DEQ-INL
Oversight Program
Annual Report
2015

DEPARTMENT OF ENVIRONMENTAL QUALITY
IDAHO NATIONAL LABORATORY OVERSIGHT PROGRAM

INL Oversight Office

Idaho Falls Office
900 N. Skyline, Suite B
Idaho Falls, Idaho 83402
Phone: (208) 528-2600
Fax: (208) 528-2605

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Table of Acronyms and Abbreviations

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

MDA	minimum detectable activity
MDC	minimum detectable concentration
NCRP	National Council on Radiation Protection and Measurements
NIST	National Institute of Standards and Technology
nCi/L	nanocuries per liter
NE	Nuclear Energy
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NRC	Nuclear Regulatory Commission
NRF	Naval Reactors Facility
ORPS	Occurrence Reporting and Processing System
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/m^3	picocuries per cubic meter
PCE	tetrachloroethylene
QAPP	Quality Assurance Program Plan
QA/QC	quality assurance/quality control
RAP	Radiological Assistance Program
RPD	Relative Percent Difference
RCRA	Resource Conservation and Recovery Act
RH-TRU	remote-handled transuranic
RSWF	Radioactive Scrap and Waste Facility
RTC	Reactor Technology Complex
RWMC	Radioactive Waste Management Complex
SBW	sodium-bearing waste
SD	Standard deviation
SI	International System of Units
SMCL	secondary maximum contaminant level
TAN	Test Area North
TCE	trichloroethylene
TDS	total dissolved solids
TLD	thermoluminescent dosimetry
TMI	Three Mile Island
TRU	transuranic
TSA	Transuranic Storage Area
TSP	total suspended particulate
TSS	total suspended solids
USGS	U.S. Geological Survey
VOC	volatile organic compound
WGA	Western Governors Association
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	µ	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 2015. 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 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.

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 2015, 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 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 2015 were consistent with past results. Water samples collected from on-site locations near INL Site facilities identified concentrations of ^{90}Sr (strontium-90), chloride, 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.

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 x 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
0.000000000000000001 = 10^{-18}	atto	a

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.

Trends

Results for 2015 monitoring in terrestrial media and air were generally consistent with historic trends. Radiation levels were consistent with historic background measurements. Concentrations of ^{90}Sr, chloride, manganese, iron, and VOCs exceeded federal drinking water standards at locations on the INL in 2015. Tritium concentration in groundwater continues to decline. Gross beta radioactivity in groundwater at all locations followed trends for ^{90}Sr. The concentrations of some contaminants in groundwater (such as gross alpha radioactivity, ^{99}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**.

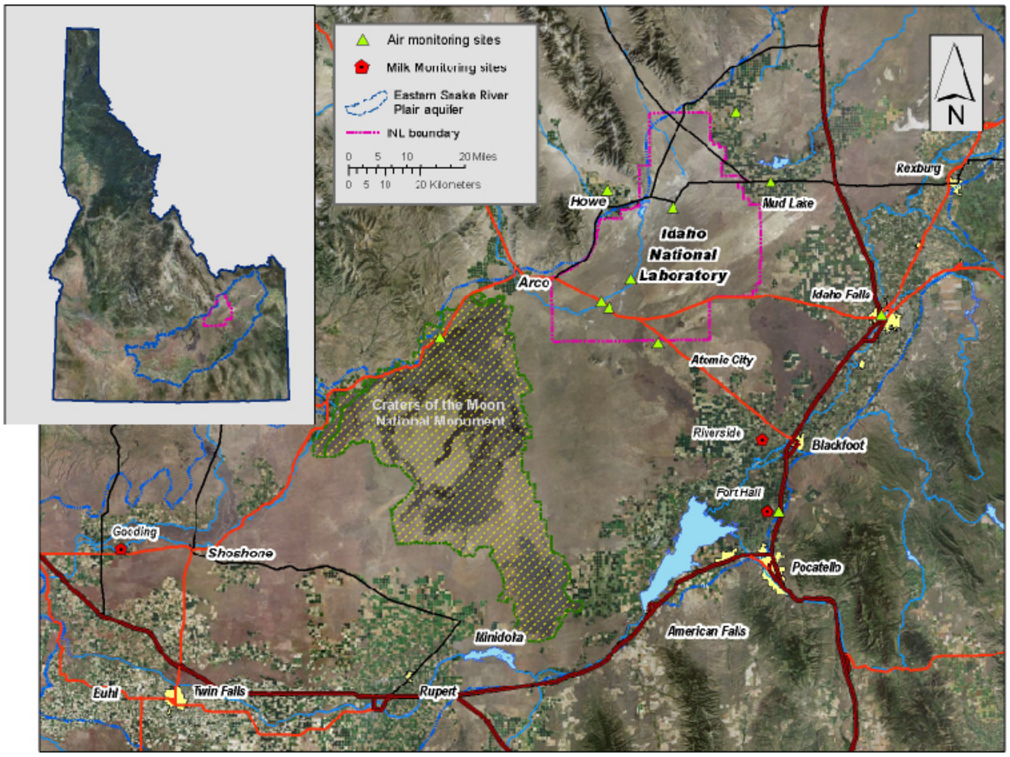

Figure 1. Locations of selected DEQ monitoring sites.

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, Monteview, 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 a total suspended particulate (TSP) matter sampler.

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}Sr (strontium-90), ^{241}Am (americium-241), ^{238}Pu (plutonium-238), and $^{239/240}$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 612 filters from TSP samplers were collected during 2015. 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 2015 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 2015.

DEQ-INL Oversight Program	Gross Alpha Range (fCi/m^3)[a]	Gross Alpha Average (fCi/m^3)	Gross Beta Range (fCi/m^3)	Gross Beta Average (fCi/m^3)
2015	0.10 to 5.79	0.99 ± 0.12	5.58 to 155.21	26.90 ± 0.58

a. fCi/m^3 – femto(10^{-15}) curies per cubic meter

Radiochemical analysis of the annual TSP filter composite samples resulted in detection of ^{238}Pu at the following locations: Howe 7.5 ± 4.9 attocurie[1] per cubic meter (aCi/m^3) (MDC 6.6 aCi/m^3) and Sand Dunes 5.7 ± 4.0 aCi/m^3 (MDC 5.5 aCi/m^3) for 2015. $^{239/240}$Pu was detected at the following locations: Atomic City 1.4 ± 1.6 aCi/m^3 (MDC 1.0 aCi/m^3); Howe 2.5 ± 2.0 aCi/m^3 (MDC 1.1 aCi/m^3); Rest Area 3.2 ± 2.0 aCi/m^3 (MDC 0.9 aCi/m^3); and Sand Dunes 1.4 ± 1.6 aCi/m^3 (MDC 1.0 aCi/m^3). These values are within the expected range due to global fallout from historic above-ground nuclear weapons testing. All of the reported concentrations are much less than one percent of the federal regulatory limits for ^{238}Pu of 2.1 fCi/m^3, $^{239/240}$Pu of 2.0 fCi/m^3, ^{241}Am of 1.9 fCi/m^3, and ^{90}Sr of 19 fCi/m^3 (40 CFR 61).

[1] An attocurie is 10^{-18} curies, or 1/1000th of a femtocurie

Atmospheric Tritium

A total of 139 atmospheric moisture samples were collected in 2015 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 2015 were 0.86 ± 0.86 pCi/m^3 at the Experimental Field Station for the time period of July 20 through August 11, 1.18 ± 0.55 pCi/m^3 at Van Buren Avenue for the time period of June 23 through July 2, 0.65 ± 0.70 pCi/m^3 at the Big Lost River Rest Area station for the time period of October 1 through October 26, and 0.54 ± 0.54 pCi/m^3 at the Sand Dunes station for the time period of May 12 through June 4.

All atmospheric tritium measurements for 2015 were much less than one percent of the concentration for compliance with federal regulations (40 CFR 61), 1500 pCi/m^3. Tritium levels were at or near background levels at all locations.

Gaseous Radioiodine

No gaseous radioiodine was detected by DEQ in 2015.

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 2015, 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 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 2015.

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

Sampling Agency	ESER Stoller[a]	BEA[b]
DEQ Gross Alpha Analysis	82.3 %	99.7%
DEQ Gross Beta Analysis	57.6 %	81.1 %

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 2015.

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 2015 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. A few of the specific radionuclide analyses of composite air samples resulted in statistical detections of human-made radionuclides at 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 2015, 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.

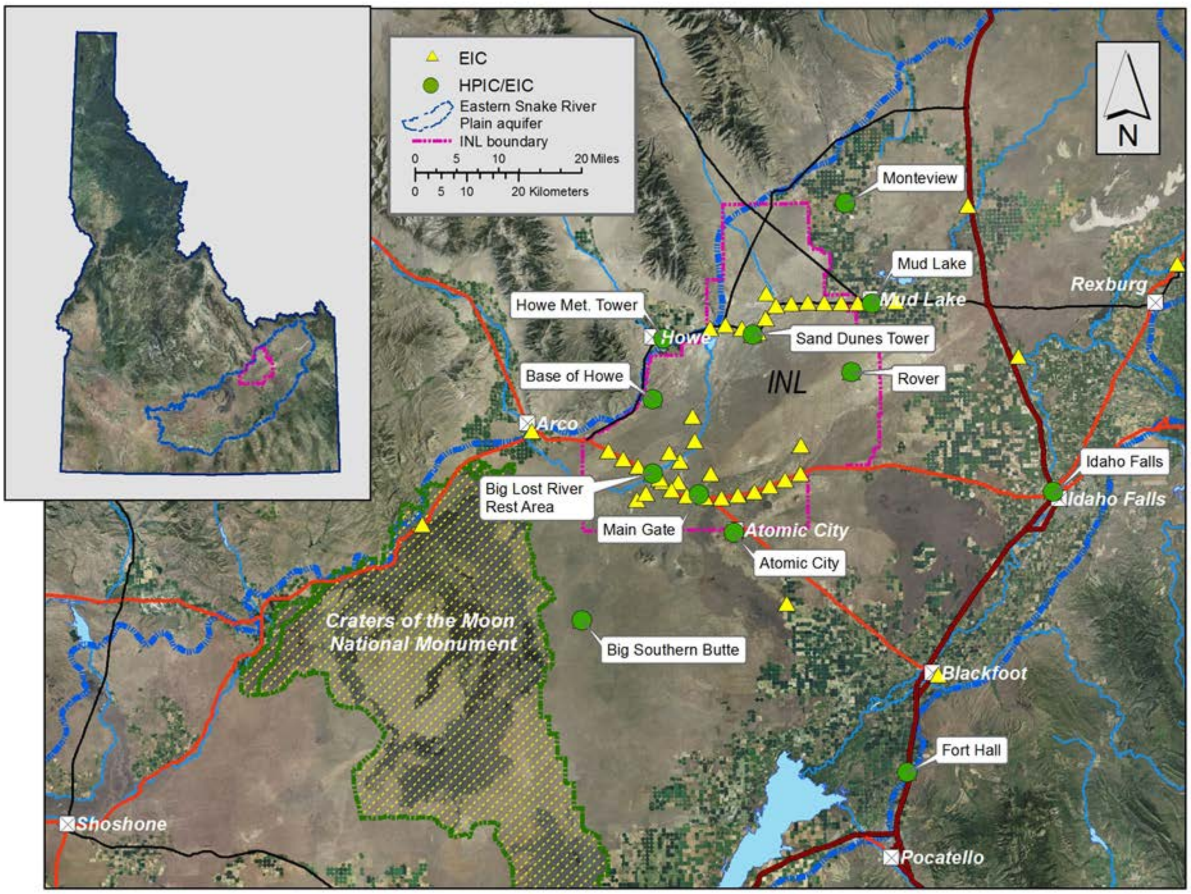

Figure 6. Locations of HPIC and EIC monitoring sites.

Radiation Monitoring Verification Results

DEQ uses EICs at several locations where DOE contractors monitor radiation using optically stimulated luminescent dosimeters (OSL) or thermoluminescent dosimetry (TLD). Results of the contractors' and DEQ's measurements are used to determine the comparability of the organizations' ambient penetrating radiation measurement programs. During 2015, 91% of BEA's annual average OSL dosimeters and 90% of ESER Gonzales-Stoller Surveillance, LLC (GSS)'s annual average TLD 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 2015. (Units in micro-Roentgen per hour or μR/hr)

Statistical Measure[c]	DEQ	ESER[a] GSS	DEQ	BEA[b]
Mean	13.6	13.9	11.9	13.7
Median	13.2	13.5	12.7	13.8
Standard Deviation	2.2	1.1	3.1	2.4
Minimum	9.7	12.9	6.4	7.1
Maximum	17.9	16.8	15.5	15.9
Average % difference		-4%		-10%

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 2015.

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

d. BEA did not have data for 1st and 2nd quarter of 2015 at the co-located site in Howe; therefore DEQ only compared results for the 3rd and 4th quarters at this location

Radiation Monitoring Impacts and Conclusions

Based upon radiation measurements made by DEQ, there were no discernable impacts from INL operations in 2015. Measurements on the INL are comparable to those at background locations. Quarterly averaged HPIC and EIC exposure measurements during 2015 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 2015, 86 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 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, cesium-137 (^{137}Cs) and other gamma-emitting radionuclides and tritium (^{3}H). Selected sites are also sampled for strontium-90 (^{90}Sr), technetium-99 (^{99}Tc), americium-241(^{241}Am), uranium isotopes (^{234}U, ^{235}U, ^{238}U), and plutonium isotopes (^{238}Pu, and $^{239/240}Pu$).

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.

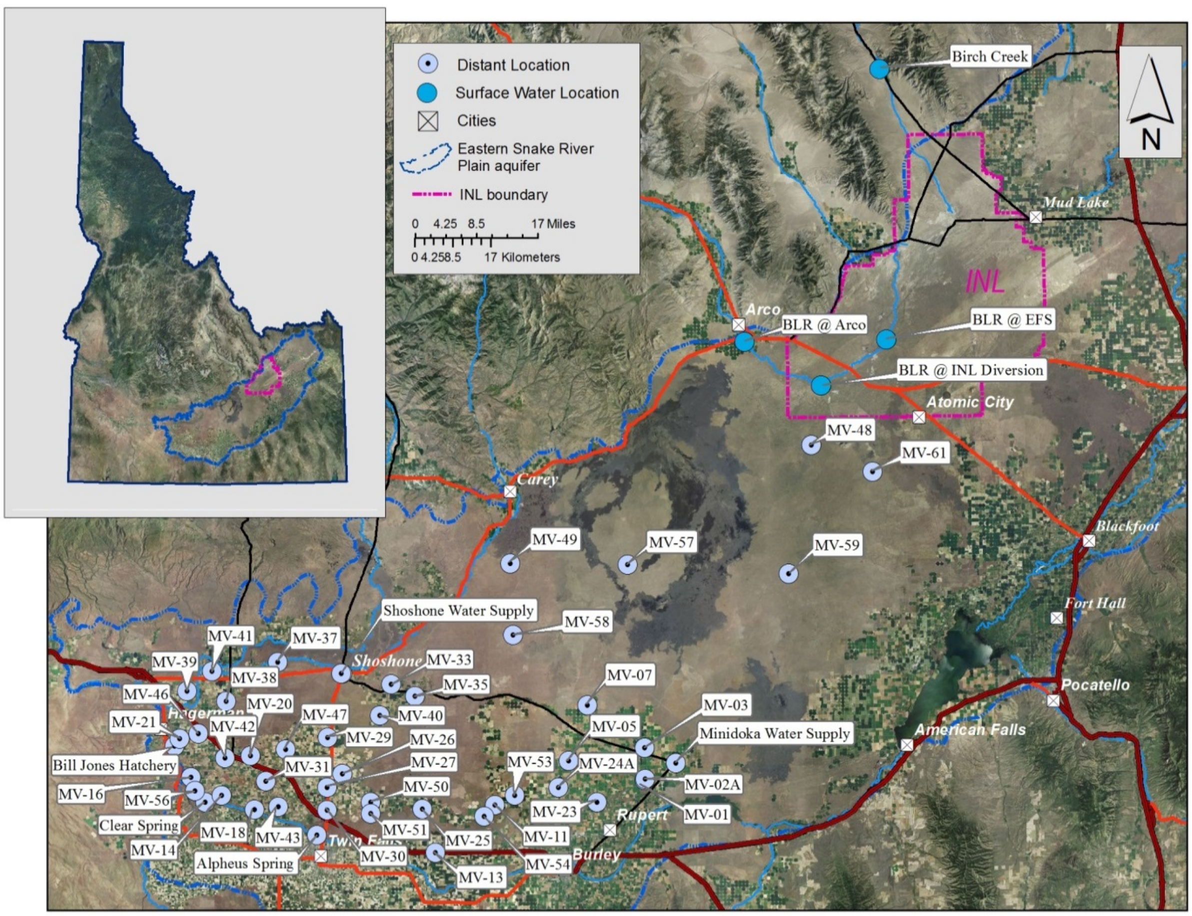

Figure 7. Water quality monitoring sites distant from the INL and surface water sites on Birch Creek and the Big Lost River (BLR).

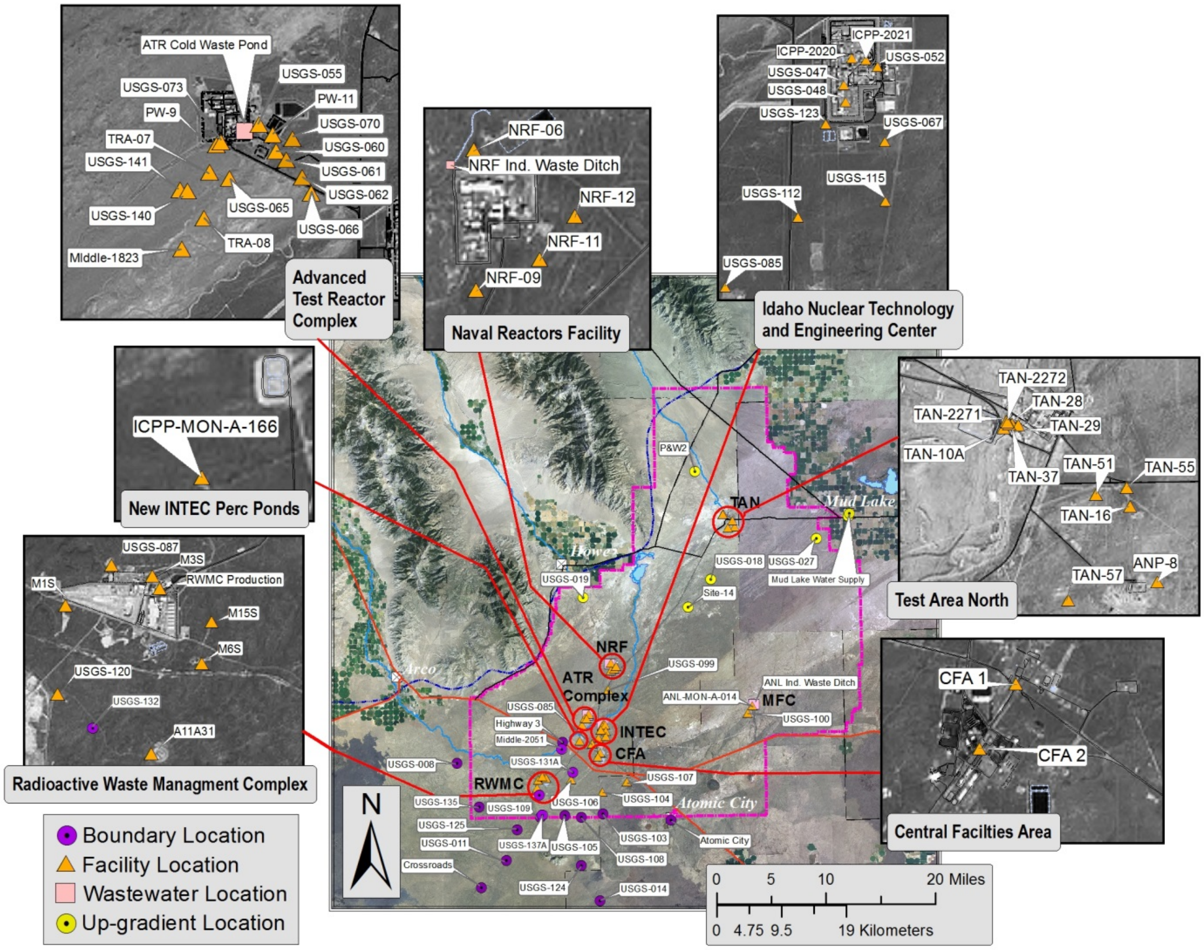

Figure 8. Water quality monitoring sites on and near the INL.

Water Monitoring Equipment and Procedures

Most ground water samples were collected from wells equipped with submersible pumps and concurrent with sampling by the DOE contractors USGS and CWI. Surface water samples were typically collected as grab samples from the water source. Water samples are collected, handled and preserved using standard methods (**Figure 9**).

Sample analyses for non-radiological analytes were conducted by the Idaho Bureau of Laboratories in Boise or their subcontractor(s). Radiological analyses were performed by ISU-EML or its subcontractor(s). Analysis methods used were consistent with industry standards.

Samples from all monitoring locations were analyzed for gross alpha and gross beta radioactivity, for gamma-emitting radionuclides, and for tritium (^{3}H). Selected sites with historic INL contamination were also sampled for strontium-90 (^{90}Sr), technetium-99 (^{99}Tc), and other site-specific analytes including uranium isotopes (^{234}U, ^{235}U, and ^{238}U), plutonium isotopes (^{238}Pu, and $^{239/240}Pu$), and americium-241 (^{241}Am). Samples were 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), trace metals (arsenic, barium, chromium, iron, manganese, lead, selenium, and zinc), and volatile organic compounds (VOCs). (**Figures 10 and 11**)

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 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 of gross alpha radioactivity for DEQ sampled sites was from facility site TAN-28 (**Table 4**). The EPA maximum contaminant level (MCL) for alpha particles is 15 pCi/L. 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}Am. In 2015, monitoring wells located at RWMC, INTEC and TAN facilities were sampled for isotopes of uranium. Uranium isotope results at the RWMC and INTEC facilities were not differentiable from natural background ranges; however, uranium isotope results collected from the TAN facility indicate ^{238}U and ^{234}U at greater than natural background levels. Uranium related to historic waste disposal activities at the TAN facility has previously been identified. During 2015, samples were collected for plutonium isotopes and ^{241}Am at the INTEC facility; neither was detected.

Table 4. Summary of selected radiological analytical results for DEQ 2015 water samples, wastewater excluded.

Analyte (pCi/L)[1]	Facility			Up-gradient, Boundary, Distant, and Surface Water			Background[2]	Drinking Water Standard (pCi/L)
	Min	Median	Max	Min	Median	Max		
Gross Alpha	<MDC[4]	<MDC	12.2 ± 3.4	<MDC	<MDC	5.6 ± 2.0	0-4[2]	15
Gross Beta	1.7 ± 0.8	5.15	1292.6 ± 14.5	<MDC	3.4	8.4 ± 1.5	0-7[2]	--[3]
^{137}Cs	<MDC	<MDC	5.5 ± 2.1	<MDC	<MDC	<MDC	0	200[3]
^{3}H	<MDC	660	14430 ± 350	<MDC	<MDC	1150 ± 130	0-40	20,000[3]
^{90}Sr	<MDC	0.92	490 ± 110	NS[5]	NS	NS	0	8[3]
^{99}Tc	0.3 ± 0.1	1.3	375.1 ± 1.9	NS	NS	NS	0	900[3]

[1] pCi/L – picocuries per liter.

[2] 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}Cs.

[3] 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.

[4] MDC is the minimum detectable concentration. Results for ^{3}H are from the standard analysis method, with an MDC of approximately 130 pCi/L.

[5] NS – Not Sampled.

Sources of naturally occurring gross beta radioactivity include radioactive potassium-40 (^{40}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-2271 (**Table 4**). This well was installed in 2015 along with another well TAN-2272 that also reported a high concentration of gross beta radioactivity (1105.1±14.7 pCi/L). These wells were installed near the TAN facility to help characterize the effects of in-situ bioremediation (ISB) observed at other wells in the area. The observed gross beta radioactivity at both wells can be accounted for by the measured ^{90}Sr, discussed following and seen in **Figure 14**.

^{137}Cs is a known ground water contaminant for both the TAN and INTEC areas. For 2015, ^{137}Cs was detected at two facility locations, including TAN-2272 (**Table 4**) and TAN-37A (4.7±1.9 pCi/L). ^{137}Cs has been detected previously at the TAN-37A location in the range of 3.7± 2.4 to 6.9±2.4 pCi/L from 2007 to 2010 and at 11.7± 2.3 pCi/L in 2014. ^{137}Cs was the only man-made gamma emitting radionuclide detected during 2015.

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

Tritium (^{3}H)

Most of the radioactivity released to the aquifer was in the form of ^{3}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}H was disposed in the aquifer by injection well and later by percolation ponds. Waste pond operations that allowed ^{3}H to infiltrate to the aquifer ceased in 1995 at INTEC and in 1993 at the ATR Complex. ^{3}H concentrations for selected wells with INL contamination near INTEC and the ATR Complex are presented in **Figure 12** (see

Figure 8 for well locations). USGS-085 was not sampled in 2015 and TRA-07 has not been co-sampled since 2013 due to lack of water. The ^{3}H concentrations found in these wells have continued to decline because ^{3}H is no longer disposed directly to the aquifer. Over time, the ^{3}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}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}H observed in wells at the RWMC is likely from wastes disposed at that facility, although up-gradient ^{3}H sources at the ATR Complex and possibly INTEC may also contribute to the ground water contamination in these wells. ^{3}H concentrations greater than background have been measured in wells approximately 4 miles past the INL southern boundary using a low-level ^{3}H analysis which has a lower minimum detectable concentration (MDC) of 10 to 14 pCi/L. **Figure 13** shows ^{3}H concentrations measured in 2015.

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 2015, seven Westbay wells were sampled, some at multiple zones within the aquifer, including USGS-103 (at 1,258 ftbls, or feet below land surface), USGS-105 (at 952 ftbls, and at 1,072 ftbls), USGS-108 (at 1,172 ftbls), USGS-131A (at 616 ftbls, and at 812 ftbls), USGS-132 (at 765 ftbls), USGS-137A (at 747 ftbls) and Middle-2051 (at 749 ftbls, and at 1,091 ftbls). Sample results from these wells show elevated ^{3}H concentrations, ranging from 100 to 1150 pCi/L, in all of the sampled aquifer zones which are likely related to INL waste disposal influences.

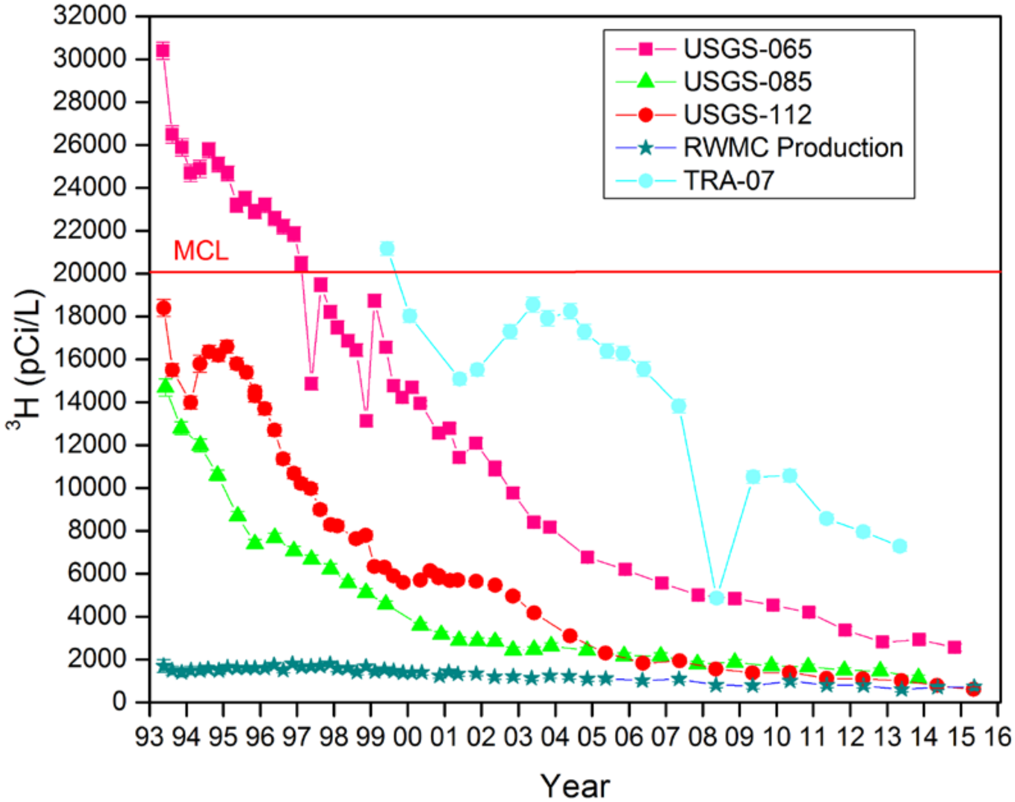

Figure 12. ^{3}H concentrations (pCi/L) over time for selected INL Site wells impacted by INL contamination.

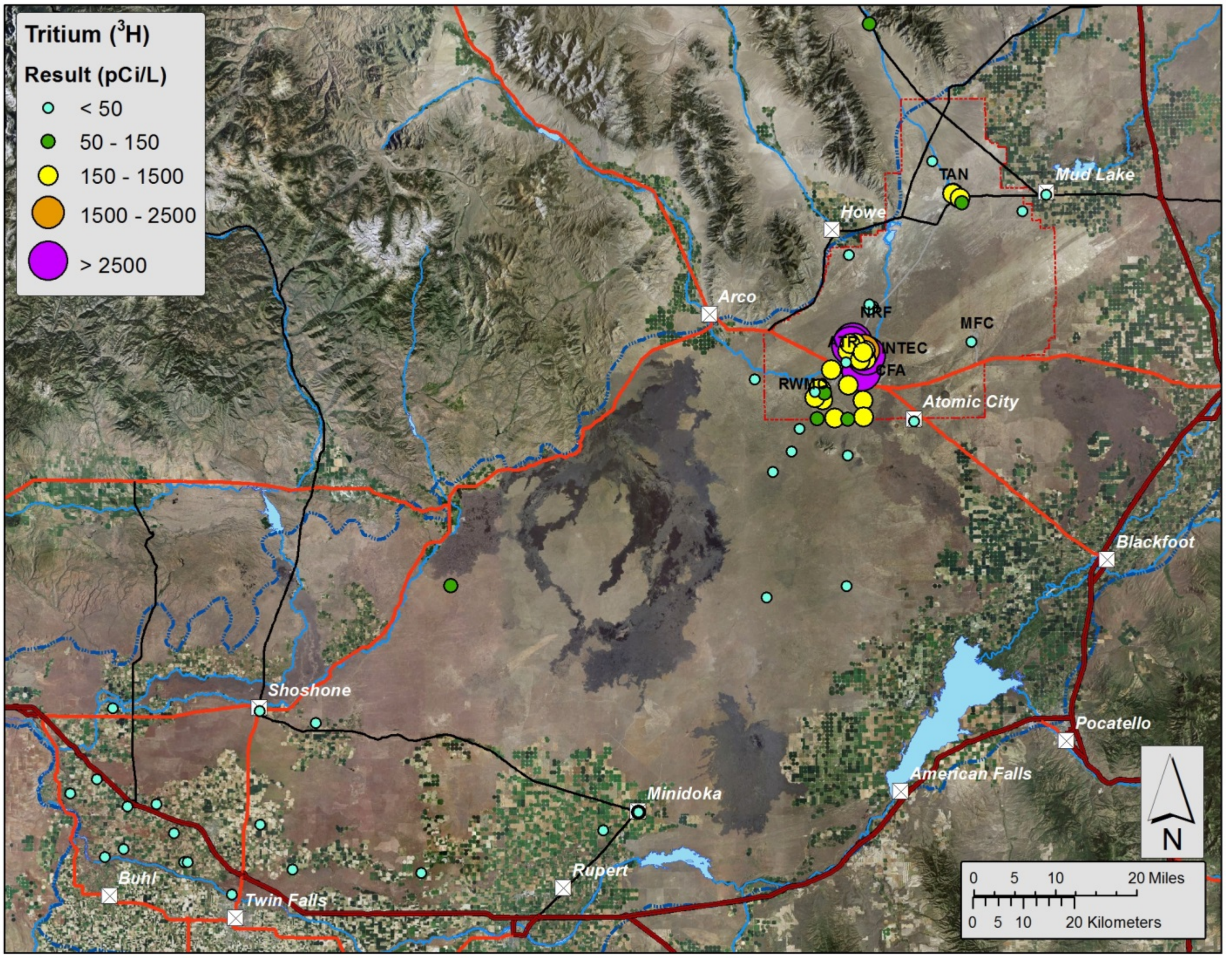

Figure 13. 2015 ^3H concentrations (pCi/L) for DEQ sample locations.

Strontium-90 (^{90}Sr)

^{90}Sr and ^{99}Tc are the primary sources for elevated gross beta radioactivity observed in wells with INL contamination. Concentrations of ^{90}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. TAN-37 can be sampled from three different depths, denoted as A (240 ftbls), B (275 ftbls), and C (375 ftbls). DEQ samples TAN-37 from the shallowest depth, A, and will refer to this monitoring site as TAN-37A throughout this report. During 2012 sampling it was reported that the concentration for ^{90}Sr at TAN-37A had dropped from 580 ± 140 pCi/L in 2011 to 261 ± 61 pCi/L in 2012. Contractor data and gross beta concentrations were evaluated at TAN-37A to confirm the drop in ^{90}Sr concentration. While the 2013 ^{90}Sr concentration at TAN-37A remained relatively steady at 289 ± 68 pCi/L, the 2014 concentration was lower with a reported value of 206 ± 48 pCi/L. For 2015, the reported ^{90}Sr concentration is 262±62 pCi/L. DEQ initially sampled TAN-37A 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 aquifer treatment (in-situ bioremediation or ISB) for volatile organic compounds (VOCs) in the ground water. In July 2012, the ISB rebound test was initiated and is still ongoing. The rebound test seeks to re-establish background conditions prior to ISB activities by putting on hold, indefinitely, all clean-up actions involving bioremediation on ground water at TAN. The drop in ^{90}Sr concentrations at

TAN-37A may be related to conditions created by the ISB rebound test as indicated by the contractor in the 2015 Annual Report for groundwater remediation at Test Area North (DOE/ID-11546). The importance of ISB treatment in relation to ^{90}Sr concentrations includes the increase of major cations through the injections of sodium lactate, and/or whey powder, or a combination of the two. The competition from increased major cations in the ground water may have caused desorption of ^{90}Sr from aquifer minerals and into the groundwater through cation displacement. As the ISB-created conditions continue to return to background conditions, the ^{90}Sr concentrations in the ground water may trend lower still through adsorption onto aquifer minerals. DEQ monitors for ^{90}Sr at five other TAN facility wells located farther from the injection facility, including TAN-10A, TAN-28, TAN-29, and two newly installed wells TAN-2271, and TAN-2272. ^{90}Sr concentrations at TAN-10A, TAN-28, and TAN-29 have shown a slight decline since DEQ first began sampling these sites in 2003. Of the wells co-sampled by DEQ in 2015, TAN-2271 and TAN-2272 produced the highest concentrations of ^{90}Sr at 490±110 and 411±97 pCi/L respectively (**Figure 14**).

At INTEC, ^{90}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 15** illustrates ^{90}Sr concentrations for wells located at or down gradient of INTEC, including ICPP-2020, USGS-047, USGS-067, and USGS-112. Monitoring well USGS-085 was not co-sampled in 2015. **Figure 15** also shows USGS-055, a perched aquifer well near the historic low-level radioactive waste ponds located adjacent to the ATR Complex. ^{90}Sr concentrations near the ATR Complex are due to past disposal practices. USGS-055 had not been sampled by the DEQ from 2009 to 2014 due to lack of water during fall co-sampling with the DOE contractor; it was sampled twice in 2015 in the spring and fall. All sites indicate that ^{90}Sr concentrations are generally steady or declining. **Figure 16** shows ^{90}Sr concentrations at DEQ sample locations during the 2015 monitoring season.

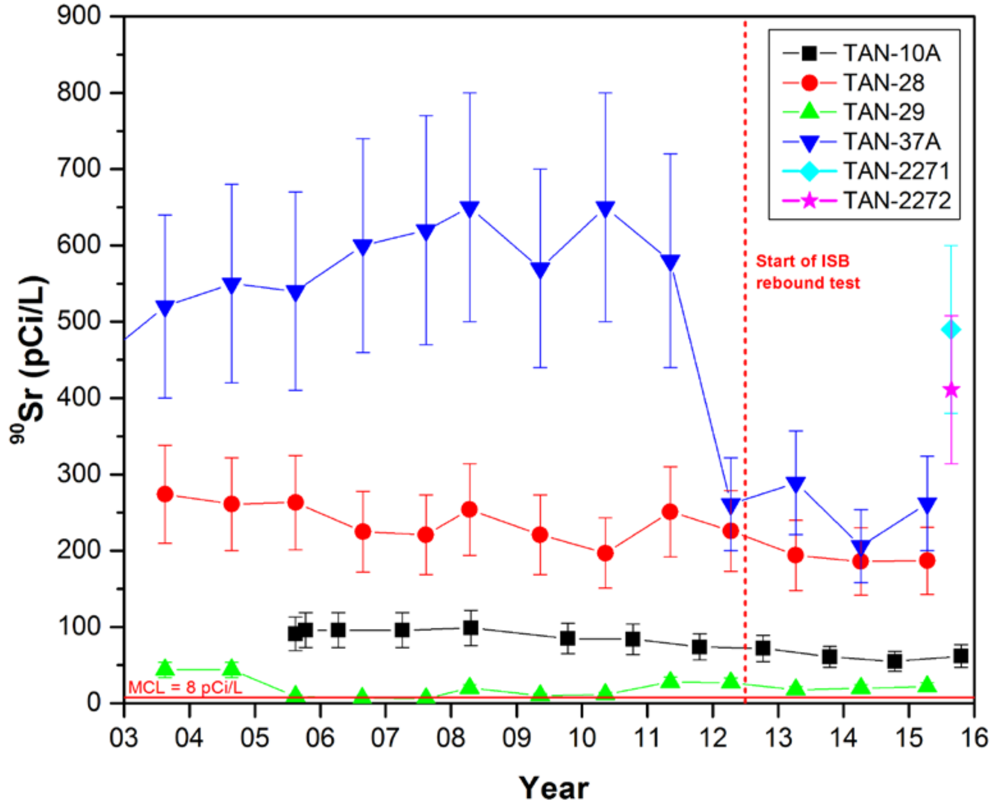

Figure 14. ^{90}Sr concentrations over time for selected wells near Test Area North (TAN).

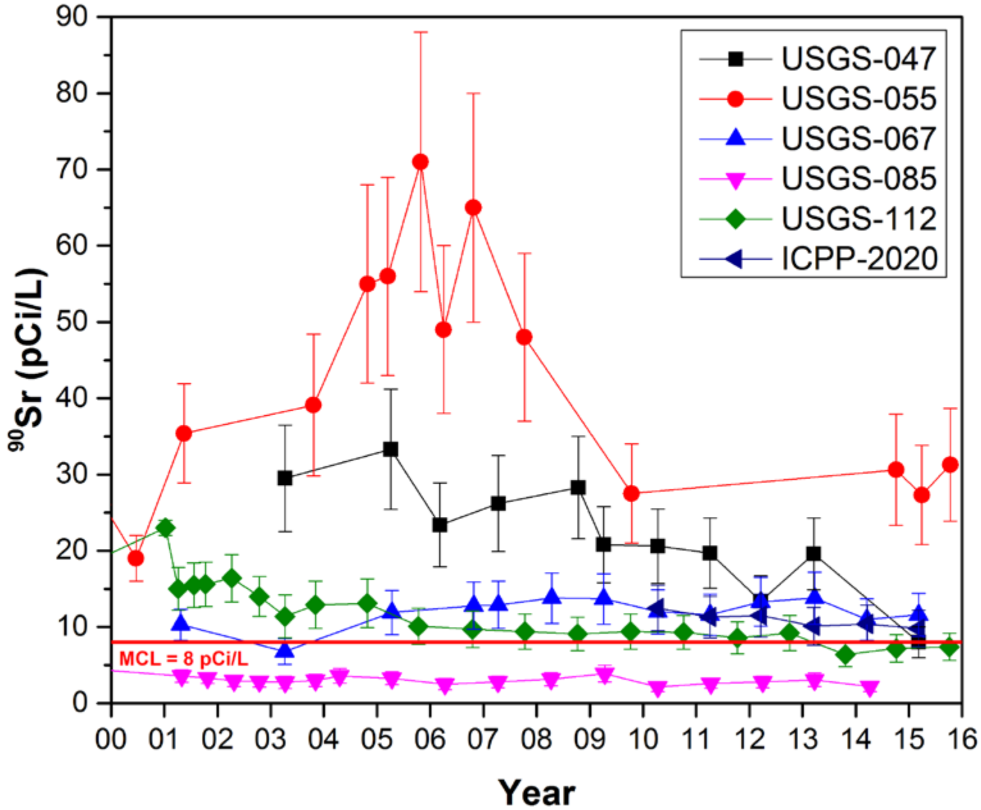

Figure 15. ^{90}Sr concentrations over time for selected INL Site wells impacted by INL contamination.

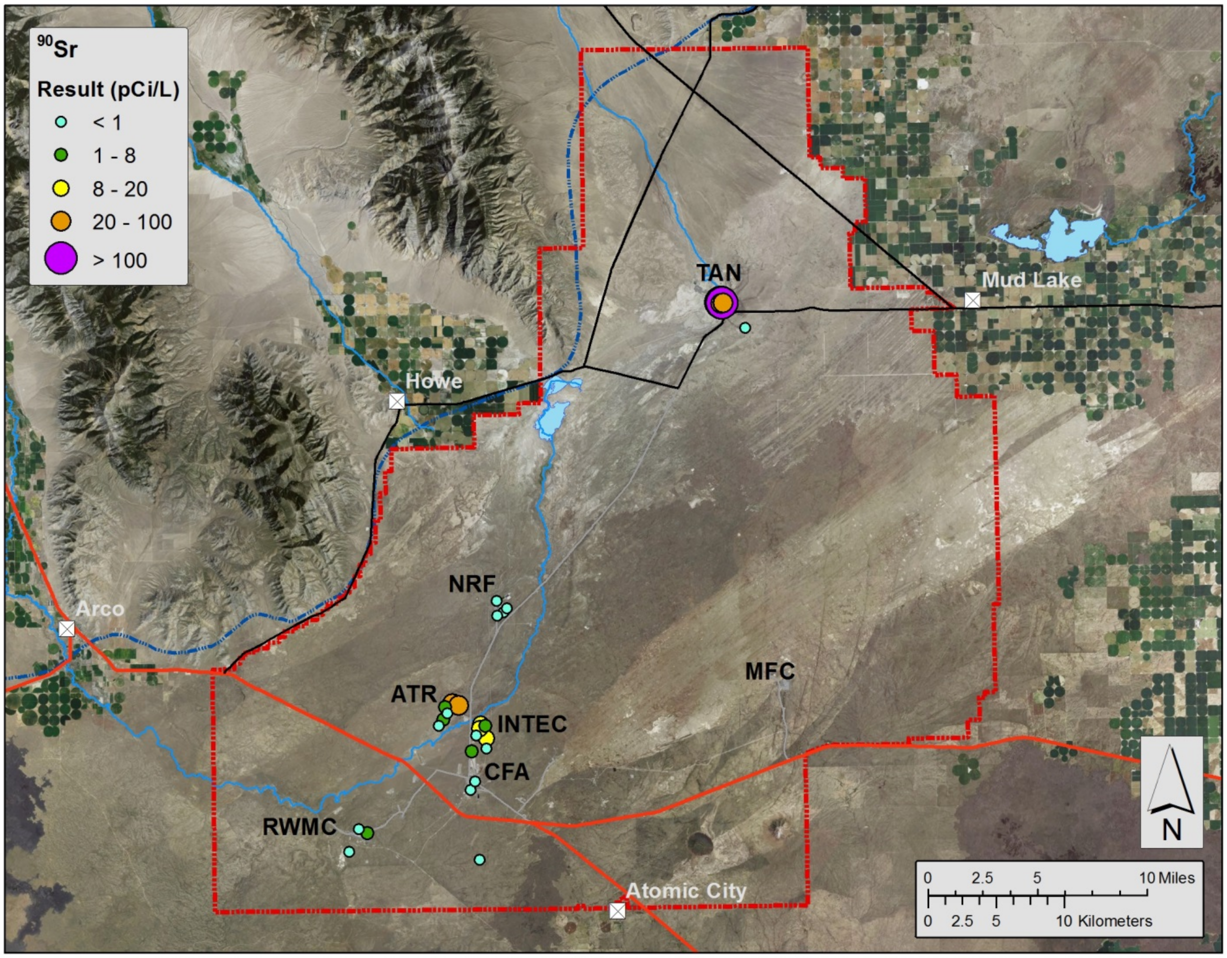

Figure 16. 2015 ^{90}Sr concentrations (pCi/L) for DEQ sample locations.

Technetium-99 (^{99}Tc)

^{99}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 2015 was for well USGS-052, located at the INTEC facility. USGS-052 had a measured ^{99}Tc value of 375.1 ± 1.9 pCi/L. Results for USGS-052 are irregular and fluctuate between sampling events but overall indicate an increasing trend since 2006. **Figure 17** shows ^{99}Tc concentrations over time for selected INL wells located at or down gradient of INTEC. Concentrations of ^{99}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 17** include USGS-067 and ICPP-2020. Results for USGS-067 show the ^{99}Tc concentration has been generally steady since 2005. 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 ^{99}Tc. All 2015 results for ^{99}Tc were below the MCL of 900 pCi/L. **Figure 18** shows ^{99}Tc concentrations at DEQ sample locations.

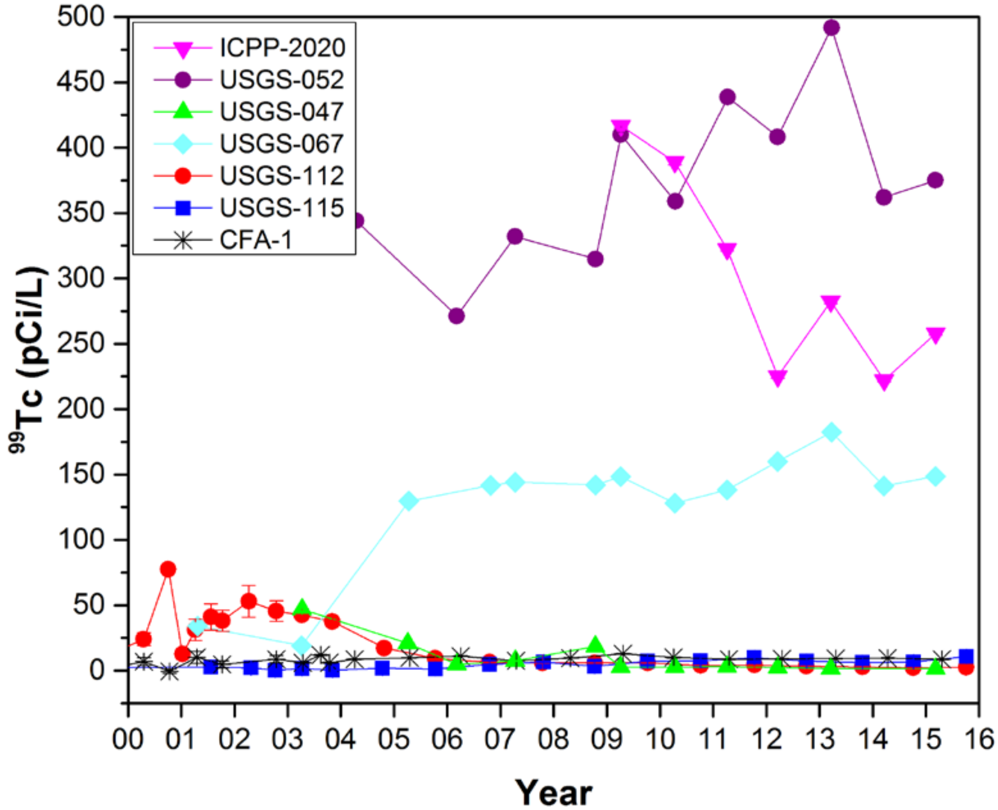

Figure 17. ^{99}Tc concentrations over time for selected INL Site wells impacted by INL contamination.

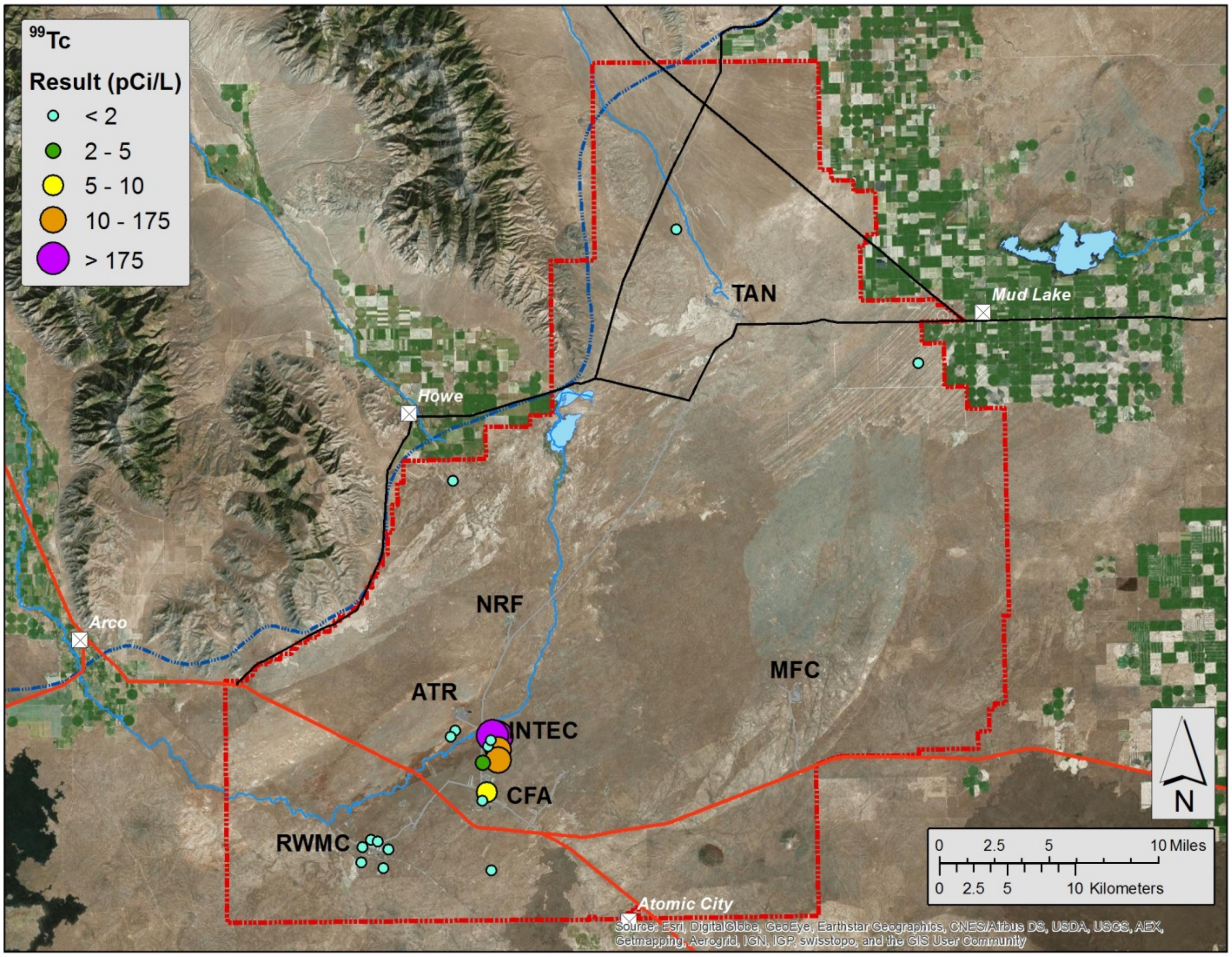

Figure 18. 2015 ^{99}Tc concentrations (pCi/L) for DEQ sample locations.

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 2015 were relatively unchanged from previous years. Common ions, nutrients, and metal results found in samples collected by DEQ in 2015 are summarized in **Table 5**. Following the table is a discussion of analytical results for chloride, chromium, manganese, iron, and VOCs, which have each exceeded their respective drinking water standards either in the recent past or during the 2015 monitoring season.

Table 5. Summary of selected non-radiological analytical results for DEQ water samples for 2015.

Analyte	Up-gradient			Facility			Boundary			Distant			Background[1]	Drinking Water Standard[2]
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max		
Common Ions/Nutrients (mg/L)														
Calcium	8.7	39	50	26	54	130	34	40	51	26	46	130	5 - 43	none
Magnesium	2.8	15	18	12	17	85	11	15	19	13	18	47	1 – 15	none
Sodium	5.0	11.9	30	7.9	14	160	5.9	9.2	17	8	21	50	5 – 14	none
Potassium	0.9	2.2	5.9	1.6	3.0	20	1.8	2.6	3.3	2.2	3.9	7.0	1 – 3	none
Total Alkalinity	90	141	162	96	151	746	134	140	153	113	154	291	41 - 337	none
Chloride	4.84	8.73	46.9	10.2	21.4	434	6.25	12.2	24.9	3.69	25.5	69.9	2 – 16	250*
Fluoride	<DL[3]	0.466	0.620	<DL	0.238	0.738	<DL	0.238	0.940	0.231	0.464	0.646	0.2 – 0.6	4
Sulfate	7.98	25.8	40.4	17.2	36.8	168	17.7	23.1	25.8	17.3	39.5	98.3	2 – 24	250*
Total Nitrate plus Nitrite	<DL	0.62	2.6	0.037	1.2	7.4	0.48	0.84	1.6	0.03	1.5	30	1 – 2	10
Total Phosphorus	<DL	0.018	0.038	0.01	0.030	1.10	0.012	0.018	0.024	0.013	0.025	0.420	<0.02	none
Metals (µg/L)														
Barium	18	64	82	21	73	1000	22	36	77	11	36	160	50 – 70	2000
Arsenic	<DL	<DL	8.8	<DL	<DL	9.6	<DL	<DL	2.4	<DL	<DL	<DL	2 - 3	10
Chromium	<DL	<DL	5.3	<DL	9.4	88	<DL	6.5	11.0	<DL	<DL	<DL	2 - 3	100
Iron	<DL	<DL	22	<DL	<DL	13000	<DL	<DL	84	<DL	<DL	110	<10	300*
Lead	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<DL	<5	15
Manganese	<DL	<DL	35	<DL	<DL	1500	<DL	<DL	19	<DL	<DL	2.8	<1 – 4	50*
Selenium	<DL	<DL	<DL	<DL	<DL	3.0	<DL	<DL	<DL	<DL	<DL	<DL	<1	50
Zinc	<DL	<DL	<DL	<DL	<DL	500	<DL	28	89	<DL	8.1	170	<10	5000*

[1]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.

[2]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.

[3]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 19**. NRF-06 is located near the NRF industrial waste ditch in which wastewater from water softeners is discharged. Chloride concentrations for DEQ 2015 sample locations are shown in **Figure 20**.

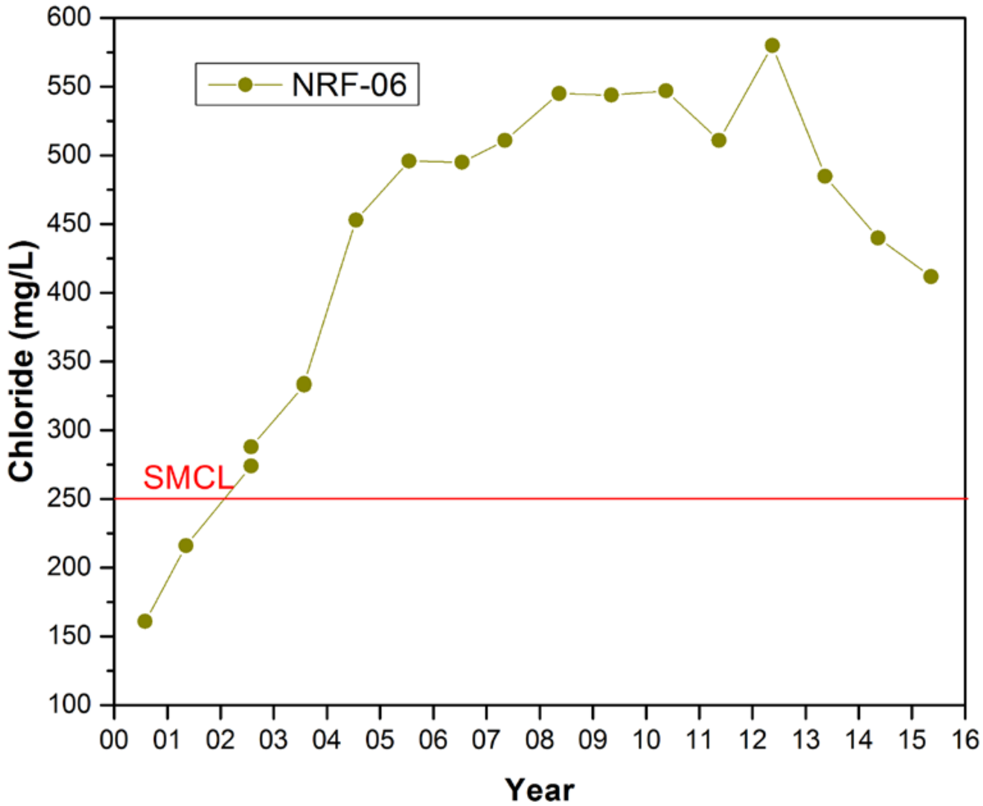

Figure 19. Chloride concentrations for sample location NRF-06 over time.

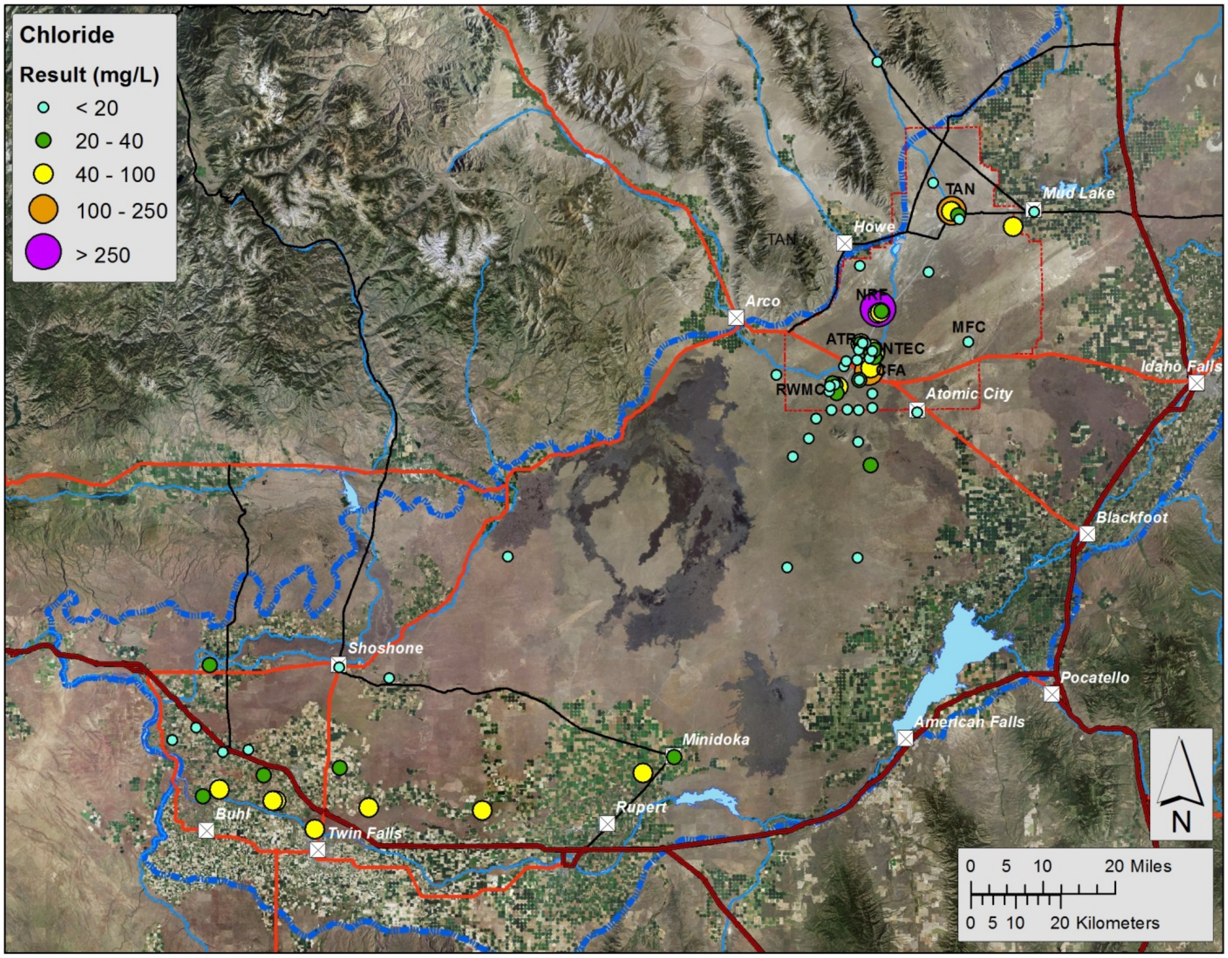

Figure 20. 2015 chloride concentrations for DEQ sample locations.

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 2015 chromium concentrations were below the maximum contaminant level (MCL) of 100 µg/L at all DEQ monitored sites. Data for ICPP-2020, TRA-07, and USGS-065 are illustrated in **Figure 21**. TRA-07 and USGS-065 are located near ATR and have historically shown elevated concentrations of chromium with a declining trend over time. TRA-07 was not sampled during 2015 due to lack of water during fall co-sampling with DOE contractors. ICPP-2020 is located at INTEC and has been sampled by the DEQ since 2009, producing 7 samples. The data show large fluctuations between sampling events from 2009 to 2012, with 2012 to 2015 results relatively consistent. Concentrations for DEQ 2015 sample locations are shown in **Figure 22**.

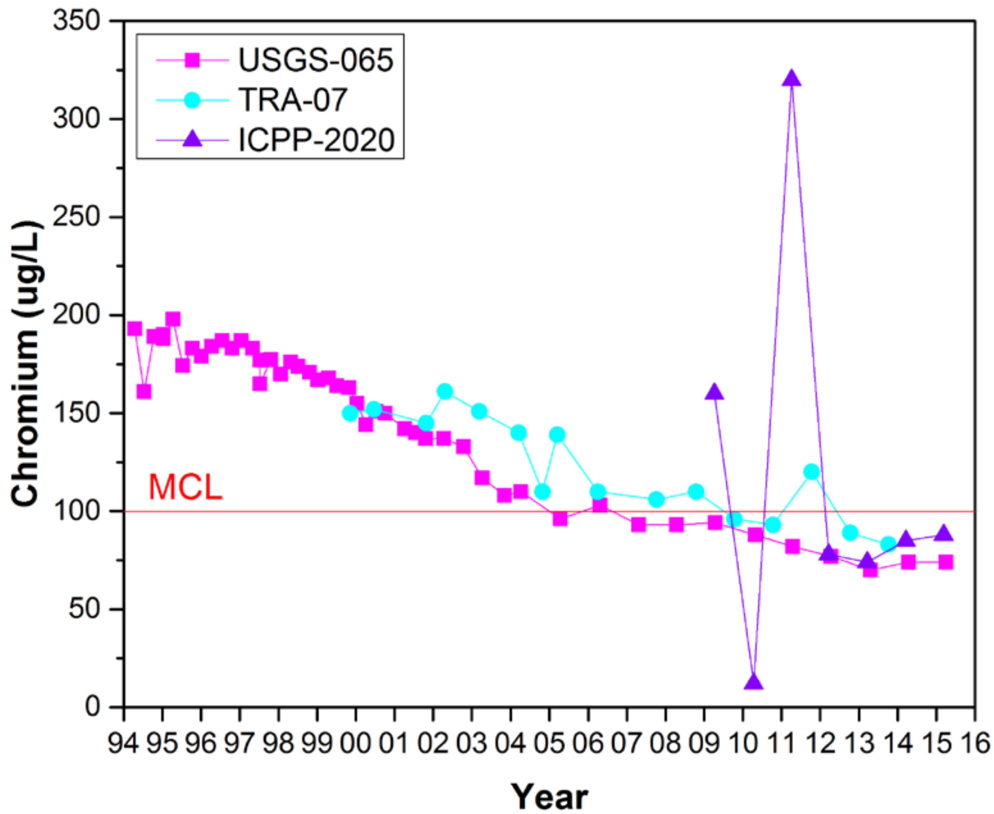

Figure 21. Chromium concentrations (µg/L) over time for selected INL Site wells impacted by INL contamination.

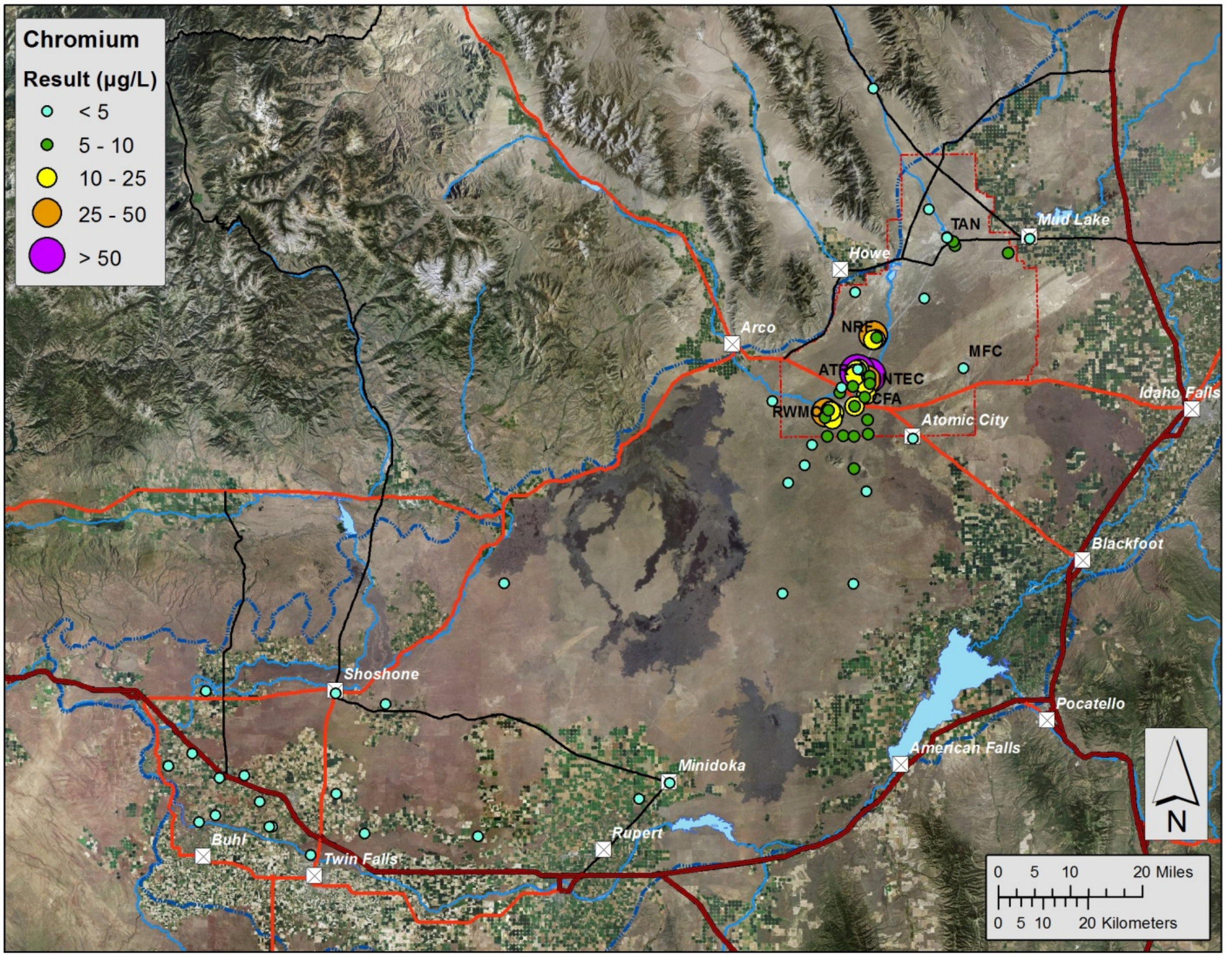

Figure 22. 2015 chromium concentrations (µg/L) for DEQ sample locations.

Manganese and Iron

Seven wells exceeded the SMCL for manganese (50 µg/L) during the 2015 sample season. All seven of the wells, including TAN-2271 (1500 µg/L), TAN-2272 (830 µg/L), TAN-10A (830 µg/L), TAN-28 (1100 µg/L), TAN-29 (420 µg/L), TAN-37A (920 µg/L), and ANP-8 (390 µg/L) are located at or down gradient of the TAN facility. Five of these wells also exceeded the SMCL for Iron (300 µg/L) during the 2015 sample season, including ANP-8 (13,000 µg/L), TAN-37A (2100 µg/L), TAN-2271 (1400 µg/L), TAN-10A (1200 µg/L), and TAN-2272 (800 µg/L). The elevated concentrations for both manganese and iron are consistent with conditions created by in-situ bioremediation (ISB) efforts as part of the clean-up action for VOCs at TAN. While ISB at the TAN facility was transitioned into a rebound test in July 2012 that is still ongoing, background conditions prior to ISB activities have not yet been re-established. Of these wells, only TAN-10A has trend data for manganese and iron which indicate that since 2012 manganese concentrations have gradually decreased from 940 µg/L to 830 µg/L in 2015, while iron concentrations have decreased from 3000 µg/L to 1200 µg/L in 2015.

Volatile Organic Compounds

Concentrations for four VOCs exceeded MCL's in wells at or near the TAN facility: Tetrachloroethylene (or PCE, MCL = 5 µg/L), trichloroethylene (or TCE, MCL = 5 µg/L), vinyl chloride (or VC, MCL = 2 µg/L), and cis-1,2-Dichloroethene (or cis-1,2-DCE, MCL = 70 µg/L).

The VOC ground water plume at the TAN facility is broken into three areas based on concentration ranges for trichloroethylene (TCE). The three areas are known as the hot spot (> 20,000 µg/L TCE) which includes a small area immediately surrounding the former injection well, the medial zone (1,000 to 20,000 µg/L TCE) which includes a longitudinal area that surrounds the hot spot and extends east with a slight dip to the south, and finally, the distal zone (5 to 1,000 µg/L TCE) a larger area still that surrounds both the hot spot and medial zones and extends farther to the southeast. Each of these three areas are remediated differently; the hot spot utilizes in-situ bioremediation (ISB), the medial zone uses a pump and treat method, and the distal portion of the plume relies on monitored natural attenuation. DEQ monitors nine wells for VOCs near the TAN facility, including five wells in the medial zone located near the ISB injection facility (TAN-2271, TAN-2272, TAN-28, TAN-29 and TAN-37A) and four wells in the distal zone (ANP-8, TAN-16, TAN-51, & TAN-55).

In July 2012, the ISB rebound test was initiated. All clean-up actions involving bioremediation on ground water at TAN were put on hold indefinitely to determine the effects of ISB on VOC concentrations. One of the rebound test objectives is to evaluate the residual TCE source in the aquifer and determine if ISB has made satisfactory progress towards reducing concentrations of TCE and other chlorinated ethenes. Re-establishment of background conditions prior to ISB activities is crucial for the assessment of the residual source remaining in the aquifer. Pre-ISB conditions have not been met and the ISB rebound test may continue for up to 5 years beyond FY 2015. These actions are in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

There are five medial zone wells sampled by DEQ, including TAN-37A, TAN-28 and TAN-29, as well as two newly installed wells TAN-2271, and TAN-2272. Of these wells, TAN-37A seems to be the least impacted from VOCs. Both TAN-2271 and TAN-2272 exceed the MCL for TCE, while monitoring wells TAN-28 and TAN-29 exceeded MCLs for TCE, and VC, with TAN-29 also exceeding the MCL for PCE, and cis-1,2-DCE. TCE and PCE concentrations in TAN-29 appear to show an upward trend since the ISB rebound test was initiated. TCE concentrations at selected TAN facility wells located in the medial zone are illustrated in **Figure 23**.

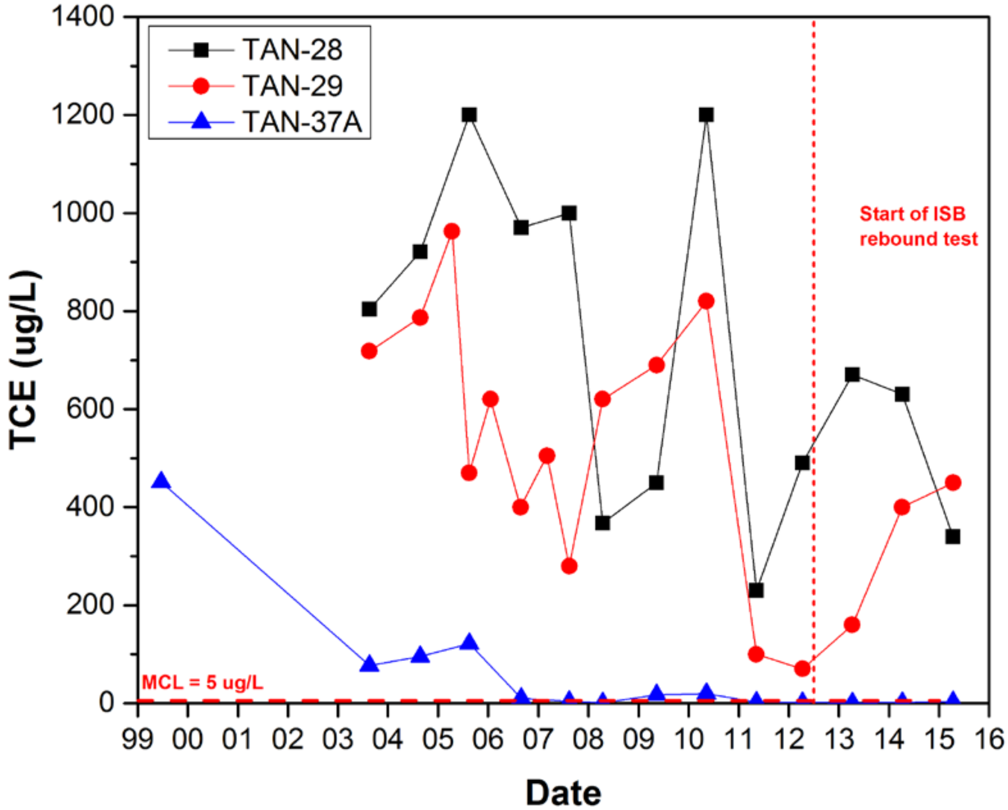

Figure 23. TCE concentrations (µg/L) over time for selected wells located in the medial zone near the ISB injection facility at TAN.

DEQ also monitors four distal zone wells located downgradient and to the southeast of TAN, including ANP-8, TAN-16, TAN-51, and TAN-55. All four wells exceeded the MCL for TCE, with TAN-51 and TAN-55 also exceeding the MCL for PCE. ANP-8 has remained relatively consistent with TAN-16 showing a slight decline in both PCE and TCE since DEQ first began sampling these sites. TAN-51 and TAN-55 on the other hand have shown more fluctuations between sampling events but show a larger downward trend overall in concentrations for PCE and TCE. TCE concentrations at TAN facility wells located in the distal zone are illustrated in **Figure 24**.

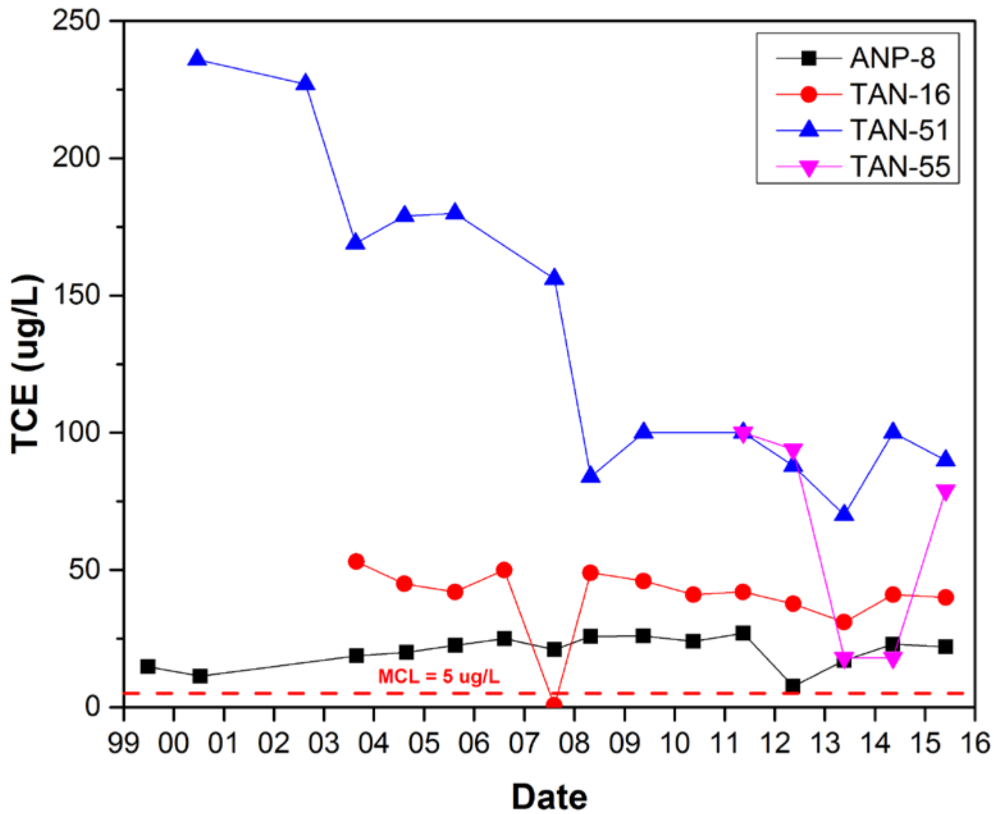

Figure 24. TCE concentrations (µg/L) over time for selected wells located in the distal zone downgradient and southeast of the TAN facility.

Two VOCs, carbon tetrachloride (or tetrachloromethane, MCL= 5 µg/L), and trichloroethylene (MCL = 5 µg/L) were detected in three of four wells at or near the RWMC facility; no MCL's were exceeded. The 2015 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 2015 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 in agreement, with all compared analyses meeting our goal of 80 percent of results passing comparison criteria.

Table 6. Radiological results for co-samples collected by DOE and DEQ in 2015.

Analyte	Number of Co-sampled pairs in 2015	Percent of Co-sampled pairs passing criteria in 2015
Gross alpha	47	94
Gross beta	47	85
^{137}Cs	51	100
^{238}Pu	7	100
$^{239/240}$Pu	7	100
^{90}Sr	36	94
^{99}Tc	8	88
^{3}H	80	99
^{234}U	10	100
^{235}U	11	100
^{238}U	10	100
^{241}Am	2	100

Non-Radiological

A summary of the sample-by-sample comparison of DEQ and DOE non-radiological results for 2015 is presented in **Table 7**. Sample-by-sample comparisons showed that results were in agreement, with all compared analyses meeting the goal of 80 percent of results passing comparison criteria.

Table 7. Non-radiological results for co-samples collected by DOE and DEQ in 2015.

Analyte	Number of Co-sampled pairs in 2015	Percent of Co-sampled pairs passing criteria in 2015
Common Ions/Nutrients		
Calcium	17	100
Magnesium	17	100
Sodium	60	100
Potassium	17	100
Chloride	60	100
Sulfate	61	100
Total Nitrate plus Nitrite	53	98
Total Phosphorus	36	92
Trace Metals		
Arsenic	9	100
Barium	9	100
Chromium	47	98
Iron	11	91
Lead	9	100
Manganese	10	100
Selenium	9	100
Zinc	9	100
VOCs[1]		
8 VOC analytes	73	80

[1]15 co-sampled VOC samples were collected and 73 paired results for the same analytes were compared.

Water Monitoring and Verification Impacts and Conclusions

DEQ sample results are largely 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. Specifically:

- Concentrations for ^{90}Sr, chloride, manganese, iron and VOCs exceeded federal drinking water standards (MCLs or SMCLs) at some sites on the INL in 2015. These sites, however, are not used for drinking water.

- No sites monitored by DEQ exceed federal drinking water standards for ^{3}H. Concentration trends for ^{3}H continue to decline. This INL contaminant is detectable at monitoring sites approximately 4 miles beyond the southern INL boundary at levels 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 all DEQ monitored sites for 2015.

- 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 (2015 soil sampling sites are shown in **Figure 25**). 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. No physical soil samples were collected during 2015.

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.

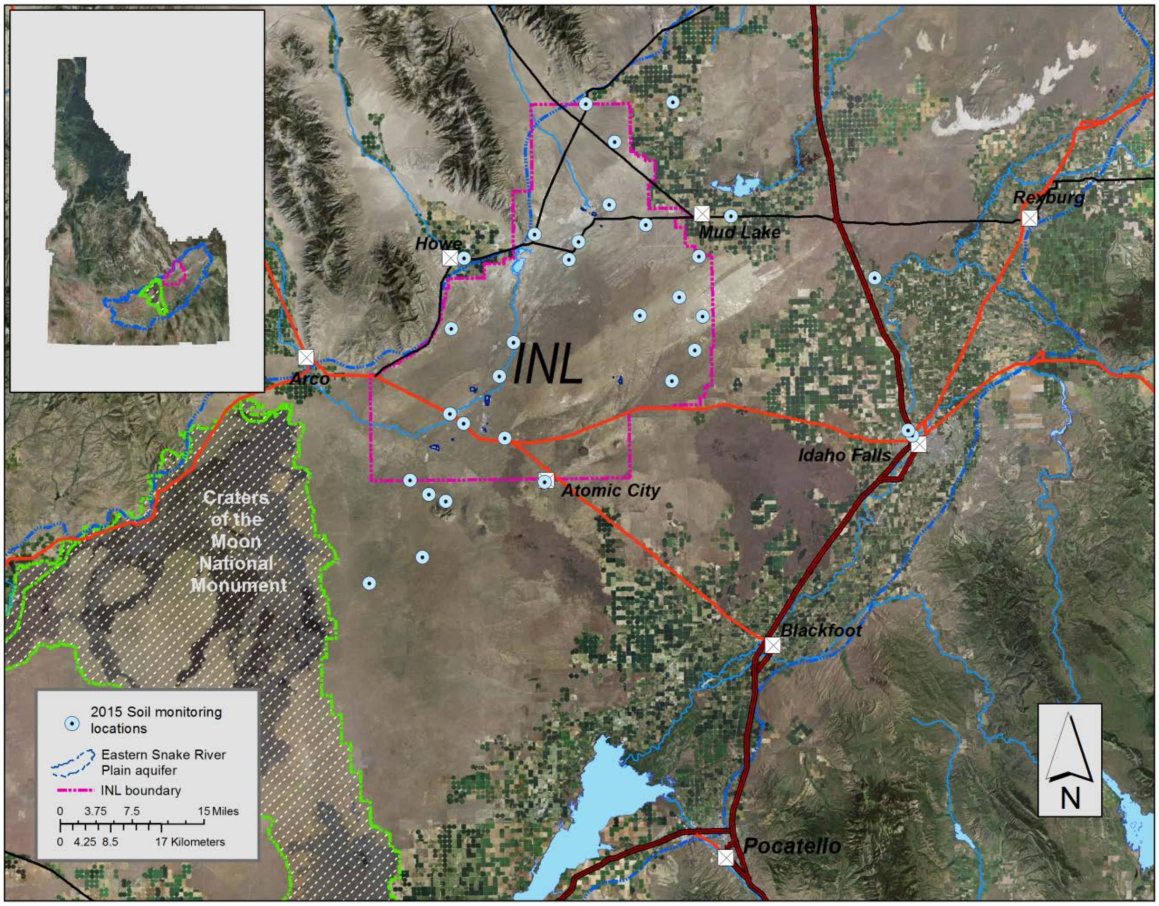

Figure 25. DEQ soil sampling locations for 2015.

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 2015, DEQ made *in-situ* gamma spectrometry measurements to estimate accumulations of gamma-emitting radionuclides in surface soil at 31 locations. Of the 31 measurements, Cesium-137 (^{137}Cs) was the only man-made radionuclide that was detected. The average ^{137}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 0.31 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 2015, DEQ analyzed 49 milk samples. Radioiodine (^{131}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}I for food, including milk, is 4600 pCi/kg.

Terrestrial Monitoring Verification Results

Naturally occurring Potassium-40 (^{40}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 (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}K results obtained by DEQ showed 100% agreement with DOE contractor results. All ^{131}I results were below the minimum detectable activity for both agencies.

The DOE contractor did not conduct any *in-situ* or physical soil sampling in 2015, so no soil radionuclide comparisons could be made.

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 2015 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 2015, the DEQ submitted 329 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 2015.

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 results using the following equation:

RPD = ((DOE result – DEQ result) / ((DEQ result + DOE result)/2)) x 100

An RPD in the range of ±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 an RPD in the range of ±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.

INL Radiological Incidents in 2015

There were no INL radiological incidents in 2015 that required activation of the INL Emergency Operations Center (EOC).

Non-INL Radiological Incidents

1. A DEQ staff member accompanied a US Nuclear Regulatory Commission (NRC) inspector and observed inspections of licensees in Pocatello and Blackfoot on May 18, 2015. A nuclear pharmacy distribution center and mobile imaging laboratory were inspected. The inspections were thorough and indicate effective regulatory control of licensees in our NRC Region.

2. DEQ/Idaho Falls Regional Office 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. Our staff also supported the EPA and DEQ review and planning for the Valley Agronomics redevelopment project on the FMC site.

Drills and Exercises

1. DEQ staff attended the Naval Reactors drill near Rock Springs, Wyoming during September 2015. We work with the Naval Nuclear Propulsion Program (NNPP), which transports spent nuclear fuel from their naval vessels via rail to Idaho. Every two years the NNPP conducts a transportation accident scenario involving a rail car carrying a spent nuclear fuel cask. The 2015 exercise was conducted at a rail crossing in Granger, Wyoming, using NNPP's newest cask, the M-180 which was designed for nuclear cores from aircraft carriers.

2. During March 2015, DEQ staff attended the DOE Radiological Assistance Program (RAP) Capstone exercise in Richland, Washington. The Capstone exercise was a multi-agency training event simulating an accident involving an automobile and a rail car loaded with radioactive material. The National Nuclear Safety Administration, the State of Washington, RAP teams from Region 6 (based in Idaho Falls) and other western Regions covering California, Hawaii, and Washington state participated in this exercise.

DEQ staff worked on the sample control hotline during the response to the simulated accident. Capstone was attended by representatives from the Federal Radiological Monitoring and Assessment Center (FRMAC) who presented information on the Consequence Management functions (field response team and home team) of FRMAC. This was an opportunity for the DEQ staff to observe a drill that engaged the FRMAC, and was therefore particularly valuable as an example of the response that would be required for a General Emergency at INL. The DEQ staff participated in field training exercises with RAP members to characterize actual radioactive materials dispersed in an outdoor training area.

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 2015, 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 WGA Technical Advisory Group. DEQ staff also participated in monthly conference calls with the WIPP Technical Advisory Group.

Emergency Response Planning and Preparedness Meetings

DEQ staff attended thirteen Local Emergency Planning Committee (LEPC) meetings, and the 2015 Wildland Fire meeting. Hospital outreach meetings were attended in late April 2015.

Classes and Presentations

1. Two DEQ staff members attended the National Radiological Emergency Preparedness meeting in Sacramento, CA.
2. DEQ staff developed and delivered training for Eastern Idaho Regional Medical Center (EIRMC) workers who may be responsible for admitting and treating potentially radiologically contaminated patients. This training was conducted in connection with the INL/CWI exercises in July 2015. It included measurements of natural and technologically produced radioactive material using radiological instruments similar to those maintained at EIRMC.
3. DEQ staff reviewed and commented on revisions in Medical Emergency Radiological Response Team training modules and video.

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 2015, we issued:

- The DEQ Annual Report for 2014.
- 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 2015, 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 26**). 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 27**) and the Rain Stick activity (**Figure 28**). Idaho Falls Earth Day was a hit with the youth enjoying the Edible Aquifer presentations (**Figure 29**) and the children and adults filling up the DEQ carry-all bags with Earth Day giveaways (**Figure 30**). DEQ gave several presentations to various schools to teach the importance of Idaho's Treasure, the Eastern Snake River Plain Aquifer. Students enjoyed getting to participate in the Edible Aquifer activity while learning more about their role in protecting the aquifer. (**Figure 31**)

Figure 26. Water Awareness Poetry Contest 2015 on display at the Idaho Falls Library.

Figure 27. Children enjoying Macro Invertebrate Mayhem activity at Water Festival 2015.

Figure 28. Children preparing their rainsticks at the Water Festival 2015.

Figure 29. Children participating in the Edible Aquifer activity at the 2015 Earth Day event.

Figure 30. DEQ preparing for the 2015 Earth Day event.

Figure 31. Teaching students about the Aquifer with the Edible Aquifer activity.

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 32** shows one community monitoring station.

Figure 32. Community monitoring station at the greenbelt in Idaho Falls.