

# **DEQ-INL**

# **Oversight Program**

# **Annual Report**

# **2013**



**Department of Environmental Quality**  
**Idaho National Laboratory Oversight Program**

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## Table of Acronyms and Abbreviations

aCi/m <sup>3</sup>	attocuries per cubic meter	EOMA	Environmental Oversight Monitoring Agreement
APGEMS	Air Pollutant Graphical Environmental Monitoring System	EPA	Environmental Protection Agency
ARP	Accelerated Retrieval Project	ESER	Environmental Surveillance Education and Research Program
AMWTP	Advanced Mixed Waste Treatment Project	ESP	Environmental Surveillance Program
ATR	Advanced Test Reactor	fCi/m <sup>3</sup>	femtocuries per cubic meter
BEA	Battelle Energy Alliance, LLC	GSS	Gonzales-Stoller Surveillance, LLC
BHS	Bureau of Homeland Security	HEPA	High efficiency particulate air filter
CDP	Calcine Disposition Project	HAD	hazard assessment document
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	HPIC	high-pressure ion chamber
CFA	Central Facilities Area	IBHS	Idaho Bureau of Homeland Security
CFR	Code of Federal Regulations	INL	Idaho National Laboratory
CH-TRU	Contact-handled transuranic	INTEC	Idaho Nuclear Technology and Engineering Center
CRR	Carbon Reduction Reformer	ISFF	Idaho Spent Fuel Facility
CWI	CH2M-WG Idaho, LLC	ISP	Idaho State Police
CX	Categorical Exclusion	ISU	Idaho State University
DEQ- INL OP	Department of Environmental Quality, Idaho National Laboratory Oversight Program	IWTU	Integrated Waste Treatment Unit
DOE	U.S. Department of Energy	LLD	lower limit of detection
EA	Environmental Assessment	LSC	liquid scintillation counting
EBR II	Experimental Breeder Reactor II	MCL	maximum contaminant level
EM	Environmental Management	MFC	Materials and Fuels Complex
EIC	electret ionization chamber	µg/L	micrograms per liter
EIS	Environmental Impact Statement	µR/hr	microRoentgen per hour
EML	Environmental Monitoring Laboratory	mg/L	milligrams per liter
		mrem	millirem or 1/1000 <sup>th</sup> of a rem

mR/hr	milliRoentgen per hour	RSWF	Radioactive Scrap and Waste Facility
MDA	minimum detectable activity	RTC	Reactor Technology Complex
MDC	minimum detectable concentration	RWMC	Radioactive Waste Management Complex
NIST	National Institute of Standards and Technology	SBW	sodium-bearing waste
nCi/L	nanocuries per liter	SD	Standard deviation
NE	Nuclear Energy	SI	International System of Units
NOAA	National Oceanic and Atmospheric Administration	SMCL	secondary maximum contaminant level
NOI	Notice of Intent	TAN	Test Area North
NRC	Nuclear Regulatory Commission	TCE	trichloroethylene
NRF	Naval Reactors Facility	TDS	total dissolved solids
ORPS	Occurrence Reporting and Processing System	TLD	thermoluminescent dosimetry
pCi/g	picocuries per gram	TMI	Three Mile Island
pCi/L	picocuries per liter	TRU	transuranic
pCi/m <sup>3</sup>	picocuries per cubic meter	TSA	Transuranic Storage Area
PCE	tetrachloroethylene	TSP	total suspended particulate
QAPP	Quality Assurance Program Plan	TSS	total suspended solids
QA/QC	quality assurance/quality control	USGS	U.S. Geological Survey
RAP	Radiological Assistance Program	VOC	volatile organic compound
RPD	Relative Percent Difference	WGA	Western Governors Association
RCRA	Resource Conservation and Recovery Act	WIPP	Waste Isolation Pilot Plant
RH-TRU	remote-handled transuranic	WLAP	wastewater land application permit

SI Prefixes				
Prefix	Symbol	Meaning	Multiplier (Numerical)	Multiplier (Exponential)
tera	T	trillion	1 000 000 000 000	$10^{12}$
giga	G	billion	1 000 000 000	$10^9$
mega	M	million	1 000 000	$10^6$
kilo	k	thousand	1 000	$10^3$
hecto	h	hundred	100	$10^2$
deka	da	ten	10	$10^1$
deci	d	tenth	0.1	$10^{-1}$
centi	c	hundredth	0.01	$10^{-2}$
milli	m	thousandth	0.001	$10^{-3}$
micro	$\mu$	millionth	0.000 001	$10^{-6}$
nano	n	billionth	0.000 000 001	$10^{-9}$
pico	p	trillionth	0.000 000 000 001	$10^{-12}$
femto	f	quadrillionth	0.000 000 000 000 001	$10^{-15}$
atto	a	quintillionth	0.000 000 000 000 000 001	$10^{-18}$

# Idaho's INL Oversight Mission

For more than half a century, the Idaho National Laboratory (INL) Site, operated by the Department of Energy (DOE) and its contractors, has been the site of research and development of nuclear technology. The work performed at INL addressed the nation's interests in establishing nuclear reactors as a viable source of energy for civilian and military applications. Beginning in the 1950s, numerous facilities were constructed at INL to study all aspects of the nuclear fuel cycle, including fuel testing, reprocessing, and reactor prototype safety testing. The INL consequently became a site for management of spent reactor fuel (primarily from naval reactors), and radioactive and mixed wastes. Covering almost 900 square miles of the Snake River Plain and located 40 miles west of Idaho Falls, Idaho, the INL was well-suited for these activities. In the late 1980s, environmental management became a major part of the INL's mission. DOE initiated projects to decontaminate and decommission aging facilities, remove waste, and perform environmental cleanup and restoration.

In 1989, the Idaho Legislature established an INL oversight program to provide citizens with independent information and analysis related to the INL Site. In 2007, legislation was enacted to confirm DEQ as the agency responsible for the INL Oversight Program (DEQ-INL OP), which verifies that INL Site activities are protective of public health and the environment. Our staff has expertise in radiation protection, hydrogeology, engineering, ecology, biology, computer science, education, and communications. We serve our fellow Idahoans by:

- Monitoring the environment on and around the INL Site.
- Evaluating potential INL Site operational impacts to the public and the environment.
- Preparing for emergencies involving radioactive materials.
- Keeping the public informed about INL Site activities.

The purpose of this report is to provide a summary of the activities performed by DEQ-INL OP during 2013. The report is divided into sections covering the Environmental Surveillance Program (ESP), Assessment of INL Site Impacts, Radiological Emergency Response Planning and Preparedness, and Public Outreach.

## Environmental Surveillance Program

DEQ provides independent environmental monitoring of the INL site for the citizens of Idaho through a multifaceted program of environmental media measurements. Measurements are made at locations on and near the INL Site, including population centers close to the INL Site boundary, and at relatively distant locations in southeast and south central Idaho. DEQ scientists use their data to evaluate public and environmental safety, and to verify monitoring of ambient environmental radiation and radioactivity in air, water, soil, and milk performed by DOE contractors. Currently, DOE funds environmental surveillance through contracts with Gonzales-Stoller, LLC (GSS), the United States Geological Survey (USGS), CH2M-WG Idaho, LLC (CWI) and the prime INL contractor, Battelle Energy Alliance (BEA). GSS conducts the Environmental Surveillance Education and Research (ESER) program, which performs environmental surveillance outside the INL site boundary – BEA performs surveillance within the INL site.

DEQ also provides the citizens of Idaho with an independent evaluation of information concerning DOE program operations. This information enables the public to reach informed conclusions about DOE activities in Idaho and potential impacts to public health and the environment.

In order to present sampling results to the public and interested agencies, DEQ publishes quarterly and annual reports. Each quarterly report contains detailed data and results of the DEQ environmental monitoring program. Annual reports summarize the quarterly data, identify general trends in the concentrations of major contaminants found in and around the INL Site, assess the impacts of DOE operations on the environment, and evaluate the reliability of DOE-contracted monitoring programs.

## Monitoring Results

In 2013, DEQ conducted monitoring to measure environmental radiation levels and radioactivity in air, water, soil, and milk around the INL Site. Radioactivity levels found in air, soil, and milk samples were typical of background values. DEQ also detected small quantities of tritium in the ground water near the southern boundary of the INL Site, which are attributed to historic INL Site operations. These concentrations, although greater than natural background levels, were less than 2 percent of the drinking water standard for tritium. No other contaminants attributable to INL Site operations were identified in ground water samples collected outside of the INL Site.

Environmental measurements made by DEQ within the INL Site in 2013 were consistent with past results. Water samples collected from on-site locations near INL Site facilities identified concentrations of <sup>90</sup>Sr (strontium-90), chloride, manganese, and volatile organic compounds (VOCs) greater than drinking water standards. These contaminants were found in known INL contaminant plumes and at levels consistent with historic trends for the sampling locations. These water sources are not used by the public or INL Site workers. Other contaminants from historic INL Site operations were identified in water, but at concentrations less than drinking water standards and within expected levels.

Tritium was occasionally detected in atmospheric moisture samples collected

### Did You Know?

The amount of radioactivity in the environment is measured using terms that describe how often the material undergoes radioactive decay.

A **curie** is a unit of radioactivity, symbolized as Ci, equal to  $3.7 \times 10^{10}$  disintegrations or nuclear transformations per second. This is approximately the amount of radioactivity emitted by one gram (1g) of radium-226. The unit is named after Pierre Curie, a French physicist.

Fractions of curie are typically used to define small amounts of radioactivity. For example:

- milli** - millicurie is simply one one-thousandth of a curie
- micro** - microcurie is simply one one-millionth of a curie
- nano** - nanocurie is simply one one-billionth of a curie
- pico** - picocurie is simply one one-trillionth of a curie
- femto** - femtocurie is one-quadrillionth of a curie
- atto** - attocurie is one-quintillionth of a curie

Multiplication Factor	Prefix	Symbol
$0.001 = 10^{-3}$	milli	m
$0.000001 = 10^{-6}$	micro	μ
$0.000000001 = 10^{-9}$	nano	n
$0.000000000001 = 10^{-12}$	pico	p
$0.000000000000001 = 10^{-15}$	femto	f
$0.00000000000000001 = 10^{-18}$	atto	a

from both on-site and off-site monitoring locations. When detected these levels were less than 1 percent of EPA regulatory limits. Environmental measurements of radioactivity in air and direct radiation were typical of background levels at all sites. Radioactivity in the terrestrial environment and food chain remained at background levels, based on soil and milk sampling results.

## ***Trends***

Results for 2013 monitoring in terrestrial media and air were generally consistent with historic trends. Radiation levels were consistent with historic background measurements. Concentrations of <sup>90</sup>Sr, chloride, manganese, and VOCs exceeded federal drinking water standards at locations on the INL in 2013. Tritium concentration in groundwater continues to decline. Gross beta radioactivity in groundwater at all locations followed trends for <sup>90</sup>Sr. The concentrations of some contaminants in groundwater (such as gross alpha radioactivity, <sup>99</sup>Tc (technetium-99), and VOCs) showed trends that were not as clearly understood, possibly resulting from changes in INL operations and cleanup efforts. Tritium concentrations in atmospheric moisture remained consistent over time.

## ***Comparison with DOE Data***

In general, there is satisfactory agreement between the environmental monitoring data reported by DEQ and the DOE. This level of comparability between DEQ and DOE confirms that both programs present reasonable representations of the state of the environment surrounding the INL. This helps to foster public confidence in both the State's and DOE's monitoring programs and in the conclusions drawn from their monitoring.

In the pages that follow, the results of DEQ's monitoring for each type of media (air, radiation, water, soil, and milk) are discussed in greater detail.

## ***Air Monitoring***

Continuous air monitoring is conducted at 11 locations to monitor concentrations of radionuclides in the atmosphere. These 11 locations include one air monitoring station operated by the Shoshone-Bannock Tribes at Fort Hall, Idaho.

Air monitoring locations (and selected other DEQ monitoring sites) are shown in **Figure 1** and continuous air monitoring stations are shown in **Figures 2 and 3**.

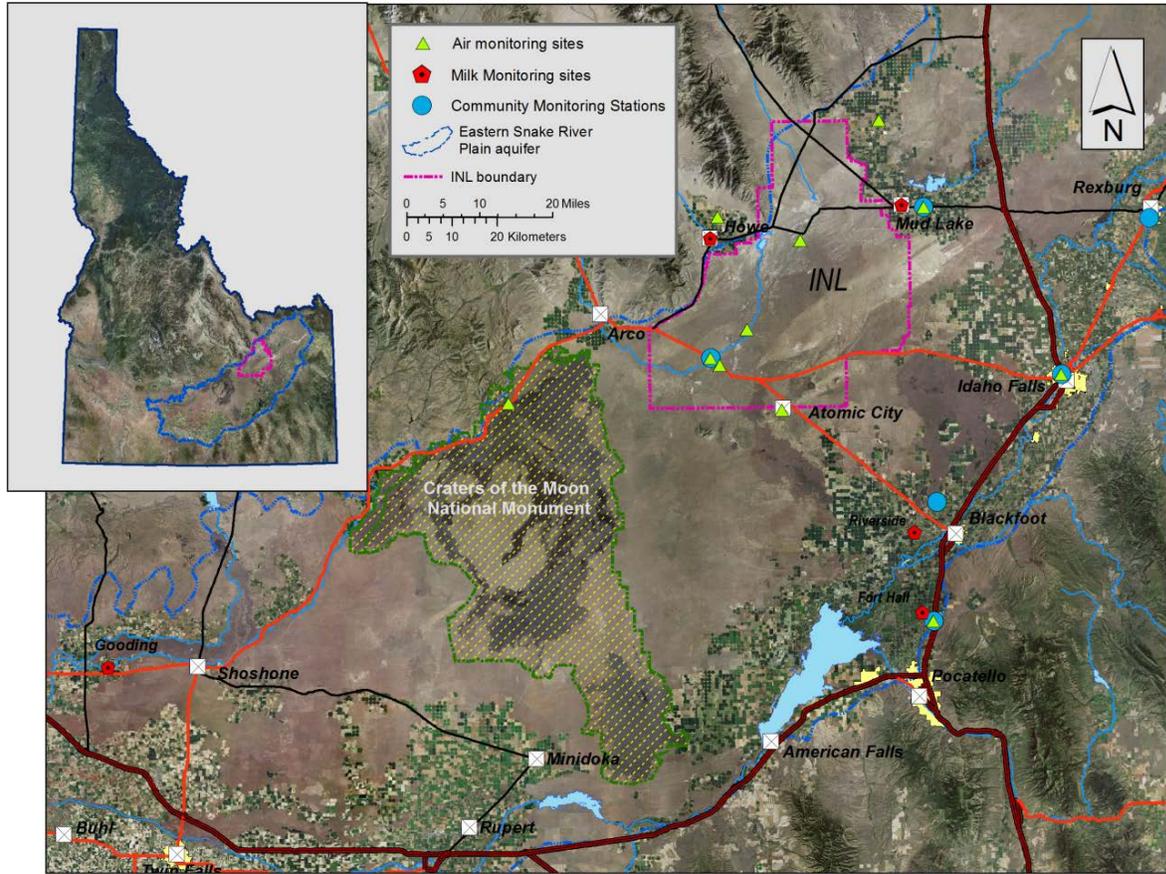


Figure 1. Locations of selected DEQ monitoring sites.

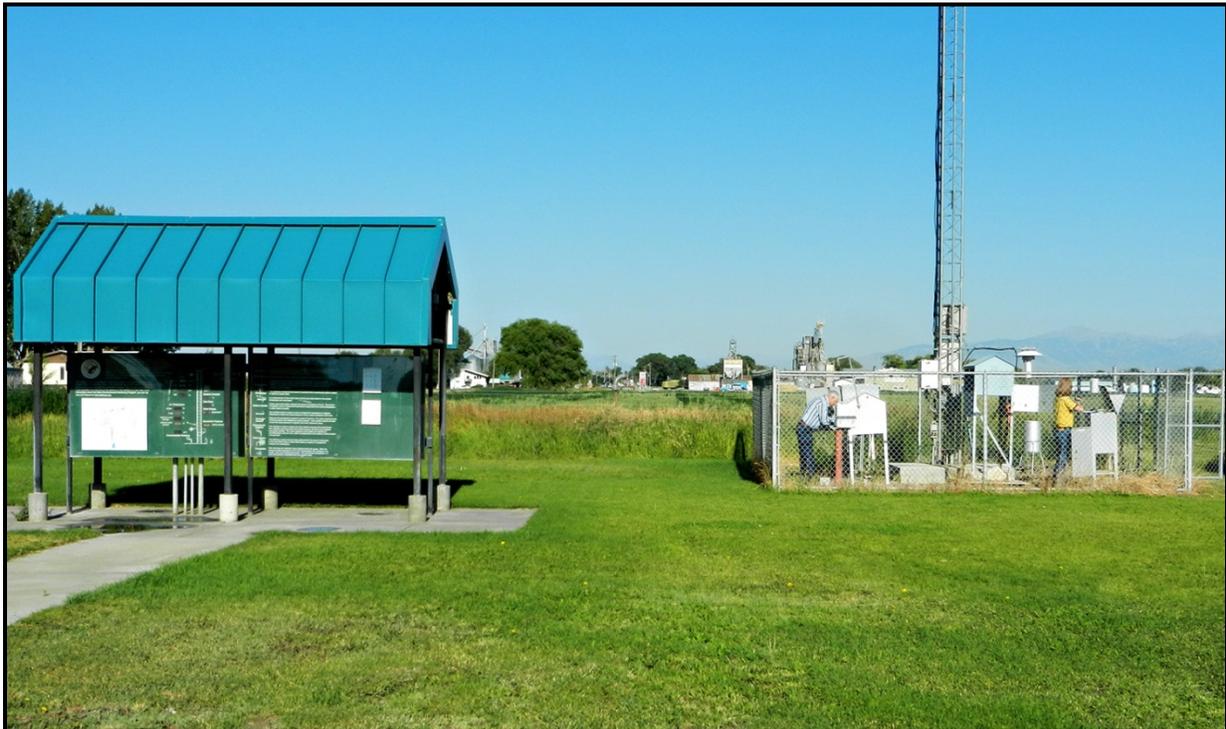


Figure 2. Off-site DEQ continuous air monitoring station.

Air monitoring stations are segregated into three categories:

- On-site stations are located within the INL boundary and include Experimental Field Station, Van Buren Avenue, Big Lost River Rest Area, and Sand Dunes/INL Gate 4.
- Off-site stations are located near the INL boundary and include Mud Lake, Montevue, Howe, and Atomic City.
- Distant background stations are located at the Craters of the Moon visitor center, Idaho Falls, and Fort Hall. Measurements at distant locations characterize the regional background conditions for comparison with conditions at on- and off-site stations.



**Figure 3. On-site DEQ continuous air monitoring station.**

Particulate air samples (filters) and radioactive iodine gas samples (charcoal cartridges) are collected weekly to monitor short-term radiological conditions in the environment. Atmospheric moisture is also collected continuously to measure tritium concentrations present in the air. Finally, precipitation samples are collected at six locations to monitor for tritium and gamma-emitting radionuclides that may be present in the environment. A DEQ air monitoring station with all four different types of sampling equipment is pictured in **Figure 4**.



**Figure 4. DEQ air monitoring station with a radioiodine sampler, an atmospheric moisture sampler, a precipitation sampler, and a total suspended particulate matter sampler (TSP).**

In order to verify results, data collected by DEQ at some air monitoring stations are directly compared to the air monitoring results obtained by the DOE and its contractors at co-located sample sites.

### **Air Monitoring Equipment and Procedures**

Particulate matter is collected on filters using high-volume total suspended particulate (TSP) matter air samplers. The filters are collected weekly and are analyzed for gross alpha and gross beta radioactivity. Air concentrations are calculated based upon the amount of radioactivity on the filter and the volume of air that has passed through the filter. Quarterly composite samples of all TSP filters collected from each location are analyzed for gamma-emitting radionuclides. Yearly composite samples of all TSP filters collected from each location are analyzed via radiochemical separation for  $^{90}\text{Sr}$  (strontium-90),  $^{241}\text{Am}$  (americium-241),  $^{238}\text{Pu}$  (plutonium-238), and  $^{239/240}\text{Pu}$  (plutonium-239/240).

Radioactive iodine (radioiodine) 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 11 air monitoring stations and analyzed together as a group. If radioiodine is detected in this grouping, the canisters are individually analyzed.

Atmospheric moisture is collected by drawing air through a column filled with molecular sieve beads (a desiccant or water-absorbing material). Upon saturation with moisture, the column is removed and the beads are heated, causing them to release their stored moisture. This moisture is then condensed and collected as water in a sample container and subsequently analyzed for tritium.

Precipitation samples are obtained at each location using a collection tray that is heated during the winter months. The sample flows from the tray into a 5-gallon container that is collected at the end of each calendar quarter or whenever it is full. The precipitation samples are analyzed for tritium and for gamma-emitting nuclides.

All samples collected from DEQ’s air monitoring program are analyzed by the Idaho State University Environmental Monitoring Laboratory (ISU-EML) or its subcontractor(s). Analysis methods used are consistent with industry standards.

### Air Monitoring Results and Trends

The following sections include results and trends for air monitoring. Results are presented with the associated analytical uncertainty,  $\pm 2$  standard deviations (SD).

#### Particulate Matter in Air

A total of 633 filters from TSP samplers were collected during 2013. The results from the analyses of off-site location samples were indistinguishable from those of on-site locations. All gross alpha and beta screening results during 2013 were less than the OP action levels for prompt response to elevated air screening measurements. Gross alpha/beta results are summarized in **Table 1**.

**Table 1. Gross alpha and beta screening ranges and averages observed by DEQ for 2013.**

DEQ	Gross Alpha Range (fCi/m <sup>3</sup> ) <sup>a</sup>	Gross Alpha Average (fCi/m <sup>3</sup> )	Gross Beta Range (fCi/m <sup>3</sup> )	Gross Beta Average (fCi/m <sup>3</sup> )
2013	0.01 to 2.97	0.95 $\pm$ 0.12	8.35 to 116.6	31.1 $\pm$ 0.6

a. fCi/m<sup>3</sup> – femto(10<sup>-15</sup>) curies per cubic meter

Radiochemical analysis of the annual TSP filter composite samples resulted in a detection of <sup>90</sup>Sr at the Rest Area sampling location with a value of 23.2  $\pm$  9.1 attocuries<sup>1</sup> per cubic meter (aCi/m<sup>3</sup>) (MDC 14.3 aCi/m<sup>3</sup>) for 2013. Of the transuranic radionuclide analytes (<sup>238</sup>Pu, <sup>239/240</sup>Pu, and <sup>241</sup>Am), <sup>241</sup>Am was detected at the Van Buren location with a value of 2.3  $\pm$  1.6 aCi/m<sup>3</sup> (MDC 2.1 aCi/m<sup>3</sup>). These values are within the expected range due to global fallout from historic above-ground weapons testing. All of these concentrations are much less than one percent of the federal annual average concentration limits for <sup>238</sup>Pu of 2.1 fCi/m<sup>3</sup>, <sup>239/240</sup>Pu of 2.0 fCi/m<sup>3</sup>, <sup>241</sup>Am of 1.9 fCi/m<sup>3</sup>, and <sup>90</sup>Sr of 19 fCi/m<sup>3</sup> (40 CFR 61).

<sup>1</sup> An attocurie is 10<sup>-18</sup> curies, or 1/1000<sup>th</sup> of a femtocurie.

## Atmospheric Tritium

A total of 138 atmospheric moisture samples were collected in 2013 from 11 monitoring locations and analyzed for tritium. Detectable airborne tritium concentrations are occasionally observed in the environment. The highest airborne tritium concentrations observed by DEQ on the INL in 2013 were  $1.09 \pm 0.45$  pCi/m<sup>3</sup> at the Experimental Field Station for the time period of July 22 through August 22, 2013 and  $0.89 \pm 0.49$  pCi/m<sup>3</sup> at Van Buren Avenue for the time period of July 15 through August 15, 2013. Airborne tritium was not detected above minimum detectable concentration during 2013 at the Big Lost River Rest Area station or the Sand Dunes station.

All atmospheric tritium measurements for 2013 were much less than one percent of the annual average concentration for compliance with federal regulations (40 CFR 61), 1500 pCi/m<sup>3</sup>. Tritium levels were at or near background levels at all locations.

## Gaseous Radioiodine

No gaseous radioiodine was detected by DEQ in 2013.

## Precipitation

No tritium or manmade gamma-emitting radionuclides were detected by DEQ in precipitation samples at any location throughout the year.

## Air Monitoring Verification Results

Gross alpha and beta particle results for suspended particulate matter samples from monitoring stations used by DEQ are compared with results from co-located stations operated by the Environmental Surveillance, Education and Research Program (ESER) and by Battelle Energy Alliance (BEA). As a convention, paired sample results are taken to agree if they differ from each other by no more than 20 percent of their average value, or to within 3 times the combined uncertainty of the two measurements. Agreement between 80% of the paired samples is considered to indicate overall statistical agreement of the programs being compared. Another test of agreement is to determine if the conclusions relevant to public health drawn from the results of one program are the same as those drawn from the results of another program.

For 2013, over 80% of BEA's and ESER's gross alpha particle results were in statistical agreement with DEQ's results, indicating overall statistical agreement between DEQ's and these organizations' data sets. (**Table 2**).

More than 80% of the paired gross beta particle results for DEQ and BEA were in statistical agreement, but comparisons between DEQ and ESER were not in overall statistical agreement (**Table 2**). Variations in sampling schedule, equipment configuration and random measurement uncertainty may contribute to observed differences. It is important to recognize that gross alpha and beta particle measurements are a screening method and do not represent quantitative measurement of specific radionuclides.

The results do agree in the important sense that all measurements from the three monitoring organizations are several orders of magnitude below the most restrictive regulatory limit for radionuclides of concern from the INL. The results from all three monitoring agencies indicate that there is no public health risk.

**Table 2. Comparison of DEQ suspended particulate matter analysis results for paired samples with ESER and BEA results in 2013.**

(Results are presented as percentage of samples that agree within 20 percent or 3 times the combined uncertainty.)

Sampling Agency	ESER Stoller <sup>a</sup>	BEA <sup>b</sup>
DEQ Gross Alpha Analysis	83.6 %	100%
DEQ Gross Beta Analysis	55.2 %	84.9 %

a. ESER – Environmental Surveillance, Education and Research [Program], conducted by DOE contractor Gonzales-Stoller Surveillance, LLC (GSS)

b. BEA – Battelle Energy Alliance, INL prime contractor during 2013.

Comparison of DEQ, ESER, and BEA tritium sample results is problematic because although sampling sites are co-located, samples are not collected at the same time. Each monitoring agency collects its tritium sample when the desiccant material becomes saturated with moisture; therefore the sampling frequency is dependent on the volume of desiccant used and the sampler flow rate resulting in differences and overlaps in sampling schedules throughout the year. Also, most of the results are near or below the MDC, where statistical uncertainties are relatively high. These factors preclude direct one-to-one comparison of results. However, all the results agree in that the maximum measured concentrations are about 3 orders of magnitude below the regulatory limit. Results from all three monitoring agencies indicate no public health risk.

### **Air Monitoring Impacts and Conclusions**

Based upon 2013 radiological air monitoring measurements, DEQ concludes that there are no discernable impacts to off-site locations as a result of INL operations. The results of screening analyses performed on particulate filters collected at boundary locations are consistent with the results obtained from background locations. A few of the specific radionuclide analyses of composite air samples resulted in statistical detections of human-made radionuclides at concentrations much less than 1% of the federal standard for members of the public (40CFR61).

Atmospheric moisture and precipitation sampling by all three agencies has occasionally shown detectable quantities of tritium in the environment; however, all detected quantities are well below federal regulatory limits and indicate no risk to public health.

Overall, DEQ and DOE contractor air monitoring results are considered to be in agreement based on (1) direct statistical comparisons or, (2) because each organizations' results support the conclusion that environmental concentrations are well below regulatory limits and pose no health concerns for the citizens of Idaho.

## ***Radiation Monitoring***

Penetrating radiation is naturally present in the environment due to cosmic sources and naturally occurring radioactive materials in rock and soil. Human-made sources include nuclear reactor operations and the residual radioactivity present in soil from historic above-ground testing of nuclear weapons. Radiological conditions on the INL and throughout the eastern Snake River Plain are continuously monitored by DEQ. Penetrating radiation is measured at each of DEQ's air monitoring stations, at meteorological towers maintained by the National Oceanic and Atmospheric Administration (NOAA), along roadways that bound or cross the INL, and at background locations far from the INL (**Figure 6**). Co-located radiation monitoring is conducted by DEQ and DOE contractors at a number of locations. DEQ measurements at these locations are compared with the DOE contractors' results to determine whether the data are in agreement.

### **Radiation Monitoring Equipment and Procedures**

A network of 12 high-pressure ion chambers (HPICs) provides "real-time" monitoring of radiation exposure rates. One of these HPIC stations is owned and operated by the Shoshone-Bannock Tribes at Fort Hall, Idaho, using equipment identical to DEQ. The real-time HPIC measurements are available to the public on the World Wide Web at

<http://www.deq.idaho.gov/inl-oversight/monitoring/gamma-radiation-measurements.aspx>

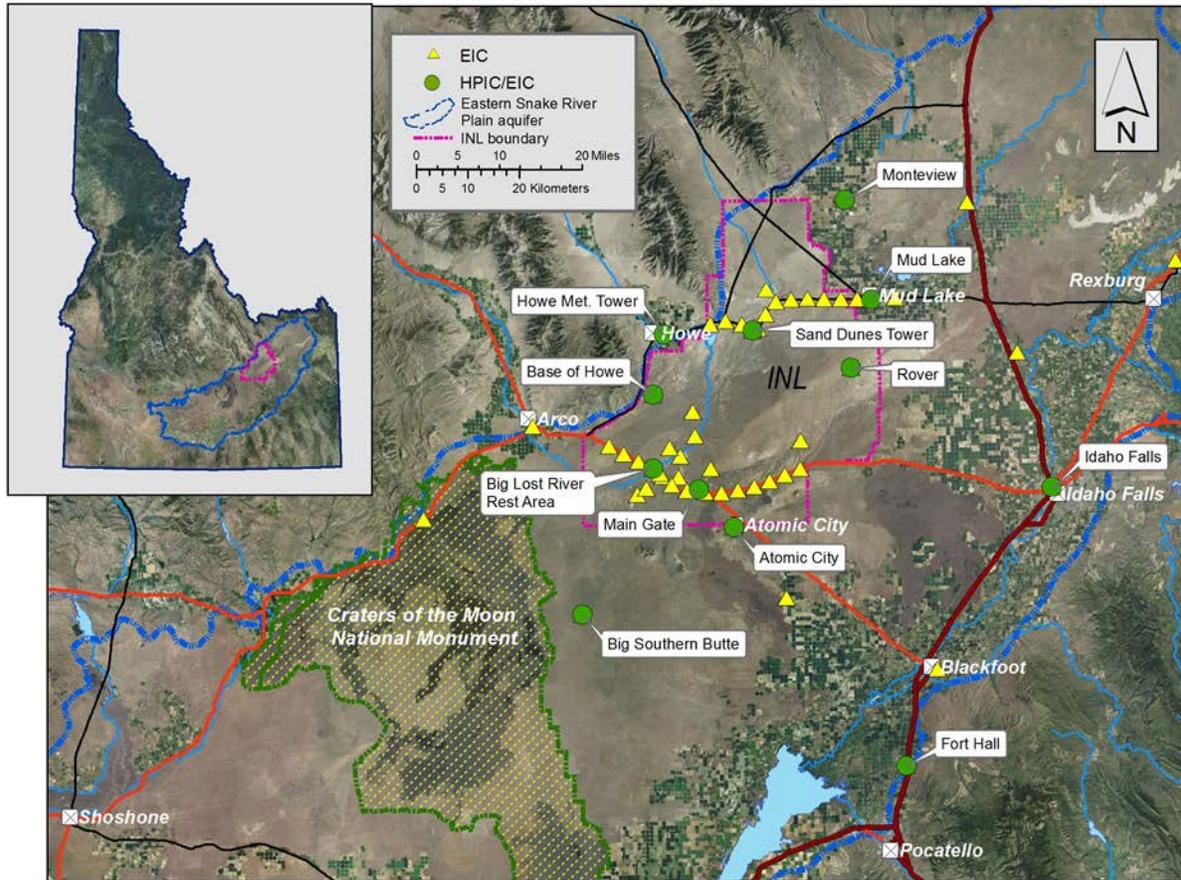
DEQ also uses a network of passive electret ionization chambers (EICs) on and around the INL to measure cumulative radiation exposure over quarterly monitoring periods. The objectives of the DEQ EIC network are to identify baseline levels (background radiation) to use for comparison in the event of an upset condition (accidental release of radioactive material), assess potential dose in the ambient environment, validate dose assessment models, and to verify contractor environmental radiation data. **Figure 5** shows a DEQ staff member collecting an EIC for analysis and deploying a new one.

### **Radiation Monitoring Results and Trends**

During the course of 2013, EIC and HPIC measurements performed at locations on the INL were similar to those at off-site monitoring locations and were consistent with expected background exposures associated with natural cosmic and terrestrial sources.

**Figure 5. Collecting an electret ionization chamber (EIC) and deploying a new one.**





**Figure 6. Locations of HPIC and EIC monitoring sites.**

### **Radiation Monitoring Verification Results**

DEQ places EICs at several locations where DOE contractors monitor radiation using optically stimulated luminescent (OSL) or thermoluminescent dosimetry (TLD). Ambient radiation measurements during 2013 showed 90% of BEA's annual average OSL dosimeter and 80% of ESER Gonzales-Stoller Surveillance, LLC (GSS)'s annual average TLD measurements agreed within 20% RPD with results from DEQ's co-located EICs (**Table 3**), meeting the program's objectives.

**Table 3. Comparison of DEQ, ESER and BEA radiation measurements at co-located sites in 2013. (Units in micro-Roentgen per hour or  $\mu\text{R/hr}$ )**

Statistical Measure	DEQ	ESER <sup>a</sup> GSS	DEQ	BEA <sup>b</sup>
Mean	12.7	14.7	12.2	11.6
Median	12.6	14.4	12.3	11.4
Standard Deviation	1.5	1.2	0.9	1.0
Minimum	11.0	13.5	11.0	10.3
Maximum	16.0	17.4	13.5	13.7
Average % difference		15%		-6%

a. ESER – Environmental Surveillance, Education and Research [Program], conducted by INL contractor Gonzales-Stoller Surveillance, LLC (GSS).

b. BEA – Battelle Energy Alliance, INL prime contractor during 2013.

### **Radiation Monitoring Impacts and Conclusions**

Based upon radiation measurements made by DEQ, there were no discernable impacts from INL operations in 2013. Measurements on the INL are comparable to those at background locations. Quarterly averaged HPIC and EIC exposure measurements during 2013 met DEQ’s criterion for agreement.

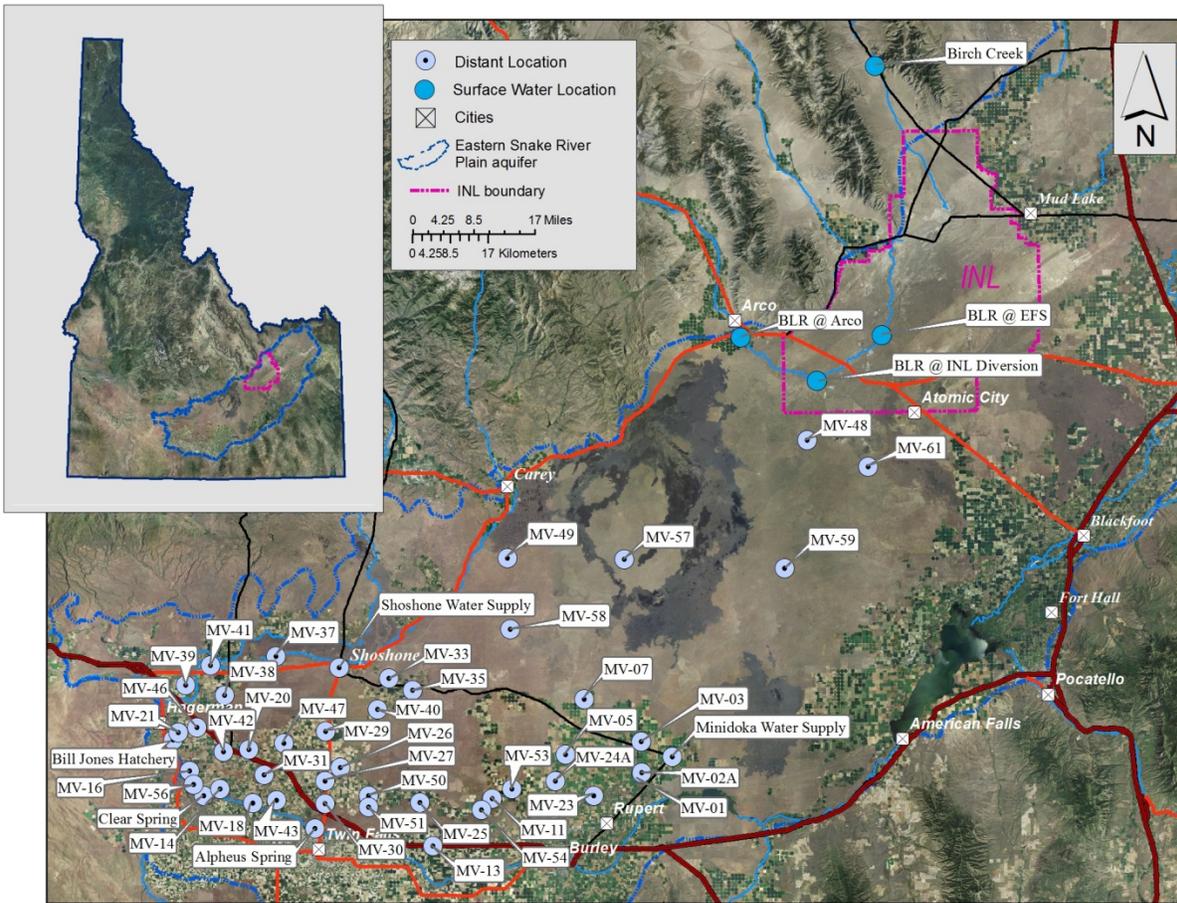
### **Water Monitoring**

During 2013, 83 water monitoring sites were sampled to aid in identifying INL impacts on the Eastern Snake River Plain Aquifer (ESRPA). Data collected from these monitoring sites were further examined to determine trends of INL contaminants and other general ground water quality indicators. Some data were also used to determine whether the monitoring results obtained by the DOE and its contractors were consistent with the sampling results obtained by DEQ for these same locations.

Samples collected from water monitoring sites are analyzed for radiological and non-radiological constituents. Measuring these constituents helps to identify INL impacts to the aquifer. Many of these analytes occur naturally in ground water and surface water. Elevated concentrations are also present in certain areas of the aquifer due to historic and ongoing INL operations. Key non-radiological analytes include various common ions, trace metals, and organic compounds. Radiological analyses focus on screening measurements and specific human-made or primarily human-made contaminants. These analytes include gross alpha and gross beta radioactivity, <sup>137</sup>Cs and other gamma-emitting radionuclides and <sup>3</sup>H. Selected sites are also sampled for <sup>90</sup>Sr, <sup>99</sup>Tc, <sup>241</sup>Am, <sup>234</sup>U, <sup>235</sup>U, <sup>238</sup>U, <sup>238</sup>Pu, and <sup>239/240</sup>Pu.

The types of sites sampled include ground water locations (wells and springs), surface water locations (streams), and selected wastewater locations from INL facilities. Sample sites are also categorized as up-gradient, facility, boundary, distant, surface water, or wastewater. Up-gradient locations are not impacted by INL operations, so they are considered representative of background ground water quality conditions. Facility locations are sample sites within the INL

that are near facilities, in areas of known contamination, or have been selected to illustrate trends for specific INL contaminants or indicators of ground water quality. Boundary locations are on or near the southern boundary of the INL or 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. Surface water and wastewater are monitored because they are current sources of recharge to the aquifer and have the potential to impact the aquifer. The water monitoring sites on and surrounding the INL are illustrated in **Figure 7** and **Figure 8**, showing the extent of the water monitoring program on the Snake River Plain.



**Figure 7. Water quality monitoring sites distant from the INL Site and surface water sites on Birch Creek and the Big Lost River (BLR).**



collected from monitoring sites for analysis of non-radiological parameters including common ions (calcium, magnesium, sodium, potassium, chloride, fluoride, sulfate, and total alkalinity), nutrients (total nitrate plus nitrite and total phosphorus), and trace metals (arsenic, barium, chromium, iron, manganese, lead, selenium, and zinc).



**Figure 9. DEQ staff member collecting ground water samples from a monitoring well.**



**Figure 10. Preserving a ground water sample from a monitoring well.**

### **Water Monitoring Results and Trends**

A summary of the ranges of analyte concentrations observed for up-gradient, facility, boundary, distant, and surface water monitoring sites is presented here. Also, analytical results from several sample locations are highlighted and examined more closely to identify current trends. Results for all DEQ environmental surveillance are available in quarterly data reports on the DEQ Web site at <http://www.deq.idaho.gov/inl-oversight/monitoring/reports.aspx>.

### **Radiological Analytes**

Gross alpha and gross beta analyses measure radioactivity contributed by alpha or beta particles in a sample, regardless of their radionuclide source. These analyses do not differentiate among the types of radionuclides present in a sample of water. Radionuclide contributors to both gross alpha and gross beta radioactivity can occur naturally, as well as due to historic INL operations. Therefore, the gross alpha and gross beta radioactivity analyses are useful in screening for the presence of specific radionuclides at levels above naturally occurring radioactive concentrations.

The primary natural sources of gross alpha radioactivity in ground water and surface water are naturally occurring uranium and thorium. The gross alpha radioactivity observed in most facility, boundary, distant, and surface water sites is due to natural sources. Some facility sites do show gross alpha radioactivity from INL sources. This is apparent not only because concentrations are

above background, but other human-made contaminants are also detectable. The highest concentration for DEQ sampled sites was from a facility site, TAN-37 (**Table 4**). The INL contractor responsible for monitoring at TAN-37 attributes the elevated gross alpha radioactivity to historic disposal of wastes that included  $^{234}\text{U}$ ; however, at this particular well  $^{234}\text{U}$  was not detected in 2013. Two nearby wells, TAN-28 and TAN-29 do show higher concentrations for  $^{234}\text{U}$ . A summary of this and other radiological results from water monitoring is shown in **Table 4**.

Select locations are sampled for uranium and plutonium isotopes and  $^{241}\text{Am}$ . In 2013, uranium isotope results (aside from those collected at/near the TAN facility) were not differentiable from natural background ranges. Neither Pu isotopes nor  $^{241}\text{Am}$  were detected in 2013.

**Table 4. Summary of selected radiological analytical results for DEQ 2013 water samples, wastewater excluded.**

Analyte (pCi/L) <sup>1</sup>	Facility			Up-gradient, Boundary, Distant, and Surface Water			Back-ground <sup>2</sup>	Drinking Water Standard <sup>3</sup>
	Min	Median	Max	Min	Median	Max		
Gross Alpha	<MDC <sup>4</sup>	<MDC	18.9 ± 4.4	<MDC	<MDC	7.1 ± 1.7	0-4 <sup>2</sup>	15
Gross Beta	<MDC	4.8	762.7 ± 10.6	<MDC	4.0	8.0 ± 1.1	0-7 <sup>2</sup>	-- <sup>3</sup>
$^{137}\text{Cs}$	<MDC	<MDC	<MDC	<MDC	<MDC	<MDC	0	200 <sup>3</sup>
$^3\text{H}$	<MDC	670	7280 ± 220	<MDC	<MDC	310 ± 110	0-40	20,000 <sup>3</sup>
$^{90}\text{Sr}$	<MDC	<MDC	289 ± 68	NS <sup>5</sup>	NS	NS	0	8 <sup>3</sup>
$^{99}\text{Tc}$	0.5 ± 0.1	1.5	491.8 ± 2.1	NS	NS	NS	0	900 <sup>3</sup>

<sup>1</sup> pCi/L – picocuries per liter.

<sup>2</sup> Background concentrations for the Snake River Plain Aquifer. Gross alpha background levels derived from over 20 years of DEQ ground water monitoring in the ESRPA. Gross beta as  $^{137}\text{Cs}$ .

<sup>3</sup> The federal drinking water standard is expressed as a cumulative annual dose of 4 millirem/year. This value was converted to a specific concentration (pCi/L) for each analyte.

<sup>4</sup> MDC is the minimum detectable concentration.

<sup>5</sup> NS – Not Sampled.

Sources of naturally occurring gross beta radioactivity include radioactive potassium-40 ( $^{40}\text{K}$ ), as well as radioisotopes that were produced from the decay of natural uranium and thorium. Several locations on the INL have gross beta levels that exceed those observed from natural sources in the ESRPA. The highest concentration of gross beta radioactivity was measured at a facility site, TAN-37 (**Table 4**). The observed gross beta radioactivity at this well can be accounted for by the measured strontium-90, discussed following and seen in **Figure 13**.

$^{137}\text{Cs}$  (Cesium-137) is a known ground water contaminant for both the TAN area and INTEC area and has been detected previously. For 2013, however,  $^{137}\text{Cs}$  was not detected in any samples.

Monitoring samples were analyzed for additional human-made contaminants such as  $^3\text{H}$ ,  $^{90}\text{Sr}$ , and  $^{99}\text{Tc}$ , and most results were consistent with concentrations measured in previous years. In the following sections, the results for  $^3\text{H}$ ,  $^{90}\text{Sr}$ , and  $^{99}\text{Tc}$  are discussed.

## Tritium ( $^3\text{H}$ )

Most of the radioactivity released to the aquifer was in the form of  $^3\text{H}$  from spent nuclear fuel reprocessing operations at the Idaho Nuclear Technology and Engineering Center (INTEC) and reactor operations at the Reactor Technology Complex (RTC), now referred to as the Advanced Test Reactor (ATR) Complex. At INTEC,  $^3\text{H}$  was disposed in the aquifer by injection well and later by percolation ponds. Waste pond operations that allowed  $^3\text{H}$  to infiltrate to the aquifer ceased in 1995 at INTEC and in 1993 at the ATR Complex.  $^3\text{H}$  concentrations for selected wells with INL contamination near INTEC and the ATR Complex are presented in **Figure 11** (see **Figure 8** for well locations). The  $^3\text{H}$  concentrations found in these wells have continued to decline because  $^3\text{H}$  is no longer disposed directly to the aquifer. Over time, the  $^3\text{H}$  contamination has undergone radioactive decay and has been diluted in the aquifer. Historic levels had previously exceeded the maximum contaminant level (MCL) of 20,000 picocuries per liter (pCi/L) for many of these sites.

$^3\text{H}$  concentrations found in wells near RWMC have also declined since about 1998, although they are much lower in concentration than those near INTEC and the ATR Complex. The primary source of  $^3\text{H}$  observed in wells at the RWMC is likely from wastes disposed at that facility, although up-gradient  $^3\text{H}$  sources at the ATR Complex and possibly INTEC may also contribute to the ground water contamination in these wells.  $^3\text{H}$  concentrations greater than background have been measured in wells approximately 4 miles past the INL southern boundary using a low-level  $^3\text{H}$  analysis which has a lower minimum detectable concentration (MDC) of 10 to 14 pCi/L. **Figure 12** shows  $^3\text{H}$  concentrations measured in 2013.

Westbay™ packer sampling systems have been installed by the USGS and DOE contractor in selected wells along the INL southern boundary. These multi-level sampling systems contain multiple sampling ports that are each isolated by permanent packer systems which allow water samples to be collected from discrete levels or zones within the well. Each zone is selected based on measured aquifer properties, and these zones are correlated to aquifer zones identified in previous USGS investigations and modeling efforts. By sampling at multiple levels in the aquifer a better understanding of the vertical distribution of wastewater constituents in the aquifer is provided. In 2013, five Westbay wells were sampled, some at multiple zones within the aquifer, including USGS-103 (at 1269.4 ftbls, or feet below land surface), USGS-105 (at 726.0 ftbls, at 849.0 ftbls, and at 1071.6 ftbls), USGS-108 (at 662.0 ftbls, at 890.0 ftbls, and at 1171.8 ftbls), USGS-132 (at 646.7 ftbls, and at 765.4 ftbls) and Middle-2051 (at 1091.1 ftbls). Sample results from these wells show elevated  $^3\text{H}$  concentrations among the different aquifer zones which are likely related to INL waste disposal influences.

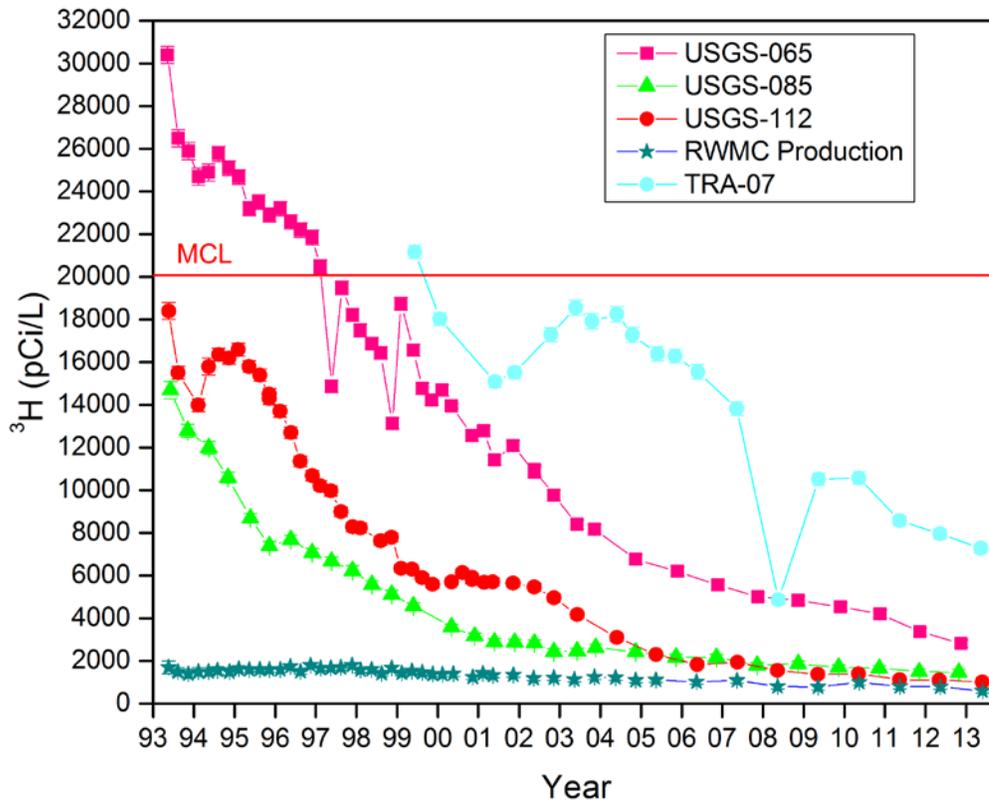
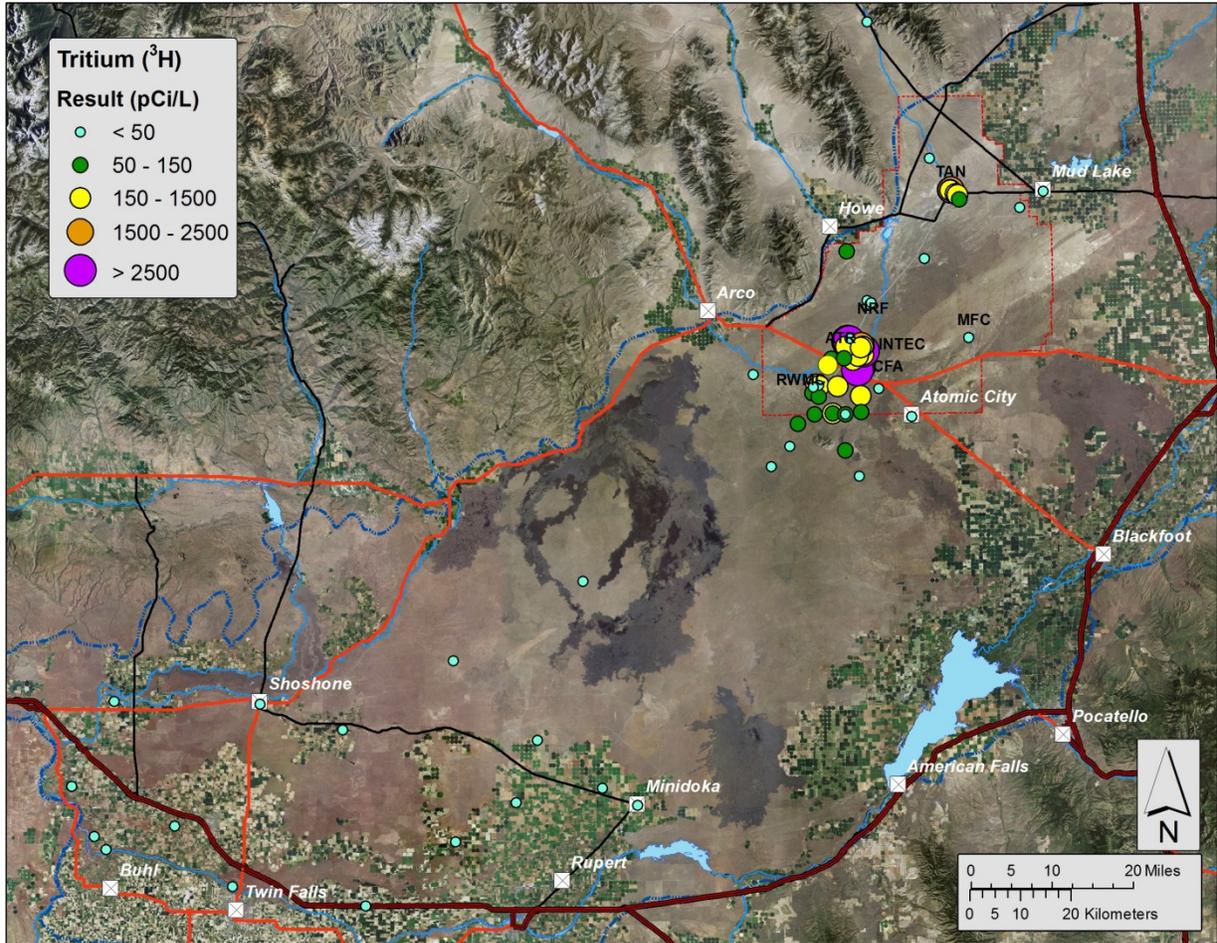


Figure 11.  $^3\text{H}$  concentrations (pCi/L) over time for selected INL Site wells impacted by INL contamination.

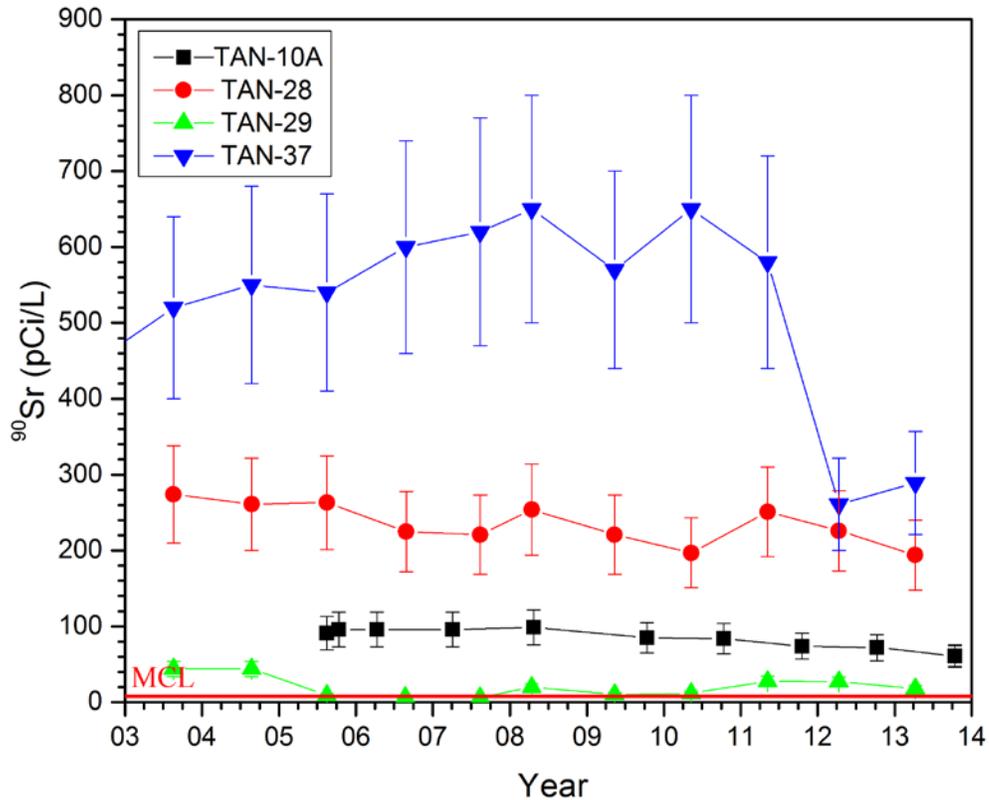


**Figure 12. 2013  $^3\text{H}$  concentrations (pCi/L) for DEQ sample locations.**

### **Strontium-90 ( $^{90}\text{Sr}$ )**

$^{90}\text{Sr}$  and  $^{99}\text{Tc}$  are the primary sources for elevated gross beta radioactivity observed in wells with INL contamination. Concentrations of  $^{90}\text{Sr}$  found in the aquifer have remained relatively constant for selected wells near the Test Area North (TAN) facility except for monitoring well TAN-37. During 2012 sampling it was reported that the concentration for  $^{90}\text{Sr}$  at TAN-37 had dropped from  $580 \pm 140$  pCi/L in 2011 to  $261 \pm 61$  pCi/L in 2012. Contractor data and gross beta concentrations were evaluated at TAN-37 to confirm the drop in  $^{90}\text{Sr}$  concentrations. For 2013, the  $^{90}\text{Sr}$  concentration at TAN-37 remains steady at  $289 \pm 68$  pCi/L. DEQ initially sampled TAN-37 in 1999 and began annual monitoring at this site in 2003. This well is located near the TAN waste injection well (used from 1953-1972), and in the region of ongoing aquifer treatment (in-situ bioremediation or ISB) for volatile organic compounds (VOCs) in the ground water. DEQ monitors for  $^{90}\text{Sr}$  at three other TAN facility wells, including TAN-10A, TAN-28, and TAN-29.  $^{90}\text{Sr}$  concentrations at these sites have remained relatively consistent with a slight decline since DEQ first began sampling these sites in 2003 (**Figure 13**).

At INTEC,  $^{90}\text{Sr}$  is thought to have been released due to historic waste injection at INTEC and more recently from leaks and spills associated with the INTEC Tank Farm facility. **Figure 14** illustrates  $^{90}\text{Sr}$  concentrations for wells located at or down gradient of INTEC, including ICPP-2020, USGS-047, USGS-067, USGS-085 and USGS-112. All sites indicate that  $^{90}\text{Sr}$  concentrations are generally steady or declining. **Figure 14** shows  $^{90}\text{Sr}$  concentrations at DEQ sample locations during the 2013 monitoring season.



**Figure 13.**  $^{90}\text{Sr}$  concentrations over time for selected wells near Test Area North (TAN).

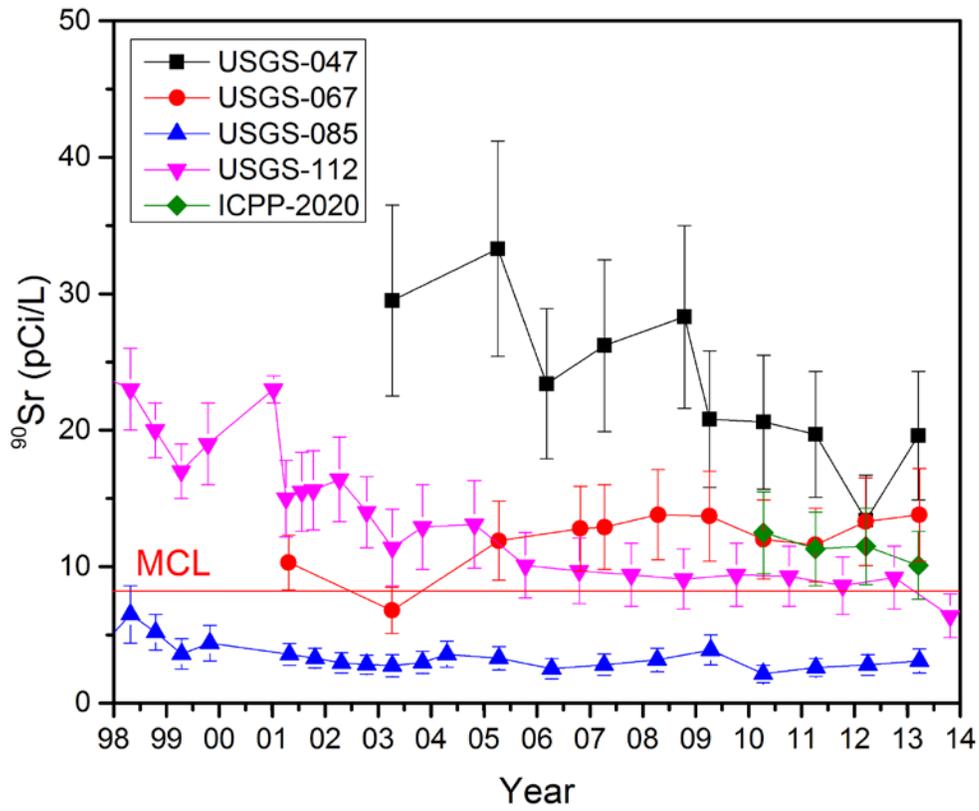


Figure 14. <sup>90</sup>Sr concentrations over time for selected INL Site wells impacted by INL contamination.

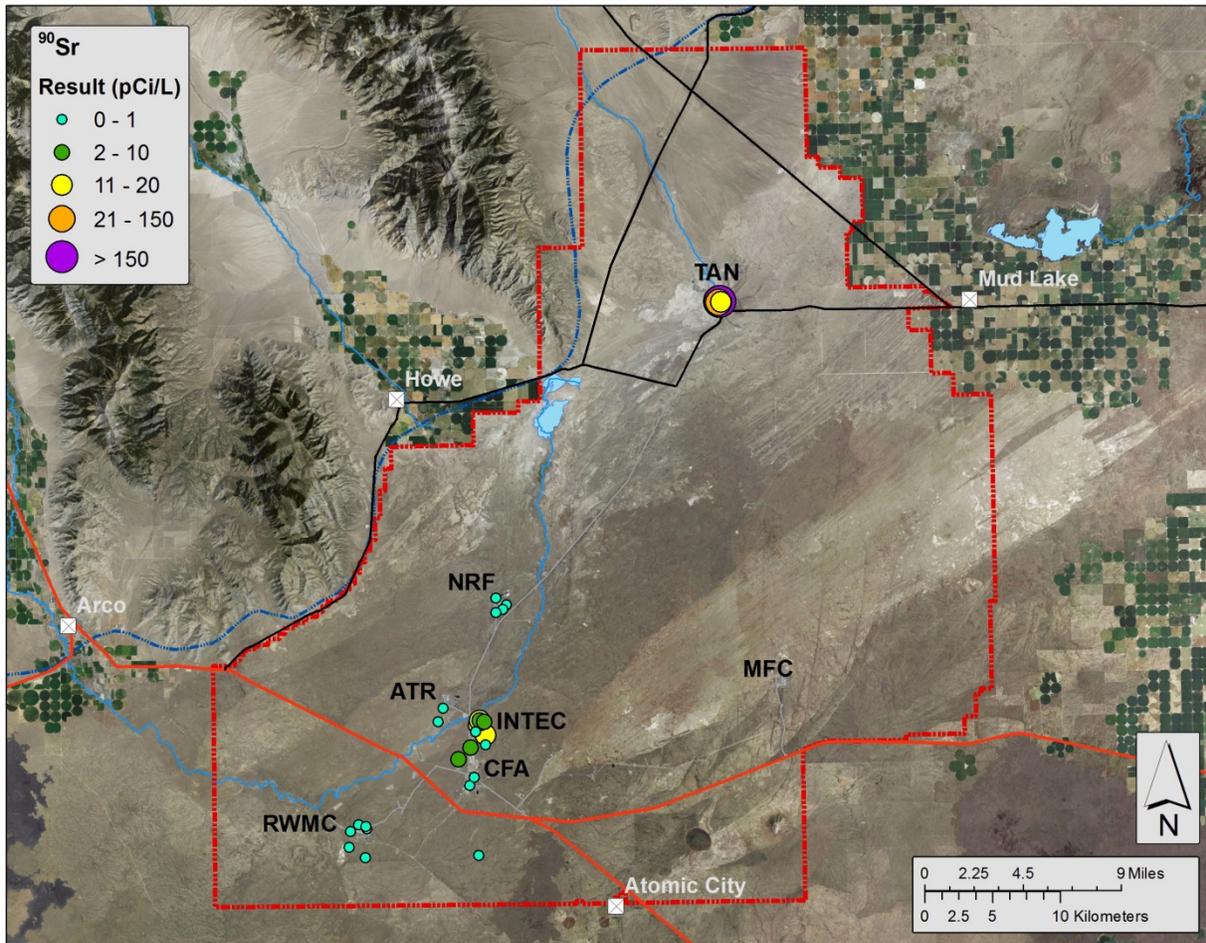
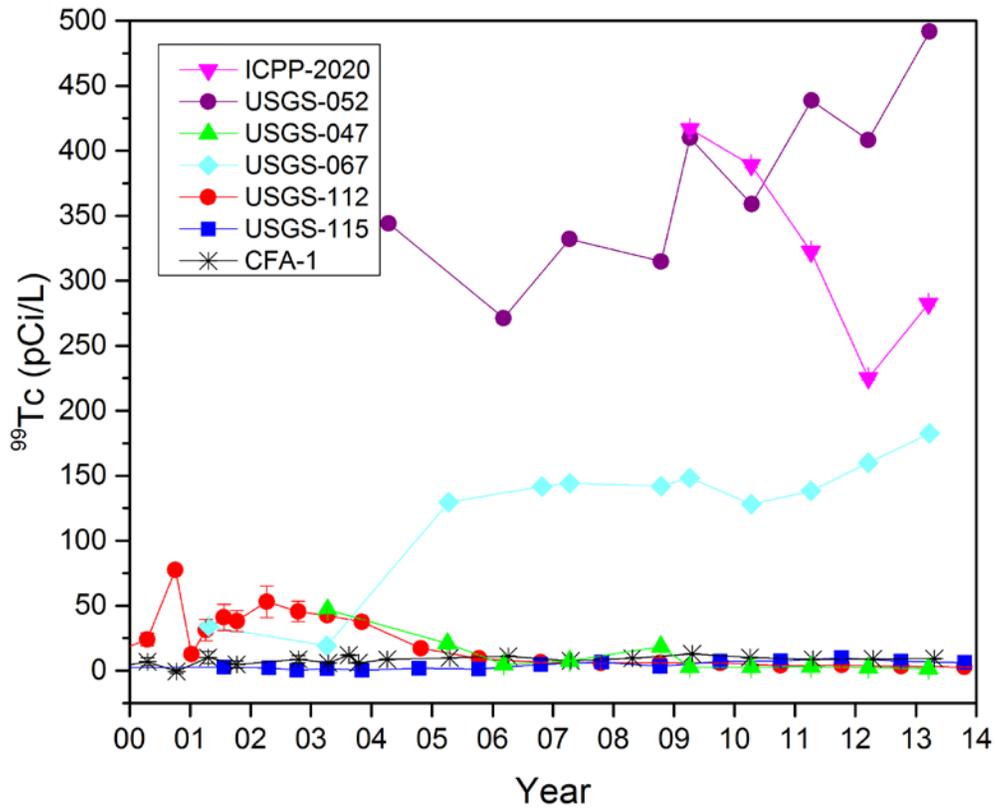


Figure 15. 2013 <sup>90</sup>Sr concentrations (pCi/L) for DEQ sample locations.

### Technetium-99 (<sup>99</sup>Tc)

<sup>99</sup>Tc is thought to have been released due to historic waste injection at INTEC and more recently from leaks and spills associated with the INTEC Tank Farm facility. The greatest concentration observed for DEQ monitored sites in 2013 was for well USGS-052 ( $491.8 \pm 2.1$  pCi/L), located at INTEC. **Figure 16** shows <sup>99</sup>Tc concentrations over time for selected INL wells located near or down gradient of INTEC. Concentrations of <sup>99</sup>Tc at four of these wells, including CFA-1, USGS-047, USGS-112, and USGS-115 have been consistent over the past several years. Other wells represented in **Figure 16** include USGS-052, USGS-067 and ICPP-2020. Results for USGS-067 show the <sup>99</sup>Tc concentration has been generally steady since 2005 with a slight increase over the last three years (2010 – 2013). Results for USGS-052 are irregular and fluctuate between sampling events but overall indicate an increasing trend. The final well includes ICPP-2020, which is located near USGS-052. DEQ began monitoring ICPP-2020 in 2009, with data generally showing a decline in concentrations of <sup>99</sup>Tc. All 2013 results for <sup>99</sup>Tc were below the MCL of 900 pCi/L. **Figure 17** shows <sup>99</sup>Tc concentrations at DEQ sample locations.



**Figure 16.  $^{99}\text{Tc}$  concentrations over time for selected INL Site wells impacted by INL contamination.**

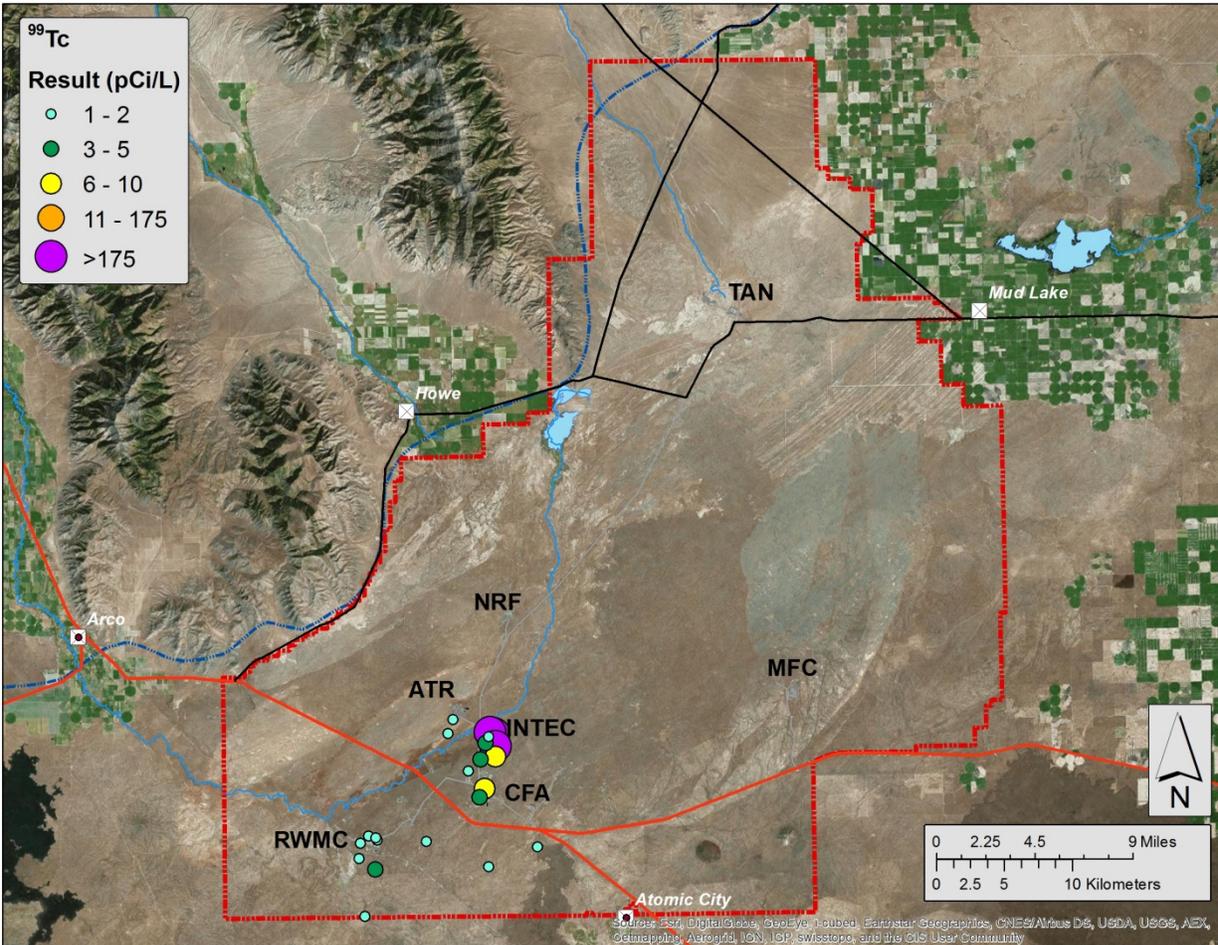


Figure 17. 2013 <sup>99</sup>Tc concentrations (pCi/L) for DEQ sample locations.

### Non-radiological Analytes

Common ions, nutrients, and metals comprise all the dissolved constituents in natural ground water. These constituents also comprise nearly all the chemical wastes disposed to surface water or ground water as a result of past INL waste disposal practices. Concentrations for most analytes measured in 2013 were relatively unchanged from previous years. Common ions, nutrients, and metal results found in samples collected by DEQ in 2013 are summarized in **Table 5**. Following the table is a discussion of analytical results for chloride, chromium, manganese and VOCs, which have each exceeded their respective drinking water standards either in the recent past or during the 2013 monitoring season.

**Table 5. Summary of selected non-radiological analytical results for DEQ water samples for 2013.**

Analyte	Up-gradient			Facility			Boundary			Distant			Background <sup>1</sup>	Drinking Water Standard <sup>2</sup>
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max		
<b>Common Ions/Nutrients (mg/L)</b>														
Calcium	10	34	51	28	52	150	34	39	47	23	42	67	5 - 43	none
Magnesium	3.5	16	18	12	17	39	12	15	18	10	16	29	1 - 15	none
Sodium	6.9	15	44	8.1	16	180	6.4	9.9	21	11	20	52	5 - 14	none
Potassium	1.3	3.1	11	1.8	2.8	6.3	1.8	2.5	3.6	2.5	3.6	6.9	1 - 3	none
Chloride	5.3	9.7	49	8.4	22	485	6.2	13	22	5.7	24	70	2 - 16	250*
Sulfate	5.9	25	40	15	36	160	17	23	35	11	38	81	2 - 24	250*
Total Nitrate plus Nitrite	<DL <sup>3</sup>	0.64	2.6	0.036	1.1	5.6	0.46	0.76	1.5	0.41	1.2	5.2	1 - 2	10
Total Phosphorus	0.011	0.019	0.039	0.011	0.028	0.130	0.017	0.020	0.030	0.018	0.024	0.077	<0.02	none
<b>Metals (µg/L)</b>														
Barium	14	56	81	22	64	250	22	40	77	5.4	37	100	50 - 70	2000
Chromium	<DL	<DL	5.5	<DL	12	83	<DL	<DL	11	<DL	<DL	<DL	2 - 3	100
Lead	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<5	15
Manganese	<DL	<DL	21	<DL	<DL	920	<DL	<DL	13	<DL	<DL	6.8	<1 - 4	50*
Zinc	<DL	<DL	<DL	<DL	<DL	650	<DL	<DL	160	<DL	<DL	110	<10	5000*

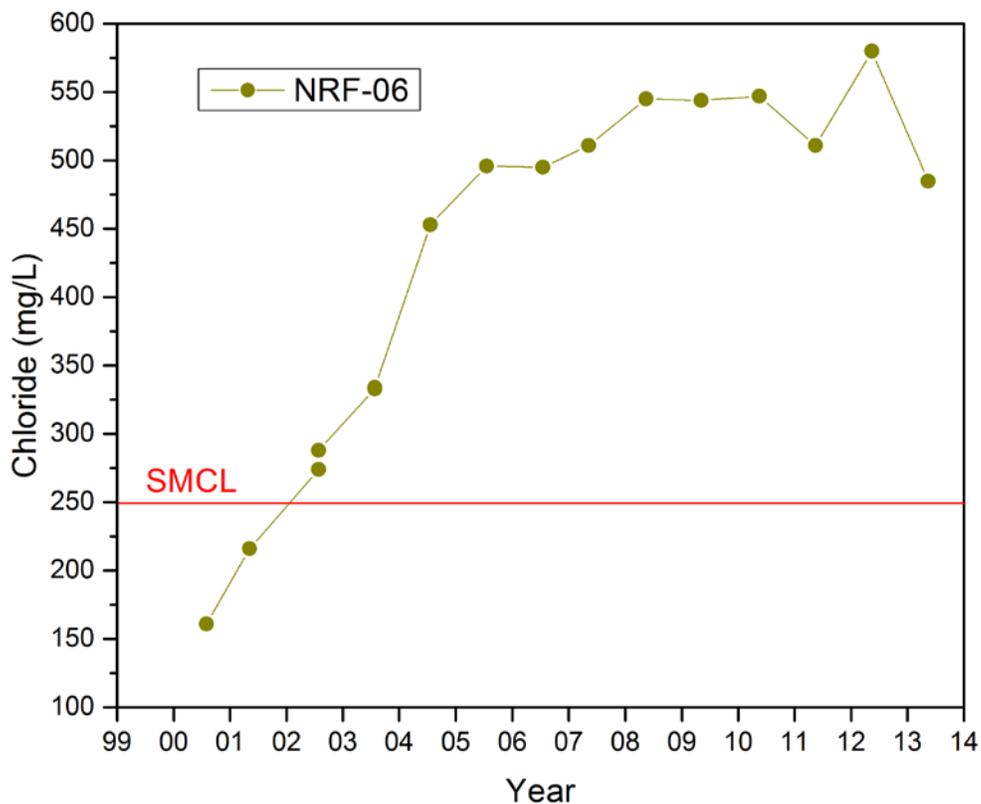
<sup>1</sup>Background concentrations for the Snake River Plain Aquifer. Depending on local geology, concentrations for sites not impacted by INL may be higher than the given background ranges.

<sup>2</sup>Primary standard unless otherwise noted. National Primary Drinking Water Regulations are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water. Maximum Contaminant Levels (MCL's) are the highest level of a contaminant that is allowed in the drinking water. \* = Secondary Drinking Water Regulations are non-enforceable guidelines regulating contaminants that may cause cosmetic effects or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply.

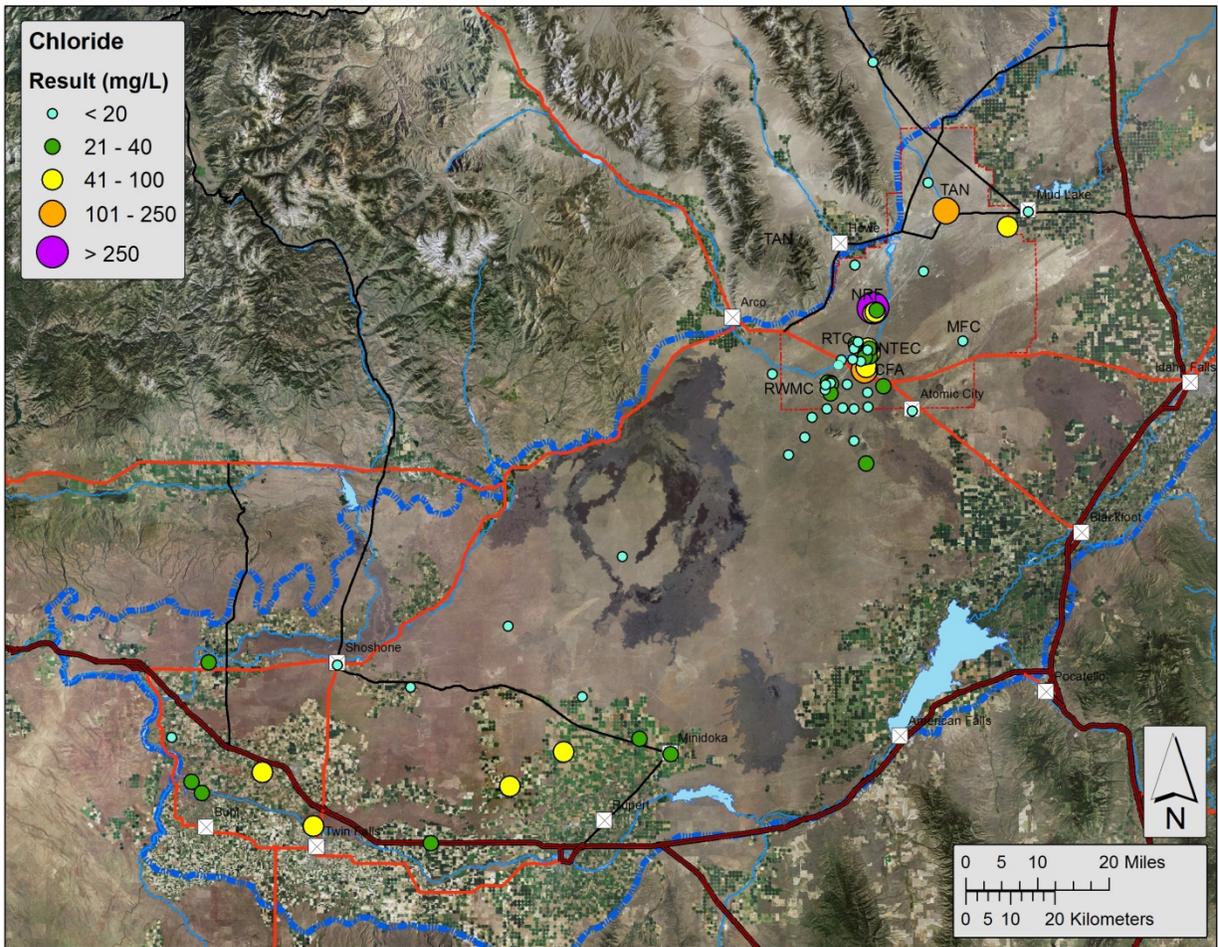
<sup>3</sup>Detection Level.

## Chloride

Chloride concentrations in ground water are often elevated in regions impacted by agriculture due to the evaporation of infiltrating irrigation water. At the INL, large quantities of chloride have been discharged in the wastewater. The primary source of chloride in INL wastewater includes the use of sodium chloride (salt) to regenerate water softeners. DEQ currently monitors only one well that has chloride concentrations which historically exceed the secondary maximum contaminant level (SMCL) of 250 mg/L. Results for NRF-06 are illustrated in **Figure 18**. NRF-06 is located near the NRF industrial waste ditch in which wastewater from water softeners is discharged. Chloride concentrations for DEQ 2013 sample locations are shown in **Figure 19**.



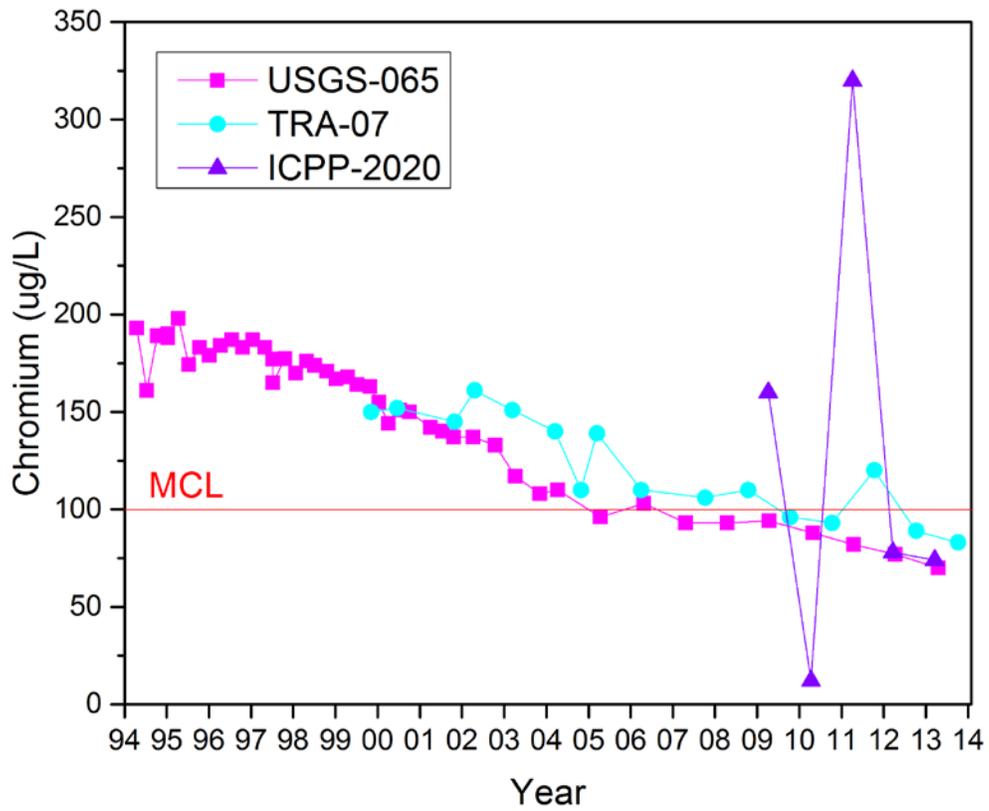
**Figure 18. Chloride concentrations for sample location NRF-06 over time.**



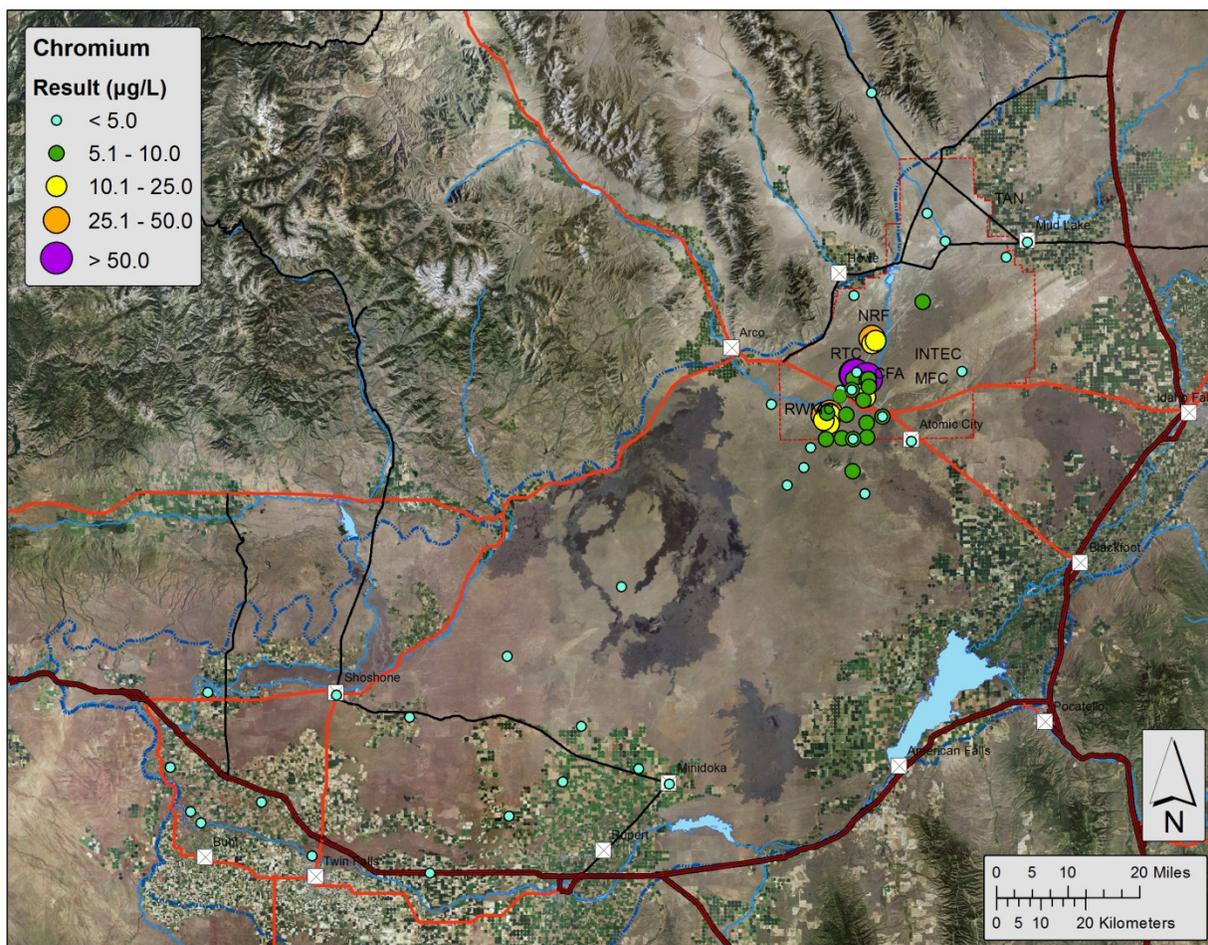
**Figure 19. 2013 chloride concentrations for DEQ sample locations.**

## Chromium

Chromium was used at the INL to prevent corrosion in industrial water systems until the early 1970s. Disposal practices at that time allowed chromium-contaminated water to percolate down to ground water from injection wells, open disposal ponds, and ditches. For this reason, chromium is observed at some INL ground water sampling sites. During 2013 chromium concentrations were found below the maximum contaminant level (MCL) of 100  $\mu\text{g/L}$  at all DEQ monitored sites. Data for ICPP-2020, TRA-07, and USGS-065 are illustrated in **Figure 20**. TRA-07 and USGS-065 are located near ATR and have historically shown elevated concentrations of chromium with a declining trend over time. ICPP-2020 is located at INTEC and has been sampled by the DEQ since 2009, producing five samples. The data, to date, have generally shown large fluctuations between sampling events. Concentrations for DEQ 2013 sample locations are shown in **Figure 21**.



**Figure 20. Chromium concentrations (µg/L) over time for selected INL Site wells impacted by INL contamination.**



**Figure 21. 2013 chromium concentrations ( $\mu\text{g/L}$ ) for DEQ sample locations.**

## Manganese

One well, TAN-10A, near the TAN facility has exceeded the SMCL for manganese ( $50 \mu\text{g/L}$ ) since 2004. In 2013 DEQ monitoring results for TAN-10A recorded a manganese concentration of  $920 \mu\text{g/L}$  which is comparable with historical values at this location. This concentration is consistent with conditions created by ongoing in-situ bioremediation (ISB) efforts as part of the clean-up action for VOCs at TAN.

## Volatile Organic Compounds

Concentrations for five VOCs exceeded MCL's in some wells at TAN: Tetrachloroethylene (or PERC, MCL =  $5 \mu\text{g/L}$ ), trichloroethylene (or TCE, MCL =  $5 \mu\text{g/L}$ ), vinyl chloride (MCL =  $2 \mu\text{g/L}$ ), cis-1,2-Dichloroethene (or cis-1,2-DCE, MCL =  $70 \mu\text{g/L}$ ) and trans-1,2-Dichloroethene (or trans-1,2-DCE, MCL =  $100 \mu\text{g/L}$ ). In July 2012, the ISB rebound test was initiated. All clean-up actions involving bioremediation on ground water at TAN were put on hold for a minimum of two years to determine how concentrations of VOCs respond. These actions are in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The concentration of carbon tetrachloride (MCL=  $5 \mu\text{g/L}$ ) exceeded its MCL for one well at the RWMC. The 2013 sample results for specific wells can be found in the quarterly reports published on our Web site: <http://www.deq.idaho.gov/inl-oversight/monitoring/reports.aspx>.

## Water Monitoring Verification Results

DEQ collects water samples at the same time and location (co-sampled) with DOE or its contractors and verifies that its monitoring results are consistent with those obtained by DOE. In the event that a significant difference is found between DEQ sample results and those of DOE, each sampling contractor's result is scrutinized individually to ascertain the cause of the difference. Some differences between results are expected due to factors that include natural variability in the media being sampled, random errors in the measurements, and systematic differences in how the samples are collected, handled and analyzed. The DEQ verification sampling program is designed to co-sample at approximately 10% of all DOE sample locations for selected analytes. Co-sampled DEQ results for 2013 were compared to the results obtained by DOE, both on an individual sample-by-sample basis, and on an overall sample average basis.

### Radiological

A summary of the sample-by-sample comparison of DEQ and DOE radiological results is presented in **Table 6**. Sample-by-sample comparisons showed that results were generally in very good agreement, with most compared analyses meeting our goal of 80 percent of results passing comparison criteria. Both gross beta and <sup>99</sup>Tc analyses fell below the 80 percent threshold; the failure to meet comparison criteria is still under investigation.

**Table 6. Radiological results for co-samples collected by DOE and DEQ in 2013.**

Analyte	Number of Co-sampled pairs in 2012	Percent of Co-sampled pairs passing criteria in 2013
<sup>241</sup> Am	0	NA
Gross alpha	46	94
Gross beta	37	78
<sup>137</sup> Cs	27	100
<sup>238</sup> Pu	4	100
<sup>239/240</sup> Pu	4	100
<sup>90</sup> Sr	19	95
<sup>99</sup> Tc	11	73
<sup>3</sup> H	61	90
<sup>234</sup> U	9	100
<sup>235</sup> U	11	100
<sup>238</sup> U	9	100

### Non-Radiological

A summary of the sample-by-sample comparison of DEQ and DOE non-radiological results for 2013 is presented in **Table 7**. Sample-by-sample comparisons showed that results were mostly in agreement with all except zinc and VOCs meeting the goal of 80 percent of results passing comparison criteria. The reason for zinc and VOC co-sampled pairs failing to meet at least 80 percent comparison criteria is under investigation.

**Table 7. Non-radiological results for co-samples collected by DOE and DEQ in 2013.**

Analyte	Number of Co-sampled pairs in 2013	Percent of Co-sampled pairs passing criteria in 2013
<b>Common Ions/Nutrients</b>		
Calcium	24	100
Magnesium	24	100
Sodium	54	100
Potassium	24	100
Chloride	59	92
Sulfate	55	96
Total Nitrate plus Nitrite	46	100
<b>Trace Metals</b>		
Barium	19	100
Chromium	39	97
Lead	17	100
Manganese	21	81
Zinc	17	76
<b>VOCs<sup>1</sup></b>	81	79

<sup>1</sup>15 co-sampled VOC samples were collected and 81 paired results for the same analytes were compared.

### **Water Monitoring and Verification Impacts and Conclusions**

DEQ sample results are generally in agreement with those reported by DOE and its contractors. Results of DEQ water monitoring have identified contamination in the Eastern Snake River Plain Aquifer as a result of historic waste disposal practices at the INL Site. Specifically:

- Concentrations for <sup>90</sup>Sr, chloride, manganese and VOCs exceeded federal drinking water standards (MCLs or SMCLs) at some sites on the INL in 2013. These sites, however, are not used for drinking water.
- No sites monitored by DEQ exceed federal drinking water standards for <sup>3</sup>H. Concentration trends for <sup>3</sup>H continue to decline. This INL contaminant is detectable at monitoring sites beyond the southern INL boundary at levels just higher than local background concentrations.
- Concentrations for other INL contaminants in water continue to decrease at most locations as a result of changes in waste disposal practices. Chromium concentrations remain below the 100 µg/L MCL at sample locations ICPP-2020 and TRA-07. Since DEQ began sampling ICPP-2020, chromium concentrations have ranged over more than an order of magnitude among the first four sampling events; however, the 2013 result remains relatively steady when compared to the 2012 result.
- INL impacts to the aquifer are not identifiable in water samples collected from sites distant from the INL.

## ***Terrestrial Monitoring***

Terrestrial monitoring is performed by measuring radionuclide accumulations in soil to help assess long-term trends of radiological conditions in the environment on and around the INL. Monitoring of milk samples is performed to indirectly verify the presence or absence of atmospheric radioiodine deposited in the terrestrial environment on and near the INL. Some of these data are also used to determine whether the monitoring results obtained by the DOE and its contractors were consistent with the soil and milk sampling results obtained by DEQ for these same locations.

### **Terrestrial Monitoring Equipment and Procedures**

DEQ uses a combination of *in-situ* gamma spectrometry and physical soil samples to monitor concentrations of gamma-emitting radionuclides in soil at DEQ air monitoring stations and selected soil sampling sites on and around the INL (2013 soil sampling sites are shown in **Figure 22**). A portable gamma radiation detector was used in the field to collect surface gamma radiation spectra, which were analyzed to identify and estimate the concentrations of gamma-emitting radionuclides present in the soil. No physical soil samples were collected during 2013.

DEQ collected milk samples from distribution centers where milk was received and from individual dairies in southern and southeastern Idaho. Milk sampling locations are shown in **Figure 1**. Raw milk samples were collected from trucks arriving at the distribution centers from each region of interest. For the independent cow and goat dairies, DEQ personnel drop off empty sample containers that are filled by the owner/operator of the dairy. The samples are picked up within 1-2 days of collection.

Two DEQ milk samples were collected and split by a DOE contractor each month. One half of the split samples were analyzed by DOE and the other half were submitted to DEQ for analysis. DEQ used the analysis results from these split samples to verify the DOE contractor's milk sampling results and conclusions.

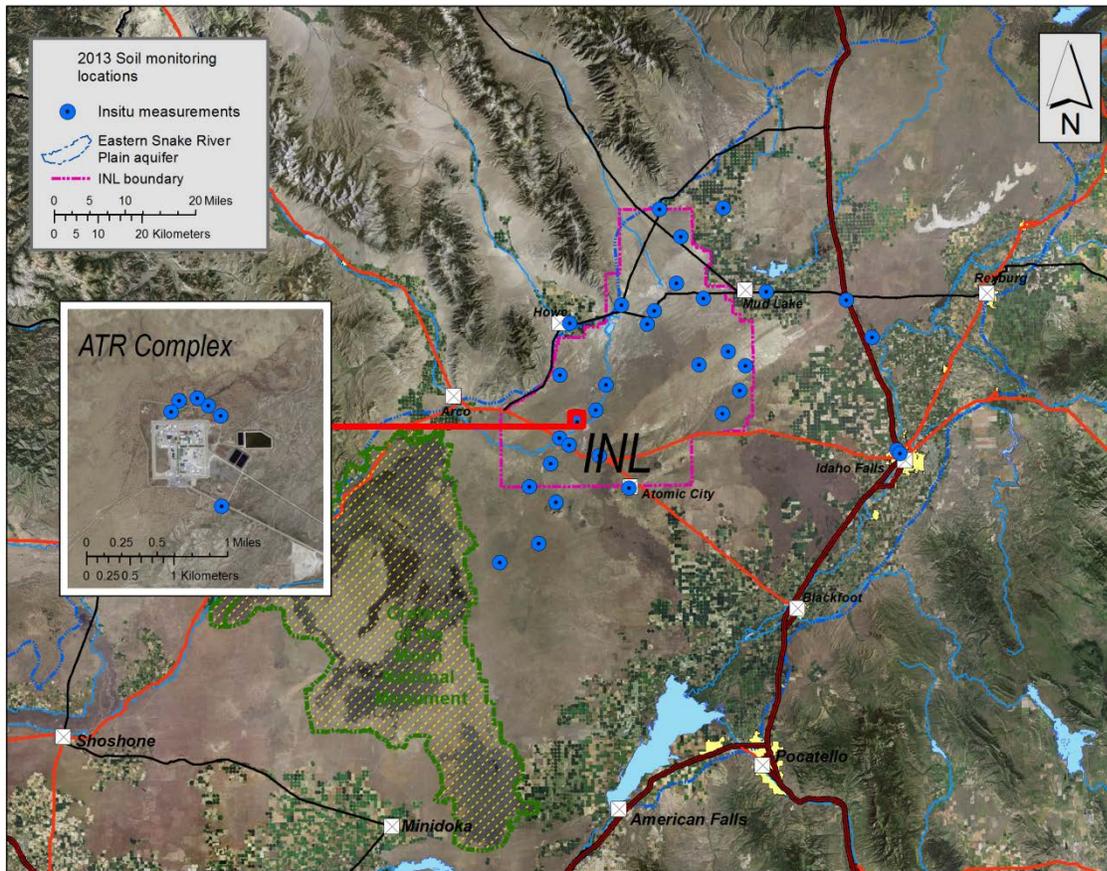


Figure 22. DEQ soil sampling locations for 2013.

### Terrestrial Monitoring Results and Trends

Monitoring concentrations of gamma-emitting radionuclides in surface soil provides insight to the transport, deposition, and accumulation of radioactive material in the environment as a result of INL operations and historic atmospheric testing of nuclear weapons. During 2013, DEQ made *in-situ* gamma spectrometry measurements to characterize accumulations of gamma-emitting radionuclides in surface soil at 37 locations.  $^{137}\text{Cs}$  was the only man-made radionuclide that was detected at any of these locations. The average  $^{137}\text{Cs}$  value for *in-situ* measurements was 0.22 picocuries per gram (pCi/g) with a minimum value of 0.05 pCi/g and a maximum of 1.37 pCi/g. All results were well below the Oversight Program’s screening level for surface soil of 6.8 pCi/g of  $^{137}\text{Cs}$  (NCRP Report 129).

Milk sampling is conducted by DEQ to determine whether radioactive iodine is present or absent in the food supply. Radioactive iodine is produced in relatively large quantities during fission reactions (e.g., in nuclear reactors). The chemical nature of iodine makes it mobile under normal conditions. Gaseous radioactive iodine can be dispersed through the atmosphere and carried along with the wind until it is deposited on plants. Dairy cows and goats that graze on radioiodine-contaminated pasture or feed will accumulate radioiodine in the milk they produce. Drinking this milk could lead to an accumulation of radioactive iodine in the thyroid gland and a greater risk of thyroid cancer.

During 2013, DEQ analyzed 56 milk samples. Radioactive iodine was not detected in any milk sample. The DEQ action level of 4.4 pCi/L is based upon the radioiodine concentration in milk necessary for an infant to receive an annual thyroid radiation dose of 5 millirem. The Food and Drug Administration (FDA) recommended maximum concentration of  $^{131}\text{I}$  for food, including milk, is 4600 pCi/kg.

### **Terrestrial Monitoring Verification Results**

Naturally occurring  $^{40}\text{K}$  is present in milk and soil and is ideal as a quality control measurement and indicator of measurement sensitivity. Therefore, many of the comparisons conducted between DEQ and DOE sample results include this isotope, especially since the target radionuclide (such as  $^{131}\text{I}$ ) is seldom detected in milk samples.

Gamma spectroscopic analysis results of the 24 milk split samples collected by the DOE contractor and submitted to DEQ for analysis were compared with DOE results.  $^{40}\text{K}$  results obtained by DEQ showed 83% agreement with DOE contractor results, which is considered satisfactory. All  $^{131}\text{I}$  results were below the minimum detectable activity for both agencies.

*In-situ* gamma spectrometry results from soil at five co-located sample sites were compared with the DOE contractor's results. DEQ and DOE contractor results for  $^{137}\text{Cs}$  showed 60% agreement. The average results for  $^{137}\text{Cs}$  are 0.50 pCi/g for DEQ and 0.39 pCi/g for the DOE contractor. These results were well below the DEQ screening level, 6.8 pCi/g for surface soil (NCRP 129).

### **Terrestrial Monitoring Impacts and Conclusions**

Based upon terrestrial radiological measurements of soil and milk, there were no discernible impacts to the environment from INL operations. Long-term accumulated deposits of radionuclides observed by soil monitoring in 2013 were consistent with historical measurements and were in the range of concentrations expected as a result of historic above-ground testing of nuclear weapons.

### ***Quality Assurance for the ESP***

This section summarizes the results of the quality assurance (QA) assessment of the data collected during calendar year 2013 by the DEQ's Environmental Surveillance Program. All analyses and quality control (QC) measures at the analytical laboratories used by the DEQ were performed in accordance with approved written procedures maintained by each laboratory. A QA/QC program was implemented for in-situ gamma spectrometric equipment, using the manufacturer's software and recommended methods. Sample collection was performed in accordance with written procedures maintained by the DEQ. Analytical results for blanks, duplicates, and spikes were used to assess the precision, accuracy, and representativeness of results from analyzing laboratories. During calendar year 2013, the DEQ submitted 396 QC samples for various radiological and non-radiological analyses. The data were validated, assigned qualifiers to designate any restrictions on their use, and deemed complete, meeting the program's data quality objectives.

## Issues and Problems

During late 2012 and through 2013, OP replaced older HPICs with new units. After the new HPICs were introduced, obvious incorrect readings were recorded intermittently by several of the units. The intermittent problems generally manifested themselves as sporadic, isolated spikes or longer-term over- and under-responses. The isolated spikes are of relatively minor concern because they do not significantly affect the average exposure measurements, are not correlated between HPIC locations (correlation of spurious signals could seriously affect interpretation of results with respect to natural or man-made origins of a fluctuation), and are considered to be a tolerable consequence of infrequent, transient power supply (power company or solar) fluctuations. The persistent, longer-term deviations of indicated exposure rate from the expected values are thought to be caused by deficiencies in the instrument power adaptors (especially inadequate weather-hardening and ruggedizing for field use) and the apparently greater sensitivity of the new units to these power supply deficiencies. During 2013, DEQ dealt with these issues by removing obviously incorrect data from quarterly data sets before developing summary statistics. DEQ is conducting an on-going effort to upgrade the reliability of instrument power adaptors or provide alternative power sources.

The HPIC measurements at Fort Hall were particularly problematic during 2013 – three HPICs installed at Fort Hall gave out-of-range results and then failed entirely, requiring the manufacturer's service. DEQ requested that Idaho Power monitor their power supply to the monitoring station, but the power company did not record any unusual conditions. The program is considering using a battery-powered supply to isolate the HPIC from the line power supply. If this does not resolve the problem, other potential causes for the equipment failures will be identified and investigated.

## Comparing Data

DEQ compares its data with DOE's to determine whether the programs' data sets are statistically equivalent, or if each programs' data support the same conclusions relative to environmental impacts and public health. To evaluate statistically the degree of agreement between organizations' split sampling and co-sampling measurements, DEQ evaluates the Relative Percent Difference (RPD) between results using the following equation:

$$RPD = ((DOE \text{ result} - DEQ \text{ result}) / ((DOE \text{ result} + DOE \text{ result})/2)) \times 100$$

An RPD in the range of  $\pm 20\%$  is considered to indicate acceptable agreement between measurements. DEQ may also calculate an average of all the RPDs found for a specific test or analyte.

DEQ also checks the agreement of results for radiological analyses by comparing the absolute value of the difference between sample results to the pooled uncertainty as follows:

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

Where:

$R_1$  = First sample value.

$R_2$  = Second sample value.

$S_1$  = 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.

Individual pairs of measurements having an absolute difference of no more than three times their pooled uncertainty, or with RPD less than  $\pm 20\%$ , are considered to be statistically in agreement. Paired data sets are considered to be in satisfactory statistical agreement if at least 80% of the individual paired results are in agreement.

## Assessing INL Impacts

DEQ evaluates public health and environmental impacts from INL activities and proposed projects. DEQ reviews INL's management of radiological materials and wastes, including inventories, storage, treatment, transportation, and disposal. DEQ supports compliance determinations of the 1995 Settlement Agreement between the State of Idaho, U.S. Navy, and DOE which outlines milestones for safe storage, treatment, and removal from Idaho of transuranic waste (TRU), high-level radioactive waste (HLW), and spent nuclear fuel (SNF). DEQ also reviews INL safety concerns and incidents through the DOE Occurrence Reporting and Processing System (ORPS).

DEQ observes and maintains awareness of INL Site activities not covered by DEQ's Waste Management/Remediation and Air Quality Divisions—who have regulatory authority over CERCLA site remediation, RCRA hazardous waste management, and INL air emissions. The major INL Site activities that DEQ observes are:

***1) Transuranic Waste Shipments to the Waste Isolation Pilot Plant***

- Advanced Mixed Waste Treatment Plant,
- Accelerated Retrieval Project,
- Sludge Repackaging Project, and
- Remote Handled TRU Project.

***2) Integrated Waste Treatment Unit Construction***

***3) Calcine Disposition Project Planning***

***4) Spent Nuclear Fuel - Receipt and Movement from Wet to Dry Storage***

***5) Occurrence Reporting and Processing System Reviews***

***6) National Environmental Policy Act Monitoring and Reviews***

### ***Transuranic Waste Shipments to the Waste Isolation Pilot Plant***

Transuranic radioactive elements are products of nuclear reactions with atomic numbers greater than uranium (such as plutonium, neptunium, americium, curium, and/or californium).

Transuranic (TRU) waste generally consists of protective clothing, tools, glassware, equipment, soils, and sludge contaminated with transuranic radioactive elements. Most transuranic waste was created during the production of nuclear weapons, during research on nuclear materials, or during treatment of waste contaminated with transuranic radioactive elements. A large portion of INL's transuranic waste originated at the Rocky Flats weapons production plant in Colorado and is now being treated, repackaged, and shipped to the Waste Isolation Pilot Plant (WIPP) in New Mexico.

Transuranic waste is divided into two categories based on the surface radiation levels of unshielded containers packaged with the waste. These two categories are:

- Contact-handled transuranic (CH-TRU) waste which is TRU waste in unshielded containers with surface radiation dose rates below 200 millirem per hour, and
- Remote-handled transuranic (RH-TRU) waste which is TRU waste in unshielded containers with surface radiation dose rates exceeding 200 millirem per hour. Because of its high surface radiation dose rate, RH-TRU waste must be handled remotely and is transported in lead shielded casks.

Transuranic waste being shipped from INL to WIPP is packaged under four projects:

- Advanced Mixed Waste Treatment Plant (Project),
- Accelerated Retrieval Project,
- Sludge Repackaging Project, and
- Remote Handled TRU Project.

### ***Advanced Mixed Waste Treatment Plant***

The Advanced Mixed Waste Treatment Plant (AMWTP) is a RCRA permitted facility that ships waste from the Transuranic Storage Area (TSA) out-of-state. Most waste at the TSA came from Rocky Flats in Colorado. In 1999, shipment of TRU waste out-of-state to WIPP in New Mexico began. Waste from the TSA that is characterized as not being TRU waste is shipped to other out-of-state disposal facilities. Per the 1995 Settlement Agreement, INL must ship at least 2,000 cubic meters (initial volume – meaning prior to compaction) of TRU waste out-of-state each year over a three year running average. Additionally, the 1995 Settlement Agreement requires that all TRU waste be removed from Idaho by a target date of 2015 and no later than 2018.

Since shipment of TRU waste to WIPP began in 1999, 42,201 cubic meters of TRU waste from the TSA and ARP (see next section) have been disposed at WIPP. Shipments to WIPP over the past three calendar years have been:

2011:	2506 cubic meters
2012:	2568 cubic meters
2013:	2487 cubic meters

This shipment volume meets the Settlement Agreement requirement to ship at least 2,000 cubic meters initial volume of TRU waste out-of-state each year over a three year running average.

### ***Accelerated Retrieval Project Activities***

The Accelerated Retrieval Project (ARP) is a CERCLA activity to remove targeted waste buried prior to 1970 in the Subsurface Disposal Area (SDA) at the INL Site. Under a 2008 agreement between DOE, EPA, and the State of Idaho, targeted waste is being excavated and retrieved from a specific 5.69 acres of the SDA. This acreage was chosen because it is expected to contain a large portion of the transuranic waste, hazardous solvents, and depleted uranium that is of concern to the State of Idaho and EPA.

Excavated targeted waste is identified, repackaged, characterized, and shipped off-site for disposal. Targeted waste characterized as transuranic is shipped to WIPP in New Mexico. Non-

transuranic targeted waste is shipped to other off-site locations for treatment or disposal as appropriate.

**ARP Targeted wastes consist of:**

- filters, graphite, and series 741 sludge containing transuranic radionuclides (i.e., americium-241 and plutonium-239/240),
- series 743 sludge containing absorbed solvents, and
- depleted uranium contained in roaster oxides.

**The ARP is being implemented in nine phases where targeted waste is excavated, packaged, characterized, and sent to WIPP for disposal. These nine phases and their status are:**

- 1) ARP I - completed in 2008 with excavation of 0.50 acres.
- 2) ARP II - completed in 2009 with excavation of 0.35 acres.
- 3) ARP III - completed excavation of 0.37 of 0.42 acres in 2009. The last 0.05 acre was excavated in 2013.
- 4) ARP IV - completed in 2011 with excavation of 0.79 acres.
- 5) ARP V - completed in 2011 with excavation of 0.55 acres.
- 6) ARP VI - completed in 2011 with excavation of 0.40 acres.
- 7) ARP VII - excavation began in 2012 and 0.15 of 0.27 acres was excavated by the end of 2013.
- 8) ARP VIII - construction began in 2011 and was completed in 2013. Excavation of 1.72 acres began in November 2013 with 0.01 acres excavated by the end of 2013.
- 9) ARP IX - slated to begin construction around 2018 with 0.69 acres planned for excavation.

At the end of 2013, DOE had excavated 3.17 acres of targeted waste and sent 5757 cubic meters of transuranic waste to WIPP from ARP.

## ***Sludge Repackaging Project***

In 2013, DOE repurposed one of the ARP structures (ARP V) to be used for treatment and repackaging of 6,000 drums (1200 cubic meters) of mixed waste sludge. This waste was originally sent to Idaho in the 1970s from the now closed Rocky Flats nuclear weapons production plant located near Denver and was stored at the TSA. These drums contain free liquid and sludge with the consistency of peanut butter making it among the most difficult materials to remove from drums and treat. These drums must have liquids removed or absorbed before this waste is acceptable for disposal at WIPP.

Prior to this project, numerous proposals and activities had been attempted to treat (remove or absorb liquid from) these drums and none had been successful. The ARP facility is using its heavy excavation equipment to empty the drums and to add absorbent for removal of free liquids. The waste is then sent through the ARP facility drum repackaging stations to repackage the waste into new drums. These drums are then transported back to AMWTP to be re-certified for shipment to WIPP.

By the end of 2013, about 4,000 sludge drums had been processed through the sludge repackaging program. The remaining 2000 drums in this batch are expected to be treated by mid-

2014. An additional batch of about 6000 sludge drums stored at the TSA is likely to be treated through the sludge repackaging project in the future.

## ***Remote-Handled Transuranic Waste Shipments***

In 2007, DOE made INL's and DOE's first shipment of RH-TRU waste to WIPP in New Mexico.

Throughout 2013 DOE continued to ship RH-TRU waste to WIPP. DOE is currently characterizing, sorting, treating, and packaging RH-TRU waste previously stored in below ground vaults north of the Materials and Fuels Complex (MFC) at the Radioactive Scrap and Waste Facility (RSWF) for shipment to WIPP. This waste originated from MFC and Argonne National Laboratory-East. DOE modified existing hot-cells at the Idaho Nuclear Technology and Engineering Center (INTEC) CPP-666 Building for processing this RH-TRU waste. Transfer of the RSWF RH-TRU waste from MFC to INTEC began in 2009. Startup of RH-TRU repackaging in CPP-666 began in January 2010 and the first RSWF RH-TRU waste shipment was sent to WIPP in February 2010. Processing of this waste will continue for several more years.

Some of the RH-TRU waste retrieved from RSWF contains elemental sodium. Elemental sodium is very reactive with water and must be removed before the waste can be shipped to WIPP. In 2013, DOE began construction of a sodium distillation system in CPP-666 to remove elemental sodium from remote handled transuranic waste. This sodium distillation system is expected to be operational in 2014. This RH-TRU sodium contaminated waste will take a couple of years to process once the system is operational.

### **Some of the activities DEQ performed in 2013 to evaluate safe management of transuranic waste included:**

- Tracked WIPP shipments and coordinated WIPP shipment safety with the Idaho State Police (ISP) (who inspect every outgoing truckload) and with other states through the Western Governors Association (WGA).
- Reviewed DOE reports detailing AMWTP progress on shipping TRU waste out of Idaho.
- Reviewed real-time radiography (RTR) screen shot paperwork for AMWTP box dumping operations to assure proper disposal volume credit was received for TRU waste processed through the AMWTP super compactor.
- Conducted visits to AMWTP to observe waste management activities.
- Observed the DOE Carlsbad Field Office TRU waste recertification audits of AMWTP associated activities.
- Participated in numerous site visits to observe activities at ARP facilities and attended meetings where ARP progress was addressed.
- Toured packaging facilities, attended meetings, and reviewed documents pertaining to the ongoing process of shipping RH-TRU waste to WIPP.

## ***Integrated Waste Treatment Unit Construction***

DOE completed construction of the Integrated Waste Treatment Unit (IWTU) in 2012. This facility was constructed to treat approximately 900,000 gallons of sodium-bearing waste (SBW) currently in four 300,000 gallon tanks (one nearly empty) at the INTEC Tank Farm. Treatment will consist of solidification and preparation of this waste for off-site disposal. Solidification of

SBW is required to meet the 1995 Settlement Agreement milestone that states, “DOE shall complete calcination of sodium-bearing liquid high-level waste by December 31, 2012.” SBW contains sodium ion in aqueous solution as well as radioactive and hazardous constituents from previous spent nuclear fuel (SNF) reprocessing and decontamination activities. Calcination of sodium-bearing waste proved to be difficult due to the presence of sodium ion and was suspended in 2000. As an alternative treatment to calcination, DOE selected steam-reforming to treat and stabilize the SBW for final disposition and the State of Idaho agreed to this Settlement Agreement change. Steam-reforming technology will solidify the SBW into a granular material that will be packaged in stainless steel canisters and stored in concrete vaults at the site pending final disposal decisions.

On June 16, 2012, during start-up testing (prior to addition of any radioactive or hazardous materials) the IWTU experienced a pressure event that caused the IWTU safety systems to safely shut down operations. The IWTU uses wood-based charcoal to bring the facility up to a temperature of 700 degrees Celsius. A component of the facility, the Carbon Reduction Reformer (CRR), became overloaded with charcoal which only partially burned due to the excess amount of charcoal and lack of adequate oxygen. The CRR ground the excess charcoal into a fine dust which passed through the CRR clogging the down-stream high efficiency particulate air filters (HEPA) and off-gas filters resulting in the pressure event. Before the IWTU can restart it must be modified to prevent a reoccurrence of the pressure event. Modifications to the facility are centered around introducing more oxygen into the CRR for better charcoal combustion; securing filter bundles so they do not move due to pressure changes; ensuring the back-pressure systems operate as designed; installing additional pressure-relief valves; and adding additional layers of monitoring to detect pressure variations. While these modifications were being evaluated, other potential problems were recognized and are also being addressed. It is anticipated that IWTU will resume start-up testing activities in early 2014. Treatment of the SBW is projected to take about seven months.

DOE has missed the 1995 Idaho Settlement Agreement milestone requiring that SBW be solidified by December 31, 2012. Therefore, per the enforcement agreement in the 1995 Idaho Settlement Agreement, shipment of DOE (but not Navy) spent fuel to INL has been suspended until treatment of the SBW is completed.

**Some of the activities DEQ performed that were related to IWTU construction included:**

- Maintained periodic contact with DOE personnel for routine updates regarding IWTU start-up progress and problems.
- Attended briefings on the pressure event and start-up testing activities.
- Toured the IWTU facility.
- Attended meetings where IWTU progress/problems were discussed.

## ***Calcine Disposition Project Planning***

The INL Calcine Disposition Project (CDP) is currently preparing construction and operation plans for a facility to treat calcine for disposal in a geologic repository. This calcine was produced from spent nuclear fuel reprocessing liquid waste that was solidified at the INL Site from 1953 to 2000.

Most of the acidic liquid waste produced during spent nuclear fuel reprocessing was calcined into a dry granular solid using a high temperature process that reduced the volume by about seven-fold. Calcining of the acidic liquid waste also greatly reduced the threat of it contaminating the Snake River Plain Aquifer. About 4,400 cubic meters of calcine is currently stored in 43 stainless steel bins within six massive shielded and reinforced concrete silos located at INTEC on the INL Site. The calcine is a mixed waste that is highly radioactive with radiation levels up to 6,000 Roentgen per hour.

In December 2009, the Department of Energy (DOE) documented in a Record of Decision (ROD) its decision to use Hot Isostatic Pressing (HIP) technology for treatment of the calcined high level waste. In the HIP process, calcine and treatment additives will be mixed and then loaded into thin wall cans that will be welded shut. These cans will be placed in a pressure vessel, which will be heated to “melt” the calcine mixture while compressing the can with high pressure argon gas to reduce volume.

Per the 1995 Settlement Agreement, DOE is required to have the calcined waste prepared for transport to a facility outside of Idaho by a target date of December 31, 2035. Additionally, the Settlement Agreement required that a RCRA Part B Permit be submitted to the State of Idaho by December 1, 2012; this requirement was met. Once the RCRA Part B Permit is finalized with the State of Idaho, further work on calcine disposition planning will be delayed until after 2016 due to Federal budget constraints.

**Some of the activities DEQ performed that were related to the calcine disposition project planning included:**

- Maintained contact with DOE personnel involved with the CDP.
- Attended meetings where CDP progress was detailed.

## ***Spent Nuclear Fuel - Receipt and Movement from Wet to Dry Storage***

### **Spent Nuclear Fuel Receipt at INL**

The Idaho Settlement Agreement milestone requiring solidification of sodium bearing waste (SBW) by the end of 2012 was not met; therefore, shipments of DOE Environmental Management (EM) owned SNF and DOE Nuclear Energy (NE) owned SNF to the INL have been suspended until treatment of the SBW is completed. However, receipt of Navy spent fuel continues as the Navy and DOE are treated as separate entities in the enforcement agreement section of the 1995 Idaho Settlement Agreement. During 2013, the Navy received two rail shipments containing three containers of SNF at the Naval Reactors Facility (NRF).

### **Spent Nuclear Fuel Movement from Wet to Dry Storage**

Most of the SNF at INL has been placed in dry storage. Under provisions of the 1995 Settlement Agreement, DOE agreed to complete the transfer of all INL SNF from wet storage to dry storage by the end of 2023 and to remove all SNF from Idaho by 2035. DOE completed transfer of DOE Environmental Management (EM) owned SNF from wet storage in Building CPP-666 to dry storage in Building CPP-603 in 2010. This leaves only the Navy SNF and DOE NE SNF in wet storage at CPP-666. Navy SNF is currently being moved from CPP-666 to dry storage at NRF.

DOE NE SNF includes: 1) Experimental Breeder Reactor II (EBR II) SNF which is being moved to the Materials and Fuels Complex (MFC) for treatment and 2) Advanced Test Reactor (ATR) SNF that is being removed from CPP-666 after it has cooled for about six years and is then cool enough to be moved to dry storage.

**Some of the activities DEQ performed that were related to the safe management of SNF included:**

- Tracked shipments of SNF into Idaho from decommissioned naval nuclear reactors.
- Maintained awareness of SNF sources, characteristics, and storage locations as the inventory of SNF changed at the INL.
- Monitored mission need activities associated with decisions regarding the Idaho Spent Fuel Facility (ISFF) (formerly the proposed Foster Wheeler fuel storage facility project) which will be used to repackage SNF for shipment out of state.
- Reviewed NRF SNF shipment quarterly reports.

### ***Occurrence Reporting and Processing System Reviews***

The DOE Occurrence Reporting and Processing System (ORPS) is an integral part of the DOE Occurrence Reporting Program. This program provides timely notification to DOE of events that could adversely affect: public or DOE worker health and safety, the environment, national security, DOE's safeguards and security interests, or functioning of DOE facilities. DOE ORPS reports provide an important resource for obtaining information on numbers and types of these events, common or related causes for these events, effectiveness of corrective actions, and lessons learned.

**Some of the activities DEQ performed to monitor the ORPS were:**

- Reviewed ORPS reports for events that occurred on the INL site.
- Performed follow-up on selected ORPS reports to assess how DOE addressed some safety and environmental incidents which occurred at the site.

### ***National Environmental Policy Act Monitoring and Reviews***

The National Environmental Policy Act (NEPA) establishes a national framework for protecting the environment. NEPA requires that Federal agencies consider the environmental impacts of their proposed actions and reasonable alternatives to those actions. The NEPA process is intended to help public officials make decisions that are based on understanding environmental consequences and take actions that protect, restore, and enhance the environment. The three basic levels of NEPA review and documentation are: (1) Environmental Impact Statement (EIS); (2) Environmental Assessment (EA); and (3) Categorical Exclusion (CX). The type of proposed action and the degree of environmental impacts determine the appropriate level of environmental review.

**During 2013, the DEQ monitored the status of the following EAs and EISs pertinent to INL:**

- 1) Idaho High-Level Waste and Facilities Disposition (DOE/EIS-0287).
- 2) Disposal of Greater-Than-Class-C Low-Level Radioactive Waste (DOE/EIS-0375).

- 3) Proposed Consolidation of Nuclear Operations Related to the Production of Radioisotope Power Systems (DOE/EIS-0373).
- 4) Hanford Tank Closure and Waste Management, Richland, Washington (DOE/EIS-0391).
- 5) Storage and Management of Elemental Mercury (DOE/EIS-0423).
- 6) EIS Notice of Intent (NOI) for Navy Recapitalization of Infrastructure Supporting Naval Spent Nuclear Fuel Handling and Examination at INL.
- 7) Resumption of Transient Testing of Nuclear Fuels and Materials at the Idaho National Laboratory (DOE/EA-1954).

## **Radiological Emergency Response Planning and Preparedness**

DEQ's role in emergency response planning and preparedness is defined in detail in the Environmental Oversight and Monitoring Agreement (EOMA) with the DOE. DEQ works with DOE and INL contractors to evaluate and participate in response planning, and to respond to incidents. DEQ works with state, federal and local agencies to respond to incidents, as described in the Idaho Hazardous Materials Response Plan. The Idaho Bureau of Homeland Security (IBHS) coordinates state emergency response actions in Idaho. Most of DEQ's emergency response activities are directed towards planning and response to INL incidents. DEQ also responds to non-INL radiological incidents to help maintain lines of communication with the State's emergency response organization, and as opportunities to test organizational readiness under real-world conditions. As a part of public outreach DEQ can provide technical information, assistance, and training to local and state authorities for incidents involving radiological materials at the INL or elsewhere in Idaho.

By agreement with DOE, INL radiological incident response planning is based on hazard assessment documents (HADs) developed by DOE contractors. These documents describe potential incidents at INL facilities that could release radionuclides to the environment. Review of current INL HADs is a key element of preparing for INL radiological emergencies. This information allows DEQ to identify scenarios that could potentially result in off-site radiological impacts, and plan appropriate responses. DEQ uses the source inventory and accident scenarios from the HADs to develop input for atmospheric dispersion and dose modeling using the Radiological Assessment System for Consequence Analysis (RASCAL) code. RASCAL uses near-real time weather data from NOAA's MesoNet for regional-scale dispersion modeling. This allows DEQ to make independent radiological dose assessments for planning purposes, and would support development of timely technical and protective action recommendations for state authorities during actual emergencies. DEQ staff also receive text messages for the INL Warning Communication Center any time their emergency resources are deployed; primarily the INL Fire Department.

### ***INL Radiological Incidents in 2013***

There was a fire in the box line at the Advanced Mixed Waste Treatment Facility located on the INL. There was no release of radioactivity outside of the facility barriers. DEQ staff responded to the INL Emergency Operations Center on September 20, 2013 in response to the event.

## ***Non-INL Radiological Incidents***

DEQ staff participated in response to notification that an unidentified, dense metallic object was found in Craigmont, in Lewis County. Based on the description of the object, it was assumed that it was likely a radiation shield for a radiological source, possibly made from depleted uranium. DEQ and IFRO staff worked with the State of Idaho emergency response coordinator (Mark Dietrich) and IBHS (Fred Abt) to provide information to the first-responding Regional Response Team concerning the significance of their radiological survey instrument readings. At the request of the State, the DOE Radiological Assistance Program (RAP) responded to the scene and characterized the object. Given the description of the object and the housing it was removed from, it was most likely a shield for a neutron source that also produced a substantial gamma radiation field, such as an americium/beryllium or radium/beryllium source. No neutron source was present, and the RAP characterization of the object showed that it was depleted uranium with trace amounts of cesium-137 contamination. The RAP after-action report indicated that "...the material did not present a threat and did not present a health hazard to the business owners, the first responders, or the general public.

## ***Drills and Exercises***

DEQ staff received notifications for drills being conducted at multiple INL facilities during 2013. DEQ staff responded to annual exercises conducted by INL contractors Battelle Energy Alliance (BEA) and CH2MHill/WGI (CWI).

DEQ staff participated in a hospital drill conducted by the Naval Reactors Program. This drill included participation of BEA, Eastern Idaho Regional Medical Center, Bingham Memorial Hospital, IBHS, and the DOE Radiological Assistance Program (RAP). DEQ staff also participated in a Naval Reactors Program transportation exercise in Fort Wayne, Indiana involving the new shipping cask designed for aircraft carrier nuclear fuel.

## ***Waste Isolation Pilot Plant Shipment Safety***

DOE contracts with the Western Governors Association (WGA) to coordinate activities related to the safe shipment of transuranic waste to WIPP through western states. DEQ works with the Idaho State Police (ISP) and the IBHS to manage WIPP shipment safety activities on the US Route 20/26, Interstate 15, and Interstate 84/86 corridors in Idaho.

During 2013, DEQ:

- Oversaw radiological equipment repairs and calibrations for DEQ, ISP, and all seven Idaho regional response teams.
- Staff members attended the National Transportation Stakeholders Forum and two meetings of the WGA Technical Advisory Group (TAG). DEQ staff also participated in monthly conference calls of the WIPP TAG.

## ***Emergency Response Planning and Preparedness Training***

DEQ staff attended 20 Local Emergency Planning Committee (LEPC) meetings and twelve INL Emergency Working Group meetings. DEQ staff attended the 2013 National Radiological Emergency Preparedness (NREP) meeting in Salt Lake City, including NRC presentations on the RASCAL code.

## ***Classes and Presentations***

DEQ staff observed and supported training on radiological response for the Boise Fire Department. Training was conducted by the DOE RAP team. DEQ staff provided equipment and actively participated in training the Idaho Falls Fire Department HazMat team. Both training sessions included classroom presentations and hands-on training with radiation survey instruments.

# Public Outreach

A fundamental aspect of DEQ's work is sharing our findings with the public and factoring public input into our activities and policy recommendations. DEQ uses several tools to provide Idahoans with independent, accurate, and timely information about activities relating to the INL and other DOE activities in Idaho – publications, events, our Web site, and our community monitoring network

## Publications

DEQ regularly issues technical and non-technical publications to communicate the findings and activities of our program. In 2013, we issued:

- The DEQ Annual Report for 2012.
- Four quarterly environmental surveillance data reports.
- The DEQ Publication: **Demolition of Excess Facilities** - Fall 2013. Some of the topics covered were:
  - Environmental Monitoring of the INL Site
  - INL Site Areas with Demolition Activities
- The DEQ Publication: **Our Changing Aquifer** - Fall 2013. Some of the topics covered were:
  - Aquifer Recharge and Discharge
  - Aquifer Storage
  - Aquifer Changes Over Time

**Idaho Department of Environmental Quality**

**Cleanup at the Idaho National Laboratory**

**Demolition of Excess Facilities**

Since its inception in 1949, the Idaho National Laboratory (INL) Site has been involved in cutting edge research for the production of nuclear power. Since that time, more than 50 nuclear research reactors have been constructed and operated on the site. These reactors were used to test reactor principles, fuel types, and construction materials. Nuclear power research was needed to develop performance and safety standards for design, construction, and operation of commercial nuclear power plants.

Many of the facilities that housed these reactors (or supported associated activities) on the INL Site were built decades ago. Some were demolished to make way for new use and were declared to be excess facilities. In 2005, the Department of Energy (DOE) started demolishing these excess facilities because ongoing maintenance and security costs could not be justified. Since 2003, about 240 excess facilities have been demolished. DOE, in contrast, the Environmental Protection Agency (EPA) and the State of Idaho worked together to plan the demolition of these facilities was completed safely, under budget, and ahead of schedule. This accomplishment was recognized in June of 2013 when the INL excess facilities demolition project was awarded a DOE Secretary's Excellence and Achievement Award.

In 2009, the Department of Environmental Quality (DEQ) prepared a routine newsletter on the status of demolition of excess INL facilities. This publication is an update to the 2009 DEQ publication which addressed completed and planned demolitions from 2005 to 2012. Since 2009, many facilities have been demolished and a few facilities scheduled for demolition had demolition delayed or cancelled. Most excess facilities were located within six major facility areas on the INL Site.

For each of the six major areas, this publication provides:

- pictures of demolition activities completed since 2008,
- a short history of past activities,
- information about ongoing activities, and
- a summary of current environmental contamination information.

\* Facilities are buildings or structures. Structures include process towers, fuel tanks, water tanks, halogenate plant, expansion tank, storage tank, and other steel facilities.



Many buildings previously used for nuclear research at the Idaho National Laboratory (INL) were built decades ago, were declared excess, and have been demolished.

**DEQ-INL Oversight Program**  
**Environmental Monitoring of the INL Site**

DEQ-INL Oversight Program regularly performs a variety of environmental monitoring activities on and around the INL Site. This monitoring focuses on environmental pathways (air, water, and soil) through which radionuclides or other contaminants from the INL Site could enter the environment. The extensive nature of the DEQ-INL Oversight Program's routine environmental monitoring is designed to detect any contamination release from the INL Site, including potential releases from demolition activities. This monitoring includes:

- Air monitoring stations that continuously sample for radioactive particulates, radon, radon progeny, and tritium.
- A radon monitoring network that collects real-time and quarterly radon measurements.
- Monthly collection of soil samples from local districts and soils production facilities that are tested for radioactive iodine.
- Annual measurements taken from undisturbed soils to screen for man-made radionuclides.
- Annual collection of ground water samples to check for radionuclides and non-radionuclide contaminants.

This monitoring is performed by DEQ scientists with expertise in ground water hydrology and health physics. For more information on DEQ-INL Oversight's environmental monitoring of the INL Site, see the DEQ-INL Oversight Program publication about Monitoring and Surveillance of the Idaho National Laboratory at <http://www.deq.idaho.gov/inl/inl-oversight.html> PDF Fall 2013

**Idaho Department of Environmental Quality**

**The INL Oversight Program**

Fall 2013

**our changing AQUIFER**

For most of the Eastern Snake River Plain, just like elsewhere, water flows from high country to low. From the surrounding high mountains it channels into streams, lakes, and smaller rivers, eventually flowing into the Snake River Plain in the portion of the plain occupied by the Idaho National Laboratory (INL). Over the last 100 years, at least in some areas, something dramatically different happens. Here, where sediments deposited by the action of wind and water slowly permeate layers of loess, streams like the Big and Little Lost Rivers simply disappear. Some of the water that flows into the aquifer with the rest being lost to the Eastern Snake River Plain Aquifer through seepage. This water will eventually re-emerge at the "Thousand Springs" reach of the Snake River, along the north-west of the Snake River Canyon between Milner and King Hill.

Vanadium mines and the fluctuating spring of the Magic Valley are but two features of the remarkable Eastern Snake River Plain Aquifer, the focus of this revised issue of the Oversight Program. And the primary source that the Department of Environmental Quality (DEQ) Oversight Program exists. Concerns about activities conducted by INL affect the aquifer and environment via the flowing flows behind the formation of a site Oversight Program. Protecting the aquifer resources is always part of the discussion to make sure that water is being conserved, whether the discussion concerns new INL research projects, increasing water based on jobs and revenue, or demolishing buildings that aren't needed anymore. The question "how will this impact the aquifer?" will always be asked. As we struggle to find the appropriate balance between competing demands for our state's finite water resources, we must have an understanding of the factors that impact the source of much of Idaho's water: the Eastern Snake River Plain Aquifer.

**Aquifer Basics: The Bathtub Concept**

An aquifer can be thought of as a bathtub—a bathtub that, in the case of the Eastern Snake River Plain Aquifer, covers 16,800 square miles and consists of thousands of cubic miles of porous, fractured rock and thin sediment layers. Water from the ground recharges the 16.8 million acre-foot of water that flows above the basin (or is splashed on the floor) in discharge from the INL. Water that is stored in the basin is replenished or recharged from the INL. When more water is recharged to the basin than flows out, the water level in the basin increases and more water is in storage. The water balance for an aquifer is:

Recharge – Discharge = Change in storage

**Aquifer Recharge**

The source that recharges the aquifer varies from a number of sources. The amount of water recharging the aquifer varies from year to year. However, the proportion of recharge from these sources stays about the same. It is estimated that 160 million acre-foot of water recharged the Eastern Snake River Plain Aquifer in water year 1989. Because a good deal of monitoring and sampling takes place that year, it provides a good benchmark for comparison.

The largest source of water recharging the aquifer is from irrigation. Irrigation water seeps into the ground, and works its way to the aquifer. For the 1989 water year (October 1979-September 1980), this accounted for 4.8 billion acre-foot, or 49% of all recharge. The next largest source of recharge to ground water that flows to the aquifer from the tributary valleys along the margins of the Snake River plain. This includes recharge from the Henry's Fork and South Fork of the Snake River, and the valleys of the Snake, Big and Little Lost Rivers, the Red and Blue Wood Rivers, Fremont and Blue River valleys, and other smaller valleys. This source added 1.4 billion acre-foot, or 18% of recharge. While the climate of the Eastern Snake River Plain Aquifer is semiarid, with less than 16 inches of precipitation each year, the timing of the rain and snow melt and snow cover melting and snow occurring in times of the year when there is less evaporation, and the water soil cover over much of the basin of the plain allows a significant amount of precipitation to recharge the aquifer in water year. This source of precipitation on the plain accounts for 0.76 billion acre-foot, or 9% of recharge.

Water subsiding from the bed of the Snake River is also a significant source of recharge. Along some lengths ("reaches") of the Snake River, the riverbed is above the aquifer level allowing water to seep through the river bed to recharge the aquifer ("leaky river"). Since aquifer levels can change during the year, some reaches of the river can "seep" during times of the year that the aquifer level is lower, and "take" when the aquifer level is above the bed of the river. About 0.6 billion acre-foot, or 9% of recharge was from Snake River losses. Just like the Snake River, other rivers and streams, as well as canals, that flow out on to the Eastern Snake River Plain can recharge the aquifer. This recharge from tributary streams and canals added 0.39 billion acre-foot, about 5% of the recharge for the 1989 water year.




Photo: Idaho Department of Environmental Quality

**our changing AQUIFER**

Our aquifer is always changing

**recharge – discharge = changes in storage**

Recharge to the aquifer increased an irrigated agriculture expanded, with about 24 million acre-foot of water added to the Eastern Snake River Plain Aquifer from the 1980's to 2002. The aquifer holds an estimated 1 billion acre-foot of water, but only 190-220 million acre-foot is most easily reached by wells.

Most (60%) of the aquifer discharge is from springs that flow to the Snake River. As aquifer levels increased, flow from springs increased, peaking in 1955. As aquifer levels have decreased, so have discharge from these springs.

**Recharge**

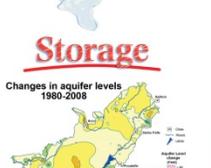
Acres irrigated and source of water for irrigation 1999, 1959 and 2000



The primary source of recharge is irrigation water diverted from surface water sources like the Snake River. As more lands were irrigated with surface water, more water recharged the aquifer. From the completion of Milner Dam in 1965 through the completion of Palouse Dam in the late 1950's, more water could be moved to "use" times to irrigate the fertile farm lands, with ground water pumped to satisfy thirsty lands that couldn't be reached by canals. Many farmers rely on both surface water and ground water sources to meet irrigation needs. When surface water is used for sprinkler irrigation, less aquifer recharge results.

**Storage**

Changes in aquifer levels 1980-2008



Surface water available for irrigation reflects the precipitation and snowfall and recharge deficit water used for irrigation and how that irrigation water is used. Prior to the 1950's peak recharge, water was added to our aquifer "spring account." Since that time, we've been "banking" water in wet years and "withdrawing" from our savings in dry years. Estimates are that we've withdrawn nearly 1 billion acre-foot, about half our savings since the 1950s.

Department of Environmental Quality  
INL Oversight Program  
[www.deq.idaho.gov/oversight.htm](http://www.deq.idaho.gov/oversight.htm)  
1-800-221-4638

DEQ-INL OP publications are available at <http://www.deq.idaho.gov/inl-oversight/monitoring/reports.aspx>

## ***Presentations and Events***

DEQ also communicates with the public about INL-related issues through schools, fairs, special interest groups, and public events. In 2013, we gave public presentations on the aquifer, and INL Site issues to a range of schools, civic groups, and special interest groups.

At the Twin Falls County Fair, we presented information on water nitrate testing, crop burning, and our various publications for the public to review and ask questions. We presented Edible Aquifer hands-on activities for the youth to participate and learn about the importance of our aquifer (**Figure 23**).

The Water Festival event was attended by over 1,000 students and we presented the Rain Stick activity and the Macro Invertebrate Mayhem activity in **Figure 24**. Each year, some of the students from the Water Festival participate in the Poetry contest. The poems and winners are displayed in the Idaho Falls Library two weeks prior to the event (**Figure 25**). Idaho Falls Earth Day was a hit with the youth enjoying the Edible Aquifer presentations (**Figure 26**) and the adults filling up the DEQ carry-all bags with Earth Day giveaways (**Figure 27**).



**Figure 23. Children enjoying the Edible Aquifer activity at the Twin Falls Fair.**



**Figure 24. Children enjoying Macro Invertebrate Mayhem activity at Water Festival 2013.**



**Figure 25. Water Awareness Poetry Contest on display at the Idaho Falls Library.**



Figure 26. Children participating in the Edible Aquifer activity at the 2013 Earth Day event.



Figure 27. DEQ participating in the 2013 Earth Day event.

## ***Community Monitoring Network***

DEQ also participates in a community monitoring network in Eastern Idaho in cooperation with the Shoshone-Bannock Tribes, the U.S. Department of Energy, and NOAA. Strategically located community monitoring stations provide real-time atmospheric and radiological data to the public at each station location and also transmit data to the World Wide Web at <http://www.idahoop.org/>. **Figure 28** shows one community monitoring station.



**Figure 28. Community monitoring station at the greenbelt in Idaho Falls.**

