

# **DEQ-INL Oversight Program Annual Report 2016**



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

MDA	minimum detectable activity	RSWF	Radioactive Scrap and Waste Facility
MDC	minimum detectable concentration	RTC	Reactor Technology Complex
NCRP	National Council on Radiation Protection and Measurements	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	WAI	Wastren Advantage Inc.
RCRA	Resource Conservation and Recovery Act	WGA	Western Governors Association
RH-TRU	remote-handled transuranic	WIPP	Waste Isolation Pilot Plant

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.
- 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 during 2016. The report is divided into sections covering the Environmental Surveillance Program (ESP), 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 Wastren Advantage, Inc. (WAI), (In April 2016, DOE-ID awarded a five-year contract to Wastren Advantage, Inc., which was previously managed by Gonzales-Stoller Surveillance, LLC, whose contract ended in March 2016), the United States Geological Survey (USGS), Idaho Cleanup Project Core contractor (Fluor LLC), and the prime INL contractor, Battelle Energy Alliance, LLC (BEA). WAI 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.

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 2016, 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 off-site 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 one 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 2016 were consistent with past results. Water samples collected from on-site locations near INL Site facilities identified concentrations of  $^{90}\text{Sr}$  (strontium-90), chloride, fluoride, sulfate, nitrate plus nitrite, manganese, iron, 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 from both on-site and off-site monitoring locations. When detected these levels were less than one 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.

### 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	$\mu$
$0.000000001 = 10^{-9}$	nano	n
$0.000000000001 = 10^{-12}$	pico	p
$0.000000000000001 = 10^{-15}$	femto	f
$0.000000000000000001 = 10^{-18}$	atto	a

## ***Trends***

Results for 2016 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, fluoride, sulfate, nitrate plus nitrite, manganese, iron, and VOCs exceeded federal drinking water standards at locations on the INL in 2016. 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.

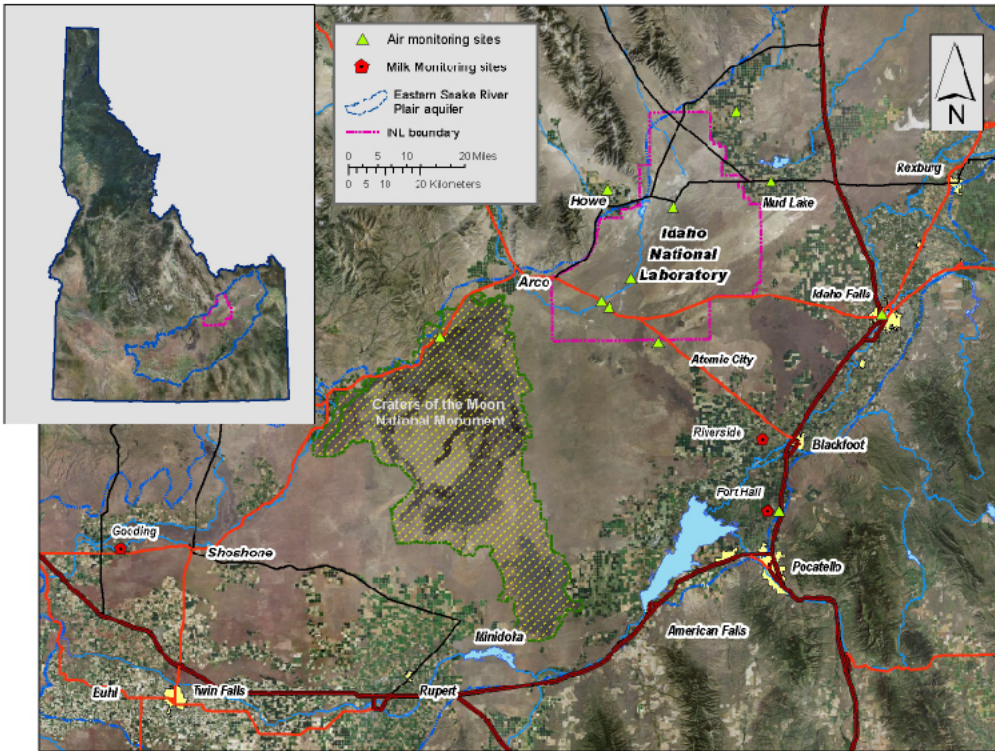
In the pages that follow, the results of DEQ's monitoring for each type of media (air, radiation, water, soil, and milk) are discussed in greater detail.

## ***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 pictured 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, Highway 20 Rest Area, and Sand Dunes/INL Gate 4.
- Off-site stations are located near the INL boundary and include Mud Lake, Montevideo, 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 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 two total suspended particulate (TSP) matter samplers.**

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 divided by 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 and subsequently analyzed for tritium.

Precipitation samples are obtained at six locations 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 monitoring results and trends for air monitoring.

### Particulate Matter in Air

A total of 588 filters from TSP samplers were collected during 2016. 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 2016 were less than the DEQ 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-INL Oversight Program for 2016.**

DEQ-INL Oversight Program	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> )
2016	-0.32 to 4.35	0.89 ± 0.12	6.46 to 86.71	25.62 ± 0.59

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 detection of <sup>90</sup>Sr at the Big Lost River Rest Area: 14.7 ± 6.2 attocuries<sup>1</sup> per cubic meter (aCi/m<sup>3</sup>) (MDC 9.6 aCi/m<sup>3</sup>). This value is within the expected range due to global fallout from historic above-ground nuclear weapons testing. The reported concentration is much less than one percent of the federal regulatory limit for <sup>90</sup>Sr of 19 fCi/m<sup>3</sup> (40 CFR 61).

### Atmospheric Tritium

A total of 129 atmospheric moisture samples were collected in 2016 from 11 monitoring locations and analyzed for tritium. Detectable airborne tritium concentrations are occasionally

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



observed in the environment. The highest airborne tritium concentrations observed by DEQ on the INL in 2016 were  $1.28 \pm 0.68$  pCi/m<sup>3</sup> at the Experimental Field Station for the time period of September 15 through September 29,  $0.89 \pm 0.42$  pCi/m<sup>3</sup> at Van Buren Avenue for the time period of March 31 through May 12,  $0.74 \pm 0.44$  pCi/m<sup>3</sup> at the Big Lost River Rest Area station for the time period of April 28 through May 26, and  $0.27 \pm 0.48$  pCi/m<sup>3</sup> at the Sand Dunes station for the time period of April 28 through May 26.

All atmospheric tritium measurements for 2016 were much less than one percent of the 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 2016.

### **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 differ from those drawn from the results of another program.

For 2016, 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, airflow measurement uncertainty, equipment configuration and random 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 2016.**

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

Sampling Agency	ESER WAI <sup>a</sup>	BEA <sup>b</sup>
DEQ Gross Alpha Analysis	80.0 %	100.0%
DEQ Gross Beta Analysis	37.2 %	81.5 %

a. ESER – Environmental Surveillance, Education and Research [Program], conducted by INL contractor Wastren Advantage Inc. (WAI).

b. BEA – Battelle Energy Alliance, INL prime contractor during 2016.

Comparing tritium sample results among DEQ, ESER, and BEA is problematic because although sampling sites are co-located, samples are not paired or split samples. 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 make a direct one-to-one comparison of results not possible. 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 2016 air quality 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. One specific radionuclide analysis of composite air samples resulted in a statistical detection of a human-made radionuclide (<sup>90</sup>Sr) at a concentration much less than 1% of the federal standard for members of the public (40 CFR 61).

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 comparison or, (2) because each organization's 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 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>

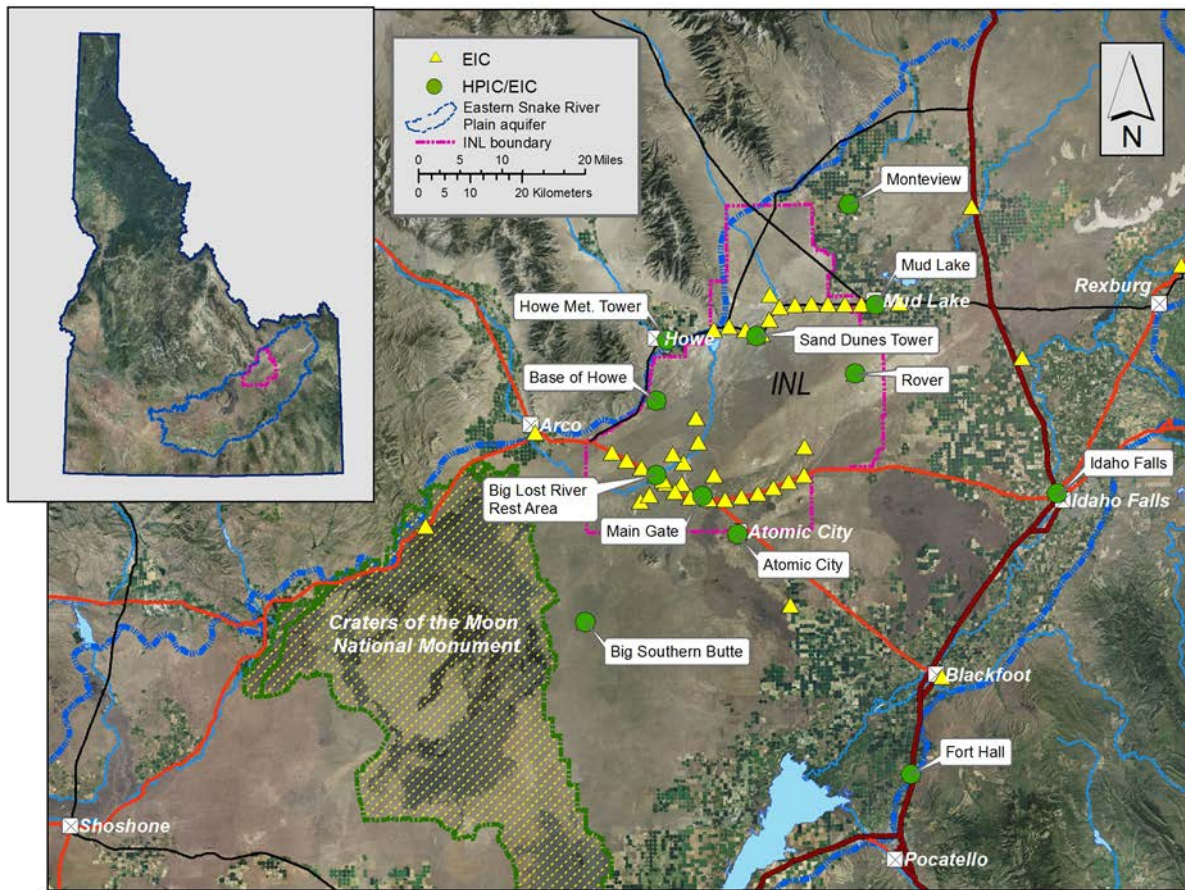
DEQ also uses a network of passive electret ionization chambers (EICs) on and around the INL to measure cumulative radiation exposure over quarterly monitoring periods. The objectives of the DEQ EIC network are to identify baseline (background radiation) levels to use for comparison in the event of an 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.



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

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

During the course of 2016, 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 radiation exposure associated with cosmic, naturally occurring terrestrial, and human-made sources.



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

### **Radiation Monitoring Verification Results**

DEQ uses EICs at several locations where DOE contractors monitor radiation using optically stimulated luminescent dosimeters (OSLD). Results of the contractors' and DEQ's measurements are used to determine the comparability of the organizations' ambient penetrating radiation measurement programs. During 2016, 100% of BEA's annual average OSLD dosimeters and 90% of ESER Wastren Advantage Inc. (WAI) annual average OSLD measurements were in statistical agreement with DEQ's measurements at co-located EIC sites (**Table 3**), meeting the program's objectives.



**Table 3. Comparison of DEQ, ESER and BEA radiation measurements at co-located sites in 2016. (Units in micro-Roentgen per hour or  $\mu\text{R/hr}$ )**

Statistical Measure <sup>c</sup>	DEQ	ESER <sup>a</sup> WAI	DEQ	BEA <sup>b</sup>
Mean	13.8	14.0	12.8	13.1
Median	13.7	13.7	13.6	13.2
Standard Deviation	1.8	1.4	2.4	2.2
Minimum	11.1	12.7	6.4	7.1
Maximum	17.7	17.2	15.0	15.9
Average % difference		-2%		-1%

a. ESER – Environmental Surveillance, Education and Research [Program], conducted by INL contractor Wastren Advantage Inc.

b. BEA – Battelle Energy Alliance, INL prime contractor during 2016.

c. Each organization’s dataset is reviewed to ensure that it supports a valid test of comparability of measurements.

## Radiation Monitoring Impacts and Conclusions

Based upon radiation measurements made by DEQ, there were no discernable impacts from INL operations in 2016. Measurements on the INL are comparable to those at background locations. Quarterly averaged HPIC and EIC exposure measurements during 2016 met DEQ’s criterion for agreement. The results from all three monitoring agencies indicate no public health risk from environmental ambient penetrating radiation from both natural and human-made sources.

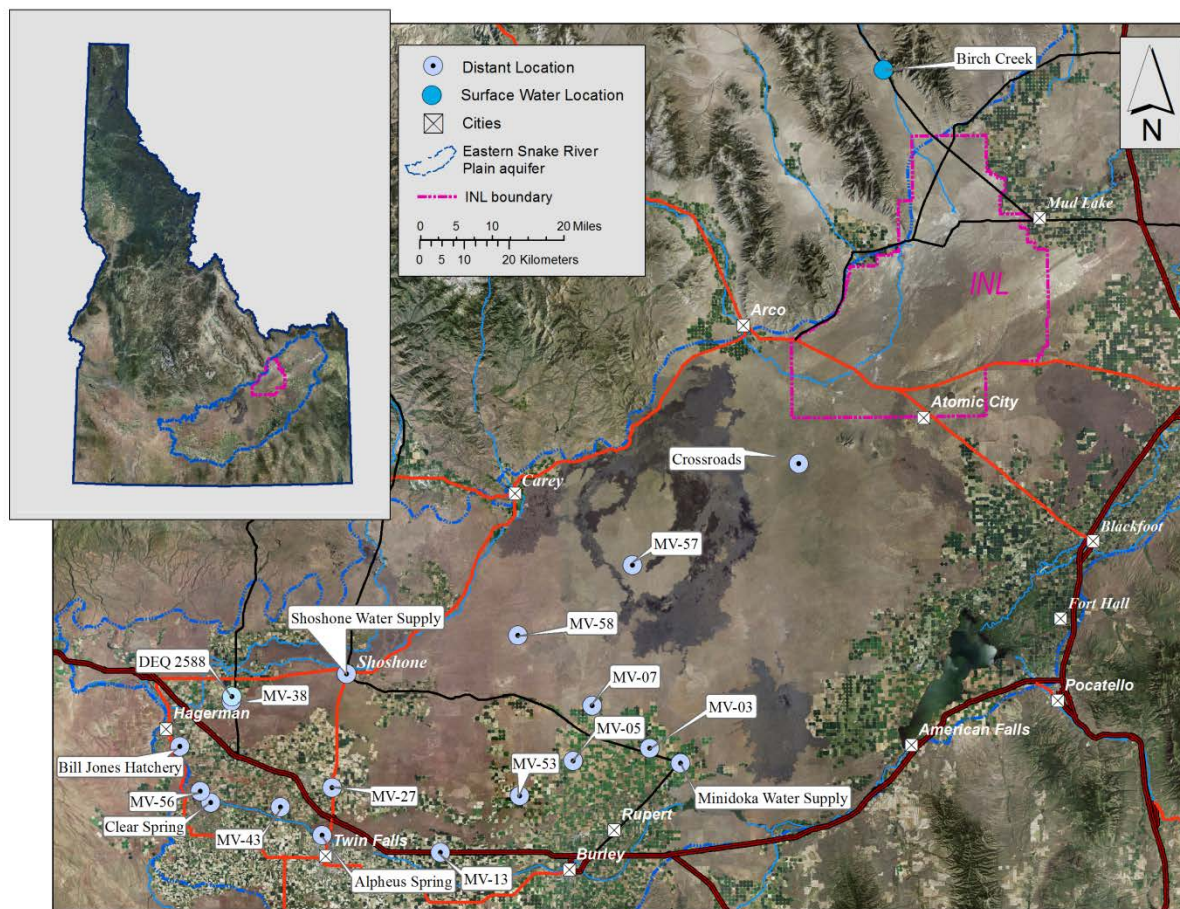
## Water Monitoring

During 2016, 86 water monitoring sites were sampled by DEQ to aid in identifying INL impacts to the Eastern Snake River Plain Aquifer (ESRPA). Data from these monitoring sites are used to evaluate long-term trends in the concentrations of INL contaminants and other groundwater quality indicators. Analytical results reported by DEQ are compared with results obtained by DOE contractors and the USGS to evaluate consistency.

Of the sites sampled in 2016, 84 are groundwater locations (wells and springs), one is a surface water location (stream), and one is a wastewater location (**Figures 7 and 8**). Each sample site is categorized as up-gradient, facility, boundary, distant, surface water, or wastewater. Up-gradient locations are situated north and northeast of INL facilities and have not been affected by INL operations. Facility locations are sample sites within the INL that are near facilities or in areas of known contamination; many are sampled to monitor trends of specific INL contaminants. Boundary locations are on or near the southern boundary of the INL, down-gradient of potential sources of INL contamination. Distant locations are farther down-gradient of the INL and include wells and springs used for agricultural, municipal, domestic, and industrial purposes. Surface water and wastewater locations are monitored because they are current sources of recharge to the aquifer.

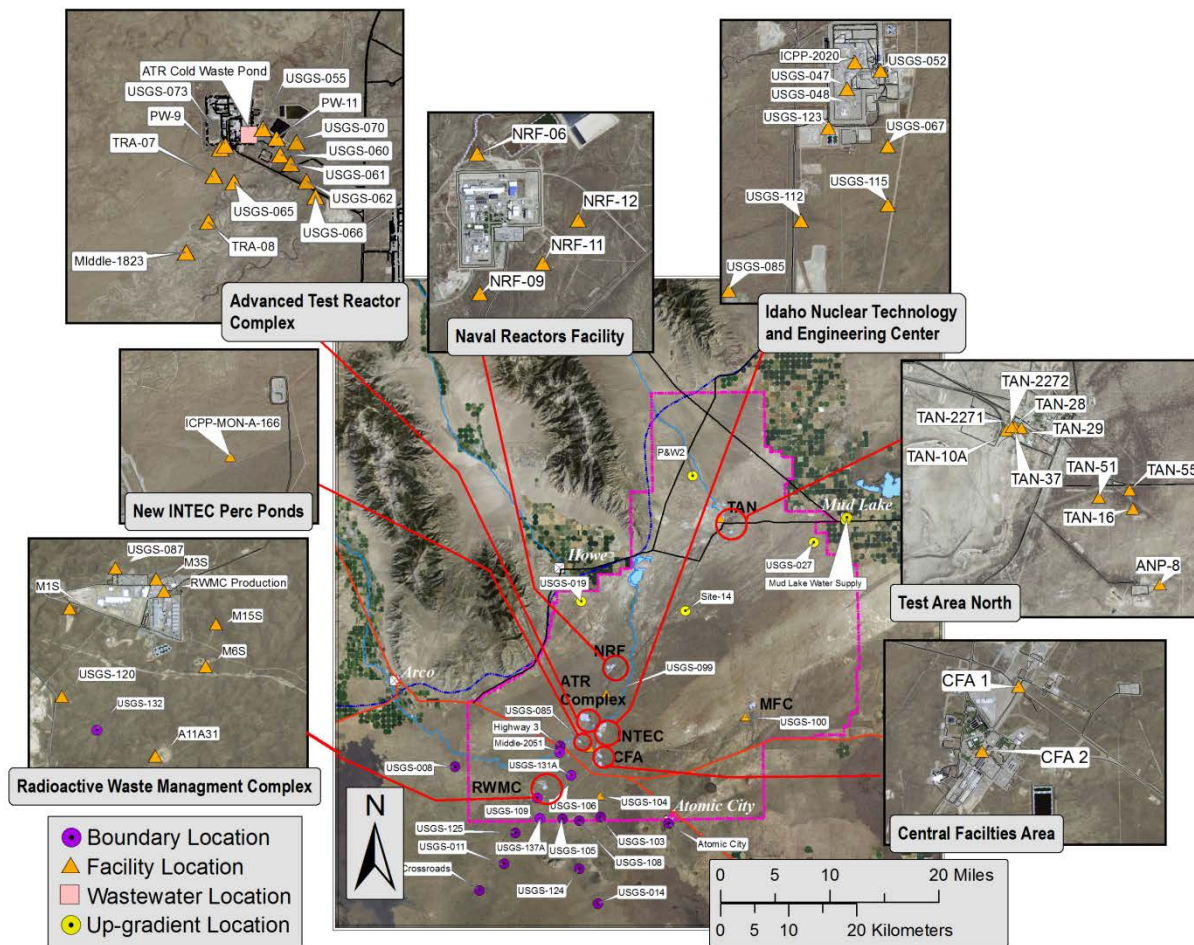
Samples collected from water monitoring sites are analyzed for various radiological and non-radiological constituents, many of which are present in the aquifer both naturally and as a result

of INL operations. Concentrations of gross alpha and gross beta radioactivity, gamma-emitting radionuclides, tritium, common ions, dissolved trace metals, and nutrients are measured at all locations. Selected sites are also sampled for specific radionuclides—including uranium and plutonium isotopes, americium-241, strontium-90, and technetium-99—and/or volatile organic compounds based on past and present INL operations or a history of elevated concentrations. Analytical results are compared to historical results and known background concentrations to evaluate INL impacts to the aquifer.



**Figure 7. Water quality monitoring sites distant from the INL.**





**Figure 8. Water quality monitoring sites on and near the INL.**

## Water Monitoring Equipment and Procedures

Most groundwater samples were collected from wells equipped with submersible pumps. Groundwater samples at some boundary locations were collected from wells fitted with Westbay™ multilevel sampling systems (referred to below as “Westbay wells”). In a Westbay well, samples may be collected from multiple aquifer zones by lowering stainless steel sample bottles to sample ports isolated by permanent packer systems. Groundwater samples from springs and the surface water sample were collected as grab samples from the water source. The wastewater sample was collected as a 24-hour composite.

Water samples were collected, handled, and preserved using standard DEQ sampling procedures (**Figures 9, 10, and 11**). Trace metals and nutrients samples were filtered, and samples for gross alpha, gross beta, gamma-emitting nuclides, uranium isotopes, plutonium isotopes, americium-241, strontium-90, trace metals, and nutrients were preserved with acid immediately after sample collection. VOCs were collected in vials already containing acid. Samples collected from all facility, boundary, surface water, and wastewater sites, most up-gradient sites, and some distant sites were collected concurrently with sample collection by the USGS or a DOE contractor.

Radiological analyses were performed by ISU-EML or its subcontractor(s). Samples from all monitoring locations were analyzed for gross alpha and gross beta radioactivity, gamma-emitting radionuclides, and tritium ( $^3\text{H}$ ). Samples from selected sites with historical INL contamination were also analyzed for uranium isotopes ( $^{234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$ ), plutonium isotopes ( $^{238}\text{Pu}$  and  $^{239/240}\text{Pu}$ ), americium-241 ( $^{241}\text{Am}$ ), strontium-90 ( $^{90}\text{Sr}$ ), and/or technetium-99 ( $^{99}\text{Tc}$ ).

Non-radiological analyses were conducted by the Idaho Bureau of Laboratories in Boise or their subcontractor(s). Samples from all locations were analyzed for common ions (calcium, magnesium, sodium, potassium, chloride, fluoride, sulfate, and total alkalinity), nutrients (total nitrate plus nitrite and total phosphorus), and dissolved trace metals (arsenic, barium, chromium, iron, manganese, lead, selenium, and zinc). Samples from selected sites were also analyzed for volatile organic compounds (VOCs).

Laboratory methods used for all analyses were consistent with industry standards for drinking water samples.



**Figure 9. Collecting ground water samples from a monitoring well.**





**Figure 10. Collecting water samples above a fish hatchery in Billingsley Creek.**



**Figure 11. Labeling samples collected at Alpheus Springs, Snake River Canyon.**



## Water Monitoring Results and Trends

A summary of analyte concentrations measured at up-gradient, facility, boundary, distant, surface water, and wastewater monitoring sites is presented here. Analytical results from several sample locations with histories of high concentrations are examined more closely to identify current trends. Results for all environmental surveillance samples collected by DEQ for the INL Oversight Program are available in quarterly data reports on the DEQ website <http://www.deq.idaho.gov/inl-oversight/monitoring/reports.aspx>.

### Radiological Analytes

DEQ samples all water monitoring locations for gross alpha and gross beta radioactivity, gamma-emitting radionuclides, and tritium. Selected locations are also sampled for specific radionuclides. Concentrations of radiological analytes measured in 2016 were generally consistent with those measured in previous years. Results are summarized in **Table 4**. Significant findings for each radiological analyte are discussed below.

**Table 4. Summary of selected radiological analytical results for DEQ 2016 water samples, wastewater excluded.**

Analyte (pCi/L)	Facility			Up-gradient, Boundary, Distant, and Surface Water			Background <sup>1</sup>	Drinking Water Standard (pCi/L)
	Min	Median	Max	Min	Median	Max		
Gross Alpha	<MDC	2.2	15.0 ± 5.9	<MDC	1.4	4.0 ± 1.5	0-4	15
Gross Beta <sup>2</sup>	<MDC	6.3	1994 ± 24	<MDC	3.4	10.6 ± 1.2	0-7	---
<sup>137</sup> Cs	<MDC	<MDC	3.6 ± 2.0	<MDC	<MDC	<MDC	0	200 <sup>4</sup>
Tritium <sup>3</sup>	<MDC	610	5760 ± 250	<MDC	<MDC	1150 ± 130	0-34	20,000 <sup>4</sup>
<sup>234</sup> U	0.90 ± 0.24	1.58	8.7 ± 1.5	NS	NS	NS	0.043-1.36	---
<sup>235</sup> U	<MDC	0.05	0.42 ± 0.15	NS	NS	NS	0-0.025	---
<sup>238</sup> U	0.41 ± 0.14	0.70	1.53 ± 0.36	NS	NS	NS	0.021-0.541	---
<sup>238</sup> Pu	<MDC	0.001	0.005	NS	NS	NS	0	---
<sup>239/240</sup> Pu	<MDC	0.0015	0.012	NS	NS	NS	0-0.003	---
<sup>241</sup> Am	<MDC	<MDC	<MDC	NS	NS	NS	0	---
<sup>90</sup> Sr	<MDC	0.87	770 ± 180	NS	NS	NS	0	8 <sup>4</sup>
<sup>99</sup> Tc	0.5 ± 0.2	1.35	351.1 ± 1.7	NS	NS	NS	0	900 <sup>4</sup>

Uncertainties are reported at 2σ. Abbreviations: pCi/L, picocuries per liter; MDC, minimum detectable concentration; NS, not sampled.

<sup>1</sup> Background levels for gross alpha, gross beta, and <sup>137</sup>Cs are derived from over 20 years of DEQ groundwater monitoring in the ESRPA. Background levels for <sup>3</sup>H, uranium isotopes, plutonium isotopes, <sup>90</sup>Sr, and <sup>99</sup>Tc are based on the minimum and median values reported for western tributary water in Table 1 in Bartholomay and Hall (2016; DOE/ID 22237). Background concentrations depend on local geology and proximity to surface water recharge locations. Concentrations for sites not influenced by INL activities may still be higher than the given background ranges.

<sup>2</sup> Gross beta as <sup>137</sup>Cs.

<sup>3</sup> Results for tritium are from the standard analysis method, with an MDC of approximately 130 pCi/L.

<sup>4</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.

### Gross Alpha and Gross Beta Radioactivity

Radionuclide contributors of alpha and beta activity occur in the aquifer naturally and as a result of past INL operations. Gross alpha and gross beta analyses measure radioactivity contributed by all alpha and beta emitters in a water sample (excluding tritium and radon). These analyses are used for screening purposes and do not yield measurements of specific radionuclide concentrations.

The primary natural sources of alpha radioactivity in groundwater and surface water are uranium and thorium, and the primary natural sources of beta radioactivity are potassium-40 and beta-emitting daughter products of naturally occurring uranium and thorium. All of these nuclides are present in the bedrock and sediments of the Eastern Snake River Plain at low concentrations, and their presence in groundwater contributes to a low but measureable level of radioactivity in the aquifer, defined as background. Background concentrations of gross alpha and gross beta radioactivity, derived from over 20 years of DEQ data collected from ESRPA locations not affected by INL activities, are given as ranges in **Table 4**.

Gross alpha levels observed at most facility locations and all up-gradient, boundary, distant, and surface water locations in 2016 were within the background range defined by DEQ and can be attributed to natural sources. Levels above background were measured at five facility locations, four of which were at Test Area North (TAN) and one of which was at the Advanced Test Reactor (ATR) complex. The single wastewater location sampled (ATR Cold Waste Pond) also had gross alpha activity slightly above background. The highest gross alpha concentration measured was  $15 \pm 5.9$  pCi/L at facility site TAN-2271. The EPA maximum contaminant level (MCL) is 15 pCi/L.

Gross beta levels exceeded background at several facility locations. Most of these are at TAN, where the highest concentration was  $1994 \pm 24$  pCi/L at TAN-2271, and at INTEC, where the highest concentration was  $171 \pm 3$  pCi/L at USGS-052. The high level of gross beta activity at TAN is due to high concentrations of  $^{90}\text{Sr}$ , discussed below. One location at ATR (USGS-070) had a gross beta concentration above background ( $58 \pm 2$  pCi/L in April and  $49 \pm 2$  pCi/L in October). Up-gradient location USGS-027 and distant location Alpheus Spring also had concentrations slightly above background ( $10.6 \pm 1.2$  pCi/L and  $9.7 \pm 1.1$  pCi/L, respectively).

### **Gamma-emitting radionuclides**

The only gamma-emitting radionuclide detected by DEQ in 2016 was cesium-137, consistent with previous years.  $^{137}\text{Cs}$  is a known groundwater contaminant at TAN and INTEC. In 2016,  $^{137}\text{Cs}$  was detected at TAN-37A ('A' denotes the shallowest sampling depth, 240 feet below the surface, in well TAN-37) at  $3.6 \pm 2.0$  pCi/L and in TAN-2271 at  $2.5 \pm 1.5$  pCi/L. Prior detections of  $^{137}\text{Cs}$  at TAN-37A from 2007 to 2015 range from  $3.7 \pm 2.4$  pCi/L to  $11.7 \pm 2.3$  pCi/L, with the maximum value reported in 2014. The MCL for  $^{137}\text{Cs}$  is 200 pCi/L.

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

Tritium is present in the ESRPA naturally and as a result of INL operations. Natural tritium, produced primarily by the interaction of atmospheric nitrogen with cosmic rays, becomes incorporated in groundwater through surface recharge, resulting in a low background concentration of tritium in young groundwater that decreases with residence time in the aquifer. The background concentration of tritium in the ESRPA is given as a range in **Table 4**. Groundwater locations close to areas of surface recharge may have natural tritium concentrations that are higher than the given background range, whereas groundwater that is distant from surface recharge, such as near the center of the Eastern Snake River Plain, will have natural tritium concentrations near zero.

Tritium contamination in the aquifer was introduced primarily by past INL waste disposal practices, including the use of wastewater injection wells and percolation ponds at ATR, INTEC, and TAN (DOE/ID-22242). Tritium concentrations once exceeded the MCL of 20,000 pCi/L at some wells in these areas; however, over the past two decades, concentrations have declined significantly as residual tritium in the aquifer has decayed radioactively and become diluted.

In 2016, elevated tritium concentrations were measured in facility wells near ATR, INTEC, TAN, the Central Facilities Area (CFA), and the Radioactive Waste Management Complex (RWMC), consistent with previous years. The highest concentration measured at each of these facility complexes was:

- ATR →  $5760 \pm 250$  pCi/L at TRA-07
- CFA →  $3340 \pm 200$  pCi/L at CFA-2
- INTEC →  $2230 \pm 160$  pCi/L at USGS-067
- TAN →  $2170 \pm 160$  pCi/L at TAN-28
- RWMC →  $660 \pm 130$  pCi/L at M3S

**Figure 12** shows tritium trends for select wells at ATR, INTEC, and RWMC. Overall, tritium concentrations in facility wells in 2016 were consistent with previous years and continue to decline gradually.

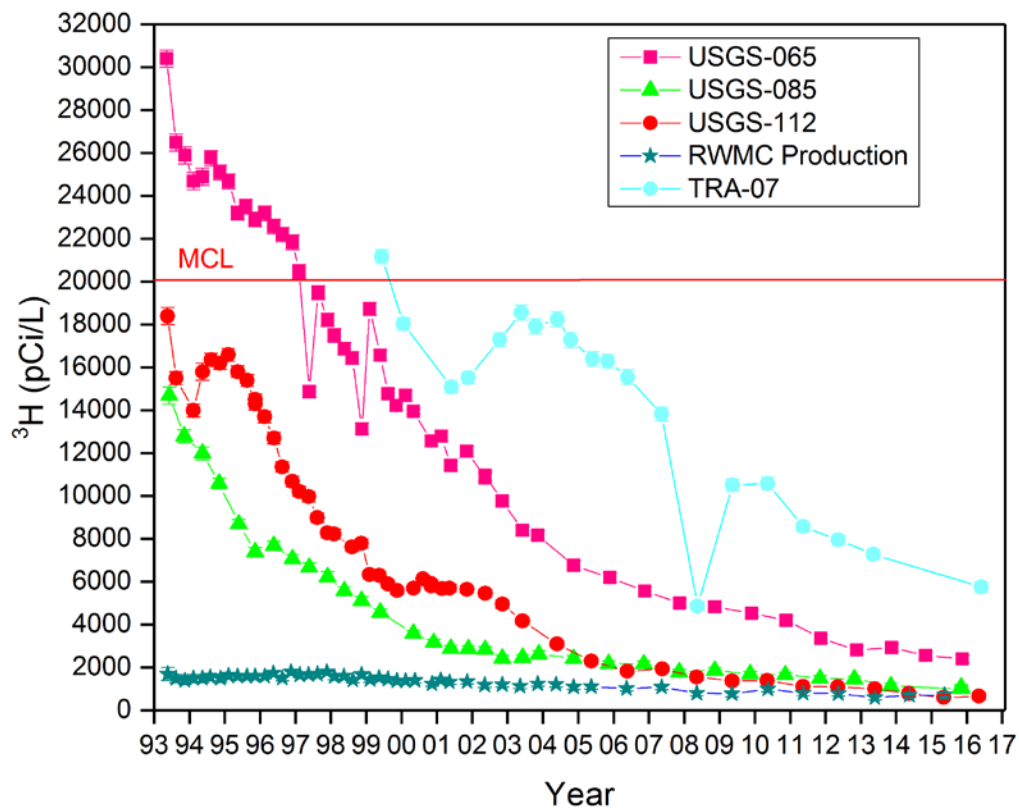
Tritium concentrations above background were also detected in samples from several boundary wells. Most of these were Westbay wells with sample ports at multiple depths (see “Water monitoring equipment and procedures” above), allowing for assessment of the vertical distribution of constituents in the aquifer. The highest tritium concentrations were found in USGS-131A at depths of 616 feet below the surface ( $940 \pm 130$  pCi/L) and 812 feet below the surface ( $1150 \pm 130$  pCi/L). Given this well’s location a few miles down-gradient from ATR, INTEC, and CFA, the elevated concentrations are likely related to INL waste disposal activities. All other Westbay-well samples were collected from depths of 747 to 1258 feet below the surface and had tritium concentrations ranging from less than the lab’s detection limit to  $180 \pm 12$  pCi/L.

The farthest down-gradient above-background detection of tritium in a boundary well was a measurement of  $56 \pm 12$  pCi/L at USGS-014, located approximately eight miles south of the INL southern boundary. This was the highest concentration measured at USGS-014 since 1999, when a result of  $58 \pm 10$  pCi/L was reported, and the first detection of tritium at this location since 2004. USGS-014 is located far from sources of recharge, so the natural tritium concentration is expected to be near zero.

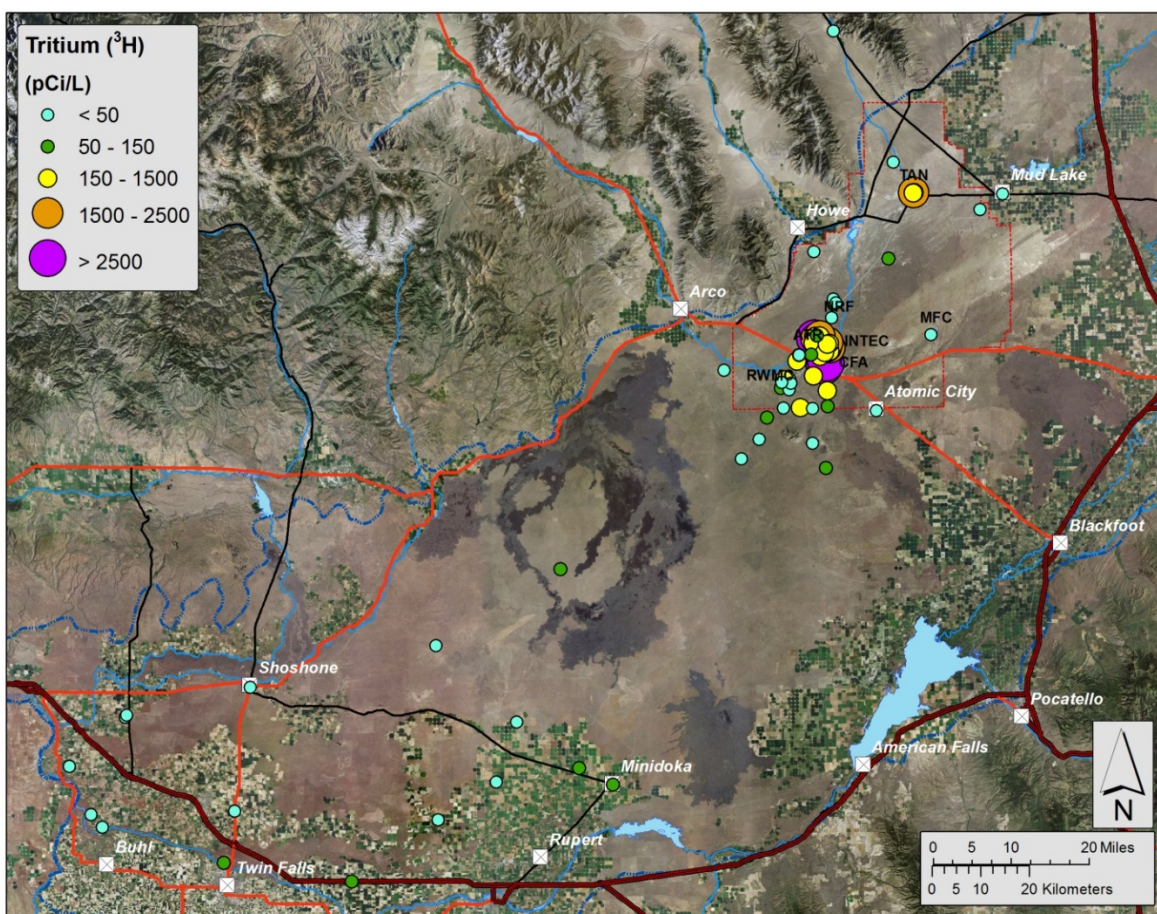
Tritium concentrations were within the background range or below lab detection limits for all distant, up-gradient, surface water, and wastewater locations except for distant well MV-57, which had a concentration of  $77 \pm 10$  pCi/L. A similar tritium concentration has been measured here before ( $75 \pm 10$  pCi/L in 1998). These elevated concentrations are likely due to recent recharge from the surface.

**Figure 13** shows a concentration map of all tritium measurements in 2016.





**Figure 12. Tritium ( $^3\text{H}$ ) concentrations (pCi/L) over time for selected INL Site wells impacted by INL contamination.**



**Figure 13. 2016 Tritium ( $^3\text{H}$ ) concentrations for DEQ sample locations.**

Locations with tritium concentrations reported as below the minimum detectable concentration (MDC) are plotted based on the value of the MDC (e.g., a location whose tritium concentration is reported as  $<100$  pCi/L will be plotted as a green circle).

## Uranium and Plutonium Isotopes

Selected locations at TAN, ATR, INTEC, and RWMC were sampled for uranium and plutonium isotopes and  $^{241}\text{Am}$  in 2016. Plutonium isotopes and  $^{241}\text{Am}$  were not detected at any location. Uranium isotopes ( $^{234}\text{U}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$ ) were detected at concentrations above background in six wells: three at TAN, two at ATR, and one at INTEC. The highest concentrations of all three uranium isotopes were found at TAN-28 (see maximum concentrations in Table 4). Elevated uranium concentrations in the groundwater at TAN have been previously identified and are attributed to past waste disposal practices.

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

$^{90}\text{Sr}$  is one of the two main sources of above-background levels of gross beta radioactivity (the other is technetium-99, discussed in the next section).  $^{90}\text{Sr}$  has been introduced to the aquifer primarily by past waste disposal practices at TAN, INTEC, and ATR. Concentrations of  $^{90}\text{Sr}$  above the MCL of 8 pCi/L are typically measured in the groundwater near TAN, INTEC, and ATR.

In 2016, the highest  $^{90}\text{Sr}$  concentrations continue to be at and near TAN. For the second year in a row, the maximum  $^{90}\text{Sr}$  concentration measured by DEQ was at well TAN-2271 ( $770 \pm 180$  pCi/L), which was installed in 2015 along with TAN-2272. High concentrations were also measured at TAN-2272 ( $380 \pm 89$  pCi/L), TAN-37A ( $369 \pm 87$  pCi/L), and TAN-28 ( $134 \pm 32$  pCi/L). These numbers are higher than 2015 measurements for TAN-2271 and TAN-37A and lower for TAN-28; however, large analytical uncertainties make concentration trends in recent years difficult to ascertain.  $^{90}\text{Sr}$  levels at TAN-10A and TAN-29 remained well below 100 pCi/L in 2016 and were consistent with measurements in previous years.  $^{90}\text{Sr}$  concentrations over time for all TAN wells sampled by DEQ are shown in **Figure 14**.

The concentration of  $^{90}\text{Sr}$  in the groundwater at TAN is directly affected by in situ bioremediation (ISB) treatment of the VOC plume (see discussion in “Volatile Organic Compounds” below). According to the 2016 annual report on groundwater remediation at TAN by the DOE contractor (DOE/ID-11561), an observed increase in  $^{90}\text{Sr}$  concentrations measured in some wells during the past two decades was probably a consequence of ISB injections into the aquifer from 1999 to 2012. Whey and sodium lactate injections increased calcium and magnesium concentrations in the groundwater, resulting in increased competition for adsorption sites on aquifer minerals and likely displacement of strontium cations into the groundwater. Injections were stopped in 2012 for a rebound test of indefinite duration, during which groundwater conditions have been allowed to re-equilibrate in order to assess the state of residual contamination and evaluate the effect of ISB treatment on radionuclide concentrations. Theoretically,  $^{90}\text{Sr}$  concentrations should decrease as conditions return to background. This may explain the  $^{90}\text{Sr}$  trend at TAN-37A, where  $^{90}\text{Sr}$  concentrations have been consistently lower post-2012 than they were pre-2012 (see **Figure 14**). In January 2016, new injections were started at TAN-2272 to treat a residual VOC source in the vicinity of TAN-28 (down-gradient of TAN-2272). Injections at this location can be expected to affect conditions at nearby well TAN-2271 and down-gradient wells TAN-37A, TAN-28, and possibly TAN-29 over the coming years.

$^{90}\text{Sr}$  concentrations above the MCL were also measured at INTEC and ATR. **Figure 15** shows  $^{90}\text{Sr}$  concentrations over time for wells at INTEC (USGS-047, USGS-067, ICP-2020), down-gradient of INTEC (USGS-085, USGS-112), and at ATR (USGS-055). The highest concentration measured near INTEC was  $12.3 \pm 3$  pCi/L at USGS-048. The highest concentration measured near ATR was  $19.4 \pm 4.7$  pCi/L at USGS-070. USGS-055, a perched aquifer well near low-level radioactive waste ponds at ATR and the usual location of the highest  $^{90}\text{Sr}$  concentration at ATR, was dry in 2016 and could not be sampled. All concentrations measured in 2016 were consistent with previous years.

A concentration map of all locations sampled for  $^{90}\text{Sr}$  in 2016 is shown in **Figure 16**.

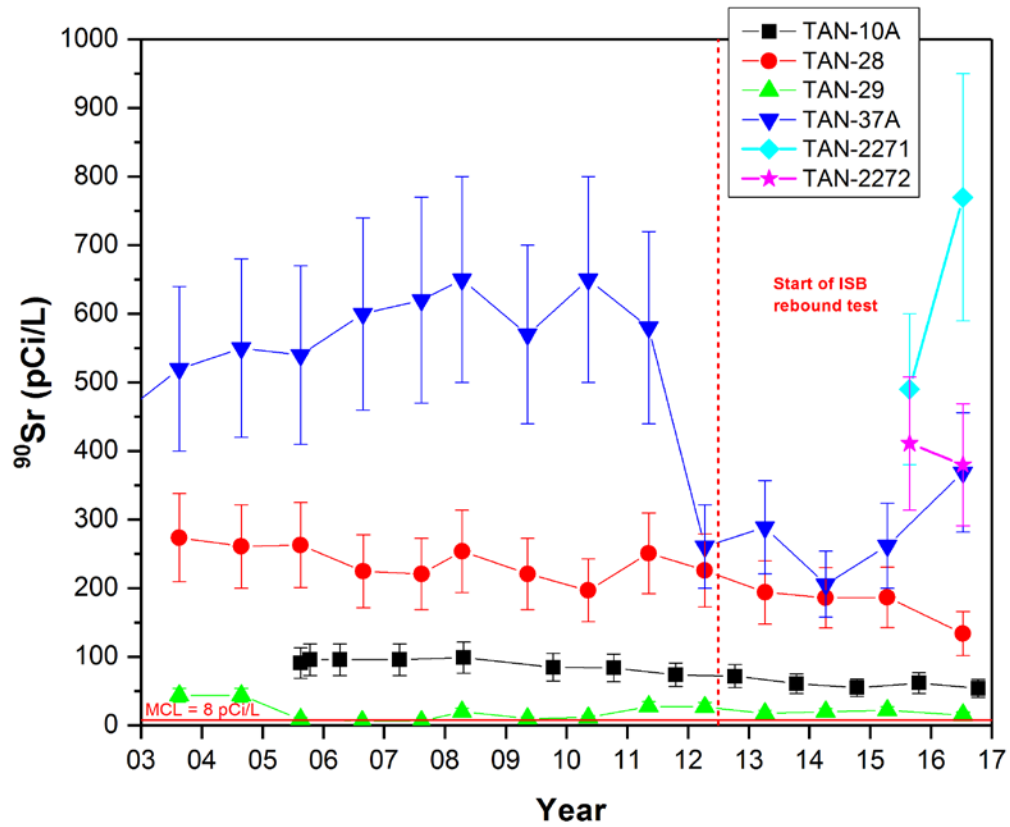


Figure 14.  $^{90}\text{Sr}$  concentrations over time for selected wells near Test Area North (TAN).



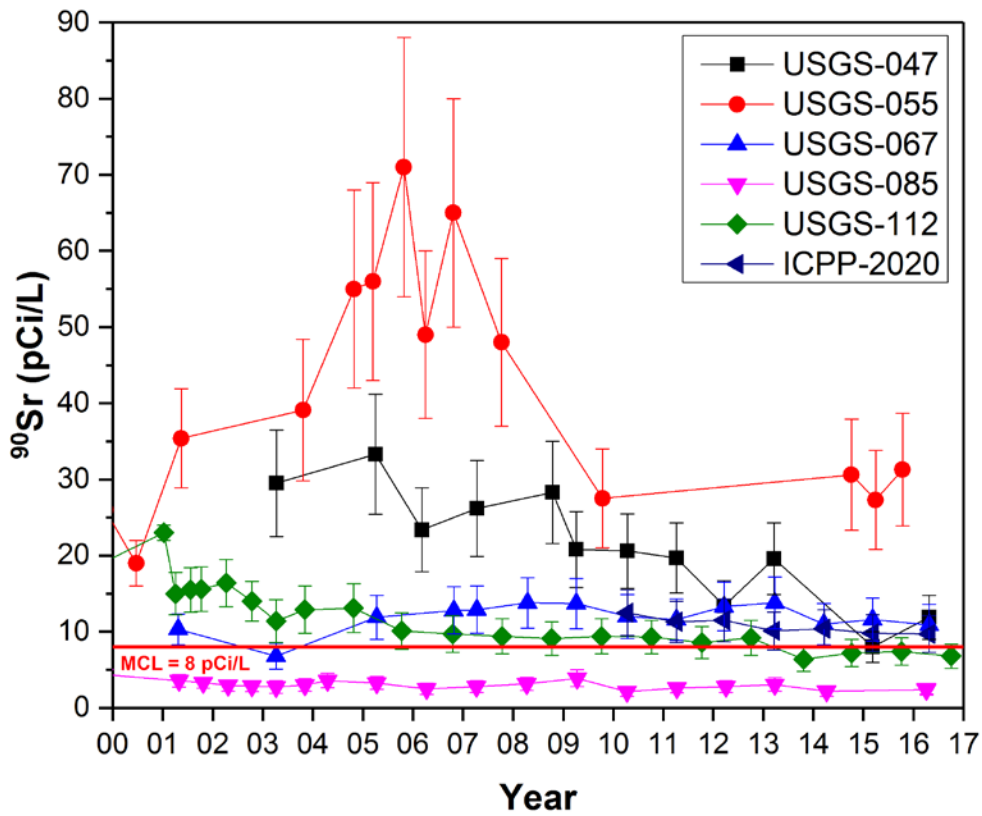
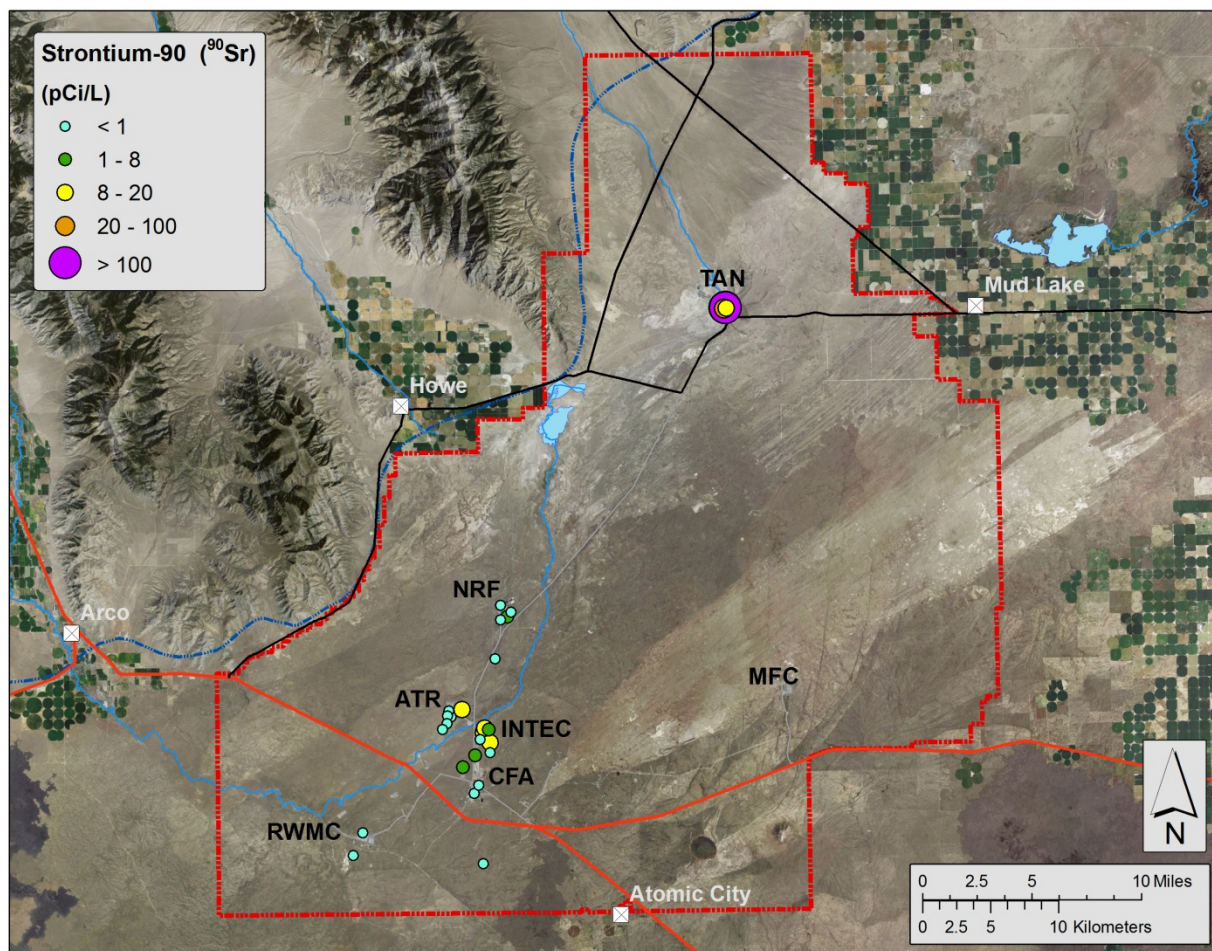


Figure 15.  $^{90}\text{Sr}$  concentrations over time for selected INL Site wells at INTEC and ATR.



**Figure 16. 2016  $^{90}\text{Sr}$  concentrations (pCi/L) for DEQ sample locations.**

### **Technetium-99 ( $^{99}\text{Tc}$ )**

$^{99}\text{Tc}$  is thought to have been released to groundwater by wastewater injection and leaks from tanks at INTEC. **Figure 17** shows  $^{99}\text{Tc}$  concentrations over time for selected INL wells located at or down-gradient of INTEC. All  $^{99}\text{Tc}$  detections in 2016 remained below the MCL of 900 pCi/L. The highest concentrations measured by DEQ in 2016 continue to be at USGS-052 ( $351.1 \pm 1.7$  pCi/L), ICPP-2020 ( $242.2 \pm 1.5$  pCi/L), and USGS-067 ( $131.2 \pm 1.1$  pCi/L).  $^{99}\text{Tc}$  concentrations measured at USGS-052 have fluctuated between about 250 and 500 pCi/L since 2004 and continue to remain in this range. Concentrations at ICPP-2020 declined from  $416.8 \pm 1.9$  pCi/L in 2009 to  $225.0 \pm 1.4$  pCi/L in 2012 and have remained between 200 and 300 pCi/L since then. Concentrations at USGS-067 have remained between 125 and 200 pCi/L since 2007. All other  $^{99}\text{Tc}$  detections in 2016 were below 10 pCi/L and were consistent with measurements in previous years. **Figure 18** shows a concentration map of all  $^{99}\text{Tc}$  sample locations in 2016.

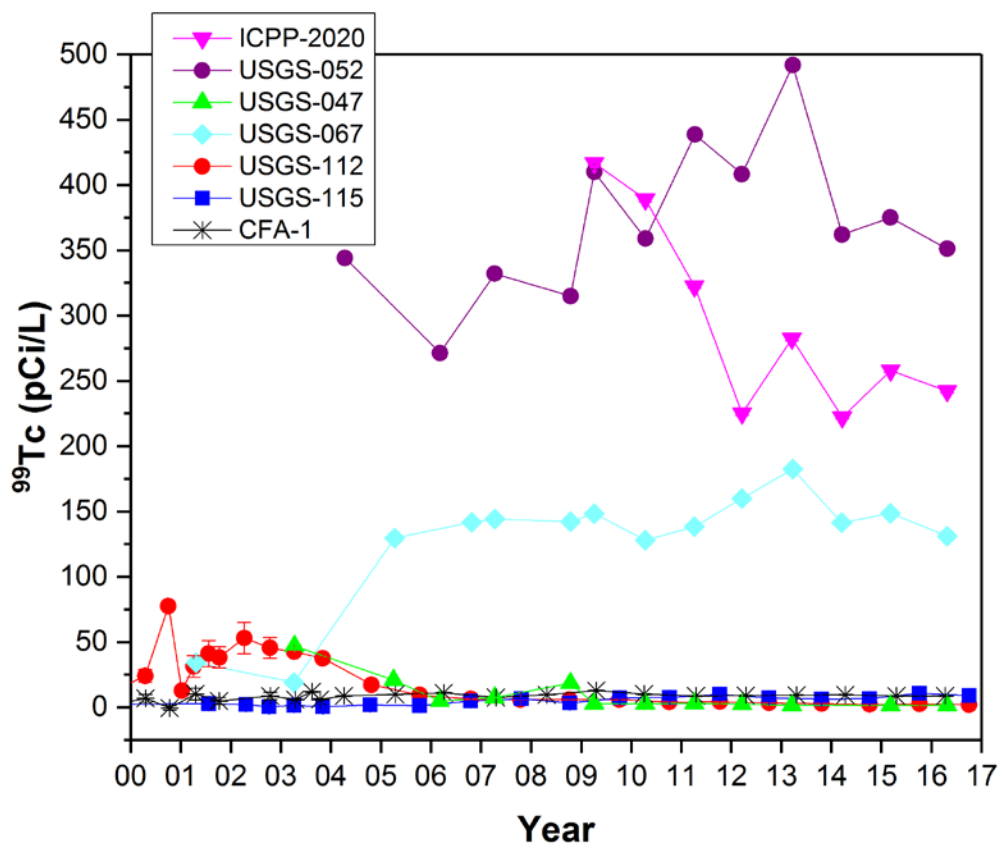


Figure 17.  $^{99}\text{Tc}$  concentrations over time for selected INL Site wells impacted by INL contamination.



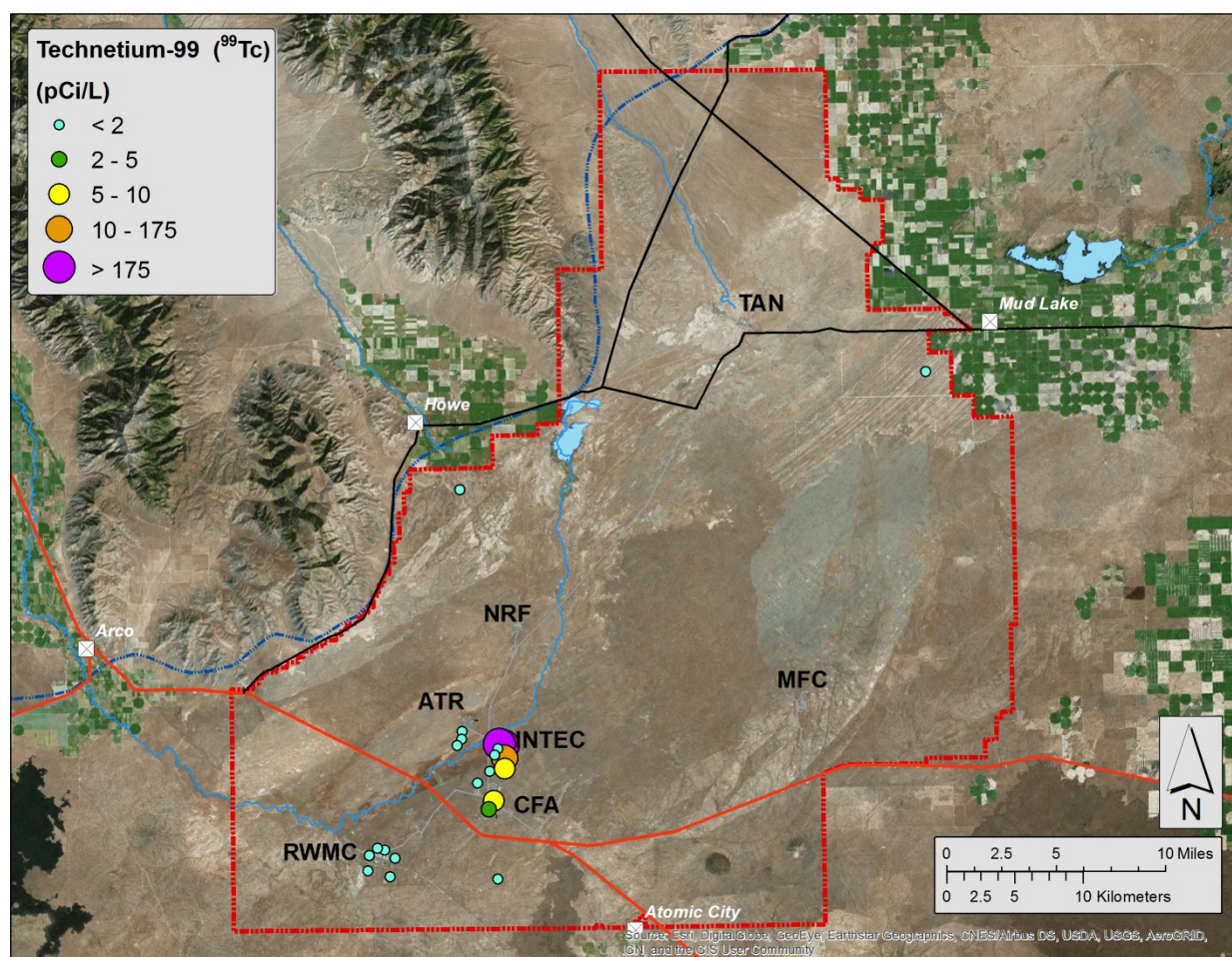


Figure 18. 2016  $^{99}\text{Tc}$  concentrations (pCi/L) for DEQ sample locations.

### Non-radiological Analytes

DEQ samples all water monitoring locations for common ions, nutrients, and dissolved trace metals. Selected locations are also sampled for VOCs. Elevated concentrations of these constituents are present in the groundwater at some locations as a result of past INL waste disposal practices.

Concentrations of non-radiological analytes measured in 2016 were generally consistent with those measured in previous years. Results are summarized in **Table 5**. Analytes that exceeded drinking water standards in 2016 or in the recent past, which include chloride, fluoride, sulfate, nitrate plus nitrite, chromium, manganese, iron, and certain VOCs, are discussed in greater detail below.



**Table 5. Summary of selected non-radiological analytical results for DEQ water samples for 2016.**

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		
Common Ions (mg/L)														
Calcium	34	46	52	26	59	170	34	40	51	22	43	68	22.6 – 40.7 <sup>a</sup>	none
Magnesium	13	16	18	12	18	110	11	16	19	11	17	28	10.1 – 15.3 <sup>a</sup>	none
Sodium	5.4	10	28	8.1	16	360	6.0	9.0	17	11	20	52	2.6 – 8.3 <sup>a</sup>	none
Potassium	1.1	1.6	6.0	1.8	3.1	11	1.8	2.6	3.4	2.5	3.6	7.0	1.2 – 2.3 <sup>a</sup>	none
Total Alkalinity (as CaCO <sub>3</sub> )	127	151	168	93	146	1170	137	148	162	108	150	220	75 – 144 <sup>a</sup>	none
Chloride	4.74	10.1	47.6	11.4	22.0	500	6.42	12.7	26.3	6.18	23.5	66.4	4.9 – 11.8 <sup>a</sup>	250*
Fluoride	<DL <sup>3</sup>	0.204	0.580	<DL	0.212	5.16 <sup>4</sup>	<DL	0.224	0.995	0.298	0.438	0.696	0.1 – 0.2 <sup>a</sup>	4
Sulfate	23.3	25.7	39.9	1.85	38.5	459	17.0	23.8	28.1	11.0	38.0	77.8	9.6 – 21.4 <sup>a</sup>	250*
Nutrients (mg/L)														
Total Nitrate plus Nitrite	0.26	0.63	2.6	<DL	1.5	12	0.48	0.83	1.6	0.4	1.4	5.3	<0.04 – 0.655 <sup>a</sup>	10 for NO <sub>3</sub> <sup>-</sup> , 1 for NO <sub>2</sub> <sup>-</sup>
Total Phosphorus	0.007	0.014	0.017	0.005	0.027	1.6	0.014	0.017	0.026	0.013	0.021	0.035	<0.01 – 0.02 <sup>b</sup>	none
Trace Metals (µg/L)														
Barium	47	73	84	22	77	1600	22	36	80	5.3	35	110	50 – 70 <sup>c</sup>	2000
Arsenic	<DL	<DL	4.1	<DL	<DL	9.3	<DL	<DL	2.4	<DL	2.3	3.2	2 – 3 <sup>c</sup>	10
Chromium	<DL	1.9	5.7	<DL	10	78	2.1	6.5	11	1.0	2.4	3.8	<0.012 – 4.0 <sup>a</sup>	100
Iron	<DL	23	40	<DL	<DL	11000	<DL	<DL	94	<DL	<DL	16	4 – 16 <sup>b</sup>	300*
Lead	<DL	<DL	<DL	<DL	<DL	3.1	<DL	<DL	1.8	<DL	<DL	<DL	<5 <sup>c</sup>	15
Manganese	<DL	1.1	8.3	<DL	<DL	3800	<DL	<DL	20	<DL	<DL	2.4	<1 – 4 <sup>d</sup>	50*
Selenium	<DL	<DL	2.1	<DL	<DL	6.2	<DL	<DL	<DL	<DL	<DL	<DL	<1 <sup>c</sup>	50
Zinc	<DL	<DL	<DL	<DL	<DL	640	<DL	<DL	110	<DL	<DL	90	<3 – 10.5 <sup>b</sup>	5000*

<sup>1</sup> Background concentrations depend on local geology. Concentrations for sites not influenced by INL activities may still be higher than the given background ranges. Sources for background ranges are: <sup>a</sup> Bartholomay and Hall, 2016 (DOE/ID-22237); <sup>b</sup> Knobel and others, 1999 (DOE/ID-22164); <sup>c</sup> Knobel and others, 1992, Journal of the Idaho Academy of Science, Vol 28, No 1, June 1992. Pages 48-60; <sup>d</sup> DEQ data compiled from distant, boundary, and surface water sites in previous years.

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

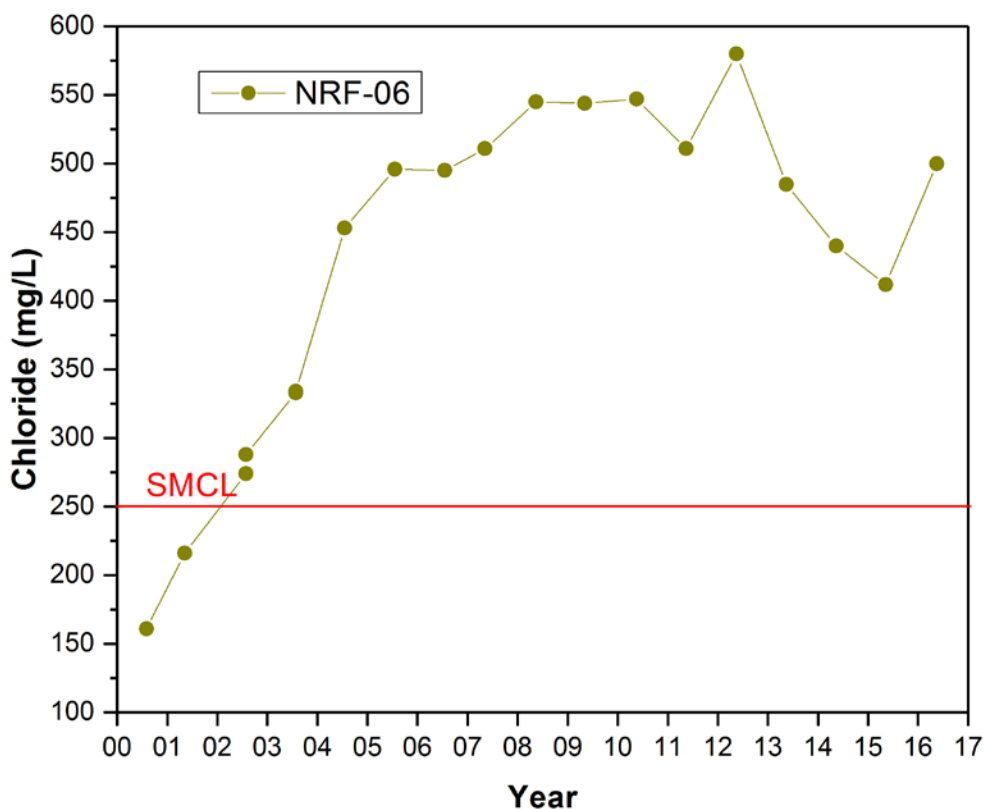
<sup>3</sup>Detection Level.

<sup>4</sup> The value was qualified as an estimate due to possible interference from chloride.

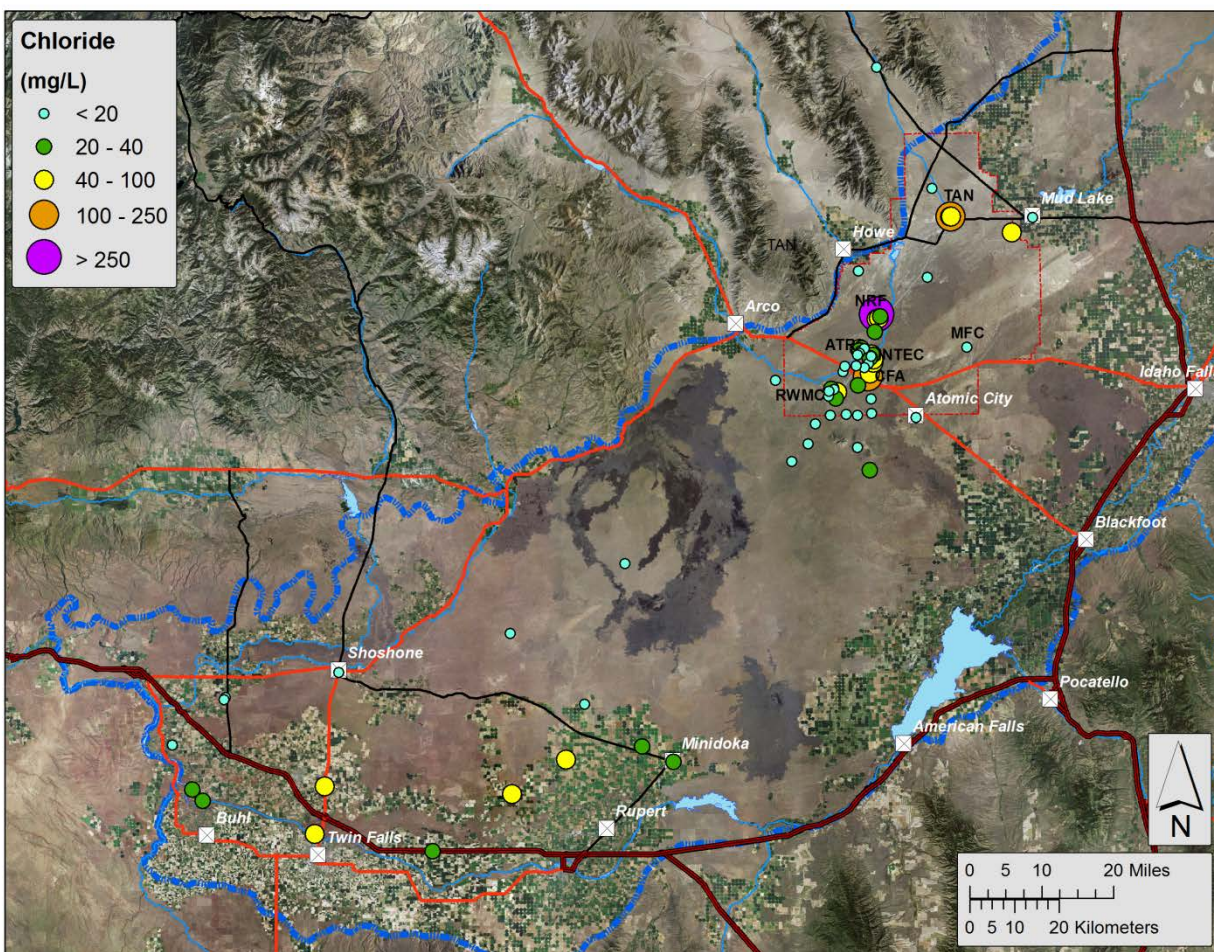
## Chloride and Fluoride

Chloride concentrations in groundwater 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. Only one well monitored by DEQ, NRF-06 at the Naval Reactors Facility (NRF), has had chloride concentrations above the secondary maximum contaminant level (SMCL) of 250 mg/L. NRF-06 is located near the NRF industrial waste ditch, in which wastewater from water softeners is discharged. The chloride concentration measured in NRF-06 in 2016 was 500 mg/L, the highest value measured since 2012 (**Figure 19**). A chloride concentration map for all 2016 sample locations is shown in **Figure 20**.

Elevated fluoride concentrations were measured at TAN-2272 (5.16 mg/L) and TAN-2271 (2.49 mg/L); however, both of these measurements were qualified as estimates due to possible chloride interference noted by the lab. Fluoride was not detected in either location in 2015, the only other year for which data exist. The MCL for fluoride is 4 mg/L.



**Figure 19. Chloride concentrations for sample location NRF-06 over time.**



**Figure 20. 2016 chloride concentrations for DEQ sample locations.**

## **Sulfate**

Effluent from the cold waste pond at ATR had a sulfate concentration of 459 mg/L when it was sampled in October 2016, above the SMCL of 250 mg/L. This is substantially higher than concentrations measured in the past few years, but not unprecedented: in 2010, sulfate was measured at 544 mg/L at this location. No other location sampled in 2016 had sulfate above or near the SMCL.

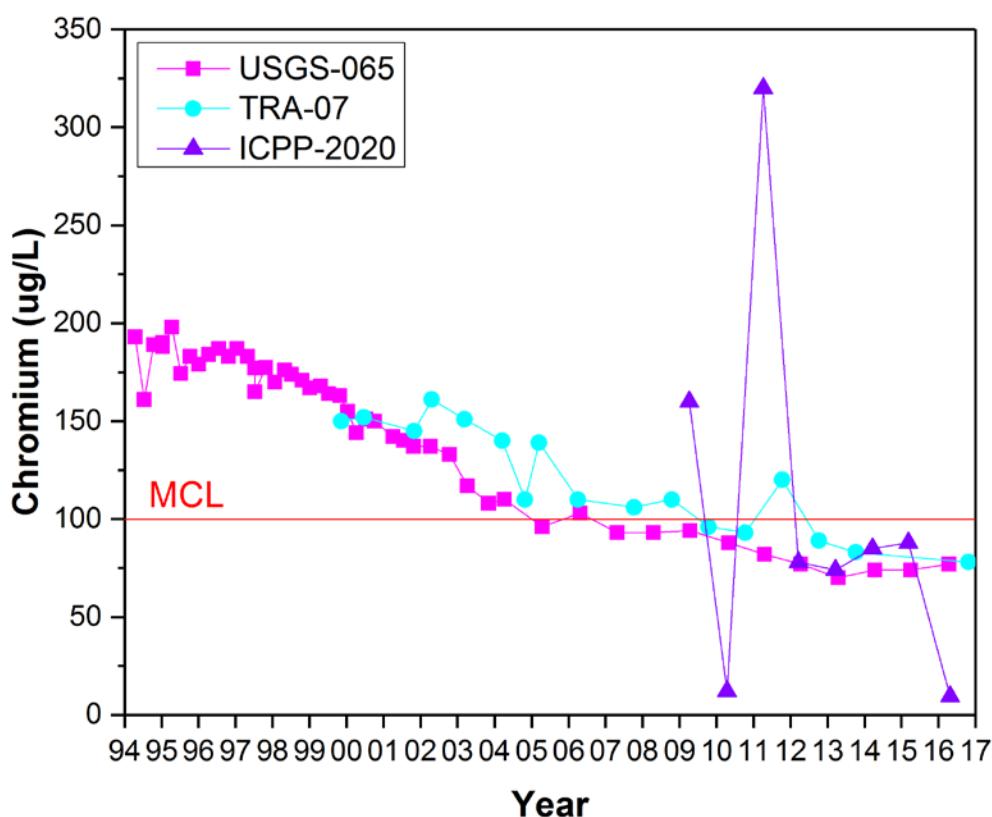
## **Nitrate plus Nitrite**

In 2016, one well exceeded the MCL of 10 mg/L for nitrate and 1 mg/L for nitrite: USGS-073 had a nitrate plus nitrite concentration of 12 mg/L. USGS-073 is a perched aquifer well located at ATR near the ATR cold waste pond. The nitrate plus nitrite concentration of the wastewater sample collected from the ATR cold waste pond in 2016 was 2.8 mg/L.

## **Chromium**

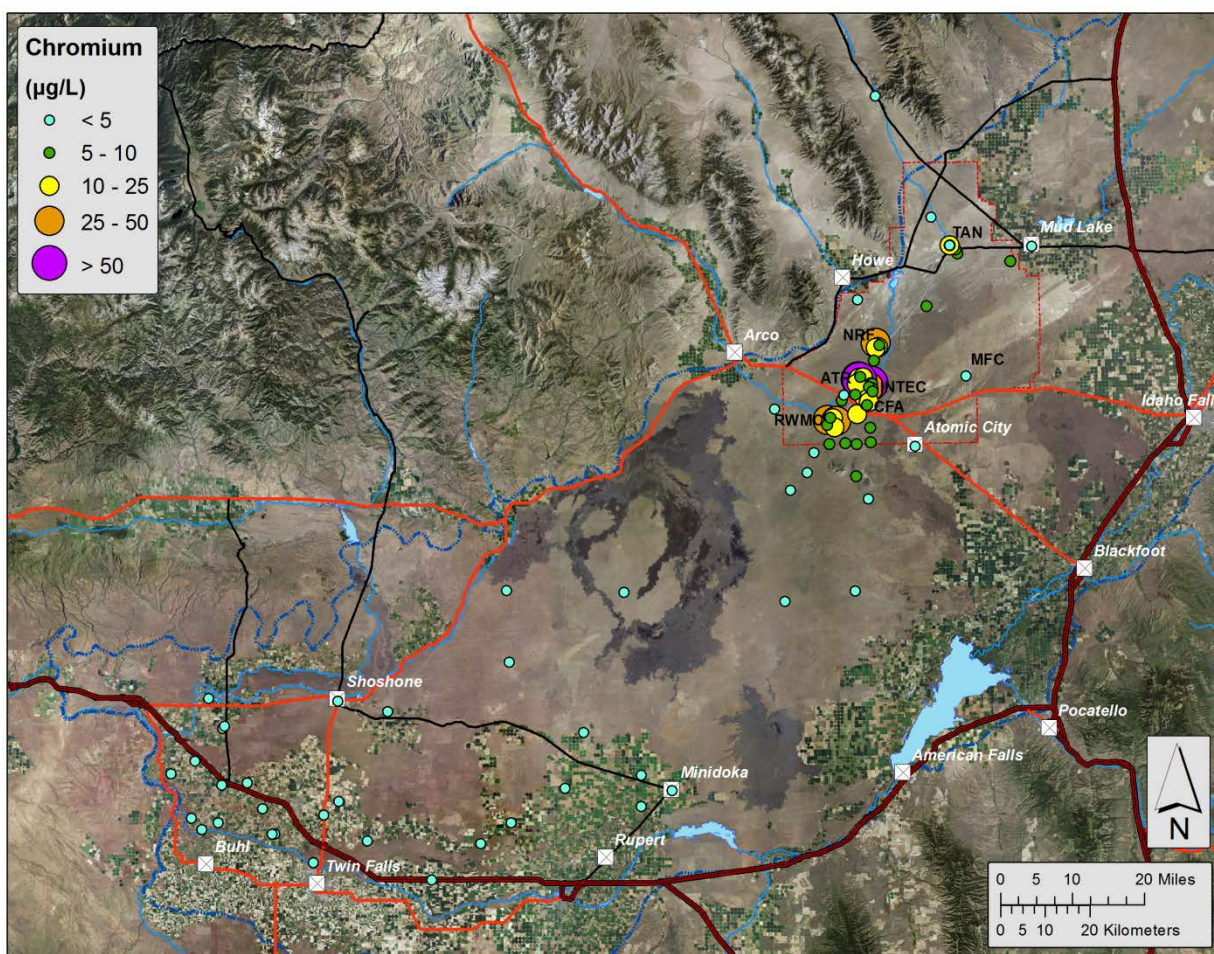
Chromium was used at the INL to prevent corrosion in industrial water systems until the early 1970s. Disposal practices at that time allowed chromium-contaminated water to percolate down to groundwater from injection wells, open disposal ponds, and ditches, resulting in elevated

chromium concentrations in some monitoring wells. In 2016, chromium concentrations were below the MCL of 100 µg/L at all locations sampled by DEQ. Results for TRA-07, USGS-065, and ICPP-2020, which have histories of high chromium levels, are shown in **Figure 21**, and a concentration map for all locations sampled in 2016 is shown in **Figure 22**. The highest concentrations measured in 2016 were at TRA-07 (78 µg/L) and USGS-065 (77 µg/L). TRA-07 and USGS-065 are located near ATR and have historically had high chromium concentrations that have steadily declined over time. The values reported for these wells in 2016 are consistent with other measurements in recent years. ICPP-2020, located at INTEC, had a chromium concentration of 9.6 µg/L in 2016. Concentrations at ICPP-2020 have ranged from 12 to 320 µg/L since it was first sampled by DEQ in 2009, and had remained in the range of 68 to 88 µg/L from 2012 to 2015 before this year's decrease.



**Figure 21. Chromium concentrations (µg/L) over time for selected INL Site wells impacted by INL contamination.**





**Figure 22. 2016 chromium concentrations (µg/L) for DEQ sample locations.**

## Manganese and Iron

Six wells exceeded the SMCL for manganese (50 µg/L) during the 2016 sample season. Five of these wells are located at or near TAN: TAN-2271 (3800 µg/L), TAN-2272 (1900 µg/L), TAN-37A (1200 µg/L), TAN-10A (780 µg/L), and TAN-28 (310 µg/L). The sixth well, PW-9 (150 µg/L), is located at ATR.

Four of the TAN wells also exceeded the SMCL for iron (300 µg/L) in 2016: TAN-2271 (11,000 µg/L), TAN-2272 (11,000 µg/L), TAN-37A (3000 µg/L), and TAN-10A (1400 µg/L).

Elevated concentrations of Mn and Fe in the groundwater are consistent with reducing conditions created by in-situ bioremediation (ISB) as part of the clean-up action for VOCs at TAN (see next section). ISB injections into the aquifer were suspended in 2012, which should have resulted in a gradual decrease in Mn and Fe concentrations as the groundwater chemistry returns to background conditions. This decrease is apparent at TAN-10A, the only well for which DEQ has enough Mn and Fe data to establish a trend. Concentrations of Mn and Fe at TAN-10A were 940 µg/L and 3000 µg/L, respectively, in 2012, and have decreased nearly continuously since then.

ISB injections were started at a new location, TAN-2272, in January 2016. TAN-2272 is close to TAN-2271 and up-gradient of TAN-37A and TAN-28; Mn and Fe concentrations are therefore

expected to increase and remain high at these locations as long as injections continue. Concentrations of Mn and Fe in TAN-2272, TAN-2271, and TAN-37A were significantly higher in 2016 than in 2015.

## Volatile Organic Compounds

The primary volatile organic compound (VOC) contamination at the INL is located at and down-gradient of TAN, where a plume originating at a former wastewater injection well extends to the east and south. The plume is characterized by high concentrations of trichloroethene (TCE) and its degradation products (cis-1,2-dichloroethene [cis-DCE], trans-1,2-dichloroethene [trans-DCE], and vinyl chloride [VC]) and lower concentrations of tetrachloroethene (PCE). The plume has been divided into three regions based on TCE concentrations reported in 1997 (INEEL/EXT-97-00931), and a different remediation strategy was chosen for each region in a 2001 Record of Decision Amendment (DOE/ID-10139):

- The hot spot ( $>20,000$   $\mu\text{g/L}$  TCE) covers a small area immediately surrounding the former injection well. The remediation strategy here has been in situ bioremediation (ISB), which involved repeated injection of a carbon source (whey and sodium lactate) into the aquifer to promote anaerobic reduction of chlorinated ethenes in the aquifer. Injections began in 1999 and were halted in 2012.
- The medial zone (1,000 to 20,000  $\mu\text{g/L}$  TCE) extends about 1500 feet east-southeast from the hot spot as a narrow lobe. The remediation strategy here is to pump, treat, and reinject groundwater.
- The distal zone (5 to 1,000  $\mu\text{g/L}$  TCE) surrounds the medial zone as a much larger lobe that extends about 900 feet west and 1.7 miles southeast of the hot spot. The remediation strategy here is monitored natural attenuation.

In July 2012, ISB injections were suspended indefinitely in order to initiate the rebound test—a multi-year pause in ISB treatment to evaluate residual VOC contamination in the aquifer once background groundwater conditions returned. In January 2016, ISB injections commenced at TAN-2272, a new well installed in 2015, to treat an apparent residual TCE source in the vicinity of TAN-28. A partial ISB rebound test continues in the vicinity of the original hot spot.

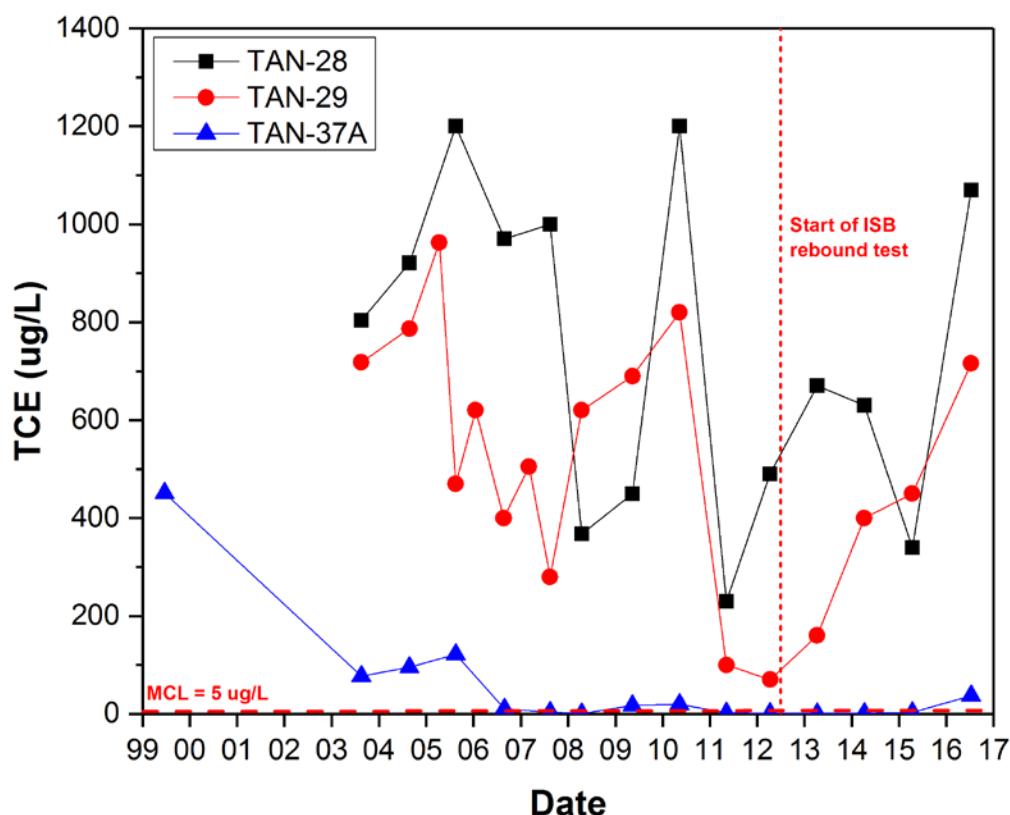
In 2016, DEQ sampled five wells in the medial zone east of the pre-2012 ISB treatment area (TAN-28, TAN-29, TAN-37A, TAN-2271, TAN-2272) and one well in the distal zone west of the pre-2012 ISB treatment area (TAN-10A). Analytical results for TAN-2271 and TAN-2272 were rejected by the lab due to low internal standard responses and failed surrogate spikes. Four other distal zone wells sampled by DEQ in most years (ANP-8, TAN-16, TAN-51, TAN-55) were not sampled in 2016.

Four VOCs were detected at concentrations above the MCL in TAN wells: TCE (MCL = 5  $\mu\text{g/L}$ ) at TAN-10A, TAN-28, TAN-29, and TAN-37A; PCE (MCL = 5  $\mu\text{g/L}$ ) at TAN-10A, TAN-28, and TAN-29; cis-DCE (MCL = 70  $\mu\text{g/L}$ ) at TAN-28 and TAN-29; and VC (MCL = 2  $\mu\text{g/L}$ ) at TAN-28 and TAN-37A. **Figure 23** shows TCE concentration trends for TAN-28, TAN-29, and TAN-37A. TCE concentrations in TAN-28 and TAN-29 have varied widely over time, probably as a result of intermittent changes in groundwater chemistry due to ISB injections as well as seasonal changes in groundwater flow (DOE/ID-11444), but clearly remained high throughout

the rebound test. In 2016, TCE concentrations in both wells (1070 µg/L at TAN-28, 716 µg/L at TAN-29) were the highest reported by DEQ since 2010. Similarly, the TCE concentration at TAN-37A climbed to 37 µg/L in 2016 after remaining below the MCL since 2011.

Other VOC detections in 2016 were at RWMC, where TCE, carbon tetrachloride (MCL = 5 µg/L), and/or chloroform (MCL = 70 µg/L) were detected at levels below the MCL in six of eight wells sampled, and in boundary Westbay well Middle-2051, where PCE was measured at the 1091- and 1141-foot depths at levels below the MCL and just above the detection limit. VOC detections at RWMC are consistent with historical observations. The low-level PCE detections in Middle-2051 are consistent with PCE detections in this well by DOE contractor Fluor Idaho beginning in November 2015. Further investigation by Fluor and the USGS in 2016 concluded that PCE detected in samples from Middle-2051 came from the water inside the well casing, which was injected during well completion in 2005 and remains isolated from the aquifer, and not from the aquifer itself (DOE/ID-11560). The source of PCE inside the well remained unknown at the end of 2016; however, contamination of the aquifer is not suspected at this time.

VOC results for all wells sampled can be found in the quarterly data reports published on the DEQ website: <http://www.deq.idaho.gov/inl-oversight/monitoring/reports.aspx>.



**Figure 23. TCE concentrations (µg/L) over time for selected wells located in the medial zone near the ISB injection facility at TAN.**

## Water Monitoring Verification Results

DEQ collects water samples at the same time and location as DOE contractors or the USGS and verifies that analytical results from co-sampled locations are consistent. The DEQ sampling verification program is designed to co-sample at approximately 10% of all DOE sample locations for selected analytes. In the event that a significant difference is found between DEQ results and those of the co-sampler, each result is scrutinized individually to ascertain the cause of the difference. Some differences between results are expected due to natural variability in the media being sampled, random errors in the measurements, and systematic differences in how the samples are collected, handled and analyzed. DEQ sets a goal of at least 80 percent of the results from co-sampled locations for each analysis passing the comparison criteria outlined in the Quality Assurance section.

### Radiological

A summary of the sample-by-sample comparison of DEQ and DOE/USGS radiological results is presented in **Table 6**. Most results were in agreement, with at least 80 percent of results for co-sampled pairs passing comparison criteria for all analyses except  $^{99}\text{Tc}$ . The reason for the differences in  $^{99}\text{Tc}$  results is unknown at present, but it is notable that for all samples pairs (including those passing the comparison criteria), the result obtained by DEQ was larger than the result obtained by the co-sampler, suggesting a systematic bias. This issue will be investigated further in the coming year.

**Table 6. Radiological results for co-samples collected by DOE and DEQ in 2016.**

Analyte	Number of co-sampled pairs in 2016	Percent of co-sampled pairs passing criteria in 2016
Gross alpha	47	91
Gross beta	47	85
$^{137}\text{Cs}$	25	96
$^{238}\text{Pu}$	7	100
$^{239/240}\text{Pu}$	7	100
$^{90}\text{Sr}$	29	90
$^{99}\text{Tc}$	10	70
$^3\text{H}$	78	99
$^{234}\text{U}$	11	100
$^{235}\text{U}$	13	100
$^{238}\text{U}$	11	100
$^{241}\text{Am}$	2	100

### Non-Radiological

A summary of the sample-by-sample comparison of DEQ and DOE/USGS non-radiological results for 2016 is presented in **Table 7**. Nearly all results were in agreement, with at least 80 percent of results for co-sampled pairs passing comparison criteria for every analysis, and 100 percent of co-sampled pairs passing comparison criteria for most analyses.



**Table 7. Non-radiological results for co-samples collected by DOE and DEQ in 2016.**

Analyte	Number of co-sampled pairs in 2016	Percent of co-sampled pairs passing criteria in 2016
<b>Common Ions/Nutrients</b>		
Calcium	16	100
Magnesium	16	100
Sodium	56	100
Potassium	16	100
Fluoride	1	100
Chloride	58	100
Sulfate	61	100
Total Nitrate plus Nitrite	55	98
Total Phosphorus	36	92
<b>Trace Metals</b>		
Arsenic	7	100
Barium	7	100
Chromium	41	95
Iron	11	100
Lead	7	100
Manganese	8	88
Selenium	7	100
Zinc	7	100
<b>VOCs<sup>1</sup></b>		
8 VOC analytes	106	80

<sup>1</sup>18 co-sampled VOC samples were collected and 106 paired results for the same analytes were compared.

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

DEQ sample results are mostly in agreement with those reported by DOE contractors and the USGS. 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. Specifically:

- Concentrations of <sup>90</sup>Sr, chloride, fluoride, sulfate, nitrate plus nitrite, manganese, iron, and some VOCs exceeded federal drinking water standards (MCLs or SMCLs) at some sites on the INL in 2016. These sites are not used for drinking water.
- Tritium was detected at a concentration above background approximately eight miles south of the southern INL boundary. No sites monitored by DEQ exceed federal drinking water standards for tritium. Concentrations of tritium continue to decline site-wide.
- Concentrations for other INL contaminants in water continue to decrease at most locations as a result of changes in waste disposal practices. Chromium concentrations remained below the 100 µg/L MCL at all sites sampled by DEQ in 2016.
- INL impacts to the aquifer are not identifiable in water samples collected at 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

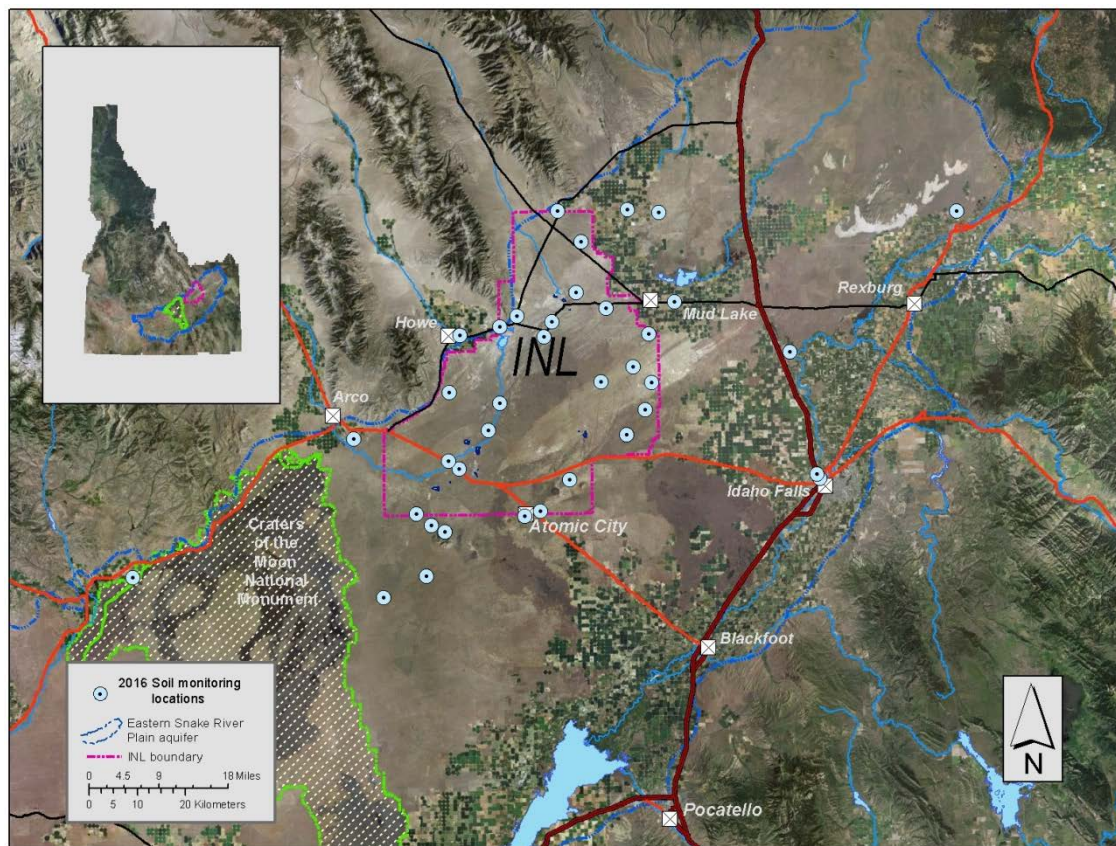
atmospheric radioiodine deposited in the terrestrial environment on and near the INL. Some of these data are also used to determine whether the monitoring results obtained by the DOE and its contractors were consistent with the soil and milk sampling results obtained by DEQ for these same locations.

### **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 (2016 soil sampling sites are shown in **Figure 24**). A portable gamma radiation detector was used in the field to collect surface gamma radiation measurements. These *in-situ* sampling measurements were then used to identify radionuclides present and to estimate soil radioactivity concentrations. Physical soil samples were also collected at nine locations during 2016.

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 24. DEQ soil sampling locations for 2016.**

## 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 2016, DEQ made *in-situ* gamma spectrometry measurements to estimate accumulations of gamma-emitting radionuclides in surface soil at 37 locations. Of the 37 measurements, Cesium-137 ( $^{137}\text{Cs}$ ) was the only man-made radionuclide that was detected. The average  $^{137}\text{Cs}$  value for *in-situ* measurements was 0.15 picocuries per gram (pCi/g) with a minimum value of 0.03 pCi/g and a maximum of 0.30 pCi/g. All results were well below the recommended federal screening limit for surface soil of 6.8 pCi/g of Cesium-137 (NCRP Report 129).

Milk sampling is conducted by DEQ to determine whether radioiodine is present or absent in the food supply. Radioiodine 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 radioiodine 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 radioiodine in the thyroid gland and a greater risk of thyroid cancer.

During 2016, DEQ analyzed 45 milk samples. Radioiodine ( $^{131}\text{I}$ ) 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 Potassium-40 ( $^{40}\text{K}$ ) 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 Iodine-131) 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 96% agreement with DOE contractor results, which is considered satisfactory. All  $^{131}\text{I}$  results were below the minimum detectable activity for both agencies.

The DOE contractor did not conduct any *in-situ* soil sampling in 2016.

Gamma spectrometry results from physical soil samples taken at nine co-located sample sites both on and off-site were compared with the DOE contractor's results. There was 89% agreement between the agencies with the average results for  $^{137}\text{Cs}$  of 0.37 pCi/g (minimum 0.16 pCi/g and maximum 0.53 pCi/g) for DEQ and 0.36 pCi/g (minimum 0.09 pCi/g and maximum 0.58 pCi/g) for the DOE contractor. These results were well below the DEQ action level and the recommended screening limit of 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 discernable impacts to the environment from INL operations. Long-term accumulation of radionuclides observed by soil monitoring was consistent with historical measurements and was in the range of concentrations expected as a result of historic above-ground testing of nuclear weapons.

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

This section summarizes the results of the quality assurance (QA) assessment of the data collected during calendar year 2016 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. 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 2016, the DEQ submitted 320 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

No major issues or problems affecting data quality were identified during 2016.

## Comparing Data

DEQ compares its data with DOE's to determine whether the programs' data sets are statistically equivalent, or if each program's 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 paired results using the following equation:

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

An RPD in the range of  $\pm 20\%$  is considered to indicate acceptable agreement between measurements. For non-radiological analysis, the RPD is used to compare paired samples in which both of the results exceed five times the detection level. If one or both of the sample results are less than five times the detection level, the absolute difference between the two results is acceptable if it is less than or equal to the larger method detection limit.

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

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

Where:

$R_1$  = First sample 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 an RPD in the range of  $\pm 20\%$ , 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.

## 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. The 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 radioactive 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 real time National Oceanic and Atmospheric Administration (NOAA) weather data 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 from the INL Warning Communication Center anytime their emergency resources are deployed; primarily the INL Fire Department.

### ***Non-INL Radiological Activities***

1. DEQ/Idaho Falls Regional Office (IFRO) health physics staff has been working with staff members of the DEQ/Pocatello Regional Office and Technical Services division on review of remediation work at the FMC site in Pocatello. The Gamma Cap Work Plan, Gamma Cap Performance Evaluation, and Performance Standards Verification Plan were reviewed.
2. DEQ/IFRO health physics staff is participating in the Idaho Preventative Nuclear Detection Group.
3. DEQ-INL OP manager attended the National Transportation Stakeholders Forum meeting in June 2016.
4. DEQ-INL OP manager attended the Western Interstate Energy Board High Level Waste Committee meeting July 6 and 7, 2016 in Denver. The group worked on a set of policy papers.

### ***Drills and Exercises***

1. DEQ IFRO staff participated in a Radiation Assistance Program training exercise on May 13, 2016.

2. DEQ IFRO staff participated in an Idaho Cleanup Project exercise on August 11, 2016. The drill involved a radiologically contaminated worker who was transferred to Bingham Memorial Hospital.
3. DEQ IFRO staff participated in an INL emergency drill on November 9, 2016.

### ***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 the Waste Isolation Pilot Plant (WIPP) through western states. DEQ works with the Idaho State Police (ISP) and the Idaho Office of Emergency Management to manage WIPP shipment safety activities on the US Route 20/26, Interstate 15, and Interstate 84 / 86 corridors in Idaho.

During 2016, DEQ:

- Oversaw radiological equipment repairs and calibrations for ISP, all seven Idaho regional response teams, the Shoshone-Bannock Tribes, and three area hospitals.
- Staff members attended the National Transportation Stakeholders Forum and two meetings of the WIPP Technical Advisory Group and Western Governors Association Waste Isolation Pilot Plant Technical Advisory Group. DEQ staff also participated in monthly conference calls with of the WIPP Technical Advisory Group.

### ***Emergency Response Planning and Preparedness Meetings***

DEQ staff attended fifteen Local Emergency Planning Committee (LEPC) meetings, and the seven regional emergency planning meetings. DEQ-INL OP Manager attended a Northwest Emergency Managers Workshop on July 14, 2016.

### ***Classes and Presentations***

1. DEQ IFRO staff reviewed and commented on updates to the Modular Emergency Response Radiological Transportation Training (MERRT) modules and videos.
2. Two DEQ IFRO employees received Radiological Worker II training on April 27 and 28, 2016.
3. One DEQ staff member attended the National Radiological Emergency Preparedness meeting May 2-5, 2016 in Charleston, SC.
4. DEQ IFRO health physics staff attended a Ludlum instrumentation class in Spokane, WA on July 25-26, 2016.
5. DEQ staff developed and delivered training for Bingham Memorial Hospital workers on radiological instrumentation. DEQ IFRO hosted a Radiation Emergency Assistance Center/Training Site (REAC/TS) course for local first responders and other regional emergency workers on October 4<sup>th</sup> and 5<sup>th</sup>, 2016.
6. DEQ IFRO supported a REAC/TS site specific evaluation and training at Eastern Idaho Regional Medical Center on October 6<sup>th</sup>, 2016.

## 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 2016, we issued:

- The DEQ Annual Report for 2015.
- Four quarterly environmental surveillance data reports.

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 2016, we gave public presentations on the aquifer, and INL Site issues to a range of schools, civic groups, and special interest groups.

The Water Festival begins with a distribution of water education materials to approximately 3100 eastern Idaho students from 44 schools. 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**). The event has now grown so large that we have extended it to two days attended by over 1,600 students. DEQ presented the Macro Invertebrate Mayhem activity (**Figure 26**) and the Rain Stick activity (**Figure 27**). Idaho Falls Earth Day was a hit with the youth enjoying the Edible Aquifer presentations (**Figure 28**) and the children and adults filling up the DEQ carry-all bags with Earth Day giveaways (**Figure 29**). DEQ led a field trip for the 2017 Idaho State University iSTEM environmental strand and water resources. Topics included a ground water/eastern snake river plain discussion (DEQ), a presentation on river and reservoirs management (Water District 1), ground water sampling (USGS INL Project office), hydro power (Idaho Falls Power), and measuring surface water flow (USGS – Idaho Falls surface water office). (**Figure 30**).





**Figure 25. Water Awareness Poetry Contest 2016 on display at the Idaho Falls Library.**



**Figure 26. Children enjoying Macro Invertebrate Mayhem activity at Water Festival 2016.**





**Figure 27. Children preparing their rainsticks at the Water Festival 2016.**



**Figure 28. Children participating in the Edible Aquifer activity at the 2016 Earth Day event.**





**Figure 29. DEQ staff handing out give-away items at the 2016 Earth Day event.**



**Figure 30. Teachers learning about ground water sampling at the iSTEM environmental strand, water resources field trip.**

## ***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 31** shows the community monitoring station in Idaho Falls. DEQ will begin the process of updating the monitoring boards at each location in 2017.



**Figure 31. Community monitoring station at the greenbelt in Idaho Falls.**

