable. Measurements made between 2σ and 3σ are examined further to determine if they are a part of a pattern (temporal or spatial) that might warrant further investigation or recounting. For example, if a particular radionuclide is typically detected at > 3σ at a specific location, a sample result between 2σ and 3σ might be considered detected.

If a result is less than or equal to 2σ there is little confidence that the radionuclide is present in the sample. Analytical results in this report are presented as the result value ± one standard deviation (1σ) for reporting consistency with the annual report. To obtain the 2σ or 3σ values simply multiply the uncertainty term by 2 or 3.

For more information concerning the ESER Program, contact GSS at (208) 525-8250, or visit the Program’s web page (http://www.gsseser.com).
2. THE INL SITE

The INL Site is a nuclear energy and homeland security research and environmental management facility. It is owned and administered by the U.S. Department of Energy, Idaho Operations Office (DOE-ID) and occupies about 890 mi² (2300 km²) of the upper Snake River Plain in Southeastern Idaho. The history of the INL Site began during World War II when the U.S. Naval Ordnance Station was located in Pocatello, Idaho. This station, one of two such installations in the U.S., retooled large guns from U.S. Navy warships. The retooled guns were tested on the nearby, uninhabited plain, known as the Naval Proving Ground. In the years following the war, as the nation worked to develop nuclear power, the Atomic Energy Commission (AEC), predecessor to the DOE, became interested in the Naval Proving Ground and made plans for a facility to build, test, and perfect nuclear power reactors.

The Naval Proving Ground became the National Reactor Testing Station (NRTS) in 1949, under the AEC. By the end of 1951, a reactor at the NRTS became the first to produce useful amounts of electricity. Over time the site has operated 52 various types of reactors, associated research centers, and waste handling areas. The NRTS was renamed the Idaho National Engineering Laboratory (INEEL) in 1974, and the Idaho National Engineering and Environmental Laboratory (INEEL) in January 1997. With renewed interest in nuclear power the DOE announced in 2003 that Argonne National Laboratory and the INEEL would be the lead laboratories for development of the next generation of power reactors. On February 1, 2005 the INEEL and Argonne National Laboratory-West became the INL. The INL is committed to providing international nuclear leadership for the 21st Century, developing and demonstrating compelling national security technologies, and delivering excellence in science and technology as one of the Department of Energy's multiprogram national laboratories.

The cleanup operation, the ICP, is now a separately managed effort. The ICP is charged with safely and cost-effectively completing the majority of cleanup work from past laboratory missions in an ongoing process.
3. AIR SAMPLING

The primary pathway by which radionuclides can move off the INL Site is through the air and for this reason the air pathway is the primary focus of monitoring on and around the INL Site. Samples for particulates and iodine-131 ($^{131}$I) gas in air were collected weekly for the duration of the quarter at 16 locations using low-volume air samplers. Moisture in the atmosphere was sampled at four locations around the INL Site and analyzed for tritium. Air sampling activities and results for the first quarter of 2014 are discussed below. A summary of approximate minimum detectable concentrations (MDCs) for radiological analyses and DOE Derived Concentration Standard (DCS) (DOE 2011) values is provided in Appendix B.

LOW- VOLUME AIR SAMPLING

Radioactivity associated with airborne particulates was monitored continuously by 18 low-volume air samplers (two of which are used as replicate samplers) at 16 locations during the first quarter of 2014 (Figure 2). Four of these samplers are located on the INL Site, seven are situated off the INL Site near the boundary, and seven have been placed at locations distant to the INL Site. Samplers are divided into INL Site, Boundary, and Distant groups to determine if there is a gradient of radionuclide concentrations, increasing towards the INL Site. Each replicate sampler is relocated every other year to a new location. At the start of 2014, one replicate sampler was moved to Idaho Falls (a Distant location) and one was moved to Main Gate (an INL Site location). An average of 20,871 ft$^3$ (591 m$^3$) of air was sampled at each location, each week, at an average flow rate of 2.07 ft$^3$/min (0.06 m$^3$/min). Particulates in air were collected on membrane particulate filters (1.2-µm pore size). Gases passing through the filter were collected with an activated charcoal cartridge.

![Figure 2. Low-volume air sampler locations.](image)

Filters and charcoal cartridges were changed weekly at each station during the quarter. Each particulate filter was analyzed for gross alpha and gross beta radioactivity using thin-window gas flow proportional counting systems after waiting about four days for naturally-occurring daughter products of radon and thorium to decay.
The weekly particulate filters collected during the quarter for each location were compositied and analyzed for gamma-emitting radionuclides. Selected composites were also analyzed by location for $^{90}$Sr, $^{238}$Pu, $^{239/240}$Pu, and $^{241}$Am as determined by a rotating quarterly schedule.

Charcoal cartridges were analyzed for gamma-emitting radionuclides, specifically for iodine-$131$ ($^{131}$I). Iodine-$131$ is of particular interest because it is produced in relatively large quantities by nuclear fission, is readily accumulated in human and animal thyroids, and has a half-life of eight days. This means that any elevated level of $^{131}$I in the environment could be from a recent release of fission products.

Gross alpha results are reported in Table C-1 and shown in Figures 3 through 6. Gross alpha data are tested for normality prior to statistical analyses, and generally show no consistent discernible distribution. Because there is no discernible distribution of the data, the nonparametric Kruskal-Wallis test of multiple independent groups was used to test for statistical differences between INL Site, Boundary, and Distant locations. The use of nonparametric tests, such as Kruskal-Wallis, gives less weight to outlier and extreme values thus allowing a more appropriate comparison of data groups. A statistically significant difference exists between data groups if the (p) value is less than 0.05. Values greater than 0.05 translate into a 95 percent confidence that the medians are statistically the same. The p-value for each comparison is shown in Table D-1. For the quarter, there was no statistical difference noted in the data, as the p-value was above 0.05.

Comparisons of gross alpha concentrations were made for each month of the quarter. Again the Kruskal-Wallis test of multiple independent groups was used to determine if statistical differences exist between INL Site, Boundary, and Distant data groups. No statistical differences in gross alpha concentrations between groups were noted during any month (Table D-1).

As an additional check, comparisons between gross alpha concentrations measured at Boundary and Distant locations were made on a weekly basis. The Mann-Whitney U test was used to compare the Boundary and Distant data because it is the most powerful nonparametric alternative to the t-test for independent samples. INL Site sample results were not included in this analysis because the onsite data, collected at only three locations, are not representative of the entire INL Site and would not aid in determining offsite impacts. In the first quarter, there was one week where a statistical difference existed between the two sample groups (Table D-2). This was during the week of February 26, when the Boundary group was statistically higher than the Distant group. Gross alpha concentrations were well below the median concentration at all locations during this week and there does not appear to be any discernable pattern in the data.

Gross beta results are presented in Table C-1 and displayed in Figures 7 through 10. The data were tested and found to be neither normally nor log-normally distributed. Box and whiskers plots were used for presentation of the data. Outliers and extreme values were retained in subsequent statistical analyses because they are within the range of measurements made in the past five years, and because these values could not be attributed to mistakes in collection, analysis, or reporting procedures. No statistical differences were noted in the quarterly data and or during any month of the quarter using the Kruskal-Wallis test (Table D-1).

Comparison of weekly Boundary and Distant gross beta data sets, using the Mann Whitney U test, showed a statistical difference between Boundary and Distant measurements during four weeks of the first quarter (Table D-1). In each case, the Boundary locations were statistically greater than the Distant locations. Analysis of the data for these weeks and the quarter as a whole did not show a consistent pattern that would indicate an INL Site impact on
the results. There was a general tendency for slightly higher results at some of the northern Boundary stations (Howe, Monteview, and Mud Lake) and lower results at some of the Distant valley stations (particularly Jackson and Sugar City). This pattern is sometimes seen in the winter months during periods of consistent inversion conditions. Gross beta concentrations for the locations on the INL Site were generally in the middle of the two offsite groups.

Iodine-131 was not detected in any of the 24 sets of charcoal cartridges measured during the first quarter. Weekly $^{131}$I results for each location are listed in Table C-2 of Appendix C.

No $^{137}$Cs or other human-made gamma-emitting radionuclides, $^{90}$Sr, or actinides (plutonium and americium) were found in quarterly composites. All available quarterly composite results are found in Appendix C, Table C-3.

Quarterly air filter samples reported in 2012 and 2013 showed results for $^{90}$Sr at the higher end of those measured historically. In addition the frequency of detection (18 of 26 samples or 69 percent) was higher than usually seen. During an audit of the ALS laboratory, discussions with laboratory personnel led to the hypothesis that the results may have been due to the presence of a naturally-occurring uranium-238 ($^{238}$U) decay product. Strontium-90 is determined in the laboratory through a series of steps which involves dissolution of the sample, chemical separation of strontium, ingrowth of the daughter yttrium-90 ($^{90}$Y), resin column extraction of the $^{90}$Y daughter, and final beta counting of the dried product. ALS laboratory personnel determined that lead-210 ($^{210}$Pb), a daughter of $^{238}$U, will remain in the resin column during column extractions. However, Bismuth-210 ($^{210}$Bi), a product of the decay of $^{210}$Pb, will elute with the $^{90}$Y in the final column rinse. Because $^{210}$Bi is a beta emitter, it will be counted in the beta counter along with $^{90}$Y, and the final count can be interpreted incorrectly as a higher detectable quantity of $^{90}$Sr. The laboratory was instructed to perform the analysis as usual and if beta activity was detected, to recount 1, 4, and 11 days later to see if the counts decreased due to radioactive decay of $^{210}$Bi (half-life of 5 days). Plotting each individual sample and using linear regression, it was shown that the samples contained a beta emitter with a half-life within the range of 3 to 6 days. Based on this information, it was concluded that the results of previous samples may have been artificially high due to the presence of $^{238}$U (and thus $^{210}$Bi) in the air samples. Because of this, ESER sent a second set of 20 air samples collected during 2013 for analysis. The laboratory was asked to wait approximately 2 weeks if beta activity was detected and then to recount in two weeks to allow for the decay of $^{210}$Bi. Using this protocol, $^{90}$Sr was detected in only 4 samples (20 percent of the total number analyzed). The protocol was used in the first quarter and will be used in all future analyses.
Figure 3. Gross alpha concentrations in air at ESER INL Site, Boundary, and Distant locations for the first quarter of 2014.
Figure 4. January gross alpha concentrations in air at ESER INL Site, Boundary, and Distant locations. Number of samples (N) = 4 at each location.
Figure 5. February gross alpha concentrations in air at ESER INL Site, Boundary, and Distant locations. Number of samples (N) = 4 at each location, except Arco (N = 3) and Main Gate (N = 2).
Figure 6. March gross alpha concentrations in air at ESER INL Site, Boundary, and Distant locations. Number of samples \((N) = 4\) at each location.
Figure 7. Gross beta concentrations in air at ESER INL Site, Boundary, and Distant locations for the first quarter of 2014.
Figure 8. January gross beta concentrations in air at ESER INL Site, Boundary, and Distant locations. Number of samples (N) = 4 at each location.
Figure 9. February gross beta concentrations in air at ESER INL Site, Boundary, and Distant locations. Number of samples (N) = 4 at each location, except Arco (N = 3) and Main Gate (N = 2).
Figure 10. March gross beta concentrations in air at ESER INL Site, Boundary, and Distant locations. Number of samples (N) = 4 at each location.
**ATMOSPHERIC MOISTURE SAMPLING**

Atmospheric moisture is collected by pulling air through a column of absorbent material (molecular sieve material) to absorb water vapor. The water is then extracted from the absorbent material by heat distillation. The resulting water samples are then analyzed for tritium using liquid scintillation.

Results were available for ten atmospheric moisture samples collected during the first quarter of 2014. Two of these exceeded the 3s uncertainty level for tritium, with similar results to those reported previously. All samples were significantly below the DOE DCS for tritium in air of $1.4 \times 10^{-8} \mu\text{Ci/mL}_{\text{air}}$ with a maximum reported value of $4.5 \times 10^{-13} \mu\text{Ci/mL}_{\text{air}}$ at Idaho Falls. Results are shown in Table C-4, Appendix C.
4. PRECIPITATION AND WATER SAMPLING

Precipitation Sampling

Precipitation samples are gathered when sufficient precipitation occurs to allow for the collection of the minimum sample volume of approximately 50 mL. Samples are taken of monthly composites from Idaho Falls and CFA, and weekly from the EFS. Precipitation samples are analyzed for tritium. Storm events in the first quarter of 2014 produced sufficient precipitation to yield only nine samples.

Tritium was measured above the 3s values in three of the nine samples. These results are listed in Table C-5 (Appendix C). Low levels of tritium exist in the environment at all times as a result of cosmic ray reactions with water molecules in the upper atmosphere and nuclear weapons testing. When detected, tritium values have remained well within the historical range and the range measured across the country by the EPA Radnet program (EPA 2013). Most samples have values up to about 150 pCi/L, with occasional values up to about 300 pCi/L.
5. AGRICULTURAL PRODUCT, WILDLIFE, AND SOIL SAMPLING

Another potential pathway for contaminants to reach humans is through the food chain. The ESER Program samples multiple agricultural products and game animals from around the INL Site and Southeast Idaho. Specifically, milk, alfalfa, grain, potatoes, lettuce, large game animals, and waterfowl are sampled. Milk is sampled throughout the year and large game animals are sampled whenever large game animals are killed onsite from vehicle collisions. Alfalfa is collected during the second quarter, lettuce and grain are sampled during the third quarter, while potatoes are collected during the fourth quarter. Waterfowl are collected in either the third or fourth quarter. See Table A-1, Appendix A, for more details on agricultural product and wildlife sampling. This section discusses results from milk and agricultural products samples available during the first quarter of 2014.

**Milk Sampling**

Milk samples were collected weekly in Idaho Falls. Monthly samples were collected at six other locations around the INL Site (Figure 11) during the first quarter of 2014. In addition, commercially-available organic milk was purchased as a control sample. All samples were analyzed for gamma emitting radionuclides, with particular emphasis on Iodine-131.

Iodine-131 was not detected in any weekly or monthly samples during the first quarter. No other human-made gamma-emitting radionuclides were found either. Data for $^{131}$I and $^{137}$Cs in milk samples are listed in Appendix C, Table C-7.

![Figure 11. ESER milk sampling locations](image)

**Large Game Animal Sampling**

No large game animals were sampled in the first quarter.
6. QUALITY ASSURANCE

The ESER Quality Assurance Program consists of five ongoing tasks which measure:

1. method uncertainty
2. data completeness
3. data accuracy, using spike, performance evaluation and laboratory control samples
4. data precision, using split samples, duplicate samples and recounts
5. presence of contamination in samples, using blanks.

Sample results are compared to criteria described in the Quality Assurance Project Plan for the INL Site Offsite Environmental Surveillance Program (GSS 2012). Criteria established by DOE for Quality Assurance activities include:

- Quality assurance program
- Personnel training and qualification
- Quality improvement process
- Documents and records
- Established work processes
- Established standards for design and verification
- Established procurement requirements
- Inspection and acceptance testing
- Management assessment
- Independent assessment

Assessments of ESER data quality are achieved through analysis of spike, performance evaluation, and duplicate samples; through sample recounts; through analysis of blank samples; and through comparison of sample results to established method quality objectives. These assessments are documented in the ESER Quality Assurance for the First Quarter of 2014 (GSS 2014).
7. REFERENCES


APPENDIX A

SUMMARY OF SAMPLING SCHEDULE
### Table A-1. Summary of the ESER Program’s Sampling Schedule

<table>
<thead>
<tr>
<th>Sample Type Analysis</th>
<th>Collection Frequency</th>
<th>LOCATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AIR SAMPLING</strong></td>
<td></td>
<td>Distant</td>
</tr>
<tr>
<td><strong>LOW-VOLUME AIR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross Alpha, Gross Beta, $^{131}I$</td>
<td>weekly</td>
<td>Blackfoot, Craters of the Moon, Dubois, Idaho Falls, Jackson WY, Sugar City</td>
</tr>
<tr>
<td>Gamma Spec</td>
<td>quarterly</td>
<td>Blackfoot, Craters of the Moon, Dubois, Idaho Falls, Jackson WY, Sugar City</td>
</tr>
<tr>
<td>$^{90}$Sr, Transuranics</td>
<td>quarterly</td>
<td>Rotating schedule</td>
</tr>
<tr>
<td><strong>ATMOSPHERIC MOISTURE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tritium</td>
<td>2 to 13 weeks</td>
<td>Blackfoot, Idaho Falls, Sugar City</td>
</tr>
<tr>
<td><strong>PRECIPITATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tritium</td>
<td>monthly</td>
<td>Idaho Falls</td>
</tr>
<tr>
<td>Tritium</td>
<td>weekly</td>
<td>None</td>
</tr>
<tr>
<td><strong>DRINKING WATER</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross Alpha, Gross Beta, Tritium</td>
<td>Semiannually</td>
<td>Craters of the Moon, Idaho Falls, Minidoka, Shoshone</td>
</tr>
<tr>
<td><strong>SURFACE WATER</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross Alpha, Gross Beta, Tritium</td>
<td>Semiannually</td>
<td>Buhl, Hagerman, Twin Falls</td>
</tr>
<tr>
<td><strong>ENVIRONMENTAL RADIATION SAMPLING</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLDs/OSLDs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Radiation</td>
<td>semiannual</td>
<td>Aberdeen, Blackfoot (2), Craters of the Moon, Dubois, Idaho Falls, Jackson WY, Minidoka, Sugar City, Roberts</td>
</tr>
<tr>
<td><strong>SOIL SAMPLING</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SOIL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Spec, $^{90}$Sr, Transuranics</td>
<td>biennially</td>
<td>Carey, Crystal Ice Caves (Aberdeen), Blackfoot, St. Anthony</td>
</tr>
</tbody>
</table>
## Table A-1. Summary of the ESER Program’s Sampling Schedule (continued)

<table>
<thead>
<tr>
<th>Sample Type Analysis</th>
<th>Collection Frequency</th>
<th>LOCATIONS</th>
<th>Distant</th>
<th>Boundary</th>
<th>INL Site</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FOODSTUFF SAMPLING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MILK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Spec ((^{131})I) weekly</td>
<td>Idaho Falls</td>
<td>None</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Spec ((^{131})I) monthly</td>
<td>Blackfoot, Dietrich, Fort Hall, Idaho Falls, Minidoka</td>
<td>Howe, Terreton</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tritium, (^{90})Sr Semi-annually</td>
<td>Blackfoot, Dietrich, Fort Hall, Idaho Falls, Minidoka</td>
<td>Howe, Terreton</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>POTATOES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Spec, (^{90})Sr annually</td>
<td>Blackfoot, Idaho Falls, Rupert, Shelley, occasional samples across the U.S.</td>
<td>Arco, Montview, Mud Lake, Terreton</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ALFALFA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Spec, (^{90})Sr annually</td>
<td>None</td>
<td>Mud Lake</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GRAIN</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Spec, (^{90})Sr annually</td>
<td>American Falls, Blackfoot, Idaho Falls, Minidoka, Roberts</td>
<td>Arco, Montview, Mud Lake, Taber, Terreton</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LETTUCE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Spec, (^{90})Sr annually</td>
<td>Blackfoot, Carey, Idaho Falls, Sugar City</td>
<td>Arco, Atomic City, FAA Tower, Howe, Montview</td>
<td>EFS</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BIG GAME</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Spec varies</td>
<td>Occasional samples across the U.S.</td>
<td>Public Highways</td>
<td>INL Site roads</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WATERFOWL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Spec, (^{90})Sr, Transuranics annually</td>
<td>Varies among: Heise, Firth, Fort Hall, Mud Lake, Market Lake, and American Falls</td>
<td>None</td>
<td>INL Site wastewater disposal ponds</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B

SUMMARY OF MDCs AND DCSs
Table B-1. Summary of Approximate Minimum Detectable Concentrations for Radiological Analyses Performed during First Quarter 2014

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Analysis</th>
<th>Approximate Minimum Detectable Concentration(^a) (MDC)</th>
<th>Derived Concentration Standard(^b) (DCS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air (particulate filter)(^e)</td>
<td>Gross alpha(^c)</td>
<td>3.82 x 10(^{-16}) µCi/mL</td>
<td>4 x 10(^{-14}) µCi/mL</td>
</tr>
<tr>
<td></td>
<td>Gross beta(^d)</td>
<td>1.21 x 10(^{-15}) µCi/mL</td>
<td>2.4 x 10(^{-13}) µCi/mL</td>
</tr>
<tr>
<td></td>
<td>(^{90})Sr</td>
<td>1.82 x 10(^{-17}) µCi/mL</td>
<td>2.5 x 10(^{-11}) µCi/mL</td>
</tr>
<tr>
<td></td>
<td>(^{137})Cs</td>
<td>8.92 x 10(^{-17}) µCi/mL</td>
<td>3.9 x 10(^{-10}) µCi/mL</td>
</tr>
<tr>
<td></td>
<td>(^{238})Pu</td>
<td>1.76 x 10(^{-18}) µCi/mL</td>
<td>3.7 x 10(^{-14}) µCi/mL</td>
</tr>
<tr>
<td></td>
<td>(^{239/240})Pu</td>
<td>1.80 x 10(^{-18}) µCi/mL</td>
<td>3.4 x 10(^{-14}) µCi/mL</td>
</tr>
<tr>
<td></td>
<td>(^{241})Am</td>
<td>3.66 x 10(^{-18}) µCi/mL</td>
<td>1.8 x 10(^{-12}) µCi/mL</td>
</tr>
<tr>
<td>Air (charcoal cartridge)(^e)</td>
<td>(^{131})I</td>
<td>5.31 x 10(^{-16}) µCi/mL</td>
<td>2.3 x 10(^{-19}) µCi/mL</td>
</tr>
<tr>
<td>Air (atmospheric moisture)</td>
<td>(^{3})H</td>
<td>81.6 pCi/L(_{water})</td>
<td>2.1 x 10(^{-7}) µCi/mL(_{air})</td>
</tr>
<tr>
<td>Air (precipitation)</td>
<td>(^{3})H</td>
<td>81.6 pCi/L</td>
<td>1.9 x 10(^{-3}) µCi/mL</td>
</tr>
<tr>
<td>Milk</td>
<td>(^{131})I</td>
<td>0.62 pCi/L</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(^{137})Cs</td>
<td>0.57 pCi/L</td>
<td>--</td>
</tr>
</tbody>
</table>

\(a\) The MDC is an estimate of the concentration of radioactivity in a given sample type that can be identified with a 95 percent level of confidence and precision of plus or minus 100 percent under a specified set of typical laboratory measurement conditions.

\(b\) DCSs, set by the DOE, represent reference values for radiation exposure. They are based on a radiation dose of 100 mrem/yr for exposure through a particular exposure mode such as direct exposure, inhalation, or ingestion of water.

\(c\) The DCS for gross alpha is equivalent to the DCSs for \(^{241}\)Am.

\(d\) The DCS for gross beta is equivalent to the DCSs for \(^{228}\)Ra.

\(e\) The approximate MDC is based on an average filtered air volume (pressure corrected) of 445 m\(^3\)/week.
APPENDIX C

SAMPLE ANALYSIS RESULTS
## TABLE C-1. Weekly Gross Alpha and Gross Beta Concentrations in Air

<table>
<thead>
<tr>
<th>Sampling Group and Location</th>
<th>Sampling Date</th>
<th>Result ± 1s (Ci/mL)</th>
<th>Result ± 1s (Bq/mL)</th>
<th>Result &gt; 3s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BOUNDARY</strong></td>
<td></td>
<td>(x 10^{-5})</td>
<td>(x 10^6)</td>
<td></td>
</tr>
<tr>
<td><strong>ARCO</strong></td>
<td>1/8/2014</td>
<td>0.94 ± 0.14</td>
<td>3.47 ± 0.51</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/15/2014</td>
<td>1.22 ± 0.16</td>
<td>4.51 ± 0.59</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/22/2014</td>
<td>1.99 ± 0.20</td>
<td>7.36 ± 0.73</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/29/2014</td>
<td>1.67 ± 0.19</td>
<td>6.74 ± 0.69</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/5/2014</td>
<td>0.83 ± 0.15</td>
<td>3.08 ± 0.54</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/12/2014</td>
<td>0.87 ± 0.15</td>
<td>3.21 ± 0.54</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/19/2014</td>
<td>0.45 ± 0.11</td>
<td>1.65 ± 0.40</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/5/2014</td>
<td>1.09 ± 0.16</td>
<td>4.03 ± 0.57</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/12/2014</td>
<td>0.34 ± 0.11</td>
<td>1.25 ± 0.40</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/29/2014</td>
<td>1.68 ± 0.19</td>
<td>5.51 ± 0.68</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/5/2014</td>
<td>0.41 ± 0.12</td>
<td>1.50 ± 0.46</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/12/2014</td>
<td>0.80 ± 0.15</td>
<td>2.97 ± 0.55</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/19/2014</td>
<td>0.48 ± 0.12</td>
<td>1.78 ± 0.45</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/26/2014</td>
<td>0.55 ± 0.12</td>
<td>2.02 ± 0.45</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/5/2014</td>
<td>0.61 ± 0.12</td>
<td>2.24 ± 0.46</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/12/2014</td>
<td>0.58 ± 0.13</td>
<td>2.13 ± 0.47</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/19/2014</td>
<td>0.79 ± 0.13</td>
<td>2.92 ± 0.48</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/26/2014</td>
<td>1.63 ± 0.18</td>
<td>6.03 ± 0.66</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>ATOMIC CITY</strong></td>
<td>1/8/2014</td>
<td>0.86 ± 0.14</td>
<td>3.18 ± 0.53</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/15/2014</td>
<td>0.70 ± 0.14</td>
<td>2.60 ± 0.51</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/22/2014</td>
<td>2.06 ± 0.21</td>
<td>7.62 ± 0.77</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/29/2014</td>
<td>1.49 ± 0.19</td>
<td>5.51 ± 0.68</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/5/2014</td>
<td>0.41 ± 0.12</td>
<td>1.50 ± 0.46</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/12/2014</td>
<td>0.80 ± 0.15</td>
<td>2.97 ± 0.55</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/19/2014</td>
<td>0.48 ± 0.12</td>
<td>1.78 ± 0.45</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/26/2014</td>
<td>0.55 ± 0.12</td>
<td>2.02 ± 0.45</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/5/2014</td>
<td>0.61 ± 0.12</td>
<td>2.24 ± 0.46</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/12/2014</td>
<td>0.58 ± 0.13</td>
<td>2.13 ± 0.47</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/19/2014</td>
<td>0.79 ± 0.13</td>
<td>2.92 ± 0.48</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/26/2014</td>
<td>1.63 ± 0.18</td>
<td>6.03 ± 0.66</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>BLUE DOME</strong></td>
<td>1/8/2014</td>
<td>0.64 ± 0.13</td>
<td>2.36 ± 0.48</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/15/2014</td>
<td>0.40 ± 0.12</td>
<td>1.47 ± 0.47</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/22/2014</td>
<td>1.57 ± 0.19</td>
<td>5.81 ± 0.67</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/29/2014</td>
<td>1.68 ± 0.19</td>
<td>6.22 ± 0.72</td>
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</tr>
<tr>
<td></td>
<td>2/5/2014</td>
<td>0.41 ± 0.13</td>
<td>1.51 ± 0.46</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/12/2014</td>
<td>0.79 ± 0.14</td>
<td>2.91 ± 0.53</td>
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</tr>
<tr>
<td></td>
<td>2/19/2014</td>
<td>0.30 ± 0.11</td>
<td>1.09 ± 0.40</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>2/26/2014</td>
<td>0.40 ± 0.11</td>
<td>1.49 ± 0.40</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/5/2014</td>
<td>0.75 ± 0.14</td>
<td>2.78 ± 0.51</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/12/2014</td>
<td>1.14 ± 0.15</td>
<td>4.22 ± 0.56</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/19/2014</td>
<td>1.08 ± 0.14</td>
<td>4.00 ± 0.53</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/26/2014</td>
<td>1.02 ± 0.15</td>
<td>3.77 ± 0.55</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>FAA TOWER</strong></td>
<td>1/8/2014</td>
<td>0.75 ± 0.14</td>
<td>2.76 ± 0.50</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/15/2014</td>
<td>0.48 ± 0.13</td>
<td>1.79 ± 0.47</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/22/2014</td>
<td>1.33 ± 0.18</td>
<td>4.92 ± 0.65</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/29/2014</td>
<td>1.27 ± 0.17</td>
<td>4.70 ± 0.64</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/5/2014</td>
<td>0.57 ± 0.13</td>
<td>2.11 ± 0.48</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/12/2014</td>
<td>0.79 ± 0.12</td>
<td>2.93 ± 0.45</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/19/2014</td>
<td>0.35 ± 0.12</td>
<td>1.31 ± 0.46</td>
<td>No</td>
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<td></td>
<td>2/26/2014</td>
<td>0.53 ± 0.13</td>
<td>1.96 ± 0.48</td>
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</tr>
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<td></td>
<td>3/5/2014</td>
<td>0.64 ± 0.14</td>
<td>2.37 ± 0.53</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/12/2014</td>
<td>0.07 ± 0.09</td>
<td>-0.25 ± 0.34</td>
<td>No</td>
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<td></td>
<td>3/19/2014</td>
<td>0.73 ± 0.13</td>
<td>2.71 ± 0.49</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>3/26/2014</td>
<td>1.10 ± 0.16</td>
<td>4.07 ± 0.59</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>HOWE</strong></td>
<td>1/8/2014</td>
<td>1.69 ± 0.15</td>
<td>4.03 ± 0.56</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/15/2014</td>
<td>0.69 ± 0.14</td>
<td>2.56 ± 0.52</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/22/2014</td>
<td>2.17 ± 0.21</td>
<td>8.03 ± 0.78</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>1/29/2014</td>
<td>2.17 ± 0.21</td>
<td>8.03 ± 0.79</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>2/5/2014</td>
<td>0.93 ± 0.15</td>
<td>3.44 ± 0.57</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Note:** 
- Yes indicates detection of gross alpha or beta above the upper 3s confidence limit.
- No indicates detection of gross alpha or beta below or equal to the upper 3s confidence limit.
<table>
<thead>
<tr>
<th>Sampling Group and Location</th>
<th>Sampling Date</th>
<th>Result ± 1s Uncertainty</th>
<th>Result ± 1s Uncertainty</th>
<th>Result &gt; 3s</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td>(x 10^11 Bq/mL)</td>
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### TABLE C-1. Weekly Gross Alpha and Gross Beta Concentrations in Air

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TABLE C-2. Weekly Iodine-131 Activity in Air.

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<th>Result ± 1s Uncertainty (x 10^{-11} , \text{Bq/mL})</th>
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<td>-0.04 ± 1.09</td>
<td>-0.14 ± 4.05</td>
<td>No</td>
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<td>03/05/2014</td>
<td>0.10 ± 0.95</td>
<td>0.37 ± 3.50</td>
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<td>1.00 ± 3.65</td>
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<td>3.53 ± 4.82</td>
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a. Invalid sample result
TABLE C-3. Quarterly Cesium-137, Strontium-90, and Actinide Concentrations in Composite Air Filters.

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<th>Sampling Group and Location</th>
<th>Sampling Date</th>
<th>Analyte</th>
<th>Result ± 1s Uncertainty (x 10^{-18} µCi/mL)</th>
<th>Result ± 1s Uncertainty (x 10^{-13} Bq/mL)</th>
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<td>ARCO</td>
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<td>AMERICIUM-241</td>
<td>-0.06 ± 0.87</td>
<td>-0.21 ± 3.21</td>
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<td>CESIUM-137</td>
<td>-45.30 ± 134.00</td>
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<td>0.89 ± 0.73</td>
<td>3.29 ± 2.70</td>
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<td>PLUTONIUM-239/240</td>
<td>2.66 ± 0.91</td>
<td>9.84 ± 3.37</td>
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<td>AMERICIUM-241</td>
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<td>-292.30 ± 484.70</td>
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<td>-0.91 ± 2.73</td>
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<td>BLUE DOME</td>
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<td>STRONTIUM-90</td>
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<tr>
<td>FAA TOWER</td>
<td>3/26/2014</td>
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<tr>
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<td>CESIUM-137</td>
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<td>13.80 ± 5.01</td>
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<td>MONTEVIEW</td>
<td>3/26/2014</td>
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<td>-163.54 ± 432.90</td>
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<td>MUD LAKE</td>
<td>3/26/2014</td>
<td>CESIUM-137</td>
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<td>DUBOIS</td>
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<td>-1.20 ± 0.66</td>
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<td>1.21 ± 0.65</td>
<td>4.48 ± 2.39</td>
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TABLE C-3. Quarterly Cesium-137, Strontium-90, and Actinide Concentrations in Composite Air Filters.

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<th>Sampling Group and Location</th>
<th>Sampling Date</th>
<th>Analyte</th>
<th>Result ± 1s Uncertainty (x 10^{-18} μCi/mL)</th>
<th>Result ± 1s Uncertainty (x 10^{-13} Bq/mL)</th>
<th>Result &gt; 3s</th>
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<td>JACKSON</td>
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<td>CESIUM-137</td>
<td>-8.93 ± 93.40</td>
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<td>SUGAR CITY</td>
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<td>106.56 ± 306.36</td>
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<td>1.95 ± 6.22</td>
<td>7.22 ± 23.01</td>
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</table>
TABLE C-4. Tritium Concentrations in Atmospheric Moisture

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<th>Sampling Date</th>
<th>Result ± 1s Uncertainty (x 10^{13} \mu Ci/mL_{air})</th>
<th>Result ± 1s Uncertainty (x 10^9 Bq/mL_{air})</th>
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<td>7.40 ± 2.59</td>
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<td>03/12/2014</td>
<td>1.64 ± 1.02</td>
<td>6.09 ± 3.77</td>
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<td>BLACKFOOT</td>
<td>12/18/2013</td>
<td>01/15/2014</td>
<td>2.10 ± 0.81</td>
<td>7.76 ± 3.00</td>
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<td>BLACKFOOT</td>
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<td>02/19/2014</td>
<td>1.62 ± 0.77</td>
<td>6.01 ± 2.84</td>
<td>No</td>
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<td>03/12/2014</td>
<td>1.16 ± 1.13</td>
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<td>01/29/2014</td>
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<td>02/26/2014</td>
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<td>SUGAR CITY</td>
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<td>03/26/2014</td>
<td>0.21 ± 0.89</td>
<td>0.79 ± 3.28</td>
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TABLE C-5. Monthly and Weekly Tritium Concentrations in Precipitation

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<th>End Date</th>
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<th>Result ± 1s Uncertainty (Bq/L)</th>
<th>Result &gt; 3s</th>
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<td>-2.29 ± 0.81</td>
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<td>1.67 ± 0.83</td>
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<td>-0.012 ± 0.045</td>
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<td>No</td>
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</tr>
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<td>02/18/14</td>
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<td>0.022 ± 0.043</td>
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<td>02/25/14</td>
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<td>0.006 ± 0.061</td>
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<tr>
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<td>01/07/14</td>
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<td>-0.035 ± 0.053</td>
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<td>0.000 ± 0.037</td>
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<td>0.96 ± 0.80</td>
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<tr>
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<td>03/04/14</td>
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</tr>
<tr>
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<td>02/04/14</td>
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<td>No</td>
<td>0.87 ± 1.64</td>
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<tr>
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<td>-0.103 ± 0.057</td>
<td>No</td>
<td>0.55 ± 1.53</td>
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</tbody>
</table>
APPENDIX D

STATISTICAL ANALYSIS RESULTS
### Table D-1. Results of the Kruskal-Wallace statistical test between INL Site, Boundary, and Distant sample groups by month.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>P&lt;sup&gt;a&lt;/sup&gt;</th>
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<td>Quarter</td>
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<td>January</td>
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<td>February</td>
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<td>March</td>
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<tr>
<td><strong>Gross Beta</strong></td>
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<td>Quarter</td>
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</tr>
<tr>
<td>January</td>
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</tr>
<tr>
<td>February</td>
<td>0.18</td>
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<tr>
<td>March</td>
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<sup>a</sup> A 'p' value greater than 0.05 signifies no statistical difference between data groups.
Table D-2. Statistical difference in weekly gross alpha and gross beta concentrations measured at Boundary and Distant locations.

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<tr>
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<tr>
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<td>March 5</td>
<td>1.00</td>
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<td></td>
<td>March 12</td>
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</tr>
<tr>
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<td>March 19</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>March 26</td>
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<tr>
<td><strong>Gross Beta</strong></td>
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<tr>
<td></td>
<td>January 8</td>
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</tr>
<tr>
<td></td>
<td>January 15</td>
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<td><strong>February 5</strong></td>
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<sup>a</sup> A 'p' value greater than 0.05 signifies no statistical difference between data groups.