Department of Environmental Quality
INL Oversight Program

ENVIRONMENTAL SURVEILLANCE PROGRAM QUARTERLY DATA REPORT

October - December, 2016

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Table of Acronyms

aCi/L	-	attocuries per liter
ATR	-	Advanced Test Reactor
BEA	-	Battelle Energy Alliance, LLC
BLR	-	Big Lost River
CERCLA	-	Comprehensive Environmental Response, Compensation and Liability Act
CFA	-	Central Facilities Area
CFR	-	Code of Federal Regulations
CITRC	-	Critical Infrastructure Test Range Complex
DEQ-INL OP	-	The State of Idaho, Department of Environmental Quality, Idaho National Laboratory Oversight Program
DOE	-	U.S. Department of Energy
EBR I & II	-	Experimental Breeder Reactors I & II
EFS	-	Experimental Field Station
EIC	-	electret ionization chamber
EML	-	Environmental Monitoring Laboratory
EPA	-	Environmental Protection Agency
ESER	-	Environmental Surveillance, Education and Research Program
ESP	-	Environmental Surveillance Program
ESRPA	-	Eastern Snake River Plain Aquifer
ftbls	-	feet below land surface
HPIC	-	high-pressure ion chamber
IBL	-	Idaho Bureau of Laboratories
ICPP	-	Idaho Chemical Processing Plant
IDL	-	instrument detection limit
INL	-	Idaho National Laboratory
INTEC	-	Idaho Nuclear Technology and Engineering Center
ISU	-	Idaho State University
LLD	-	lower limit of detection
LSC	-	liquid scintillation counting
MCL	-	maximum contaminant level
MDA	-	minimum detectable activity
MDC	-	minimum detectable concentration
MFC	-	Materials and Fuels Complex
µg/L	-	micrograms per liter
mg/L	-	milligrams per liter
MP	-	milepost
mrem	-	millirem or 1/1000th of a rem
mR	-	milliRoentgen
mR/hr	-	milliRoentgen per hour
µR/hr	-	microRoentgen per hour
MV	-	Magic Valley
NIST	-	National Institute of Standards and Technology
nCi/L	-	nanocuries per liter
NCRP	-	National Council on Radiation Protection and Measurements
NOAA	-	National Oceanic and Atmospheric Administration
NRF	-	Naval Reactors Facility
PBF	-	Power Burst Facility
pCi/g	-	picocuries per gram
pCi/L	-	picocuries per liter
pCi/m^3	-	picocuries per cubic meter
QAPP	-	Quality Assurance Program Plan
QA/QC	-	Quality Assurance/Quality Control
RCRA	-	Resource Conservation and Recovery Act
RPD	-	relative percent difference
RTC	-	Reactor Technology Complex
RWMC	-	Radioactive Waste Management Complex
SD	-	standard deviation
SMC	-	Specific Manufacturing Capability
SMCL	-	secondary maximum contaminant level
TAN	-	Test Area North
TDS	-	total dissolved solids
TMI	-	Three Mile Island
TRA	-	Test Reactor Area
TSP	-	total suspended particulate
TSS	-	total suspended solids
USGS	-	U.S. Geological Survey
VOC	-	volatile organic compound
WLAP	-	Wastewater Land Application Permit

Introduction

The State of Idaho, Department of Environmental Quality, Idaho National Laboratory Oversight Program (DEQ-INL OP) conducts an Environmental Surveillance Program (ESP) at locations on the INL, near the boundaries of the INL, and at distant locations to the INL in accordance with accepted monitoring procedures and management practices. This program is designed to provide the people of the state of Idaho with independently evaluated information about the impacts of the Department of Energy's (DOE) activities in Idaho.

The primary objective for DEQ-INL OP's ESP is to maintain an independent environmental monitoring and verification program designed to verify and supplement DOE's environmental data and programs. This program also provides the citizens of Idaho with information on current and proposed DOE programs that has been independently evaluated to enable them to reach informed conclusions about DOE activities in Idaho and potential impacts to public health and the environment.

Results of the ESP are published using two distinct reporting formats: quarterly data reports and an annual ESP report. The annual ESP report is designed for a broad audience and summarizes the results of the ESP for the previous four quarters. The annual report's primary emphasis is to focus on trends, ascertain the impacts of DOE operations on the environment, and confirm the validity of DOE monitoring programs. This quarterly report is designed to document the results of the ESP on a quarterly basis and provide detailed data. It is organized according to the media sampled and also provides a quality assurance assessment.

Air and Precipitation Monitoring Results

The ESP operated eight air monitoring stations on and near the INL as well as two monitoring stations distant from the INL during the fourth quarter, 2016 (**Figure 1**). These stations employed instrumentation for collecting airborne particulate matter, gaseous radioiodine, precipitation, and water vapor for tritium analysis (**Table 1**). The Shoshone-Bannock Tribes operated an air monitoring station located at Fort Hall. The Fort Hall station uses identical instrumentation and sampling protocol as the ten stations operated by the ESP. The DEQ-INL OP reports the Fort Hall station data as an additional distant site.

Airborne particulate matter was sampled using high-volume total suspended particulate (TSP) air samplers. Starting midway through the 3rd quarter another model HVP 4304 TSP sampler was started at Idaho Falls air station alongside the current sampler (HVP 3804). The new sampler (HVP 4304) is being operated to test dependability and durability under field conditions. Weekly gross alpha and gross beta particulate radioactivity results for filters from the TSP samplers are presented in **Appendix A** and summarized as a range of results in **Table 2**. Results are within the expected historical range.

Composites of filters collected using TSP samplers during the course of a calendar quarter are analyzed using gamma spectroscopy. Typically, gamma spectroscopy results are only reported when exceeding a minimum detectable activity (MDA) or minimum detectable concentration (MDC). Gamma spectroscopy results for the fourth quarter of 2016 for TSP filters are presented in **Table 3**. The only reported gamma-emitting radionuclide was beryllium-7, a naturally occurring, cosmogenic radionuclide.

Radioactive iodine samples are collected weekly. Samples are collected by drawing air through a canister filled with activated charcoal using a low-volume air pump. The activated charcoal contained in the canister traps the radioiodine by adsorption onto its porous surface. Each week, canisters are collected from all eleven air monitoring stations and analyzed together as a composite. If Iodine-131 is detected in this grouping, the canisters are individually analyzed. No radioactive isotopes of iodine, specifically Iodine-131, were detected on the weekly charcoal cartridges used to collect this nuclide during the fourth quarter.

Atmospheric moisture was collected by drawing air through hygroscopic media at each of the 11 monitoring stations. This moisture was stripped from the hygroscopic media and analyzed to calculate the atmospheric tritium concentration. Reported values are the result of either a single sample or a weighted mean based upon the volume of air sampled when more than one atmospheric moisture sample was collected during the calendar quarter. Weighted mean atmospheric tritium was below the minimum detectable concentration (MDC) during the fourth quarter of 2016. There is one individual sample within the weighted mean that exceeded MDC located at the Craters of the Moon sampling site: 1.16 pCi/m^3 (MDC 0.99 pCi/m^3).While the results are above MDC they are still well below the DEQ-INL OP action level of 150 pCi/m^3 (40 CFR 61).Average atmospheric tritium concentrations are presented in **Table 4**.

Precipitation samples were collected at six monitoring locations during the fourth quarter of 2016. Precipitation samples were analyzed for tritium and gamma-emitting radionuclides. Reported values were either the result of a single sample or a weighted mean when more than one precipitation sample was collected during the calendar quarter. Tritium and gamma-emitting radionuclides were below minimum detectable concentration in precipitation collected during the fourth quarter of 2016. Tritium and Cesium-137 analysis results are presented in **Table 5**.

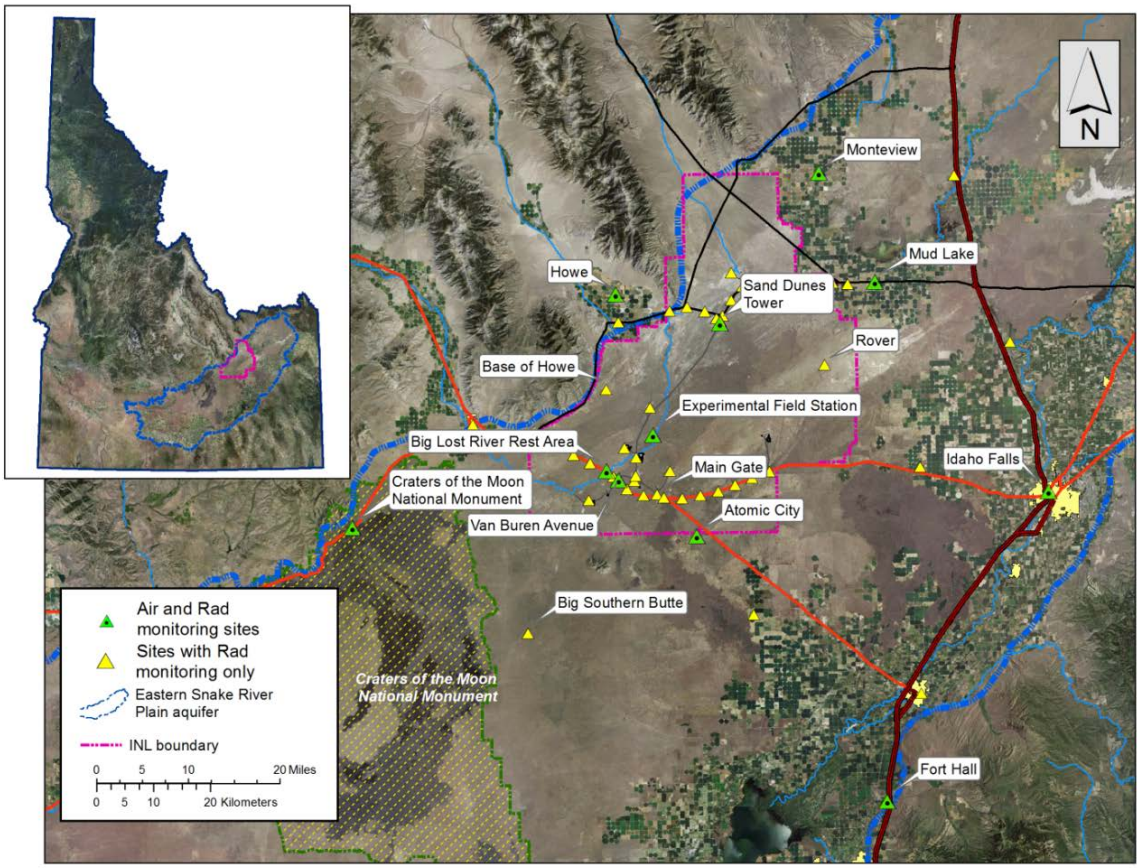

Figure 1. Air and radiation (Rad) monitoring locations.

Table 1. Sampling locations and sample type

Station Locations	Sample type[1]			
	TSP	Radioiodine	Water Vapor	Precipitation
On-site Locations				
Big Lost River Rest Area	□	□	■	■
Experimental Field Station	□	□	■	
Sand Dunes Tower	□	□	■	
Van Buren Avenue	□	□	■	
Boundary Locations				
Atomic City	□	□	■	■
Howe	□	□	■	■
Monteview	□	□	■	■
Mud Lake	□	□	■	■
Distant Locations				
Craters of the Moon	□	□	■	
Fort Hall[2]	□	□	■	
Idaho Falls	□	□	■	■

[1] □Samples collected weekly; ■ Samples collected quarterly.
[2]TSP and radioiodine samples collected by Shoshone-Bannock Tribes.

Table 2. Range of gross alpha and gross beta concentrations for TSP filters, fourth quarter, 2016.

Station Location	Concentration					
	Gross Alpha			Gross Beta		
On-Site Locations						
Big Lost River Rest Area	0.5	-	1.6	18.9	-	64.4
Experimental Field Station	0.4	-	1.4	13.4	-	51.8
Sand Dunes Tower	0.3	-	1.0	11.4	-	46.8
Van Buren Avenue	0.1	-	1.1	11.8	-	43.1
Boundary Locations						
Atomic City	0.3	-	1.2	13.1	-	51.5
Howe	0.4	-	1.5	11.6	-	43.4
Monteview	0.2	-	1.3	14.0	-	54.1
Mud Lake	0.7	-	2.1	19.4	-	69.8
Distant Locations						
Craters of the Moon	0.4	-	1.1	12.7	-	46.2
Fort Hall[1]	NS[2]	-	NS[2]	NS[2]	-	NS[2]
Idaho Falls – HVP 3804	0.4	-	1.6	19.3	-	68.0
Idaho Falls – HVP 4304	0.2	-	1.2	13.4	-	46.4

[1]Operated by Shoshone-Bannock Tribes.
[2]Sampler out of service.
Note: Concentrations are expressed in 1 x 10^{-3} pCi/m^3.

Table 3. Gamma spectroscopy analysis data for TSP filters, composite samples, fourth quarter, 2016.

Station Location	Naturally Occurring Radionuclide Beryllium-7		Man-Made Gamma Emitting Radionuclides	
	Concentration	± 2 SD	Concentration	MDC
On-site Locations				
Big Lost River Rest Area	63.1	3.4	<MDC[2]	
Experimental Field Station	54.7	3.0	<MDC	
Sand Dunes Tower	41.4	2.3	<MDC	
Van Buren Avenue	40.6	2.4	<MDC	
Boundary Locations				
Atomic City	55.5	3.0	<MDC	
Howe	44.0	2.5	<MDC	
Monteview	51.9	2.9	<MDC	
Mud Lake	67.1	3.7	<MDC	
Distant Locations				
Craters of the Moon	61.1	3.3	<MDC	
Fort Hall[1]	NS[3]	NS[3]	<MDC	
Idaho Falls – HVP 3804	56.1	3.2	<MDC	
Idaho Falls – HVP 4304[3]	48.9	2.8	<MDC	

[1]Operated by Shoshone-Bannock Tribes.
[2]MDC for Cs-137 typically (0.05-0.10) x 10^{-3} pCi/m^3.
Note: Concentrations are reported in 1 x 10^{-3} pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).
[3]NS – Sampler out of service

Table 4. Tritium concentrations in air from atmospheric moisture, fourth quarter, 2016

Station Location	Tritium		
	Concentration	± 2 SD	MDC
On-site Locations			
Big Lost River Rest Area	0.04	0.35	0.59
Experimental Field Station	0.32	0.40	0.66
Sand Dunes Tower	0.11	0.38	0.63
Van Buren Avenue	0.25	0.49	0.83
Boundary Locations			
Atomic City	0.06	0.36	0.61
Howe	-0.02	0.22	0.38
Mud Lake	-0.26	0.48	0.84
Monteview	0.18	0.40	0.67
Distant Locations			
Craters of the Moon	0.58	0.42	0.69
Fort Hall[1]	0.17	0.31	0.52
Idaho Falls	0.21	0.43	0.72

[1]Operated by Shoshone-Bannock Tribes.
Note: Concentrations are reported in pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Table 5. Tritium and Cesium-137 concentrations from precipitation, fourth quarter, 2016

Station Location	Tritium			Cesium-137		
	Concentration	± 2 SD	MDC	Concentration	± 2 SD	MDC
On-site Locations						
Big Lost River Rest Area	-30	110	190	0.1	1.6	2.7
Boundary Locations						
Atomic City	-20	110	190	-0.7	2.2	3.8
Howe	20	110	190	0.7	2.4	4.0
Monteview	-20	110	190	-0.5	1.6	2.8
Mud Lake	-10	110	190	1.0	1.3	2.2
Distant Locations						
Idaho Falls	-20	110	190	0.2	1.4	2.4

Note: Concentrations are reported in pCi/L with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Environmental Radiation Monitoring Results

The ESP operated 14 environmental radiation stations during the fourth quarter of 2016 (**Figure 1**). To detect gamma radiation, each station is instrumented with triplicate electret ionization chambers (EIC), and 11 of the stations also are equipped with a high-pressure ion chamber (HPIC) (**Table 6**).

The Shoshone-Bannock Tribes operate an additional environmental radiation monitoring station at Fort Hall equipped with EICs and an HPIC, both of which are owned and operated by the DEQ-INL OP. The DEQ-INL OP reports these results as a distant site.

HPICs are instruments capable of real-time measurements, and are sensitive enough to detect small changes in gamma radiation levels. The real-time gamma radiation measurements collected by the HPICs at each location are radioed to DEQ-INL OP and presented graphically via the worldwide web at http://www.deq.idaho.gov/inl-oversight/monitoring/gamma-radiation-measurements.aspx.

EICs are a passive-integrating system that provides a cumulative measure of environmental gamma radiation exposure in the field. EICs are deployed, collected, and analyzed quarterly. EICs offer an inexpensive methodology to measure gamma radiation over a wide area, particularly in regions which do not have a power source. EICs can also provide valuable gamma radiation data in the event of an emergency. For this reason EICs are deployed at an additional 40 locations by DEQ-INL OP in a widespread network around the INL measuring external radiation. This information is tabulated in **Appendix B.**

These two systems are used by DEQ-INL OP to measure external gamma radiation for various radiological monitoring objectives. **Table 7** lists the average radiation exposure rates measured by the HPICs for fourth quarter 2016. **Table 8** lists the EIC monitoring results for fourth quarter 2016. Overall exposure rates were within the expected historical range of values observed by DEQ-INL OP for background radiation.

Table 6. Summary of instrumentation at radiation monitoring stations.

Station Location	Instrument Type	
	HPIC	EIC
On-site Locations		
Base of Howe	■	■
Big Lost River Rest Area	■	■
Experimental Field Station		■
Main Gate	■	■
Rover	■	■
Sand Dunes Tower	■	■
Van Buren Avenue		■
Boundary Locations		
Atomic City	■	■
Big Southern Butte	■	■
Howe Met Tower	■	■
Monteview	■	■
Mud Lake/Terreton	■	■
Distant Locations		
Craters of the Moon		■
Fort Hall	■	■
Idaho Falls	■	■

Table 7. Average gamma exposure rates, fourth quarter, 2016, from HPIC network.

Station Location	Exposure Rate (µR/hr)	
	Quarterly Average	± 2 SD
On-site Locations		
Base of Howe	15.6	1.0
Big Lost River Rest Area	14.9	1.0
Main Gate	14.4	1.0
[1]Rover	-	-
Sand Dunes Tower	13.2	0.9
Boundary Locations		
Atomic City	12.3	1.1
Big Southern Butte	14.7	1.5
Howe Met Tower	11.1	1.3
Monteview	13.2	0.8
Mud Lake / Terreton	14.0	1.0
Distant Locations		
Fort Hall	12.4	1.1
Idaho Falls	12.7	0.9

[1]Rover location HPIC electronics had various electronic malfunctions and/or extreme temperature interference and the data was therefore unusable; no data is available for fourth quarter 2016 at this location.

Table 8. Electret ionization chamber (EIC) cumulative average exposure rates, fourth quarter, 2016.

Station Location	Exposure Rate (µR/hr)	
	Quarterly Average[1]	± 2 SD
On-Site Locations		
[2]Base of Howe	10.0	0.6
Big Lost River Rest Area	14.4	3.4
Experimental Field Station	14.3	2.3
Main Gate	12.9	1.7
[3]Rover	10.9, 12.4	
Sand Dunes Tower	14.5	2.3
Van Buren Avenue	15.3, 17.8	
Boundary Locations		
Atomic City	12.3	1.8
[4]Big Southern Butte	9.4	1.4
Howe Met Tower	9.7, 10.5	
Monteview	13.6	2.2
Mud Lake/Terreton	11.4, 13.3	
Distant Locations		
Craters of the Moon	12.1	3.5
Fort Hall	11.5	3.1
Idaho Falls	9.9	0.8

[1]Results are the average of triplicate exposure rate measurements with the associated sample variability (±2 SD), or the 2 measured exposure rates remaining after removal of an outlying value. One of the triplicate measurements is rejected if it is outside the average of the triplicate measurements ±2 SD of the historical population variability. Typically, the two most consistent measurements are reported, based on judgment of the data analyst.

[2,3,4] Base of Howe, Big Southern Butte, and Rover EIC's could not be collected in January due to weather/road conditions. The data reported in this table for these locations represents the average exposure rate from October 2016 through April 2017.

Water Monitoring Results

Water monitoring sites are sampled for the purposes of examining trends of INL contaminants and other general ground water quality indicators and for verifying DOE monitoring results. Sites sampled include ground water locations (wells and springs), surface water locations (streams), and selected wastewater sites. Sample sites have been selected to aid in identifying INL impacts on the Eastern Snake River Plain Aquifer (ESRPA), and are categorized as up-gradient, facility, boundary, distant, surface water, and waste water (**Figure 2 and Figure 3**). Up-gradient locations are not impacted by INL operations and are considered representative of background ground water quality conditions. Facility sites are sample locations on the INL near facilities, in areas of known contamination, or wells selected to illustrate trends for specific INL contaminants or indicators of ground water quality. Boundary locations are on or near the perimeter of the INL and are down-gradient of potential sources of INL contamination. Distant locations are monitored to provide trends in water quality down-gradient of the INL and include wells and springs used for irrigation, public water supply, livestock, domestic, and industrial purposes. During the fourth quarter of 2016, 2 up-gradient, 21 facility, 3 boundary, 5 distant, 1 surface water, and 1 waste water location were sampled.

Most sites sampled by DEQ-INL OP are sampled with another agency or organization. Samples are collected at about the same time using the same collection equipment as the other agency or organization (co-sampled). DEQ-INL OP verifies work by these agencies monitoring on behalf of DOE by comparing results from co-sampled sites.

Gross alpha and gross beta analyses are conducted as a screening tool for alpha and beta emitting radionuclides potentially released from INL operations. Quantitative gamma analyses are conducted to identify and determine concentrations of gamma emitting radionuclides. Selected sites are sampled for the man-made, alpha emitting isotopes of plutonium (^{238}Pu, $^{239/240}$Pu), uranium (^{234}U, ^{235}U, and ^{238}U), and americium (^{241}Am); and beta emitting radionuclides technetium-99 (^{99}Tc) and strontium-90 (^{90}Sr), based on historic INL contamination. In the event of suspect or unexpected levels of gross radioactivity, additional samples may also be analyzed for other specific radionuclides.

Gross alpha radioactivity was detected at 15 facility locations, 3 boundary, 3 distant, 1 surface water, and 1 waste water location. Most gross alpha concentrations were within the range of concentrations observed for naturally-occurring radioactivity; however, concentrations at some locations were significantly higher than their historical averages and were recounted by the laboratory. The recounts resulted in the laboratory qualifying four gross alpha concentrations as estimates (J), **Table 9**. The laboratory was unable to identify a specific QA issue with the original analyses. There were no exceedances of the EPA maximum contaminant level (MCL) for alpha particles set at 15 pCi/L.

Gross beta radioactivity was detected at every location sampled this quarter except for the lone surface water site. Concentrations observed at these locations, including up-gradient, facility, boundary, distant and surface water, are consistent with the expected ranges found in each area. The MCL for beta and gamma radioactivity is 4 mrem/year, equivalent to 8 pCi/L if the source is ^{90}Sr; 900 pCi/L if ^{99}Tc; 20,000 pCi/L if tritium (^{3}H); or 200 pCi/L if ^{137}Cs. Man-made, gamma emitting radioactivity was not detected at any of the sampled locations. Results for gross alpha; gross beta; and man-made, gamma emitting ^{137}Cs are shown in **Table 9**.

One site was sampled for isotopes of plutonium, with all results reporting as non-detectable (**Table 10**). Five sites were sampled for isotopes of uranium (**Table 11**). All sites had detectable results for ^{234}U and ^{238}U. Two sites, M3S and TRA-07, showed results for ^{235}U that were greater than the MDC. The value for M3S is less than three standard deviations and is considered a non-detection, while the value for TRA-07 is just greater than three standard deviations and is considered a detection. The results observed at the seven sample sites cannot be distinguished from background values, which means the uranium found in the samples is likely to be naturally occurring. One site was sampled for ^{241}Am this quarter. This nuclide was not detected (**Table 12**).

Four of the fifteen samples analyzed for ^{90}Sr had detectable results this quarter, with all four collected from areas of known contamination (**Table 13**). All thirteen locations sampled for ^{99}Tc had detectable results this quarter that were within the expected ranges of concentrations (**Table 14**).

Using the standard analytical method, ^{3}H was detected at thirteen facility locations (**Table 15**). Tritium levels found at these facility wells are similar to historic concentrations for these sites and are consistent with INL waste disposal influences at each facility. Sample location TAN-10A has shown an increase in ^{3}H over the last few years with concentrations of 280±120 pCi/L in 2009 up to 560±120 pCi/L in 2016. Selected water samples with tritium concentrations not measurable using the standard method (typically a MDC of 130 pCi/L) are analyzed using an electrolytic enrichment method with a much lower MDC of 10 to 14 pCi/L. There were no samples analyzed using the enrichment method this quarter. A backlog of 95 samples remains.

Samples were also analyzed for metals and the results shown in **Table 16**. All results are within their expected ranges, except for the PW-9 result for chromium reported as a non-detect. DEQ-INL OP has monitored PW-9 annually since 2014 showing chromium concentrations of 33µg/L in October 2014, and 40 µg/L in October 2015. The Laboratory confirmed the non-detectable concentration reported for chromium this quarter. Common ion results are shown in **Table 17** and nutrient results are shown in **Table 18**. All results are consistent with the expected values at each location. One site, USGS-073,

exceeded the MCL for Nitrite + Nitrate as Nitrogen. USGS-073 is a perched water well located south of the ATR Complex. DEQ-INL OP has monitored USGS-073 since 2015 reporting an increase in Nitrite + Nitrate as Nitrogen concentration during each sampling event (3.1 mg/L in April 2015, 7.4 mg/L in October 2015, and 12 mg/L in October 2016). The Laboratory confirmed the 12 mg/L concentration reported for Nitrite + Nitrate as Nitrogen this quarter.

Volatile Organic Compounds (VOCs) were sampled at eight locations this quarter in areas of known contamination near RWMC and TAN. Six of the eight locations had detectable concentrations for VOCs. Results are illustrated in **Table 19** and are consistent with previous concentrations found at these locations. The background concentrations for VOCs should be undetectable. The results discussed in this section only refer to detectable VOC concentrations; a complete list of analyses is shown in **Appendix C**.

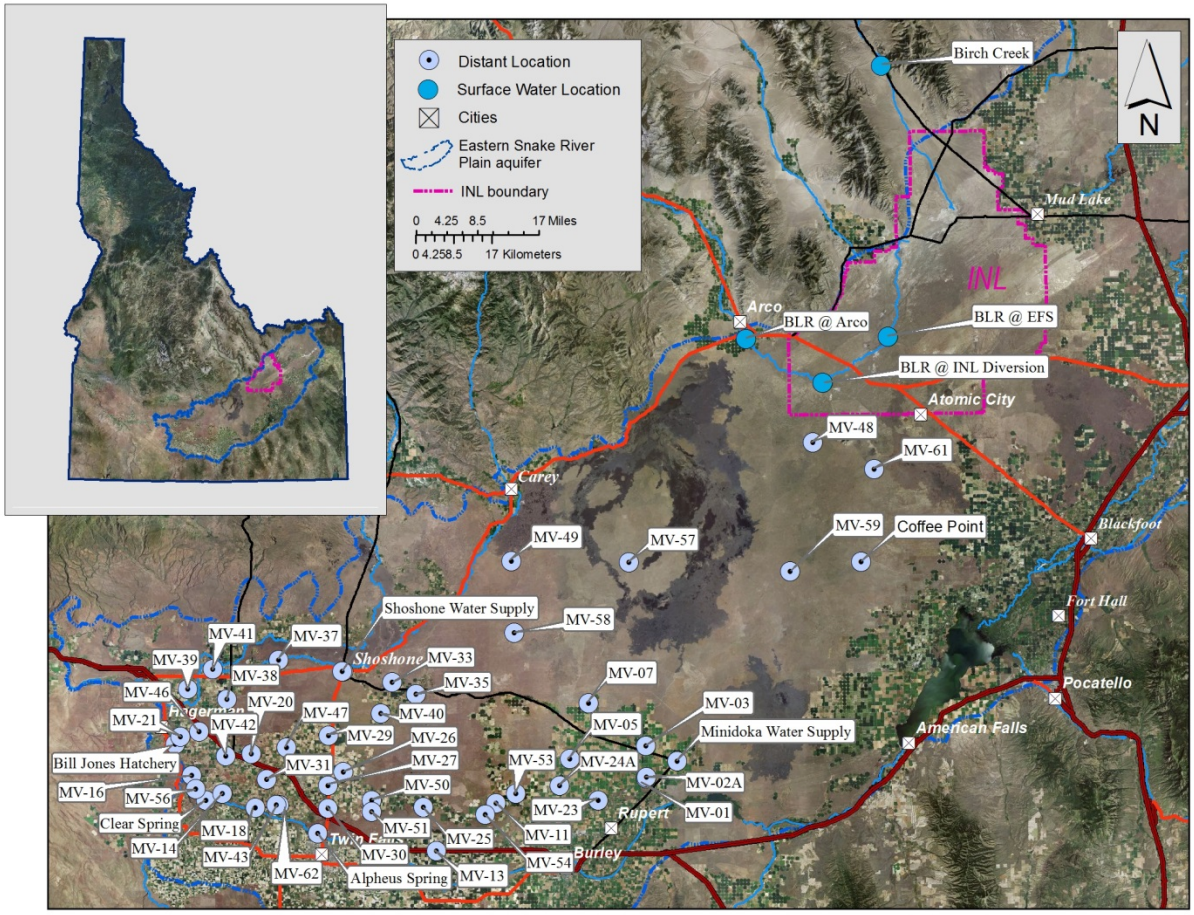

Figure 2. Distant and Surface Water monitoring locations.

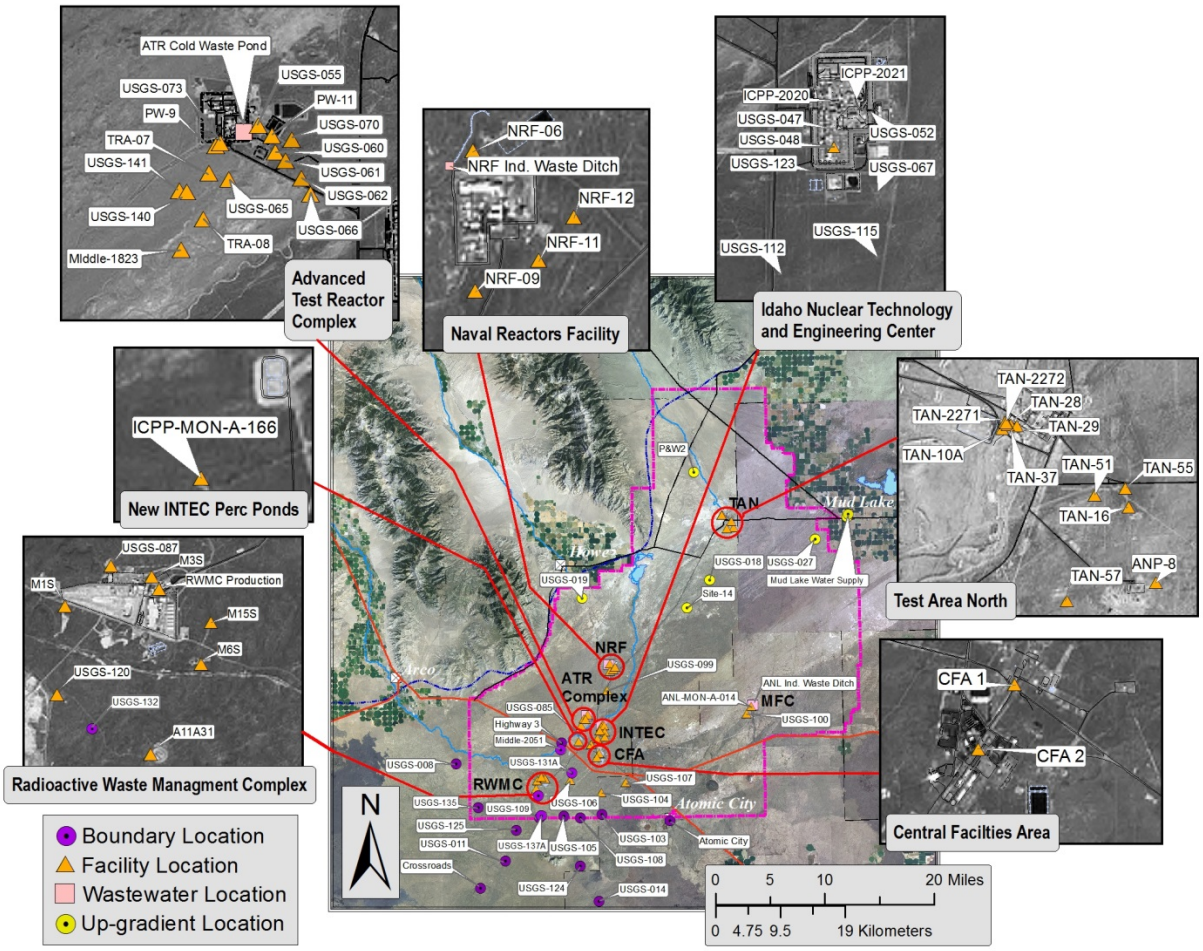

Figure 3. Up-gradient, facility, boundary, and wastewater monitoring locations.

Table 9. Gross alpha, gross beta, and gamma-emitting radionuclide concentrations for water samples, fourth quarter, 2016.

Sample Location	Sample Date	Gross Alpha			Gross Beta			Man-made gamma-emitting radionuclide Cesium-137		
		Concentration[1,2]		±2 SD	Concentration[1,2]		±2 SD	Concentration[1,2]		±2 SD
Up-gradient										
Mud Lake Water Supply	11/3/2016	0.6	U	0.6	4.3		0.8	-0.3	U	1.2
Site-14	10/20/2016	1.5	U	1.0	2.8		0.9	-0.4	U	1.5
Facility										
A11A31	11/2/2016	1.5		0.9	4.1		0.9	1.0	U	1.4
CFA 2	10/20/2016	2.3	U	1.8	5.6		1.5	1.0	U	1.6
M15S	11/2/2016	1.2	U	1.2	4.1		1.0	0.5	U	1.4
M1S	11/1/2016	2.3		0.9	2.9		0.8	-0.1	U	1.2
M3S	11/1/2016	2.2		1.0	3.7		0.9	0.6	U	1.5
M6S	11/1/2016	3.4	J	1.1	4.0		0.9	-0.8	U	2.4
Middle-1823	10/25/2016	3.5	J	1.2	1.9		0.9	2.3	U	1.7
PW-11	10/25/2016	3.9		1.4	6.3		1.1	-0.3	U	1.6
PW-9	10/19/2016	10.2		3.0	6.3		2.1	1.6	U	1.5
TAN-10A	10/12/2016	5.0		2.0	144		3.9	1.5	U	1.5
TRA-07	10/26/2016	4.0		1.7	6.2		1.1	1.0	U	1.4
TRA-08	10/26/2016	1.9		1.0	3.2		0.9	-0.5	U	2.1
USGS-060	10/19/2016	1.7	U	1.3	5.2		1.0	-1.8	U	2.1
USGS-066	10/19/2016	4.4		1.8	7.6		1.1	1.1	U	1.5
USGS-070	10/26/2016	1.3	U	1.2	49.2		1.9	0.0	U	1.3
USGS-073	10/19/2016	4.0		1.9	6.9		1.5	0.6	U	1.8
USGS-104	10/18/2016	0.2	U	0.9	3.7		0.9	0.9	U	1.7
USGS-112	10/3/2016	2.3		1.0	20.4		1.3	-0.9	U	1.8
USGS-115	10/3/2016	3.2	J	1.1	10.1		1.1	0.8	U	1.5
USGS-120	10/11/2016	1.7		0.9	3.4		0.9	1.1	U	1.6
Boundary										
Highway 3	10/18/2016	1.6		1.0	2.9		0.9	0.3	U	1.5
USGS-014	10/11/2016	2.5		1.0	3.4		0.9	-0.1	U	1.6
USGS-125	10/11/2016	2.9		1.0	1.5		0.9	0.0	U	1.3
Distant										
Alpheus Spring	11/4/2016	2.2		1.2	8.3		1.1	0.2	U	2.2
Bill Jones Hatchery	11/4/2016	1.1	U	1.0	3.4		0.9	-0.2	U	1.2
Clear Spring	11/4/2016	0.5	U	0.9	5.5		1.0	-0.8	U	1.5
Minidoka Water Supply	11/4/2016	3.5	J	1.3	3.9		1.0	0.6	U	1.9
Shoshone Water Supply	11/4/2016	1.5		1.0	2.9		0.9	-0.7	U	2.2
Surface water										
Birch Creek	10/13/2016	1.3		0.8	1.1	U	0.8	0.0	U	1.5
Waste Water										
ATR Cold Waste Pond	10/18/2016	6.0		2.6	4.8		1.7	1.0	U	1.6

[1]Data qualifiers: U = non-detection, J = estimate, R = rejected.
[2]Concentrations expressed in pCi/L.

Table 10. Reported concentrations of plutonium isotopes in water samples, fourth quarter, 2016.

Sample Location	Sample Date	Plutonium-238			Plutonium-239/240			Plutonium-241		
		Concentration[1,2]		±2 SD	Concentration[1,2]		±2 SD	Concentration[1,2]		±2 SD
Facility										
USGS-120	10/11/2016	0.001	U	0.017	0.012	U	0.017	NR	-	-

[1]Data qualifiers: U = non-detection, J = estimate, R = rejected, NR = analysis not requested.
[2]Concentrations expressed in pCi/L.

Table 11. Reported concentrations of uranium isotopes in water samples, fourth quarter, 2016.

Sample Location	Sample Date	Uranium-234			Uranium-235			Uranium-238		
		Concentration[1,2]		±2 SD	Concentration[1,2]		±2 SD	Concentration[1,2]		±2 SD
Facility										
A11A31	11/2/2016	1.32		0.29	0.029	U	0.039	0.41		0.13
M15S	11/2/2016	1.20		0.28	0.013	U	0.038	0.48		0.15
M1S	11/1/2016	0.90		0.24	0.040	U	0.054	0.41		0.14
M3S	11/1/2016	1.57		0.34	0.050	U*	0.046	0.64		0.18
M6S	11/1/2016	1.40		0.32	0.011	U	0.042	0.51		0.17
TRA-07	10/26/2016	2.14		0.43	0.102		0.067	0.95		0.23
TRA-08	10/26/2016	1.86		0.41	0.047	U	0.057	0.63		0.19

[1]Data qualifiers: U = non-detection, J = estimate, R = rejected.
[2]Concentrations expressed in pCi/L.
*The result is greater than the MDC but is less than 3 SD so is therefore considered a non-detection.

Table 12. Reported concentrations of americium-241 in water samples, fourth quarter, 2016.

Sample Location	Sample Date	Americium-241		
		Concentration[1,2]		±2 SD
Facility				
USGS-120	10/11/2016	-0.020	U	0.033

[1]Data qualifiers: U = non-detection, J = estimate, R = rejected.
[2]Concentrations expressed in pCi/L.

Table 13. Reported concentrations of strontium-90 in water samples, fourth quarter, 2016.

Sample Location	Sample Date	Strontium-90		
		Concentration[1,2]		±2 SD
Facility				
CFA 2	10/20/2016	0.36	U	0.31
Middle-1823	10/25/2016	0.23	U	0.32
PW-11	10/25/2016	-0.16	U	0.27
PW-9	10/19/2016	0.01	U	0.30
TAN-10A	10/12/2016	54		13
TRA-07	10/26/2016	0.39	U	0.32
TRA-08	10/26/2016	0.29	U	0.30
USGS-060	10/19/2016	0.87		0.41
USGS-066	10/19/2016	0.21	U	0.30
USGS-070	10/26/2016	16.4		4.0
USGS-073	10/19/2016	0.41	U	0.32
USGS-104	10/18/2016	0.18	U	0.29
USGS-112	10/3/2016	6.8		1.6
USGS-115	10/3/2016	0.17	U	0.23
USGS-120	10/11/2016	-0.06	U	0.21

[1]Data qualifiers: U = non-detection, J = estimate, R = rejected.
[2]Concentrations expressed in pCi/L.

Table 14. Reported concentrations of technetium-99 in water samples, fourth quarter, 2016.

Sample Location	Sample Date	Technetium-99		
		Concentration[1,2]		±2 SD
Facility				
A11A31	11/2/2016	0.5		0.2
CFA 2	10/20/2016	2.3		0.2
M15S	11/2/2016	0.8		0.2
M1S	11/1/2016	0.5		0.2
M3S	11/1/2016	1.6		0.2
M6S	11/1/2016	0.7		0.2
Middle-1823	10/25/2016	0.6		0.2
TRA-07	10/26/2016	1.5		0.2
TRA-08	10/26/2016	0.7		0.2
USGS-104	10/18/2016	1.1		0.2
USGS-112	10/3/2016	2.0		0.2
USGS-115	10/3/2016	9.0		0.3
USGS-120	10/11/2016	1.2		0.2

[1]Data qualifiers: U = non-detection, J = estimate, R = rejected.
[2]Concentrations expressed in pCi/L. Samples are filtered unless otherwise indicated.

Table 15. Tritium concentrations for water samples, fourth quarter, 2016.

Sample Location	Sample Date	Tritium		
		Concentration[1,2]		±2 SD
Up-gradient				
Mud Lake Water Supply	11/3/2016	60	U	110
Site-14	10/20/2016	140	U	110
Facility				
A11A31	11/2/2016	10	U	100
CFA 2	10/20/2016	3340		200
M15S	11/2/2016	-20	U	100
M1S	11/1/2016	-60	U	90
M3S	11/1/2016	660		130
M6S	11/1/2016	-20	U	100
Middle-1823	10/25/2016	670		120
PW-11	10/25/2016	1510		150
PW-9	10/19/2016	3610		200
TAN-10A	10/12/2016	560		120
TRA-07	10/26/2016	5760		250
TRA-08	10/26/2016	920		130
USGS-060	10/19/2016	0	U	110
USGS-066	10/19/2016	120	U	110
USGS-070	10/26/2016	750		130
USGS-073	10/19/2016	970		130
USGS-104	10/18/2016	580		120
USGS-112	10/3/2016	660		140
USGS-115	10/3/2016	880		130
USGS-120	10/11/2016	130	U	100
Boundary				
Highway 3	10/18/2016	60	U	110
USGS-014	10/11/2016	-40	U	110
USGS-125	10/11/2016	140	U	110
Distant				
Alpheus Spring	11/4/2016	-40	U	110
Bill Jones Hatchery	11/4/2016	10	U	100
Clear Spring	11/4/2016	-50	U	110
Minidoka Water Supply	11/4/2016	100	U	110
Shoshone Water Supply	11/4/2016	-30	U	90
Surface water				
Birch Creek	10/13/2016	-40	U	110
Waste water				
ATR Cold Waste Pond	10/18/2016	130	U	110

[1]Data qualifiers: U = non-detection, J = estimate, R = rejected.

[2]Concentrations expressed in pCi/L.

Table 16. Reported metals concentrations in water samples, fourth quarter, 2016.

Sample Location	Sample Date	Concentration[1,2]															
		Arsenic		Barium		Chromium		Iron		Lead		Manganese		Selenium		Zinc	
Up-gradient																	
Site-14	10/20/2016	4.1		65		5.2		<10	U	<1.0	U	<1.0	U	<2.0	U	<10	U
Facility																	
A11A31	11/2/2016	<2.0	U	34		12		<10	U	<1.0	U	1.6		<2.0	U	110	
CFA 2	10/20/2016	<2.0	U	87		10		14		<1.0	U	1.4		2.7		<10	U
M15S	11/2/2016	<2.0	U	27		28		16		<1.0	U	2.1		2.9		<10	U
M1S	11/1/2016	3.2		22		34		24		<1.0	U	<1.0	U	2.8		<10	U
M3S	11/1/2016	<2.0	U	46		13		<10	U	<1.0	U	<1.0	U	<2.0	U	<10	U
M6S	11/1/2016	2.1		32		31		33		<1.0	U	<1.0	U	3.7		<10	U
Middle-1823	10/25/2016	<2.0	U	65		11		<10	U	<1.0	U	1.8		<2.0	U	<10	U
PW-11	10/25/2016	<2.0	U	88		21		<10	U	<1.0	U	<1.0	U	<2.0	U	<10	U
PW-9	10/19/2016	<2.0	U	55		<1.0	U	45		<1.0	U	150		<2.0	U	<10	U
RWMC Production	10/12/2016	<2.0	U	41		12		<10	U	<1.0	U	<1.0	U	<2.0	U	<10	U
TAN-10A	10/12/2016	<2.0	U	230		<1.0	U	1400		<1.0	U	780		<2.0	U	<10	U
TRA-07	10/26/2016	<2.0	U	62		78		27		<1.0	U	1.3		<2.0	U	20	
TRA-08	10/26/2016	<2.0	U	49		20		<10	U	<1.0	U	<1.0	U	<2.0	U	<10	U
USGS-060	10/19/2016	9.3		76		5.4		<10	U	<1.0	U	<1.0	U	<2.0	U	<10	U
USGS-066	10/19/2016	<2.0	U	40		9.8		30		<1.0	U	6.9		<2.0	U	<10	U
USGS-070	10/26/2016	9.2		74		15		<10	U	<1.0	U	<1.0	U	<2.0	U	<10	U
USGS-073	10/19/2016	<2.0	U	140		18		<10	U	<1.0	U	<1.0	U	2.3		<10	U
USGS-104	10/18/2016	<2.0	U	33		8.1		<10	U	<1.0	U	<1.0	U	<2.0	U	<10	U
USGS-112	10/3/2016	<2.0	U	86		12		<10	U	<1.0	U	<1.0	U	<2.0	U	<10	U
USGS-115	10/3/2016	<2.0	U	64		6.0		50		<1.0	U	1.4		<2.0	U	640	
USGS-120	10/11/2016	2.1		46		10		<10	U	<1.0	U	<1.0	U	<2.0	U	<10	U
Boundary																	
Highway 3	10/18/2016	<2.0	U	54		2.1		<10	U	<1.0	U	<1.0	U	<2.0	U	110	
USGS-014	10/11/2016	2.4		22		4.0		10		<1.0	U	1.4		<2.0	U	<10	U
USGS-125	10/11/2016	<2.0	U	36		3.6		94		<1.0	U	20		<2.0	U	<10	U
Surface water																	
Birch Creek	10/13/2016	<2.0	U	73		<1.0	U	40		<1.0	U	1.1		<2.0	U	<10	U
Waste water																	
ATR Cold Waste Pond (total)	10/18/2016	4.5		150		9.1		<10	U	<1.0	U	2.0		3.6		<10	U

[1]Data qualifiers: U = non-detection, J = estimate, R = rejected, "<" = a result below the Minimum Detectable Concentration (MDC), NR = analysis not requested.
[2]Concentrations are expressed in µg/L. Samples are filtered unless otherwise indicated.

Table 17. Reported common ion concentrations in water samples, fourth quarter, 2016.

Sample Location	Sample Date	Concentration[1,2]															
		Calcium		Magnesium		Sodium		Potassium		Fluoride		Chloride		Sulfate		Alkalinity[3]	
Up-gradient																	
Site-14*	10/20/2016	34		13		14		2.9		0.478		10.1		25.5		127	
Facility																	
A11A31*	11/2/2016	37		16		19		3.5		0.239		21.5		38.5		128	
CFA 2*	10/20/2016	72		24		28		4.2		<0.200	U	119		43.8		126	
M15S*	11/2/2016	43		20		16		3.7		0.250		63.4		42.6		93	
M1S*	11/1/2016	26		12		11		2.4		0.278		13.7		22.3		93	
M3S*	11/1/2016	44		14		8.1		2.6		0.230		15.7		26.5		138	
M6S*	11/1/2016	38		19		15		3.2		0.240		28.7		62.9		99	
Middle-1823*	10/25/2016	51		17		10		1.8		<0.200	U	11.4		35.2		167	
PW-11*	10/25/2016	90		18		18		3.8		0.236		17.8		154		150	
PW-9*	10/19/2016	64		19		20		2.5		<0.200	U	63.3		62.6		122	
RWMC Production*	10/12/2016	47		16		9.1		2.7		0.243		27.1		31.2		144	
TAN-10A*	10/12/2016	76		21		39		3.6		<0.200	U	94.6		35.7		207	
TRA-07*	10/26/2016	83		19		16		2.9		<0.200	U	21.8		154		135	
TRA-08*	10/26/2016	50		17		10		2.2		<0.200	U	11.8		46.8		155	
USGS-060*	10/19/2016	66		18		13		2.8		0.231		16.0		92.2		149	
USGS-066*	10/19/2016	81		17		14		2.1		0.215		18.0		134		142	
USGS-070*	10/26/2016	66		20		14		3.0		0.223		15.9		92.5		151	
USGS-073*	10/19/2016	98		22		18		3.0		<0.200	U	99.7		52.1		140	
USGS-104*	10/18/2016	36		14		8.7		2.5		0.236		14.8		21.9		120	
USGS-112*	10/3/2016	50		13		12		2.5		0.254		17.7		30.8		150	
USGS-115*	10/3/2016	43		13		16		3.8		0.276		43.2		25.4		110	
USGS-120*	10/11/2016	37		17		17		3.2		0.253		18.7		33.9		141	
Boundary																	
Highway 3*	10/18/2016	45		11		6.0		2.4		0.238		6.42		21.6		141	
USGS-014*	10/11/2016	37		16		17		2.8		0.995		21.5		22.6		137	
USGS-125*	10/11/2016	37		15		11		2.7		0.252		12.4		24.9		140	
Surface water																	
Birch Creek*	10/13/2016	46		16		5.4		1.1		0.204		4.74		25.7		151	
Waste water																	
ATR Cold Waste Pond	10/18/2016	140		52		32		4.8		0.425		34.1		459		110	

[1]Data qualifiers: U = non-detection, J = estimate, R = rejected. * = samples are filtered for calcium, magnesium, sodium and potassium. "<" = a result below the Minimum Detectable Concentration (MDC). NR = analysis not requested.
[2]Concentrations are expressed in mg/L.
[3]As $CaCO_3$.

Table 18. Reported nutrient concentrations in water samples, fourth quarter, 2016.

Sample Location	Sample Date	Concentration[1,2]			
		Nitrite + Nitrate		Phosphorus	
Up-gradient					
Site-14	10/20/2016	0.63		0.016	
Facility					
A11A31	11/2/2016	0.83		0.017	
CFA 2	10/20/2016	3.3		0.020	
M15S	11/2/2016	1.3		0.014	
M1S	11/1/2016	1.0		0.023	
M3S	11/1/2016	0.85		0.021	
M6S	11/1/2016	1.9		0.025	
Middle-1823	10/25/2016	1.0		0.028	
PW-11	10/25/2016	1.5		0.036	
PW-9	10/19/2016	2.7		0.005	
RWMC Production	10/12/2016	1.0		0.110	
TAN-10A	10/12/2016	0.24		0.051	
TRA-07	10/26/2016	1.0		0.024	
TRA-08	10/26/2016	1.0		0.022	
USGS-060	10/19/2016	1.3		0.200	
USGS-066	10/19/2016	1.4		0.021	
USGS-070	10/26/2016	1.4		0.280	
USGS-073	10/19/2016	12		0.032	
USGS-104	10/18/2016	0.86		0.022	
USGS-112	10/3/2016	1.0		0.030	
USGS-115	10/3/2016	1.6		0.009	
USGS-120	10/11/2016	0.9		0.022	
Boundary					
Highway 3	10/18/2016	0.5		0.024	
USGS-014	10/11/2016	1.3		0.014	
USGS-125	10/11/2016	0.62		0.015	
Surface water					
Birch Creek	10/13/2016	0.26		0.008	
Waste water					
ATR Cold Waste Pond	10/18/2016	2.8		1.5	

[1]Data qualifiers: U = non-detection, J = estimate, R = rejected, NR = analysis not requested.
[2]Concentrations expressed in mg/L. Samples are filtered unless otherwise noted.

Table 19. Reported VOC concentrations in water samples, fourth quarter, 2016.

Sample Location	Sample Date	Concentrations[1,2]						
		1,1-Dichloroethene	Carbon tetrachloride	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Tetrachloroethylene (PERC)	Trichloroethylene	Vinyl chloride
A11A31	11/2/2016	<0.5	1.86	<0.5	<0.5	<0.5	0.93	<0.5
M15S	11/2/2016	<0.5	3.87	<0.5	<0.5	<0.5	2.5	<0.5
M1S	11/1/2016	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
M3S	11/1/2016	<0.5	3.77	<0.5	<0.5	<0.5	1.25	<0.5
M6S	11/1/2016	<0.5	2.53	<0.5	<0.5	<0.5	0.89	<0.5
RWMC Production	10/12/2016	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TAN-10A	10/12/2016	<0.5	<0.5	2.36	0.56	8.84	35.6	<0.5
USGS-120	10/11/2016	<0.5	1.11	<0.5	<0.5	<0.5	<0.5	<0.5

[1]Data qualifiers: J = estimate, R = rejected. < = a result less than the Minimum Detectable Concentration (MDC).
[2]Concentrations expressed in µg/L.

Terrestrial Monitoring Results

The DEQ-INL OP conducts terrestrial (soil and milk) monitoring to characterize deposition and migration of contaminants, and provide independent verification of DOE's terrestrial monitoring programs. Physical soil sampling and *in-situ* gamma spectrometry are used to characterize actual deposition and accumulation of radioactive contaminants in soils. Milk samples are collected to evaluate the potential for ingestion of radioactivity by the population around the INL. No physical soil sampling was performed during the fourth calendar quarter of 2016.

Milk

DEQ-INL OP monitors milk for the naturally occurring radionuclide potassium-40 (^{40}K) and man-made iodine-131 (^{131}I). Milk samples are collected on a monthly basis. Results for analyses of milk samples are presented in **Table 20**. ^{40}K was detected in all samples within the expected range of concentration. ^{131}I was not detected. Based on measurements of radionuclides in milk, there were no discernable impacts to the off-site environment from INL operations.

Table 20. Gamma spectroscopy analysis data for milk samples, fourth quarter, 2016.

Sample Location/Dairy	Sample Date	Naturally occurring Potassium-40		Man-made Iodine-131[1]
		Concentration[3]	± 2 SD	
Monitoring Samples				
Gooding	10/27/2016	1313	109	<MDC
	11/28/2016	1218	108	<MDC
	12/21/2016	1397	108	<MDC
Riverside	10/03/2016	1799	132	<MDC
	11/07/2016	2048	143	<MDC
	12/05/2016	1781	132	<MDC
Verification Samples[2]				
Howe	10/04/2016	1313	109	<MDC
Rupert	10/04/2016	1408	97	<MDC
Dietrich	11/01/2016	1348	95	<MDC
Terreton	11/01/2016	1358	110	<MDC
Rupert	12/06/2016	1426	109	<MDC
Idaho Falls	12/06/2016	1422	114	<MDC

[1] <MDC – Less than Minimum Detectable Concentration (approximately 4 pCi/L for iodine-131).
[2] DEQ-INL OP samples collected by the off-site INL environmental surveillance contractor.
[3] Concentrations are expressed in pCi/L.

Soil

DEQ-INL OP monitors long-term radiological conditions via physical soil sampling as well as field instrumentation capable of identifying and measuring *in-situ* concentrations of gamma-emitting radionuclides in soil. Monitoring concentrations of gamma-emitting radionuclides in surface soil provides some insight to transport, deposition, and accumulation of radioactive material in the environment as a result of INL operations as well as historical above ground testing of nuclear weapons. *In-Situ* gamma spectroscopic measurements were performed at 37 locations (**Figure 4**) during the fourth calendar quarter of 2016. ^{137}Cs was the only man made gamma emitting radionuclide detected. Analysis results for ^{137}Cs concentrations for *in-situ* soil monitoring are shown in **Table 21.**

Table 21. *In-Situ* gamma spectroscopic analysis results (^{137}Cs) for soil monitoring, fourth quarter, 2016.

Location	Date Acquired	Concentration[1]	2-sigma	MDA
Boundary Sampling Locations				
Monteview Soil Site	11/15/2016	0.122	0.023	0.008
Monteview Air Station	11/15/2016	0.055	0.021	0.010
Mud Lake Soil Site #2	11/15/2016	0.114	0.028	0.010
Mud Lake/Terreton Air Station	11/15/2016	0.034	0.022	0.011
Atomic City Soil Site	11/22/2016	0.199	0.025	0.009
Butte City	11/22/2016	0.158	0.025	0.010
Atomic City	11/22/2016	0.124	0.023	0.010
Frenchman's Cabin	11/30/2016	0.148	0.020	0.007
Big Southern HPIC	11/30/2016	0.156	0.028	0.009
Large Grid 18-4	11/30/2016	0.194	0.030	0.010
Large Grid 12-4	11/30/2016	0.153	0.027	0.009
Large Grid 12-5	11/30/2016	0.162	0.022	0.008
Howe Met Tower	12/2/2016	0.059	0.017	0.008
Reno Ranch	12/6/2016	0.222	0.025	0.006
Distant Sampling Locations				
Roberts	11/15/2016	0.123	0.033	0.011
Idaho Falls CMS[3]	11/16/2016	0.034	0.017	0.008
Idaho Falls Air Station[2]	11/16/2016	0.069	0.025	0.008
St. Anthony	11/16/2016	0.203	0.033	0.011
Carey	11/22/2016	0.180	0.026	0.010
On site Sampling Locations				
Van Buren	11/22/2016	0.226	0.028	0.011
Big Lost River Rest Area	11/22/2016	0.153	0.026	0.011
Large Grid 18-8	11/29/2016	0.221	0.027	0.010
Large Grid 24-2	11/29/2016	0.216	0.030	0.009
Large Grid 24-7	11/29/2016	0.144	0.028	0.010
Large Grid 18-3	11/29/2016	0.121	0.023	0.009
Rover	11/29/2016	0.147	0.025	0.009
INL Main Gate	12/2/2016	0.119	0.025	0.011
Experimental Field Station	12/2/2016	0.296	0.042	0.009
Large Grid 6-3	12/2/2016	0.174	0.029	0.010
Sand Dunes	12/2/2016	0.113	0.022	0.009
Large Grid 18-7	12/2/2016	0.117	0.022	0.009
Base of Howe	12/2/2016	0.123	0.021	0.008
Howe	12/2/2016	0.182	0.022	0.007
Large Grid 24-9	12/6/2016	0.138	0.035	0.010
Large Grid 24-8	12/6/2016	0.193	0.028	0.009
Large Grid 18-1	12/6/2016	0.124	0.024	0.008
Large Grid 30-1	12/6/2016	0.163	0.024	0.007

[1]Concentrations are reported in pCi/g.
[2]DEQ-INL OP HPIC air monitoring station near Idaho Falls, ID.
[3]DEQ-INL OP HPIC Community Monitoring Station (CMS) near John's Hole Bridge, Idaho Falls, ID.

The average Cesium-137 value was 0.15 picocuries per gram (pCi/g) with a minimum value of 0.03 pCi/g and a maximum of 0.30 pCi/g, well below the DEQ-INL OP action level of 6.4 pCi/g and the recommended federal screening limit for surface soil of 6.8 pCi/g (NCRP Report 129). Based upon terrestrial radiological measurements of soil and milk, there were no discernable impacts to the off-site environment from INL operations. Long-term accumulation of radionuclides observed by soil monitoring was consistent with historical measurements and was in the range of concentrations expected as a result of historic above-ground testing of nuclear weapons.

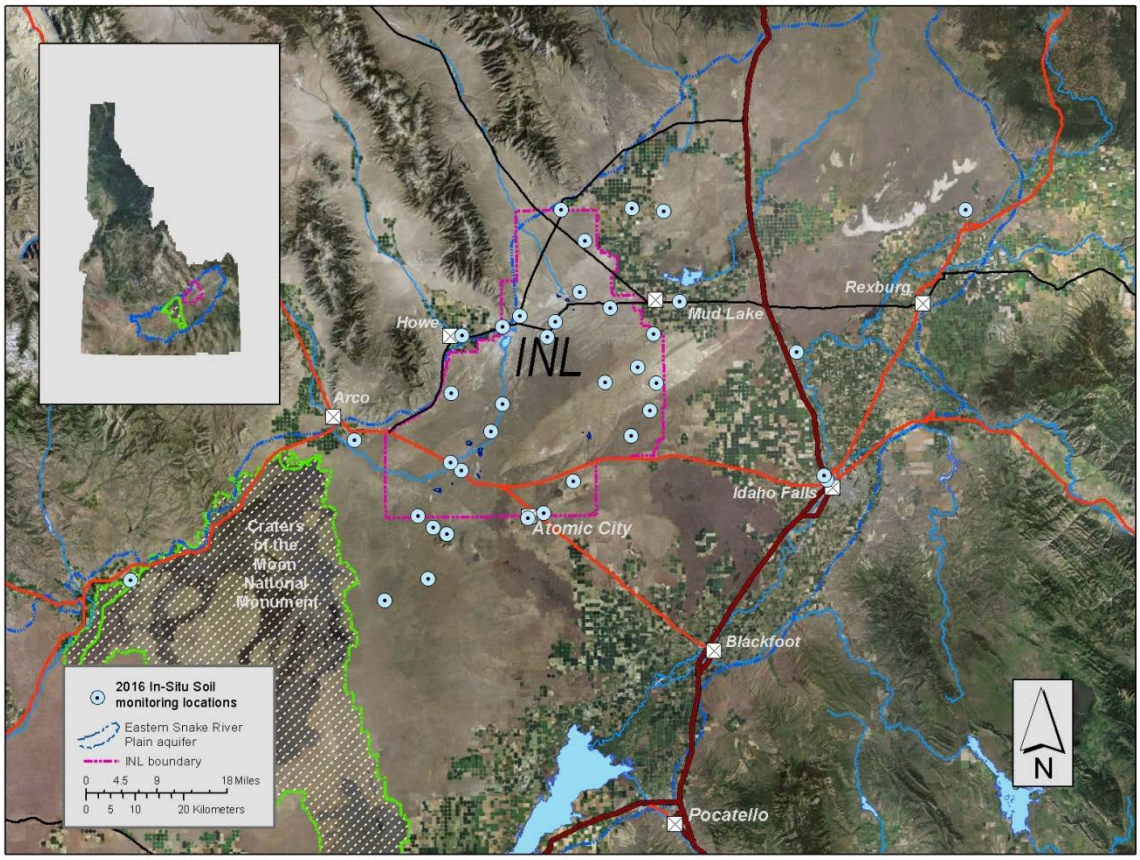

Figure 4. *In-Situ* soil monitoring locations, fourth quarter 2016.

Quality Assurance

The measurement of any physical quantity is subject to inaccuracy from errors that may be introduced during sample collection, measurement, calibration, and the reading and reporting of results. While all of these inaccuracies cannot be quantified with certainty for each analytical result, a quality assurance program can evaluate the overall quality of a data set and, in many cases, identify and address errors or inaccuracies. The DEQ-INL OP quality assurance program is designed to (1) ensure sample integrity, (2) ensure precision and accuracy in the analytical results, and (3) ensure that the environmental data are representative and complete.

This section summarizes the results of the quality assurance (QA) assessment of the data collected for the fourth quarter of 2016 for the DEQ-INL OP's ESP. It also summarizes the quality control (QC) samples (spikes, blanks, and duplicates) submitted to the Idaho Bureau of Laboratories-Boise (IBL) for non-radiological analyses and to Idaho State University's Environmental Monitoring Laboratory (ISU-EML) for radiological analyses during the quarter. All analyses and QC measures at the analytical laboratories used by the ESP are performed in accordance with approved written procedures maintained by each respective analytical laboratory. Sample collection is performed in accordance with written procedures maintained by the DEQ-INL OP.

Analytical results for blanks, duplicates, and spikes are used to assess the precision, accuracy, and representativeness of results from analyzing laboratories. During the fourth quarter of 2016, the DEQ-INL OP submitted 76 QC samples for various radiological and non-radiological analyses (**Table 22**).

Blank Samples

Blank samples consist of matrices that have negligible, acceptably low, or immeasurable amounts of the analyte(s) of interest in them. They are designed to determine if an analysis will yield a "zero" result when no contaminant is present, or a sufficiently low result to serve as an acceptable measure of "background." Blank samples are used to monitor for bias introduced during sample collection, storage, shipment, and analysis. Blank sample results submitted for gross alpha and gross beta screening in air for the fourth quarter of 2016 are presented in **Table 23**.

Blank sample results for select gamma emitters in air from composited air filters are presented in **Table 24**. Data for blank analyses used to assess data quality for tritium in water vapor in air are presented in **Table 25**. Blank analyses results for radiological and non-radiological analytes in ground and surface water are presented in **Table 26**, **Table 27**, **Table 28**, and **Table 29**.

No anomalies were observed from the assessment of field blank samples as measured by the analytical laboratories used by DEQ-INL OP for the fourth quarter of 2016.

Duplicate Samples

A laboratory's analytical precision capability, i.e., its ability to reproduce results, is assessed by comparing duplicate sample results. Duplicate samples are samples collected from the same location at approximately the same time and are considered to be essentially identical in composition. The difference between duplicate sample results is expressed as the relative percent difference (RPD), calculated from the following equation:

$RPD = (R_1 - R_2)/((R_1 + R_2)/2)*100$

Where:

R_1 = First sample result.

R_2 = Second sample result.

A relative percent difference of up to ± 20 percent is acceptable. For non-radiological analysis, the RPD is used to compare each set of duplicate samples in which both of the results exceed five times the detection level. If one or both of the duplicate sample results are less than five times the detection level, the absolute difference between the two results is acceptable if it is less than or equal to the method detection limit.

For radiological analysis, the RPD is calculated (using the above equation) to compare duplicate samples if both duplicate results are greater than the sample-specific minimum detectable concentration (MDC). DEQ-INL OP also considers duplicate sample results that have an absolute difference of no more than three times the pooled error (or "3 sigma") to be in acceptable agreement. This is accomplished using the following equation:

$|R_1 - R_2| \leq 3(S_1^2 + S_2^2)^{1/2}$

Where:

R_1 = First sample result.

R_2 = Second sample result.

S_1 = Uncertainty (one standard deviation) associated with the laboratory measurement of the first sample.

S_2 = Uncertainty (one standard deviation) associated with the laboratory measurement of the second sample.

Radiological duplicate sample results satisfying either the RPD or pooled error test are considered acceptable.

Duplicate results for ground and surface water are presented in **Table 30** for radiological analyses, and **Table 31 Table 32**, for non-radiological analyses. Duplicate results for radiological analyses are presented in **Table 33** for *in-situ* soil analyses**.**

There were no anomalies observed from the assessment of duplicate samples as measured by the analytical laboratories used by DEQ-INL OP for the fourth quarter of 2016.

Spiked Samples

Spiked samples are samples to which known concentrations of specific analytes have been added in order to assess the bias a laboratory may have in accurately measuring these analytes. To determine agreement after laboratory analysis, DEQ-INL OP calculates the ratio of the spike concentration determined from the laboratory measurement to the known spike concentration in the sample. This result is known as percent recovery (%R) and the acceptable range used by DEQ-INL OP is 100 ± 25 percent. Additionally, all results were qualified as "estimates (J)" if the associated quality control spike sample had a recovery of 50 – 74% or 126 – 150%, provided that each result was greater than the instrument detection limit (IDL). All results were qualified as "rejected (R)" if the associated quality control spike sample had a recovery of < 50% or > 150%, provided each result was also greater than the IDL.

During fourth quarter 2016, no field matrices were spiked to assess the influence of the sample media on laboratory performance; however, several non-radiological spiked samples were created using de-ionized water and submitted to the analytical laboratories for analyses. These non-radiological constituents were used to assess ground water analyte recovery rates and the results are presented in **Table 34, Table 35,** and **Table 36.** The percent recoveries for all spiked samples were found within the acceptable range of 100 ± 25 percent.

DEQ-INL OP also prepares additional "spike-like" quality control samples to assess ambient radiation measurement bias. Once per quarter, DEQ-INL OP irradiates a number of electret ionization chambers (EICs) to verify EIC response. Irradiations of EICs are conducted in a repeatable geometry to a known exposure of near 30 mR and two additional higher and lower exposures, ranging from 15 to 60 mR. EIC responses are compared directly with the exposure received from the NIST traceable cesium-137 source provided by ISU-EML. EIC response is considered acceptable if each measurement has a percent recovery of 100 ± 25% when compared to the known irradiated quantity. The irradiation results for fourth quarter 2016 are presented in **Table 37**. Real-time pressure correction is used to calculate the net exposure measured by these EIC control sets. All EIC spiked samples passed the DEQ-INL OP criteria.

There were no other anomalies observed from the assessment of spiked samples as measured by the analytical laboratories used by DEQ-INL OP for the fourth quarter of 2016.

Laboratory QC Issues

The gross alpha concentrations of seven samples were significantly higher than their historical averages and were recounted by the laboratory. In three cases the recounts agreed with the original analyses and the original analyses were considered official by the laboratory. In the other four cases the recounts did not agree with the original analyses and were closer in value to historical averages. The laboratory was unable to identify a specific QA issue with the original analyses that would justify rejecting them, as a result the laboratory qualified the four original analyses as estimates (J), **Table 9**.

Analytical QA/QC Assessment

No issues involving sample chain of custody, sample holding times, and the analysis of blank, duplicate, and spiked samples were observed during the fourth quarter of 2016, which significantly affected data quality. Methodologies and data reports issued by the contracting laboratories generally conformed to the requirements of DEQ-INL OP during the fourth quarter of 2016.

Data usability is the measure of data that is not rejected compared to the amount that was expected to be obtained. The overall data usability rate for the fourth quarter of 2016 met the minimum criteria of the DEQ-INL OP ESP and is summarized in **Table 22**.

Preventative Maintenance and Equipment Reliability

All equipment was calibrated and checked according to prescribed periodicity. During the fourth quarter of 2016 the TSP blower at the Howe sampling station was replaced and the radioiodine pump at Idaho Falls was replaced. Service reliability for air sampling equipment for the fourth quarter of 2016 is summarized in **Table 38**.

Conclusion

All data collected for the fourth quarter of 2016 have been assigned the applicable qualifiers to designate the appropriate use of the data. In addition, all data has been verified and deemed complete meeting the requirements and data quality objectives established by DEQ-INL OP.

Table 22. Summary of the analytical performance and usability of the analyses performed for the DEQ-INL OP ESP, fourth quarter, 2016.

Media Sampled	Collection Device	Analyte	Test Analyses	Blank Analyses	Duplicate Analyses	Spike Analyses	Data Rejected[1]	Analyzing Lab[2]
Air								
Particulate	4-inch filter	Gross alpha	143	13	0	0	2	ISU-EML
		Gross beta	143	13	0	0	2	ISU-EML
		Gamma emitters	11	1	0	0	0	ISU-EML
		Radiochemical	0	0	0	0	0	ISU Sub
Water Vapor	Desiccant column	Tritium	35	5	0	0	0	ISU-EML
Gaseous	Charcoal filter	Iodine-131	13	0	0	0	0	ISU-EML
Precipitation	Poly bottle	Tritium	6	0	0	0	0	ISU-EML
		Gamma emitters	6	0	0	0	0	ISU-EML
Water								
Groundwater & Surface Water	Grab or composite	Gross alpha	32	1	1	0	0	ISU-EML
		Gross beta	32	1	1	0	0	ISU-EML
		Gamma emitters	32	1	1	0	0	ISU-EML
		Tritium	32	1	1	0	0	ISU-EML
		Enriched tritium	0	0	0	0	0	ISU-EML
		Technetium-99	13	0	0	0	0	ISU-EML
		Radiochemical	24	0	1	0	0	ISU Sub
		Metals	27	1	1	2	0	IBL
		Common Ions	27	1	1	2	0	IBL
		Nutrients	27	1	1	2	0	IBL
		Volatile Organics	8	2	0	1	0	IBL
Terrestrial								
Milk	Grab or composite	Gamma emitters	12	0	0	0	0	ISU-EML
Soil	*in situ*	Gamma emitters	37	0	11	0	0	DEQ-INL OP
	Grab – "puck"	Gamma emitters	0	0	0	0	0	ISU-EML
Radiation								
Ambient	EICs	Gamma Radiation	55	0	0	9	0	DEQ-INL OP
	HPICs	Gamma Radiation	11	NA	NA	NA	0	DEQ-INL OP
Total Test Analyses			**726**	**41**	**19**	**16**	**4**	
Total of QC Analyses (blanks, duplicates, and spikes)			**76**					
Percentage of QC analyses of total Test analyses[3]			**10.5%**					
Percentage of usable data[4]			**99.4%**					

[1] Combined Laboratory and DEQ-INL OP rejection criteria (data was rejected for any reason).

[2] ISU-EML = Idaho State University – Environmental Monitoring Laboratory; ISU Sub = Subcontract laboratory to ISU-EML; IBL = Idaho Bureau of Laboratories, Boise; IBL Sub = Subcontract laboratory to IBL; DEQ-INL OP = Analyzed by INL Oversight Program, Idaho Department of Environmental Quality.

[3] Analyzing quality control samples at a rate of approximately 5 to 10 percent of the total number of test analyses performed for the year is deemed appropriate for the DEQ-INL OP ESP.

[4] Data usability rate [total analyses – rejected data]/[total analyses] of 90 percent or higher is acceptable for the DEQ-INL OP ESP.

Table 23. Blank analysis results for gross alpha and beta in particulate air (TSP), fourth quarter, 2016.

Collection Period		Corrected volume (m^3)[1]	Gross alpha		Gross beta	
Start	Stop		Value	Uncertainty (± 2 SD)	Value	Uncertainty (± 2 SD)
09/29/16	10/06/16	2025	0.0	0.1	-0.1	0.5
10/06/16	10/13/16	2025	-0.1	0.1	-0.2	0.4
10/13/16	10/20/16	2025	0.0	0.1	-0.5	0.5
10/20/16	10/27/16	2025	-0.1	0.1	-0.3	0.5
10/27/16	11/03/16	2025	0.0	0.1	-0.3	0.4
11/03/16	11/10/16	2025	0.0	0.1	-0.4	0.4
11/10/16	11/17/16	2025	0.0	0.1	0.1	0.5
11/17/16	11/23/16	2025	0.1	0.1	0.4	0.5
11/23/16	12/01/16	2025	0.0	0.1	0.0	0.5
12/01/16	12/08/16	2025	0.2	0.1	0.2	0.4
12/08/16	12/15/16	2025	-0.1	0.1	0.2	0.4
12/15/16	12/22/16	2025	0.0	0.1	0.4	0.5
12/22/16	12/29/16	2025	-0.1	0.1	0.1	0.5

Note: Concentrations and associated uncertainties (± 2 SD) are expressed in 1 x 10^{-3} pCi/m^3.
[1] A volume equal to the average of the volumes collected through each valid field filter was used to compute "concentrations" for the blank for meaningful comparison to sample results. No air was passed through the blank filters.

Table 24. Blank analysis results for gamma spectroscopy for TSP particulate air filters, composite samples, fourth quarter, 2016.

Analysis Date	Beryllium-7			Ruthenium-106/Rhodium-106			Antimony-125		
	Concentration[1]	± 2 SD	MDC	Concentration	± 2 SD	MDC	Concentration	± 2 SD	MDC
01/29/17	-5	41	70	-12	58	101	0	8	14

Analysis Date	Cesium-134			Cesium-137		
	Concentration[1]	± 2 SD	MDC	Concentration	± 2 SD	MDC
01/29/17	2	2	5	2	4	4

Note: Concentrations are expressed in 1 x 10^{-5}pCi/m^3 with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).
[1] These concentrations are from blank filters collected weekly, composited, and analyzed for the calendar quarter. A composite volume equal to the sum of the weekly average volumes collected through each valid field filter was used to compute "air concentrations" for the blank for meaningful comparison to sample results. No air was actually passed through the blank filters.

Table 25. Blank analysis results for tritium in water vapor from air samples, fourth quarter, 2016.

Sample Number	Start Date	Collection Date	Analysis Date	Tritium		
				Concentration	± 2 SD	MDC
OP164ZTR01	12/14/16	12/21/16	02/14/17	0.10	0.09	0.14
OP164ZTR02	12/14/16	12/21/16	02/14/17	0.02	0.11	0.18
OP164ZTR03	12/14/16	12/21/16	02/14/17	0.11	0.11	0.18
OP164ZTR04	01/04/17	01/25/17	02/14/17	0.02	0.11	0.18
OP164ZTR05	01/04/17	01/25/17	02/14/17	0.00	0.08	0.14

Note: Concentrations are expressed in nCi/L with associated uncertainty (± 2 SD) and minimum detectable concentration (MDC).

Table 26. Radiological blank analysis results in groundwater and/or surface water, fourth quarter, 2016.

Sample Number	Sample Date	Concentration[1]	± 2 SD	MDC	Within Blank Criteria?
Gross Alpha					
161W590	11/02/2016	0.4	0.3	0.5	Yes
Gross Beta					
161W590	11/02/2016	0.3	0.6	0.9	Yes
Cesium-137					
161W590	11/02/2016	-0.3	1.3	2.3	Yes
Tritium					
161W591	11/02/2016	90	110	190	Yes

[1] Concentrations are expressed in pCi/L with associated uncertainty (± 2 SD) and minimum detectable concentrations (MDC).

Table 27. Blank analysis results (µg/L) for metals in groundwater and/or surface water, fourth quarter, 2016.

Sample Number	Sample Date	Arsenic	Barium	Chromium	Iron	Lead	Manganese	Selenium	Zinc
161W593	11/02/2016	<2.0	<1.0	<1.0	<10	<1.0	<1.0	<2.0	<10

Table 28. Blank analysis results (mg/L) for common ions and nutrients in groundwater and/or surface water, fourth quarter, 2016.

Sample Number	Sample Date	Calcium	Magnesium	Sodium	Potassium	Fluoride	Chloride	Sulfate	Total Alkalinity	Total Nitrogen	Total Phosphorus
161W594,593,592	11/02/2016	<0.1	<0.1	<0.1	<0.1	<0.2	<0.4	<0.8	<1.0	<0.01	<0.005

Table 29. Blank analysis results (µg/L) for VOCs in groundwater and/or surface water, fourth quarter, 2016.

Sample Number	Sample Date	1,1-Dichloroethene	Carbon tetrachloride	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Tetrachloroethylene (PERC)	Trichloroethylene	Vinyl chloride
161W577	10/11/2016	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
161W595	11/02/2016	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Table 30. Duplicate radiological analysis results in pCi/L for groundwater and/or surface water, fourth quarter, 2016.

Analysis/Sample Location	Original Sample Number	Concentration	± 2 SD	Duplicate Sample Number	Concentration	± 2 SD	$/R_1-R_2/$	$3(S_1^2+S_2^2)^{1/2}$	Within Criteria?[1]
Gross Alpha									
USGS-060	161W691	1.7	1.3	161W709	1.5	1.2	0.2	2.7	Yes
Gross Beta									
USGS-060	161W691	5.2	1.0	161W709	4.8	1.0	0.4	2.1	Yes
Gamma Spectroscopy Cesium-137									
USGS-060	161W691	-1.8	2.1	161W709	0.8	2.4	2.6	4.8	Yes
Tritium									
USGS-060	161W693	0	110	161W711	40	110	40	233	Yes
Strontium-90									
USGS-060	161W692	0.87	0.41	161W710	0.41	0.34	0.46	0.80	Yes

[1] $|R_1-R_2| \leq 3(S_1^2+S_2^2)^{1/2}$

Table 31. Duplicate results for metals (µg/L) in groundwater, fourth quarter, 2016.

Sample Location	Sample Number	Sample Date	Arsenic	Barium	Chromium	Iron	Lead	Manganese	Selenium	Zinc
USGS-060	161W695	10/19/2016	9.3	76	5.4	<10	<1.0	<1.0	1.4	<10
USGS-060	161W713	10/19/2016	9.5	78	5.5	<10	<1.0	<1.0	2.7	<10
RPD			**-2**	**-3**	**-2**	**0**	**0**	**0**	**-63***	**0**

Relative Percent Difference (RPD) = $(R_1-R_2) / ((R_1+R_2)/2)*100$

*Both results were less than five times the detection limit; their absolute difference is acceptable (≤ the method detection limit of 2.0 µg/L).

Table 32. Duplicate results for common ions and nutrients (mg/L) in groundwater, fourth quarter, 2016.

Sample Location	Sample Number	Sample Date	Calcium	Magnesium	Sodium	Potassium	Fluoride	Chloride	Sulfate	Total Alkalinity	Total Nitrogen	Total Phosphorus
USGS-060	161W696,695,694	10/19/2016	66	18	13	2.8	0.231	16	92.2	149	1.3	0.2
USGS-060	161W714,713,712	10/19/2016	67	19	13	2.8	0.231	16	91.6	150	1.3	0.2
RPD			**-2**	**-5**	**0**	**0**	**0**	**0**	**1**	**-1**	**0**	**0**

Relative Percent Difference (RPD) = $(R_1-R_2) / ((R_1+R_2)/2)*100$

Table 33. Duplicate analyses of gamma emitting radionuclides in soil, fourth quarter, 2016.

Sample Location	Sample Date	Original Result K-40 (pCi/g)[1]	QA Result K-40 (pCi/g)[1]	K-40 RPD (%)	K-40 Less than 3 sigma test	K-40 Meets either criterion?	Original Result Cs-137 (pCi/g)[1]	QA Result Cs-137 (pCi/g)[1]	Cs-137 RPD (%)	Cs-137 Less than 3 sigma test	Cs-137 Meets either criterion?
Monteview Soil	11/15/2016	10.8 ± 0.6	10.4 ± 0.6	-3.9	In Spec	Yes	0.122 ± 0.023	0.137 ± 0.020	10.9	In Spec	Yes
Mud Lake Soil	11/15/2016	20.7 ± 0.9	21.6 ± 0.9	4.6	In Spec	Yes	0.114 ± 0.028	0.090 ± 0.025	-23.7	In Spec	Yes
St. Anthony Soil	11/16/2016	20.2 ± 0.9	21.6 ± 0.9	6.6	In Spec	Yes	0.203 ± 0.033	0.218 ± 0.028	7.2	In Spec	Yes
Carey	11/22/2016	15.6 ± 0.8	15.3 ± 0.8	-1.6	In Spec	Yes	0.180 ± 0.026	0.181 ± 0.026	0.3	In Spec	Yes
Atomic City Soil	11/22/2016	14.2 ± 0.7	15.1 ± 0.8	6.1	In Spec	Yes	0.199 ± 0.025	0.231 ± 0.023	15.0	In Spec	Yes
LG 24-7	11/29/2016	14.8 ± 0.9	17.7 ± 0.8	18.1	No	Yes	0.144 ± 0.028	0.128 ± 0.025	-11.4	In Spec	Yes
LG 12-4	11/30/2016	13.9 ± 0.7	13.4 ± 0.7	-3.6	In Spec	Yes	0.153 ± 0.027	0.132 ± 0.033	-14.6	In Spec	Yes
LG 12-5	11/30/2016	10.8 ± 0.6	10.0 ± 0.6	-7.6	In Spec	Yes	0.162 ± 0.022	0.157 ± 0.022	-3.1	In Spec	Yes
LG 6-3	12/2/2016	17.0 ± 0.8	16.4 ± 0.8	-3.6	In Spec	Yes	0.174 ± 0.029	0.171 ± 0.028	-1.6	In Spec	Yes
LG 24-8	12/6/2016	12.7 ± 0.7	14.5 ± 0.7	13.7	No	Yes	0.193 ± 0.028	0.213 ± 0.031	9.7	In Spec	Yes
Reno Ranch	12/6/2016	10.4 ± 0.6	11.8 ± 0.6	12.9	No	Yes	0.222 ± 0.025	0.206 ± 0.024	-7.2	In Spec	Yes

[1]Result ±2 SD

Table 34. De-ionized water spike results (in µg/L) and percent recovery for metals in groundwater and/or surface water, fourth quarter, 2016.

Spike Sample Number	Sample Date	Barium			Chromium			Lead			Manganese			Zinc		
		Spike	Result	%R[1]	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
161W581	10/10/2016	58.9	62	**105**	11.7	12	**103**	6.07	6.3	**104**	6.52	6.9	**106**	23.7	29	**122**
161W840	10/31/2016	120	120	**100**	13.1	13	**99**	6.75	6.9	**102**	7.25	8	**110**	26.4	27	**102**

[1]A percent recovery of 100 ± 25 is considered acceptable and is recorded as %R.

Table 35. De-ionized water spike results (in mg/L) and percent recovery for common ions and nutrients in groundwater and/or surface water, fourth quarter, 2016.

Spike Sample Number	Sample Date	Calcium			Magnesium			Sodium			Potassium			Fluoride		
		Spike	Result	%R[1]	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
161W581,580	10/10/2016	18.2	18	**99**	4.63	4.6	**99**	9.48	9.3	**98**	1.9	1.9	**100**	0.811	0.642	**79**
161W840,839	10/31/2016	37.3	38	**102**	9.47	9.4	**99**	19.4	19	**98**	3.89	3.8	**98**	3.41	3.61	**106**

[1]A percent recovery of 100 ± 25 is considered acceptable and is recorded as %R.

Table 35. continued. De-ionized water spike results (in mg/L) and percent recovery for common ions and nutrients in groundwater and/or surface water, fourth quarter, 2016.

Spike Sample Number	Sample Date	Chloride			Sulfate			Total Alkalinity as $CaCO_3$			Total Nitrogen			Total Phosphorus		
		Spike	Result	%R[1]	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
161W582,580	10/10/2016	65.1	66.7	**103**	21.1	21.2	**101**	103	101	**98**	2.45	2.4	**98**	0.0204	0.020	**98**
161W841,839	10/31/2016	72.4	73.3	**101**	13.4	13.5	**101**	107	104	**97**	3.31	3.3	**100**	0.0156	0.016	**103**

[1]A percent recovery of 100 ± 25 is considered acceptable and is recorded as %R.

Table 36. De-ionized water spike results (in µg/L) and percent recovery for VOCs in groundwater and/or surface water, fourth quarter, 2016.

Spike Sample Number	Sample Date	Carbon Tetrachloride			Styrene			Tetrachloroethylene			Trichloroethylene			Vinyl Chloride		
		Spike	Result	%R[1]	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R	Spike	Result	%R
161W583	10/10/2016	4.94	4.67	**95**	7.39	5.96	**81**	6.28	5.45	**87**	7.05	7.26	**103**	7.56	8.11	**107**

[1]A percent recovery of 100 ± 25 is considered acceptable and is recorded as %R.

Table 37. Electret ionization chamber (EIC) irradiation results (categorized as spiked samples), fourth quarter, 2016.

Electret #	Exposure Received		Net Measured Exposure[1]		%R	Within Spec?
	(mR)	Uncertainty (±1 SD, mR)	(mR)	Uncertainty (±1 SD, mR)		
SHY932	45	2.3	45.1	1.4	100.1	Y
SHD904	45	2.3	43.7	1.3	97.1	Y
SHY927	45	2.3	37.5	1.4	83.4	Y
				Triplicate AVG:	**93.5**	
SHC847	30	1.5	29.7	1.3	99.1	Y
SIR666	30	1.5	26.7	1.4	88.9	Y
SHY855	30	1.5	29.9	1.4	99.7	Y
				Triplicate AVG:	**95.9**	
SHY942	21	1.1	22.9	1.4	109.1	Y
SHY896	21	1.1	19.4	1.4	92.2	Y
SHC772	21	1.1	21.3	1.3	101.5	Y
				Triplicate AVG:	**100.9**	

Note: A percent recovery (%R) of 100 ± 25 is considered acceptable.
[1] Net measured exposure estimate includes a correction for atmospheric pressure.

Table 38. Air sampling field equipment service reliability (percent operational), fourth quarter, 2016.

Station Locations	Sample Type			
	TSP	Radioiodine	Atmospheric Moisture	Precipitation
Onsite Locations				
Big Lost River Rest Area	100%	100%	100%	100%
Experimental Field Station	100%	100%	100%	NC[1]
Sand Dunes Tower	100%	100%	100%	NC[1]
Van Buren Avenue	100%	100%	100%	NC[1]
Boundary Locations				
Atomic City	100%	100%	100%	100%
Howe	92%	100%	100%	100%
Monteview	100%	100%	100%	100%
Mud Lake	100%	100%	100%	100%
Distant Locations				
Craters of the Moon	100%	100%	100%	NC[1]
Idaho Falls	100%	100%	100%	100%

Note: The values in this table were calculated by dividing the number of weeks the equipment was in operation by the number of weeks in the quarter.

[1] NC = Sample not collected at this location.

Appendix A

Table A-1. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2016.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
On-Site Locations						
Big Lost River Rest Area	09/29/16	10/06/16	1.0	0.2	33.1	1.3
	10/06/16	10/13/16	0.7	0.2	32.9	1.2
	10/13/16	10/20/16	0.9	0.2	18.9	1.0
	10/20/16	10/27/16	0.9	0.2	39.3	1.4
	10/27/16	11/03/16	0.6	0.2	19.8	1.0
	11/03/16	11/10/16	1.0	0.2	51.4	1.5
	11/10/16	11/17/16	1.6	0.3	64.4	1.7
	11/17/16	11/23/16	0.9	0.2	30.6	1.3
	11/23/16	12/01/16	0.7	0.2	24.5	1.1
	12/01/16	12/08/16	0.6	0.2	24.0	1.1
	12/08/16	12/15/16	0.5	0.2	25.1	1.1
	12/15/16	12/22/16	1.0	0.2	47.5	1.5
	12/22/16	12/29/16	0.7	0.2	29.6	1.2
Experimental Field Station	09/29/16	10/06/16	1.1	0.4	30.7	1.7
	10/06/16	10/13/16	0.6	0.2	27.8	1.2
	10/13/16	10/20/16	0.8	0.2	13.4	0.9
	10/20/16	10/27/16	1.0	0.3	34.3	1.3
	10/27/16	11/03/16	0.5	0.2	16.4	1.0
	11/03/16	11/10/16	1.4	0.3	45.9	1.5
	11/10/16	11/17/16	1.2	0.3	51.8	1.6
	11/17/16	11/23/16	0.8	0.2	26.6	1.3
	11/23/16	12/01/16	0.5	0.2	18.2	0.9
	12/01/16	12/08/16	0.5	0.2	20.8	1.1
	12/08/16	12/15/16	0.4	0.2	21.1	1.1
	12/15/16	12/22/16	0.9	0.2	39.4	1.4
	12/22/16	12/29/16	0.5	0.2	28.5	1.2
Sand Dunes Tower	09/29/16	10/06/16	0.5	0.2	18.5	1.0
	10/06/16	10/13/16	0.5	0.2	22.2	1.0
	10/13/16	10/20/16	0.6	0.2	11.4	0.8
	10/20/16	10/27/16	0.9	0.2	29.2	1.1
	10/27/16	11/03/16	0.4	0.2	12.4	0.8
	11/03/16	11/10/16	0.7	0.2	35.2	1.2
	11/10/16	11/17/16	1.0	0.2	46.8	1.4
	11/17/16	11/23/16	0.7	0.2	22.9	1.1
	11/23/16	12/01/16	0.4	0.2	15.6	0.8
	12/01/16	12/08/16	0.5	0.2	18.5	0.9
	12/08/16	12/15/16	0.3	0.2	19.7	1.0
	12/15/16	12/22/16	0.6	0.2	32.5	1.2
	12/22/16	12/29/16	R[1]	R[1]	R[1]	R[1]

[1]R – Results rejected due to insufficient sample volume caused by a tripped breaker.

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2016.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Van Buren Avenue	09/29/16	10/06/16	0.7	0.2	22.4	1.1
	10/06/16	10/13/16	0.5	0.2	22.2	1.0
	10/13/16	10/20/16	0.7	0.2	11.8	0.9
	10/20/16	10/27/16	0.7	0.2	26.4	1.1
	10/27/16	11/03/16	0.6	0.2	12.9	0.9
	11/03/16	11/10/16	1.1	0.2	39.0	1.3
	11/10/16	11/17/16	1.1	0.3	43.1	1.4
	11/17/16	11/23/16	0.6	0.2	17.9	1.1
	11/23/16	12/01/16	0.5	0.2	15.5	0.8
	12/01/16	12/08/16	0.4	0.2	17.7	1.0
	12/08/16	12/15/16	0.1	0.2	16.8	0.9
	12/15/16	12/22/16	0.6	0.2	31.3	1.2
	12/22/16	12/29/16	0.3	0.2	21.5	1.0
Boundary Locations						
Atomic City	09/29/16	10/06/16	0.3	0.2	24.7	1.1
	10/06/16	10/13/16	0.8	0.2	25.6	1.1
	10/13/16	10/20/16	0.7	0.2	13.1	0.9
	10/20/16	10/27/16	0.7	0.2	31.0	1.2
	10/27/16	11/03/16	0.3	0.1	14.6	0.9
	11/03/16	11/10/16	1.2	0.3	44.2	1.4
	11/10/16	11/17/16	1.1	0.2	51.5	1.5
	11/17/16	11/23/16	0.7	0.2	24.8	1.2
	11/23/16	12/01/16	0.5	0.2	18.2	0.9
	12/01/16	12/08/16	0.4	0.2	18.5	0.9
	12/08/16	12/15/16	0.5	0.2	19.6	1.0
	12/15/16	12/22/16	0.6	0.2	37.0	1.3
	12/22/16	12/29/16	0.5	0.2	26.2	1.1
Howe	09/29/16	10/06/16	0.5	0.2	21.7	1.1
	10/06/16	10/13/16	0.4	0.2	23.0	1.1
	10/13/16	10/20/16	0.6	0.2	11.6	0.9
	10/20/16	10/27/16	0.8	0.2	27.8	1.2
	10/27/16	11/03/16	0.4	0.2	13.0	0.9
	11/03/16	11/10/16	0.8	0.2	32.5	1.3
	11/10/16	11/17/16	1.0	0.3	43.4	1.4
	11/17/16	11/23/16	0.6	0.2	22.0	1.2
	11/23/16	12/01/16	1.0	0.3	22.9	1.4
	12/01/16	12/08/16	1.5	0.5	17.0	1.7
	12/08/16	12/15/16	0.4	0.2	18.8	1.0
	12/15/16	12/22/16	0.6	0.2	30.4	1.2
	12/22/16	12/29/16	0.4	0.2	23.3	1.1

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2016.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Monteview	09/29/16	10/06/16	0.7	0.2	22.7	1.1
	10/06/16	10/13/16	0.7	0.2	24.5	1.1
	10/13/16	10/20/16	0.7	0.2	14.8	0.9
	10/20/16	10/27/16	1.1	0.3	33.4	1.3
	10/27/16	11/03/16	0.6	0.2	14.0	0.9
	11/03/16	11/10/16	1.1	0.3	38.8	1.4
	11/10/16	11/17/16	1.3	0.3	54.1	1.6
	11/17/16	11/23/16	0.7	0.2	25.9	1.3
	11/23/16	12/01/16	0.6	0.2	21.1	1.0
	12/01/16	12/08/16	0.5	0.2	23.7	1.1
	12/08/16	12/15/16	0.2	0.2	24.8	1.1
	12/15/16	12/22/16	1.0	0.2	40.8	1.4
	12/22/16	12/29/16	0.6	0.2	27.3	1.2
Mud Lake	09/29/16	10/06/16	1.1	0.3	31.1	1.3
	10/06/16	10/13/16	1.0	0.3	39.7	1.4
	10/13/16	10/20/16	1.0	0.2	19.4	1.0
	10/20/16	10/27/16	1.6	0.3	50.0	1.6
	10/27/16	11/03/16	0.9	0.2	22.0	1.1
	11/03/16	11/10/16	2.1	0.3	68.2	1.7
	11/10/16	11/17/16	1.6	0.3	69.8	1.8
	11/17/16	11/23/16	1.0	0.3	40.5	1.5
	11/23/16	12/01/16	0.9	0.2	28.6	1.1
	12/01/16	12/08/16	0.7	0.2	21.6	1.1
	12/08/16	12/15/16	0.7	0.2	35.9	1.3
	12/15/16	12/22/16	1.4	0.3	60.2	1.7
	12/22/16	12/29/16	0.7	0.2	39.0	1.4
Distant Locations						
Craters of the Moon	09/29/16	10/06/16	0.5	0.2	26.5	1.2
	10/06/16	10/13/16	0.5	0.2	24.1	1.1
	10/13/16	10/20/16	0.5	0.2	12.7	0.9
	10/20/16	10/27/16	0.6	0.2	30.4	1.2
	10/27/16	11/03/16	0.4	0.2	13.3	0.9
	11/03/16	11/10/16	NS[1]	NS[1]	NS[1]	NS[1]
	11/10/16	11/17/16	1.1	0.3	46.2	1.4
	11/17/16	11/23/16	0.7	0.2	21.7	1.1
	11/23/16	12/01/16	0.6	0.2	19.3	0.9
	12/01/16	12/08/16	0.5	0.2	20.1	1.0
	12/08/16	12/15/16	0.6	0.2	19.3	1.0
	12/15/16	12/22/16	0.9	0.2	44.9	1.4
	12/22/16	12/29/16	0.4	0.2	18.9	1.0

[1]NS – No sample – Sampler not restarted the previous week.

Table A-1 continued. Weekly concentrations (in 1 x 10^{-3} pCi/m^3) for gross alpha and gross beta analyses for TSP filters for all locations, fourth quarter, 2016.

Sample Location	Collection Date		Gross Alpha		Gross Beta	
	Start	Stop	Concentration	±2 SD	Concentration	±2 SD
Fort Hall[1]	09/29/16	10/06/16	NS[3]	NS[3]	NS[3]	NS[3]
	10/06/16	10/13/16	NS[3]	NS[3]	NS[3]	NS[3]
	10/13/16	10/20/16	NS[3]	NS[3]	NS[3]	NS[3]
	10/20/16	10/27/16	NS[3]	NS[3]	NS[3]	NS[3]
	10/27/16	11/03/16	NS[3]	NS[3]	NS[3]	NS[3]
	11/03/16	11/10/16	NS[3]	NS[3]	NS[3]	NS[3]
	11/10/16	11/17/16	NS[3]	NS[3]	NS[3]	NS[3]
	11/17/16	11/23/16	NS[3]	NS[3]	NS[3]	NS[3]
	11/23/16	12/01/16	NS[3]	NS[3]	NS[3]	NS[3]
	12/01/16	12/08/16	NS[3]	NS[3]	NS[3]	NS[3]
	12/08/16	12/15/16	NS[3]	NS[3]	NS[3]	NS[3]
	12/15/16	12/22/16	NS[3]	NS[3]	NS[3]	NS[3]
	12/22/16	12/29/16	NS[3]	NS[3]	NS[3]	NS[3]
Idaho Falls - HVP 3804	09/29/16	10/06/16	0.7	0.2	27.3	1.2
	10/06/16	10/13/16	R[4]	R[4]	R[4]	R[4]
	10/13/16	10/20/16	1.2	0.3	19.6	1.1
	10/20/16	10/27/16	1.0	0.3	33.8	1.3
	10/27/16	11/03/16	0.8	0.2	19.8	1.0
	11/03/16	11/10/16	1.5	0.3	50.3	1.5
	11/10/16	11/17/16	1.6	0.3	68.0	1.8
	11/17/16	11/23/16	0.9	0.2	26.9	1.3
	11/23/16	12/01/16	0.7	0.2	19.3	1.0
	12/01/16	12/08/16	0.5	0.2	20.3	1.0
	12/08/16	12/15/16	0.4	0.2	24.2	1.1
	12/15/16	12/22/16	1.3	0.3	54.9	1.6
	12/22/16	12/29/16	0.6	0.2	28.7	1.2
Idaho Falls - HVP 4304[2]	09/29/16	10/06/16	1.0	0.2	30.4	1.2
	10/06/16	10/13/16	1.1	0.3	33.8	1.3
	10/13/16	10/20/16	1.0	0.2	20.0	1.0
	10/20/16	10/27/16	1.0	0.2	36.5	1.3
	10/27/16	11/03/16	0.6	0.2	17.5	1.0
	11/03/16	11/10/16	1.0	0.2	30.3	1.2
	11/10/16	11/17/16	1.2	0.3	46.4	1.4
	11/17/16	11/23/16	0.5	0.2	16.8	1.0
	11/23/16	12/01/16	0.4	0.2	13.4	0.8
	12/01/16	12/08/16	0.3	0.2	14.5	0.9
	12/08/16	12/15/16	0.2	0.2	16.0	0.9
	12/15/16	12/22/16	0.8	0.2	35.9	1.3
	12/22/16	12/29/16	0.4	0.2	17.7	1.0

[1] Operated by Shoshone Bannock-Tribes.

[2] HVP 4304 – This is a new sampler model being operated side by side with sampler HVP 3804 to test the dependability and durability in field conditions.

[3] NS – Sampler out of service.

[4] R – Results rejected due to insufficient sample volume caused by a tripped breaker.

Appendix B

Table B.1. Results for all electret ionization chamber (EIC) locations, fourth quarter, 2016.

Sample Location	Net Corrected Exposure Rate (µR/hr)[1]	± 2 SD (µR/hr)
Arco	14.1	2.6
Craters of the Moon	12.1	3.5
Big Lost River Rest Area	14.4	3.4
Van Buren Avenue	15.3, 17.8	
Experimental Field Station	14.3	2.3
Main Gate	12.9	1.7
Atomic City	12.3	1.8
Taber	11.4	2.0
Blackfoot	12.0, 14.0	
Ft. Hall	11.5	3.1
Idaho Falls	9.9	0.8
Mud Lake/ Terreton	11.4, 13.3	
Monteview	13.6	2.2
Sand Dunes Tower	14.5	2.3
Howe Met. Tower	9.7, 10.5	
MP276 -20	13.4	0.8
MP274 -20	10.7	2.3
MP272 -20	12.2	1.4
MP270 -20	10.0, 10.5	
MP268 -20	12.0	1.6
MP266 -20	12.3	1.8
MP264 -20	13.3	0.5
MP270 -20/26	14.7	2.9
MP268 -20/26	16.2	3.5
MP266 -20/26	16.4, 17.2	
MP263 -20/26	13.3	1.2
MP261 -20/26	11.9	3.2
MP259 -20/26	11.3, 14.6	
MFC (EBR II)	12.3	2.0
EBR I	13.6	1.4
RWMC	15.4	2.8
CFA	16.4	3.1
CITRC (PBF)	12.7, 14.6	
INTEC	11.2, 15.5	
ATR (TRA)	18.2, 18.5	
NRF	12.8	0.8
TAN/SMC	12.2	1.3
Mud Lake Bank of Commerce	15.9	2.1
MP43-33	12.2	1.0
MP41-33	17.2, 18.2	
MP39-33	16.8	2.8
MP 37-33	14.4	3.4
MP35-33	12.8	0.7
MP33-33	16.3	1.3
MP31-33	17.6, 17.8	
MP29-33	14.4	1.3
MP27-33	17.4	3.4
MP25-33	14.1	2.1
MP23-33	10.9, 13.1	
[2]Base of Howe	10.0	0.6

Table B.1. continued. Results for all electret ionization chamber (EIC) locations, fourth quarter, 2016.

Sample Location	Net Corrected Exposure Rate (µR/hr)[1]	± 2 SD (µR/hr)
[3]Rover	10.9, 12.4	
Hamer	15.1, 16.6	
Sugar City	16.3, 19.3	
Roberts	12.3, 14.3	
[4]Big Southern Butte	9.4	1.4

[1]Results are the average of triplicate exposure rate measurements with the associated sample variability (±2 SD), or the 2 measured exposure rates remaining after removal of an outlying value. One of the triplicate measurements is rejected if it is outside the average of the triplicate measurements ±2 SD of the historical population variability. Typically, the two most consistent measurements are reported, based on judgment of the data analyst.

[2,3,4] Base of Howe, Big Southern Butte, and Rover EIC's could not be collected in January due to weather/road conditions. The data reported in this table for these locations represents the average exposure rate from October 2016 through April 2017.

Appendix C

Table C-1. List of volatile organic compounds (VOCs) analyzed for water samples.

Analyte	Minimum detectable concentrations (MDC) (expressed in µg/L)
Benzene	0.5
Carbon tetrachloride	0.5
Chlorobenzene	0.5
1,4-Dichlorobenzene	0.5
1,2-Dichlorobenzene	0.5
1,2-Dichloroethane	0.5
1,1-Dichloroethene	0.5
cis-1,2-Dichloroethene	0.5
trans-1,2-Dichloroethene	0.5
1,2-Dichloropropane	0.5
Ethylbenzene	0.5
Methylene Chloride	0.5
Styrene	0.5
Tetrachloroethene (PCE)	0.5
Toluene	0.5
1,2,4-Trichlorobenzene	0.5
1,1,1-Trichloroethane	0.5
1,1,2-Trichloroethane	0.5
Trichloroethylene	0.5
Vinyl chloride	0.5
Xylenes (total)	0.5
Bromodichloromethane	0.5
Dibromochloromethane	0.5
Bromoform	0.5
Chloroform	0.5
Bromobenzene	0.5
Bromochloromethane	0.5
Bromomethane	0.5
n-Butylbenzene	0.5
sec-Butylbenzene	1.0
tert-Butylbenzene	0.5
Chloroethane	0.5
Chloromethane	0.5
2-Chlorotoluene	0.5

Table C.1 continued. List of volatile organic compounds (VOCs) analyzed for water samples.

Analyte	Minimum detectable concentrations (MDC) (expressed in µg/L)
4-Chlorotoluene	0.5
1,2-Dibromo-3-chloropropane (DBCP)	0.5
1,2-Dibromoethane (EDB)	0.5
Dibromomethane	0.5
1,3-Dichlorobenzene	0.5
Dichlorodifluoromethane	0.5
1,1-Dichloroethane	0.5
1,3-Dichloropropane	0.5
2,2-Dichloropropane	0.5
1,1-Dichloropropene	0.5
cis-1,3-Dichloropropene	0.5
trans-1,3-Dichloropropene	1.0
Hexachlorobutadiene	0.5
Isopropylbenzene	0.5
p-Isopropyltoluene	0.5
Methyl Tert Butyl Ether (MTBE)	0.5
Naphthalene	0.5
n-Propylbenzene	0.5
1,1,1,2-Tetrachloroethane	0.5
1,1,2,2-Tetrachloroethane	0.5
1,2,3-Trichlorobenzene	0.5
Trichlorofluoromethane	0.5
1,2,3-Trichloropropane	0.5
1,2,4-Trimethylbenzene	1.0
1,3,5-Trimethylbenzene	0.5