DEQ-INL
Oversight Program
Annual Report
2014

DEPARTMENT OF ENVIRONMENTAL QUALITY
IDAHO NATIONAL LABORATORY OVERSIGHT PROGRAM

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

The purpose of this report is to provide a summary of the activities performed by DEQ during 2014. The report is divided into sections covering the Environmental Surveillance Program (ESP), Assessment of INL Site Impacts, Radiological Emergency Response Planning and Preparedness, and Public Outreach.

Environmental Surveillance Program

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

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

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

Monitoring Results

In 2014, 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 2014 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, 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 3.7×10^{10} disintegrations or nuclear transformations per second. This is approximately the amount of radioactivity emitted by one gram (1g) of radium-226. The unit is named after Pierre Curie, a French physicist.

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

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

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

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 2014 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, and VOCs exceeded federal drinking water standards at locations on the INL in 2014. 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 shown in **Figures 2 and 3**.

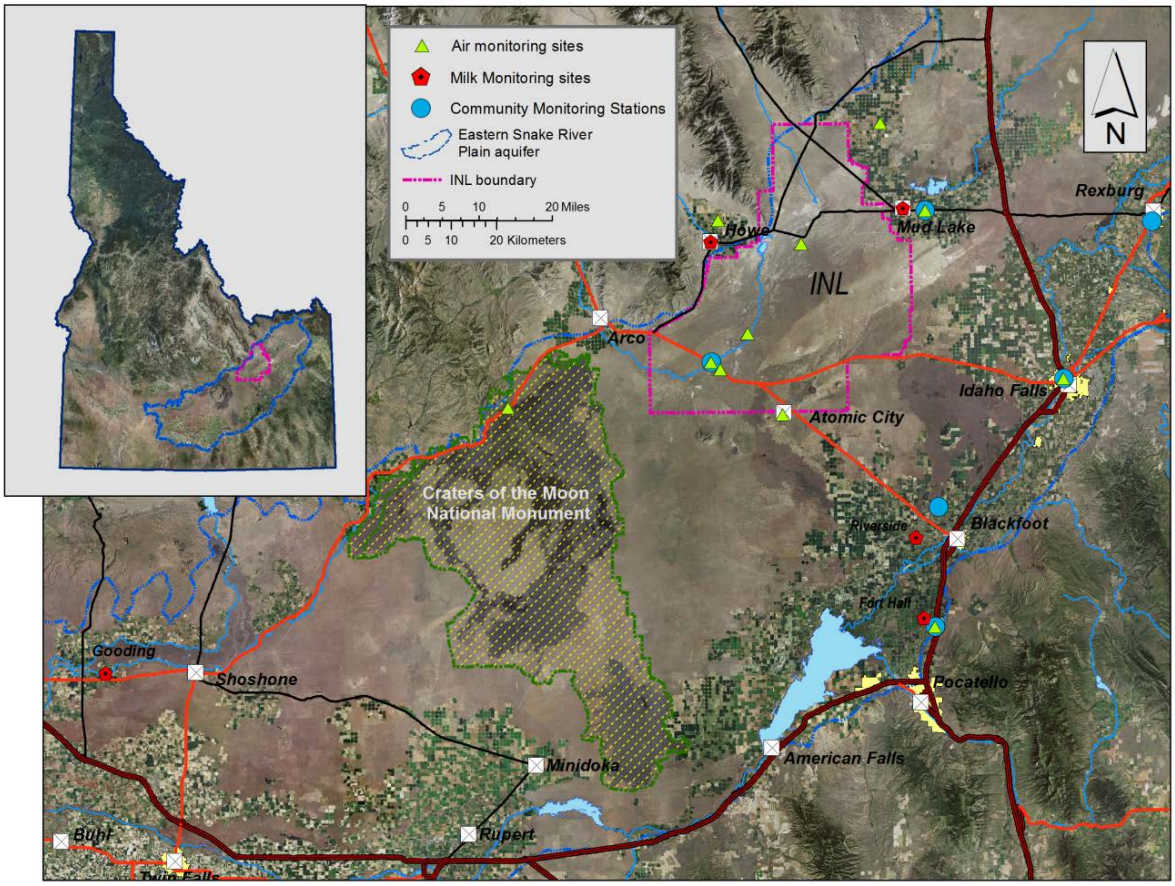

Figure 1. Locations of selected DEQ monitoring sites.

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

Air monitoring stations are segregated into three categories:

- On-site stations are located within the INL boundary and include Experimental Field Station, Van Buren Avenue, Big Lost River Rest Area, and Sand Dunes/INL Gate 4.
- Off-site stations are located near the INL boundary and include Mud Lake, 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 each location using a collection tray that is heated during the winter months. The sample flows from the tray into a 5-gallon container that is collected at the end of each calendar quarter or whenever it is full. The precipitation samples are analyzed for tritium and for gamma-emitting nuclides.

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

Air Monitoring Results and Trends

The following sections include monitoring results and trends for air monitoring.

Particulate Matter in Air

A total of 623 filters from TSP samplers were collected during 2014. 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 2014 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 for 2014.

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)
2014	0.12 to 4.98	0.95 ± 0.12	6.58 to 95.97	25.95 ± 0.59

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

Radiochemical analysis of the annual TSP filter composite samples resulted in detection of ^{90}Sr at the following locations: Experimental Field Station 16.4 ± 7.6 attocuries[1] per cubic meter (aCi/m^3) (MDC 13.2 aCi/m^3); Howe 13.4 ± 6.8 aCi/m^3 (MDC 12.3 aCi/m^3); and Mud Lake 15.3 ± 6.0 aCi/m^3 (MDC 9.5 aCi/m^3) for 2014. Of the transuranic radionuclide analytes (^{238}Pu, $^{239/240}Pu$, and ^{241}Am), $^{239/240}Pu$ was detected at the following locations: Experimental Field Station 1.7 ± 1.2 aCi/m^3 (MDC 1.5 aCi/m^3); Fort Hall 1.2 ± 0.8 aCi/m^3 (MDC 0.7 aCi/m^3); Idaho Falls 2.5 ± 1.3 aCi/m^3 (MDC 1.1 aCi/m^3); and Van Buren 1.7 ± 1.1 aCi/m^3 (MDC 1.3 aCi/m^3). The detection of ^{238}Pu at the Idaho Falls sampling location, 3.2 ± 2.0 aCi/m^3 (MDC 2.7 aCi/m^3), is an estimate considering ^{238}Pu was also detected in the blank filter composite, 3.0 ± 1.8 aCi/m^3 (MDC 2.5 aCi/m^3). These values are within the expected range due to global fallout

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

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).

Atmospheric Tritium

A total of 134 atmospheric moisture samples were collected in 2014 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 2014 were 1.97 ± 1.14 pCi/m^3 at the Experimental Field Station for the time period of August 7 through August 22, 0.79 ± 1.03 pCi/m^3 at Van Buren Avenue for the time period of September 18 through October 2, 1.99 ± 1.04 pCi/m^3 at the Big Lost River Rest Area station for the time period of August 8 through August 22, and 1.30 ± 0.89 pCi/m^3 at the Sand Dunes station for the time period of August 14 through September 4.

All atmospheric tritium measurements for 2014 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 2014.

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 2014, 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 2014.

(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	83.6 %	99%
DEQ Gross Beta Analysis	56.8 %	82.1 %

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 2014.

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 2014 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 concentrations much less than 1% of the federal standard for members of the public (40CFR61).

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

Overall, DEQ and DOE contractor air monitoring results are considered to be in agreement based on (1) direct statistical 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 2014, 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 natural, cosmic, terrestrial, and human-made sources.

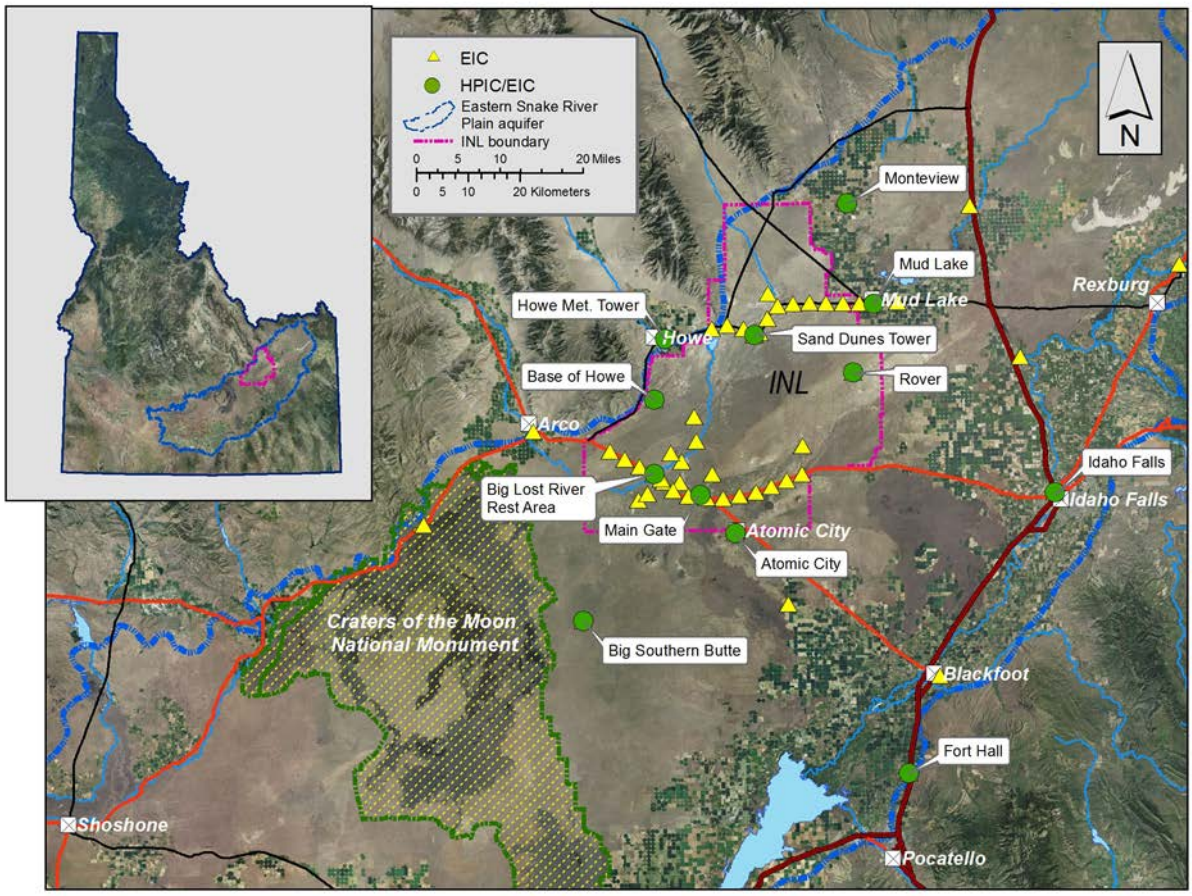

Figure 6. Locations of HPIC and EIC monitoring sites.

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 2014, 80% of BEA's annual average OSL dosimeter measurements and 89% 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 2014. (Units in micro-Roentgen per hour or µR/hr)

Statistical Measure[c]	DEQ	ESER[a] GSS	DEQ	BEA[b]
Mean	12.5	14.9	11.9	14.5
Median	12.3	14.4	12.2	14.5
Standard Deviation	0.7	1.3	1.1	1.0
Minimum	11.6	13.6	9.0	13.1
Maximum	14.0	17.8	12.8	16.6
Average % difference		-18%		-17%

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 2014.
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 2014. Measurements on the INL are comparable to those at background locations. Quarterly averaged HPIC and EIC exposure measurements during 2014 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 2014, 76 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, ^{137}Cs and other gamma-emitting radionuclides and ^{3}H. Selected sites are also sampled for ^{90}Sr, ^{99}Tc, ^{241}Am, ^{234}U, ^{235}U, ^{238}U, ^{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.

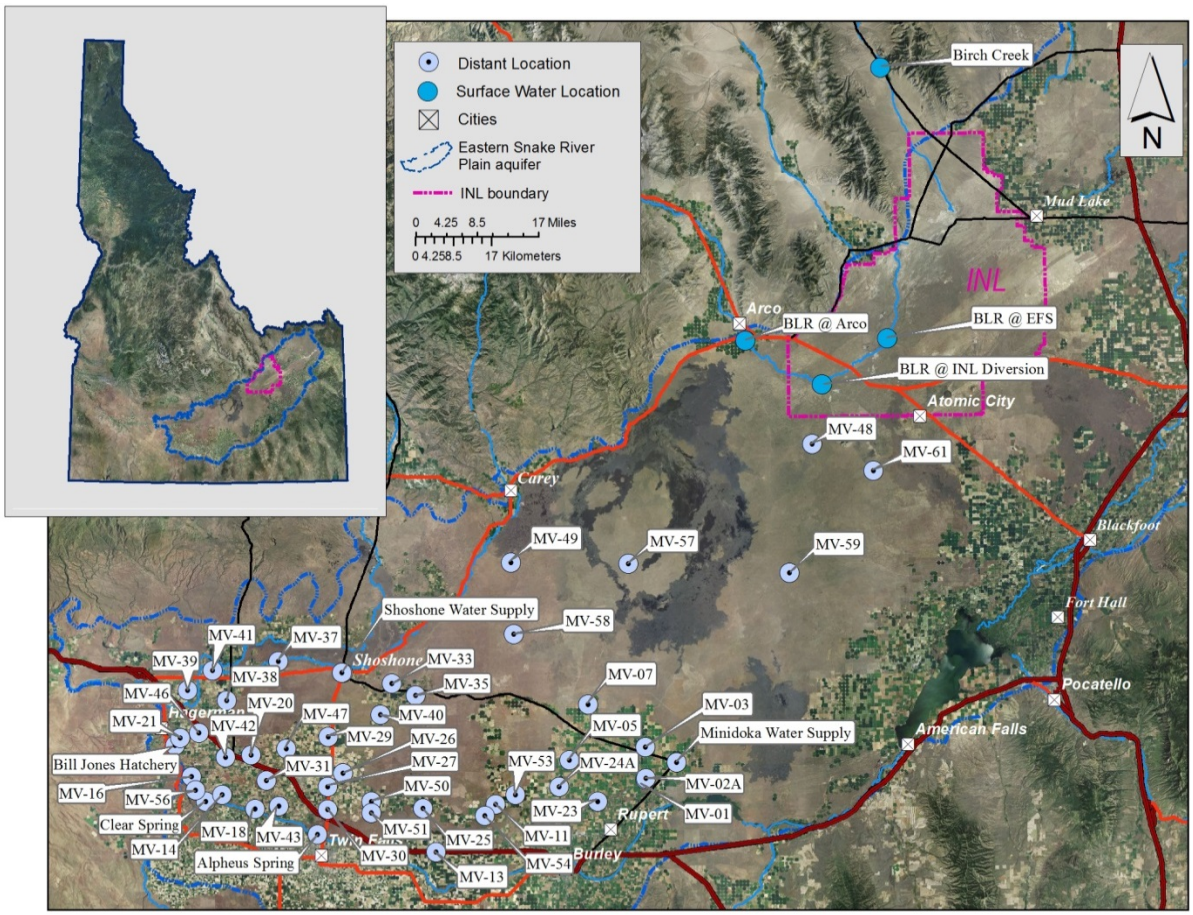

Figure 7. Water quality monitoring sites distant from the INL and surface water sites on Birch Creek and the Big Lost River (BLR).

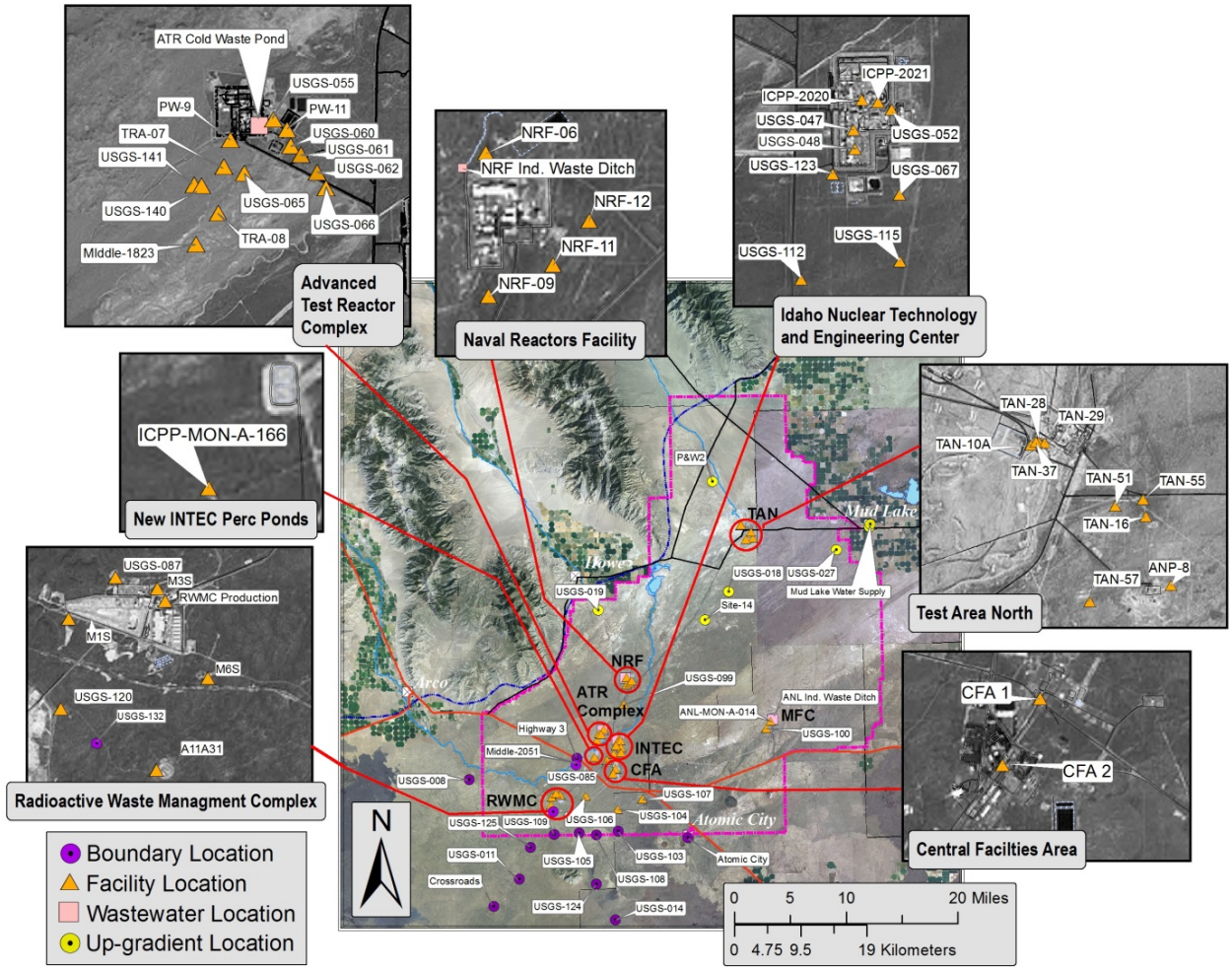

Figure 8. Water quality monitoring sites on and near the INL.

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 (**Figures 9 and 10**).

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), and trace metals (arsenic, barium, chromium, iron, manganese, lead, selenium, and zinc).

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

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

Water Monitoring Results and Trends

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

Radiological Analytes

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

The primary natural sources of gross alpha radioactivity in ground water and surface water are naturally occurring uranium and thorium. The gross alpha radioactivity observed in most facility, boundary, distant, and surface water sites is due to natural sources. Some facility sites do show gross alpha radioactivity from INL sources. This is apparent not only because concentrations are above background, but other human-made contaminants are also detectable. The highest

concentration of gross alpha radioactivity for DEQ sampled sites was from facility site CFA-2 (**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 2014, three facility locations were sampled for isotopes of uranium, including the RWMC, INTEC and TAN facilities. 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 2014, samples were collected for plutonium isotopes and ^{241}Am at the INTEC facility; neither were detected.

Table 4. Summary of selected radiological analytical results for DEQ 2014 water samples, wastewater excluded.

Analyte (pCi/L)[1]	Facility			Up-gradient, Boundary, Distant, and Surface Water			Back-ground[2]	Drinking Water Standard[3]
	Min	Median	Max	Min	Median	Max		
Gross Alpha	<MDC[4]	<MDC	7.1 ± 3.2	<MDC	<MDC	5.7 ± 2.4	0-4[2]	15
Gross Beta	2.5 ± 0.9	5.0	699 ± 10	<MDC	4.0	11.4 ± 2.3	0-7[2]	--[3]
^{137}Cs	<MDC	<MDC	11.7 ± 2.3	<MDC	<MDC	<MDC	0	200[3]
^{3}H	<MDC	735	5220 ± 200	<MDC	<MDC	300 ± 110	0-40	20,000[3]
^{90}Sr	<MDC	<MDC	206 ± 48	NS[5]	NS	NS	0	8[3]
^{99}Tc	0.6 ± 0.2	2.2	362 ± 2	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-37 (**Table 4**). TAN-37 can be sampled from three different depths, denoted as A (240 ftbls, or feet below land surface), 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. The observed gross beta radioactivity at this well can be accounted for by the measured ^{90}Sr, discussed following and seen in **Figure 12**.

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

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 11** (see **Figure 8** for well locations). 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 minimum detectable concentration (MDC) of 10 to 14 pCi/L. **Figure 12** shows ^{3}H concentrations measured in 2014.

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 2014, five 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 851 ftbls, and at 1,072 ftbls), USGS-108 (at 1,172 ftbls), USGS-132 (at 765 ftbls) and Middle-2051 (at 1,091 ftbls). Sample results from these wells show elevated ^{3}H concentrations, ranging from 60 to 300 pCi/L, in all of the sampled aquifer zones which are likely related to INL waste disposal influences.

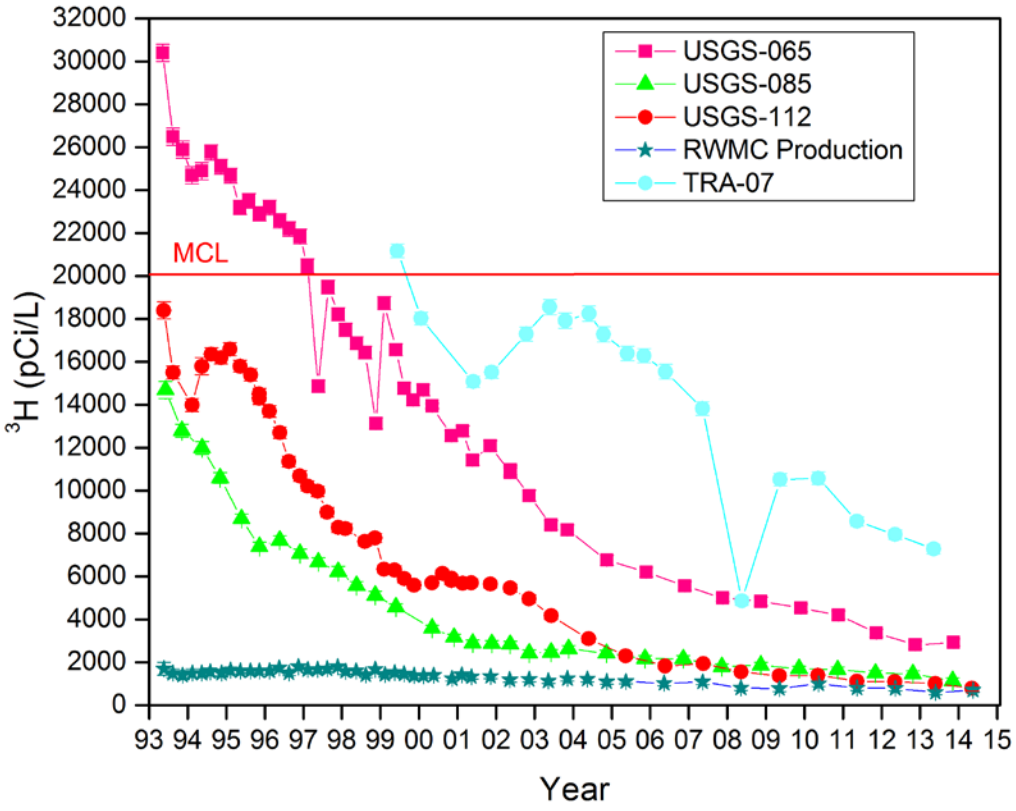

Figure 11. ^{3}H concentrations (pCi/L) over time for selected INL Site wells impacted by INL contamination.

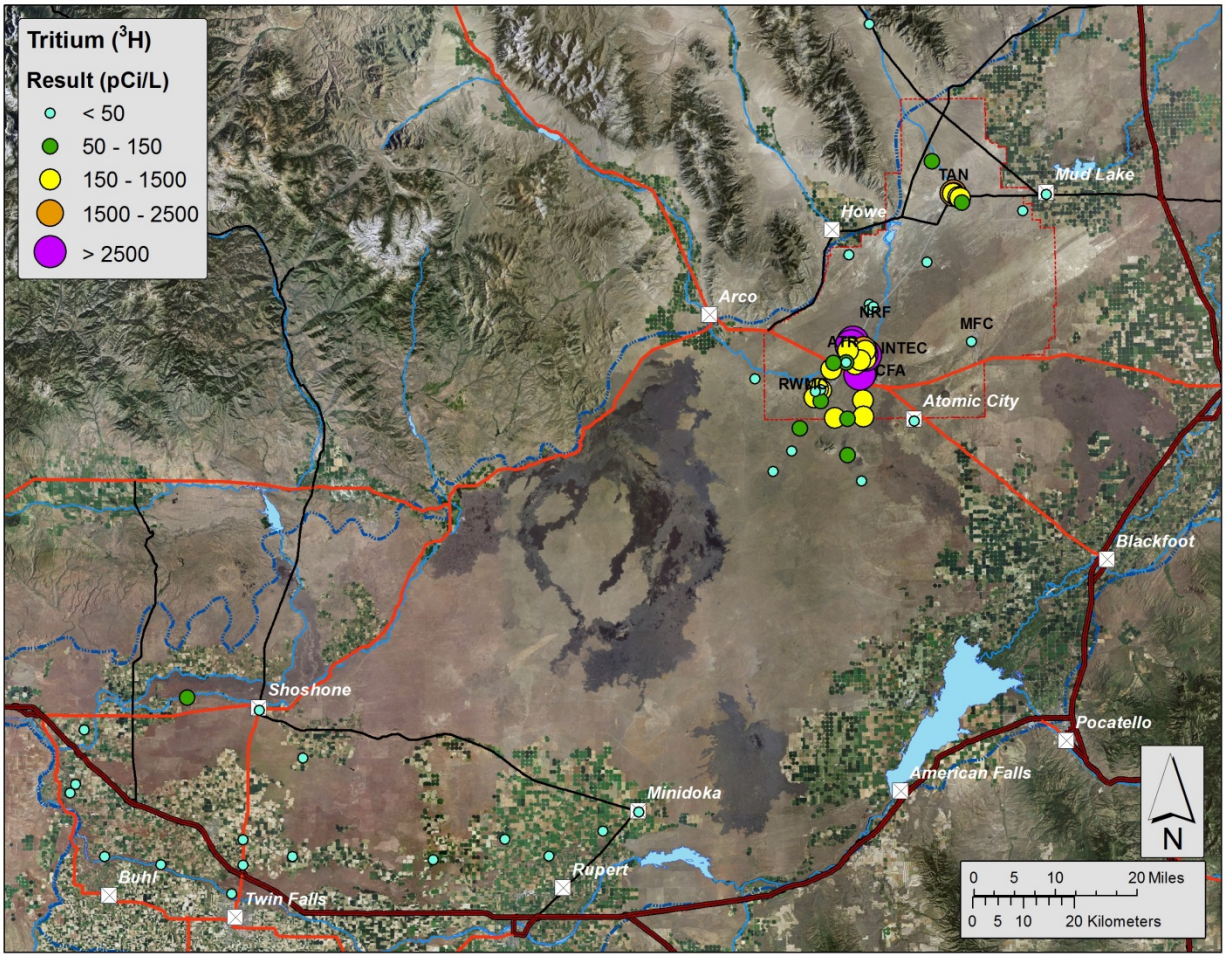

Figure 12. 2014 ^{3}H concentrations (pCi/L) for DEQ sample locations.

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-37A. 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 is lower with a reported value of 206 ± 48 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 2014 Annual Report for Groundwater Remediation at Test Area North (DOE/ID-11521). 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 three other TAN facility wells located farther from the injection facility, including TAN-10A, TAN-28, and TAN-29. ^{90}Sr concentrations at these sites have shown a slight decline since DEQ first began sampling these sites in 2003 (**Figure 13**).

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 14** illustrates ^{90}Sr concentrations for wells located at or down gradient of INTEC, including ICPP-2020, USGS-047, USGS-067, USGS-085 and USGS-112. Monitoring well USGS-047 was not sampled in 2014 due to broken equipment. **Figure 14** 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 since 2009 due to lack of water during fall co-sampling with the DOE contractor. All sites indicate that ^{90}Sr concentrations are generally steady or declining. **Figure 15** shows ^{90}Sr concentrations at DEQ sample locations during the 2014 monitoring season.

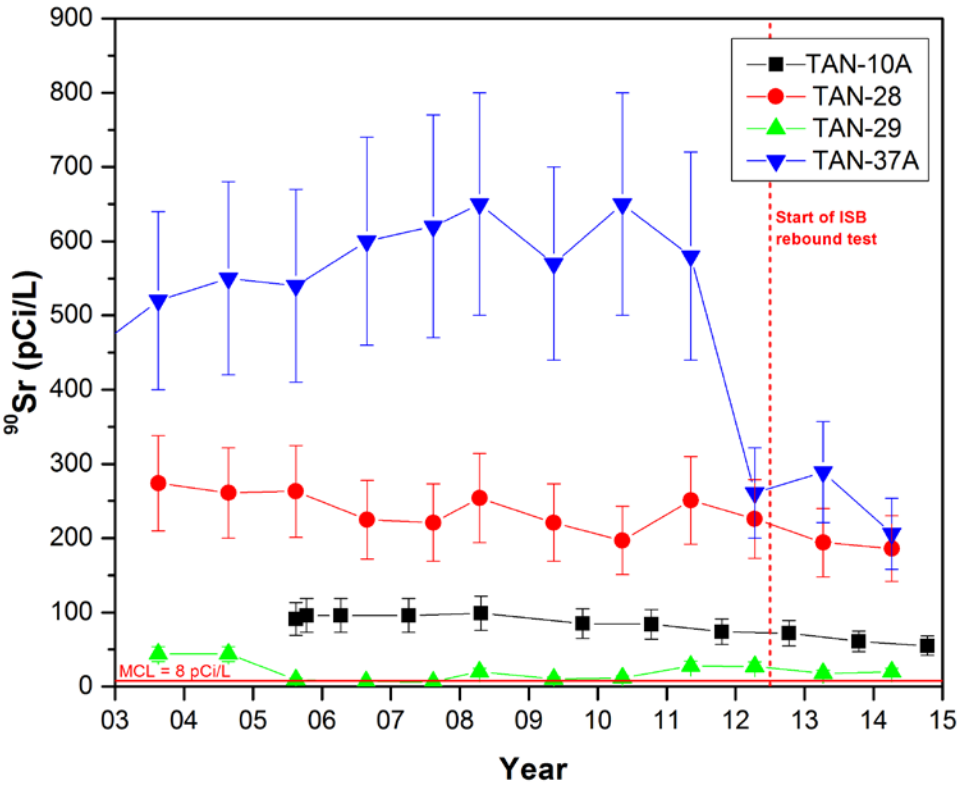

Figure 13. ^{90}Sr concentrations over time for selected wells near Test Area North (TAN).

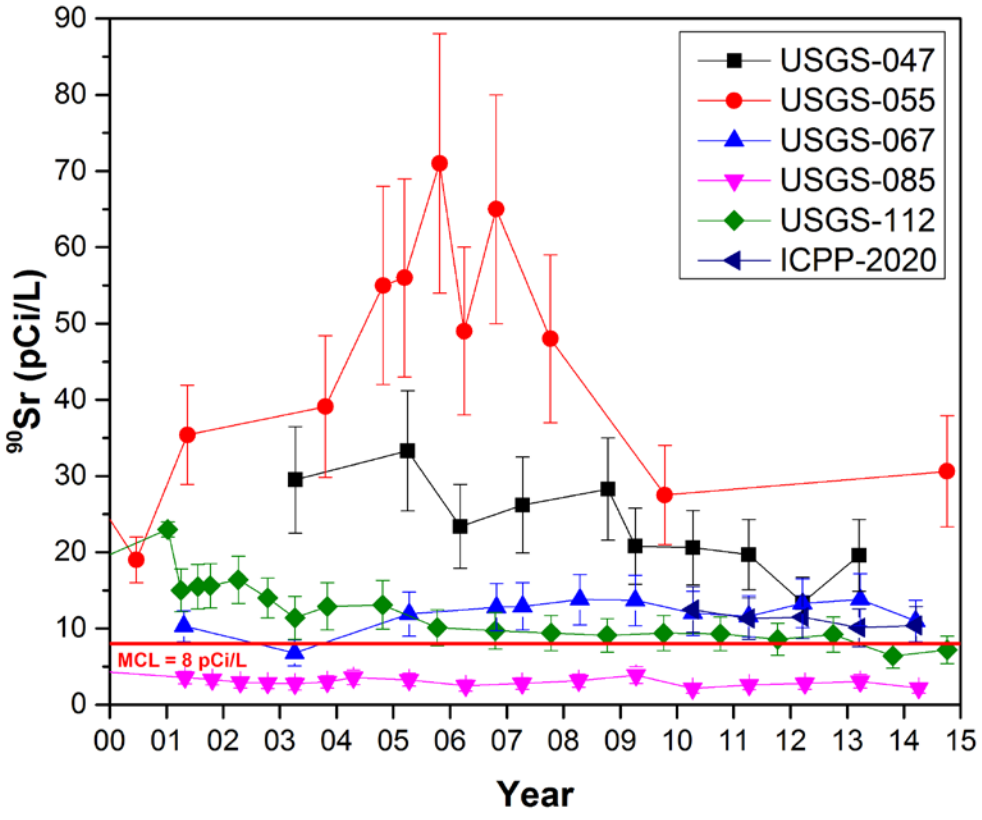

Figure 14. ^{90}Sr concentrations over time for selected INL Site wells impacted by INL contamination.

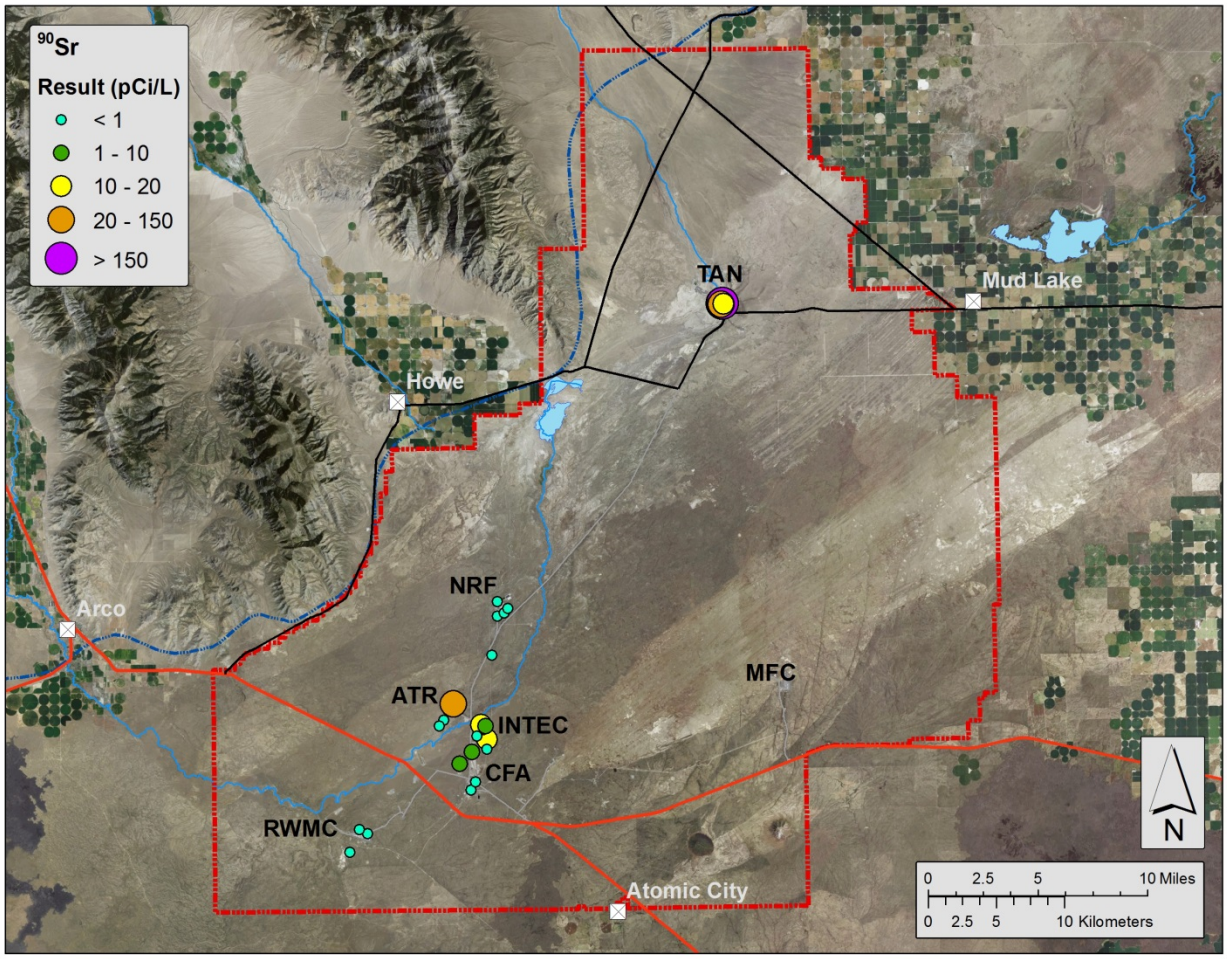

Figure 15. 2014 ^{90}Sr concentrations (pCi/L) for DEQ sample locations.

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 2014 was for well USGS-052, located at the INTEC facility. USGS-052 had a measured ^{99}Tc value of 362.1 ± 1.6 pCi/L, which is considerably lower than the 2013 reported value of 491.8 ± 2.1 pCi/L. Results for USGS-052 are irregular and fluctuate between sampling events but overall indicate an increasing trend since 2006. **Figure 16** 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 15** include USGS-067 and ICPP-2020. Results for USGS-067 show that the ^{99}Tc concentration has been generally steady since 2005. The final well is ICPP-2020, which is located near USGS-052. DEQ began monitoring ICPP-2020 in 2009, with data generally showing a decline in ^{99}Tc concentrations. All 2014 results for ^{99}Tc were below the MCL of 900 pCi/L. **Figure 17** shows ^{99}Tc concentrations at DEQ sample locations.

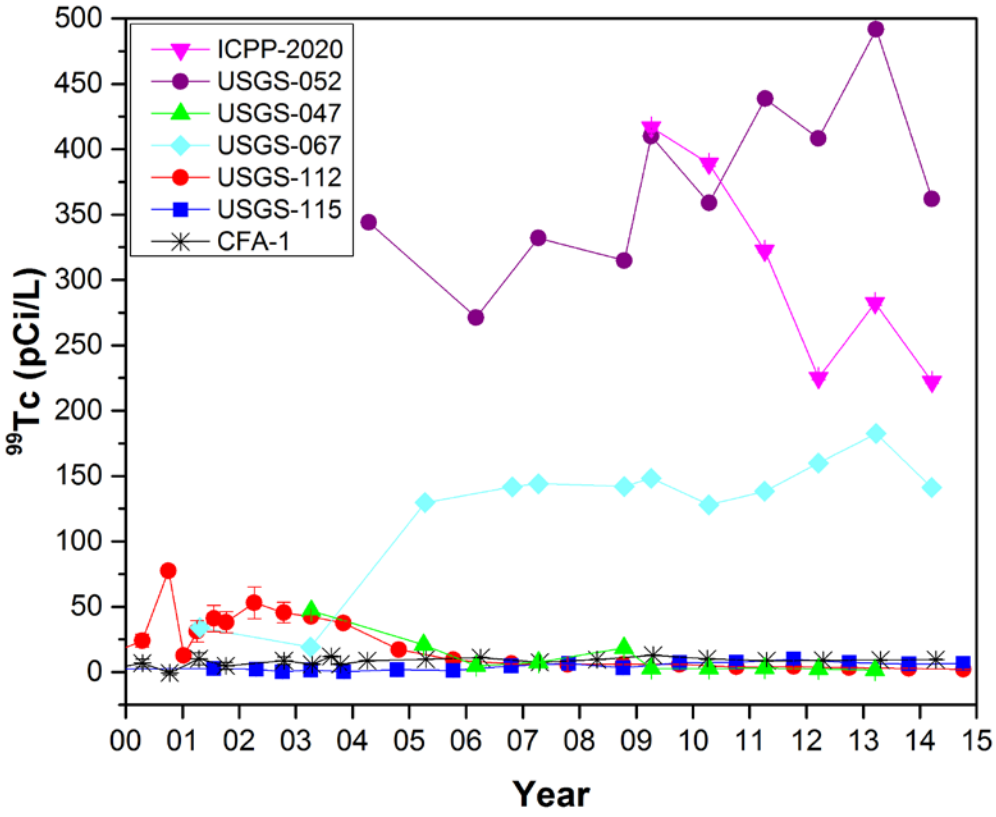

Figure 16. ^{99}Tc concentrations over time for selected INL Site wells impacted by INL contamination.

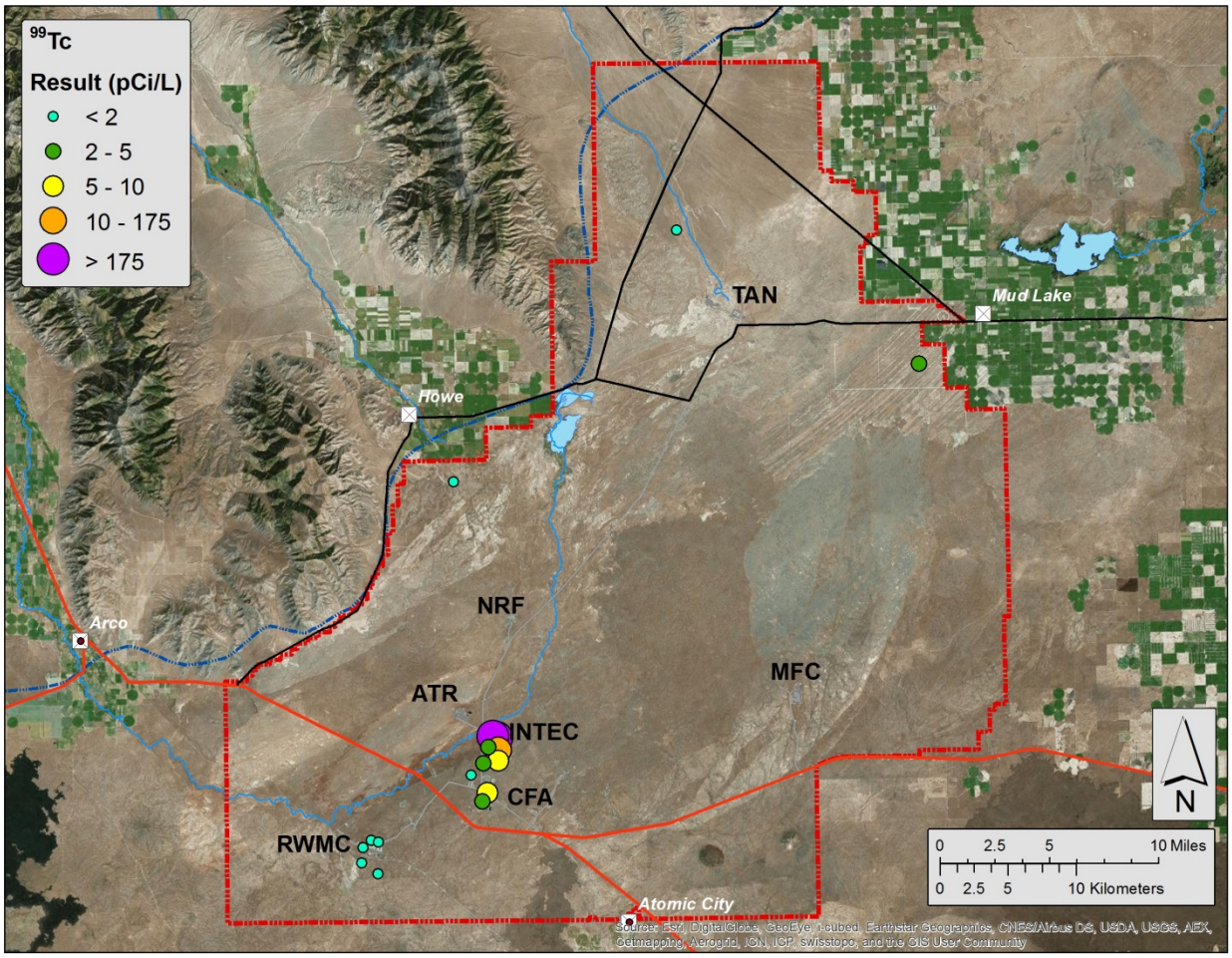

Figure 17. 2014 ^{99}Tc concentrations (pCi/L) for DEQ sample locations.

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 2014 were relatively unchanged from previous years. Common ions, nutrients, and metal results found in samples collected by DEQ in 2014 are summarized in **Table 5**; selenium and lead were not detected at any location in 2014 and are not included in the table. Following the table is a discussion of analytical results for chloride, chromium, manganese and VOCs, which have each exceeded their respective drinking water standards either in the recent past or during the 2014 monitoring season.

Table 5. Summary of selected non-radiological analytical results for DEQ water samples for 2014.

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	9.1	43	52	26	54	150	35	40	46	30	57	77	5 - 43	none
Magnesium	2.8	16	18	12	18	38	12	16	19	15	20	33	1 – 15	none
Sodium	5.4	12	31	7.9	16	170	6.1	9.1	18	15	34	48	5 – 14	none
Potassium	1.0	2.3	6.1	1.9	2.8	6.4	1.8	2.6	3.4	3.2	5.4	7.0	1 – 3	none
Total Alkalinity[4]	90	143	160	95	142	226	133	138	154	126	176	233	41 - 337	none
Chloride	4.70	8.77	47.5	9.40	22.6	440	6.39	11.8	22.9	7.54	37.9	68.0	2 – 16	250*
Fluoride	<DL[3]	0.572	0.704	<DL	0.255	0.710	<DL	0.261	0.980	0.259	0.479	0.730	0.2 – 0.6	4
Sulfate	8.68	25.8	40.3	16.5	37.9	175	17.0	23.0	25.5	20.1	60.4	81.4	2 – 24	250*
Total Nitrate plus Nitrite	<DL	0.62	2.6	0.085	1.5	5.8	0.47	0.76	1.5	0.80	2.1	5.6	1 – 2	10
Total Phosphorus	0.005	0.018	0.044	0.007	0.029	0.220	0.018	0.021	0.028	0.019	0.032	0.069	<0.02	none
Metals (µg/L)														
Barium	20	67	87	24	84	270	23	39	82	18	64	130	50 – 70	2000
Arsenic	<DL	<DL	9.1	<DL	<DL	8.6	<DL	<DL	<DL	<DL	<DL	<DL	2 - 3	10
Chromium	<DL	<DL	5.6	<DL	12	85	<DL	<DL	8.8	<DL	<DL	<DL	2 - 3	100
Iron	<DL	<DL	170	<DL	<DL	3100	<DL	<DL	110	<DL	<DL	160	<1	300
Manganese	<DL	<DL	39	<DL	<DL	890	<DL	<DL	21	<DL	<DL	6.8	<1 – 4	50*
Zinc	<DL	<DL	<DL	<DL	<DL	540	<DL	58	110	<DL	<DL	79	<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.

[4]As $CaCo_3$.

Chloride

Chloride concentrations in ground water are often elevated in regions impacted by agriculture due to the evaporation of infiltrating irrigation water. At the INL, large quantities of chloride have been discharged in the wastewater. The primary source of chloride in INL wastewater includes the use of sodium chloride (salt) to regenerate water softeners. DEQ currently monitors only one well that has chloride concentrations which historically exceed the secondary maximum contaminant level (SMCL) of 250 mg/L. Results for NRF-06 are illustrated in **Figure 18**. NRF-06 is located near the NRF industrial waste ditch in which wastewater from water softeners is discharged. Chloride concentrations for DEQ 2014 sample locations are shown in **Figure 19**.

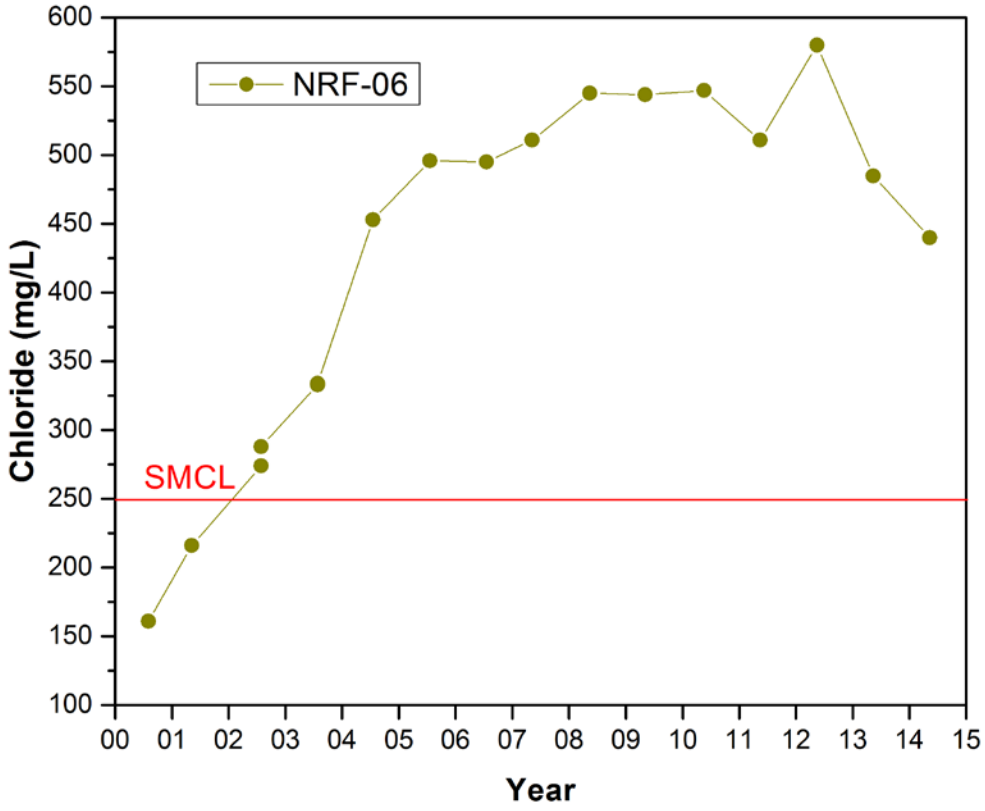

Figure 18. Chloride concentrations for sample location NRF-06 over time.

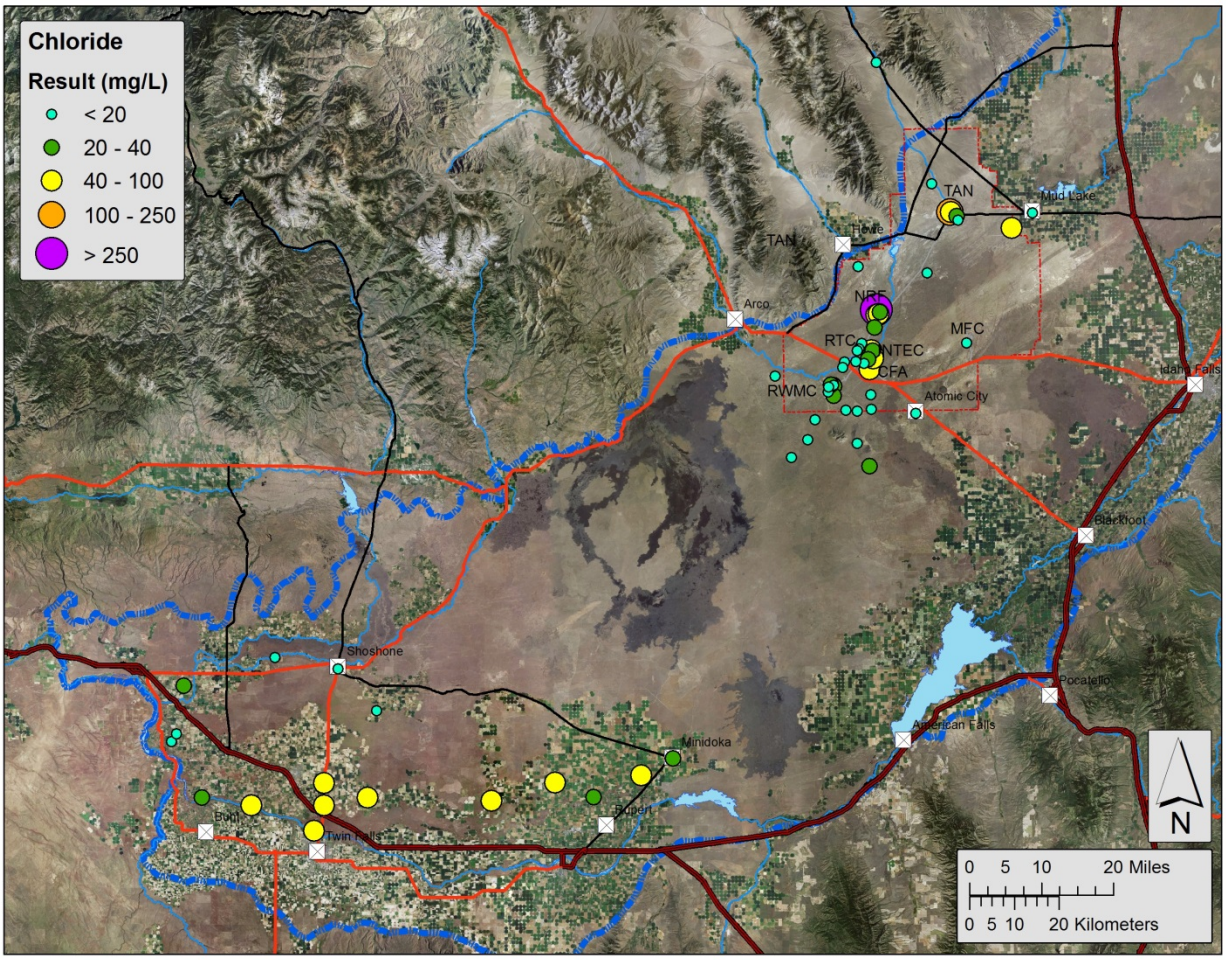

Figure 19. 2014 chloride concentrations for DEQ sample locations.

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 2014 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 20**. 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 2014 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 6 samples. The data show large fluctuations between sampling events from 2009 to 2012, with 2012 to 2014 results relatively consistent. Concentrations for DEQ 2014 sample locations are shown in **Figure 21**.

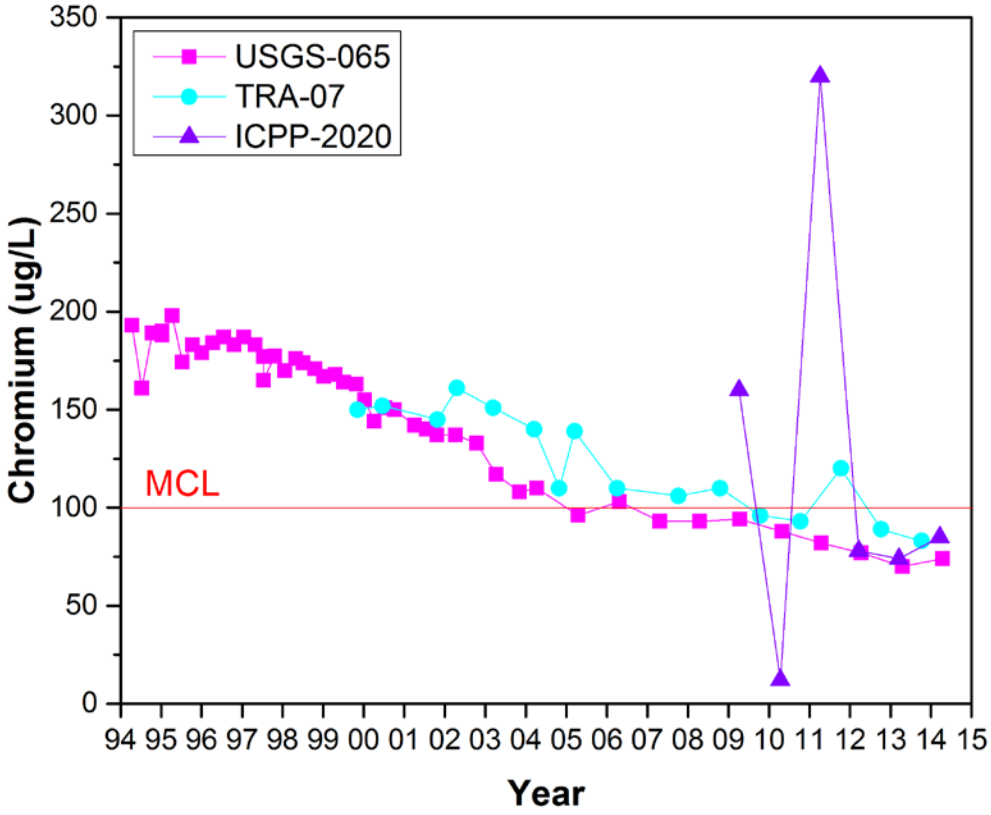

Figure 20. Chromium concentrations (µg/L) over time for selected INL Site wells impacted by INL contamination.

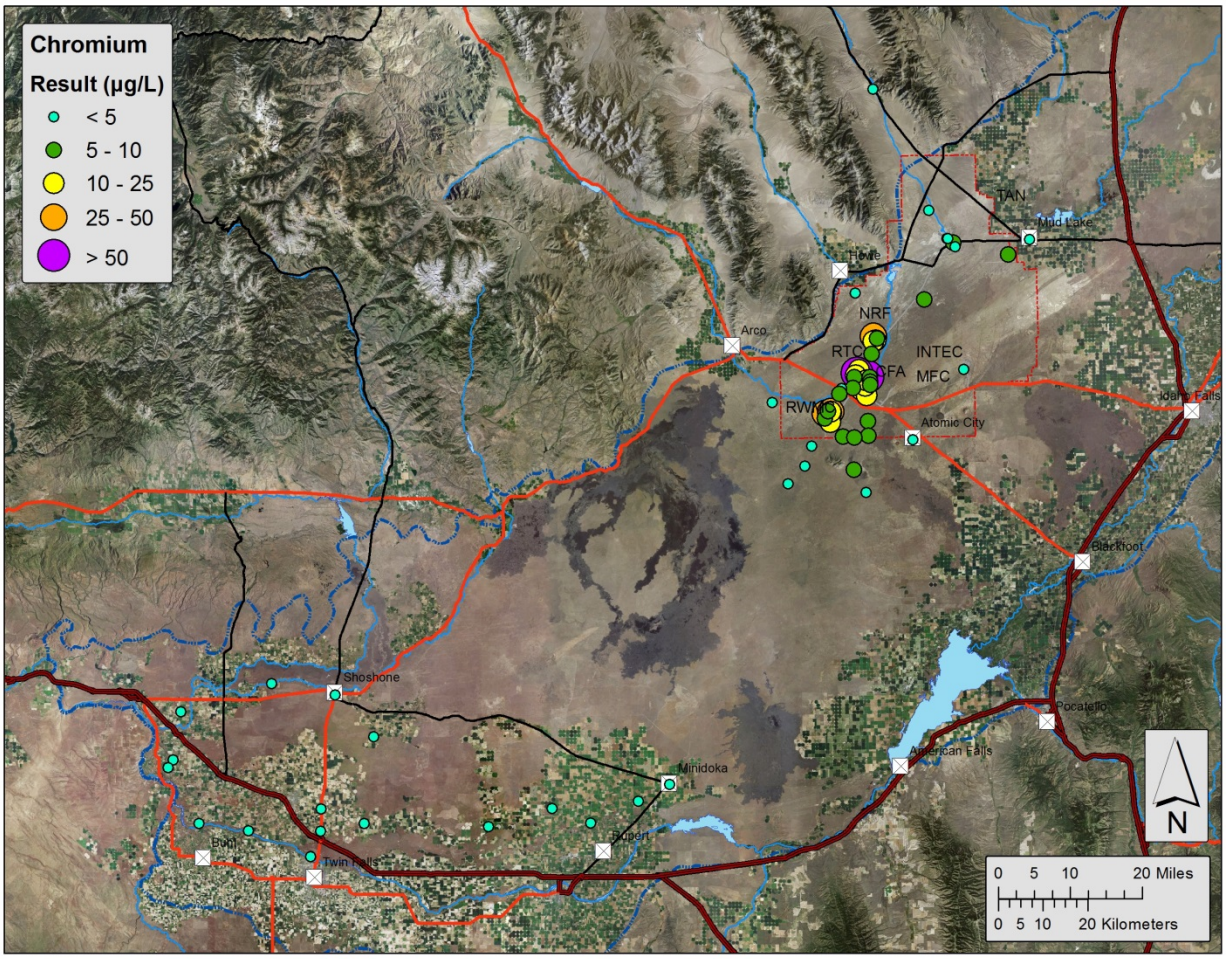

Figure 21. 2014 chromium concentrations (µg/L) for DEQ sample locations.

Manganese

Four wells exceeded the SMCL for manganese (50 µg/L) during the 2014 sample season. Three of the wells, TAN-10A (890 µg/L), TAN-29 (520 µg/L), and ANP-8 (63 µg/L) are located at or down gradient of the TAN facility. These elevated concentrations 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 the three wells located near TAN, only TAN-10A has trend data for manganese which indicate that since 2007 manganese concentrations have generally stayed the same showing no effects from the ISB rebound test to date. The other exceedance of the SMCL for manganese was at PW-9, a perched aquifer well located at the ATR Complex. The reported value of 64 µg/L is most likely due to past waste water disposal practices.

Volatile Organic Compounds

Concentrations for five VOCs exceeded MCL's in wells at or near the TAN facility: Tetrachloroethylene (or PERC, MCL = 5 µg/L), trichloroethylene (or TCE, MCL = 5 µg/L), vinyl chloride (or VC, MCL = 2 µg/L), cis-1,2-Dichloroethene (or cis-1,2-DCE, MCL = 70 µg/L) and trans-1,2-Dichloroethene (or trans-1,2-DCE, MCL = 100 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.

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 2014. These actions are in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

There are three medial zone wells sampled by DEQ, including TAN-37A, TAN-28 and TAN-29. Of these three wells, TAN-37A seems to be the least impacted from VOCs, only exceeding the MCL for trans-1,2-DCE. Monitoring wells TAN-28 and TAN-29, however, exceeded MCLs for PERC, TCE, and VC, with TAN-29 also exceeding the MCL for cis-1,2-DCE. TCE concentrations in both wells appear to show an upward trend since the ISB rebound test was initiated, with TAN-28 beginning the upward trend just before the start of the ISB rebound test. TAN-29 also shows an upward trend for PERC during the same time period. TCE concentrations at TAN facility wells located in the medial zone are illustrated in **Figure 22**.

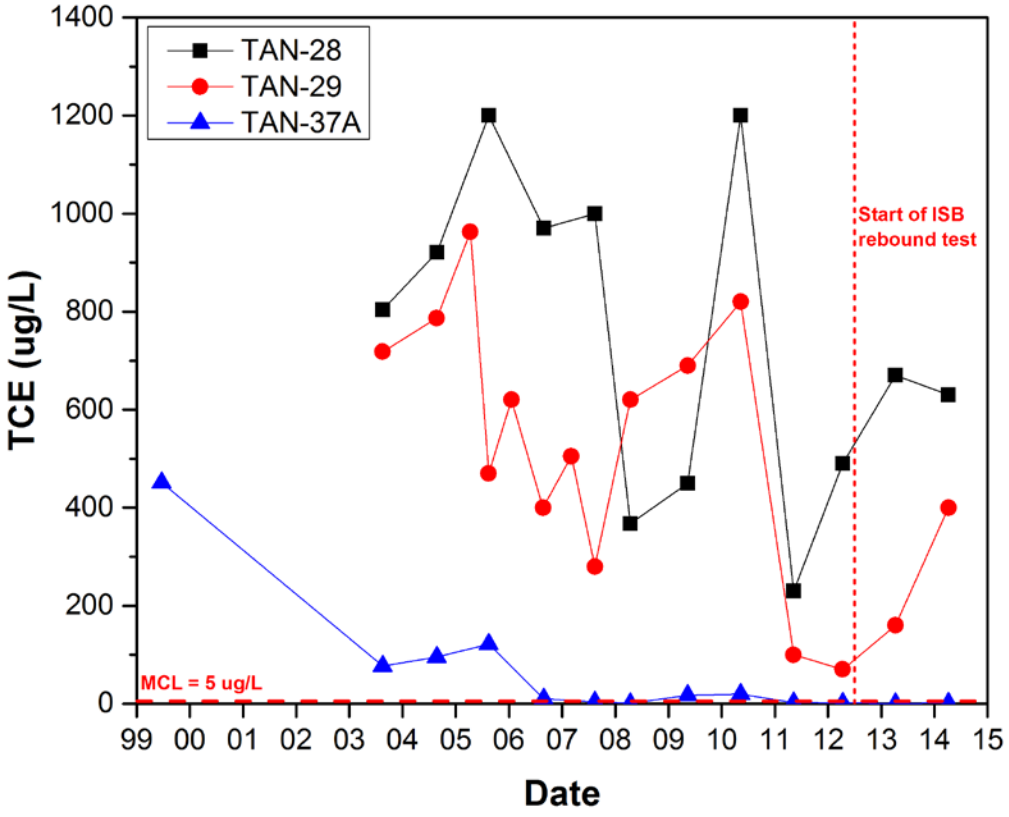

Figure 22. TCE concentrations (µg/L) over time for selected wells located in the medial zone near the ISB injection facility at TAN.

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 all but ANP-8 exceeding the MCL for PERC. ANP-8 and TAN-16 have remained relatively consistent with a slight decline in both PERC 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 PERC and TCE. TCE concentrations at TAN facility wells located in the distal zone are illustrated in **Figure 23**.

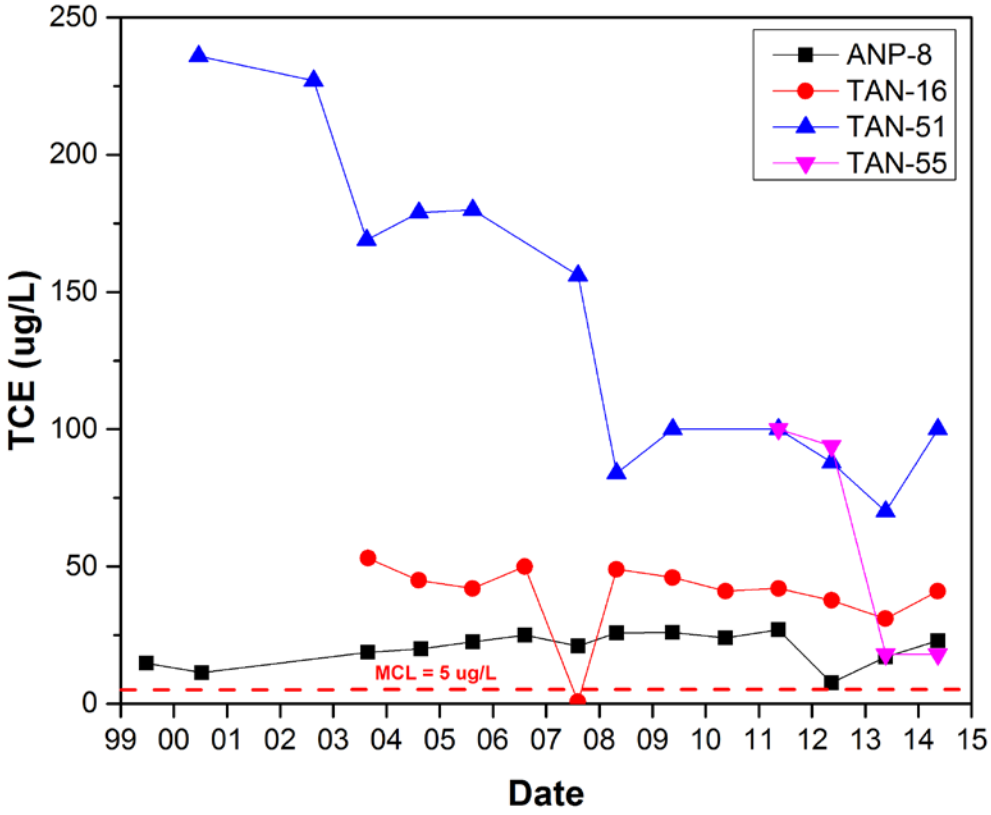

Figure 23. TCE concentrations (µg/L) over time for selected wells located in the distal zone downgradient and southeast of the TAN facility.

Two VOCs, carbon tetrachloride (or tetrachloromethane, MCL= 5 µg/L), and trichloroethylene (MCL = 5 µg/L) were detected in four wells at or near the RWMC facility. Carbon tetrachloride exceeded its MCL at the RWMC Production well. The 2014 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 2014 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 2014.

Analyte	Number of Co-sampled pairs in 2012	Percent of Co-sampled pairs passing criteria in 2013
Gross alpha	44	100
Gross beta	44	96
^{137}Cs	40	98
^{238}Pu	4	100
$^{239/240}$Pu	4	100
^{90}Sr	27	100
^{99}Tc	8	100
^{3}H	67	100
^{234}U	9	100
^{235}U	9	100
^{238}U	9	100

Non-Radiological

A summary of the sample-by-sample comparison of DEQ and DOE non-radiological results for 2014 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 2014.

Analyte	Number of Co-sampled pairs in 2014	Percent of Co-sampled pairs passing criteria in 2014
Common Ions/Nutrients		
Calcium	13	100
Magnesium	13	100
Sodium	47	100
Potassium	13	100
Chloride	52	100
Sulfate	47	98
Total Nitrate plus Nitrite	47	98
Trace Metals		
Barium	8	100
Chromium	35	97
Lead	7	100
Manganese	10	100
Zinc	6	100
VOCs[1]		
8 VOC analytes	62	90

[1]12 co-sampled VOC samples were collected and 62 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 and VOCs exceeded federal drinking water standards (MCLs or SMCLs) at some sites on the INL in 2014. 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 2014.

- 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 (2014 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 seven locations during 2014.

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.

Additionally, two 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

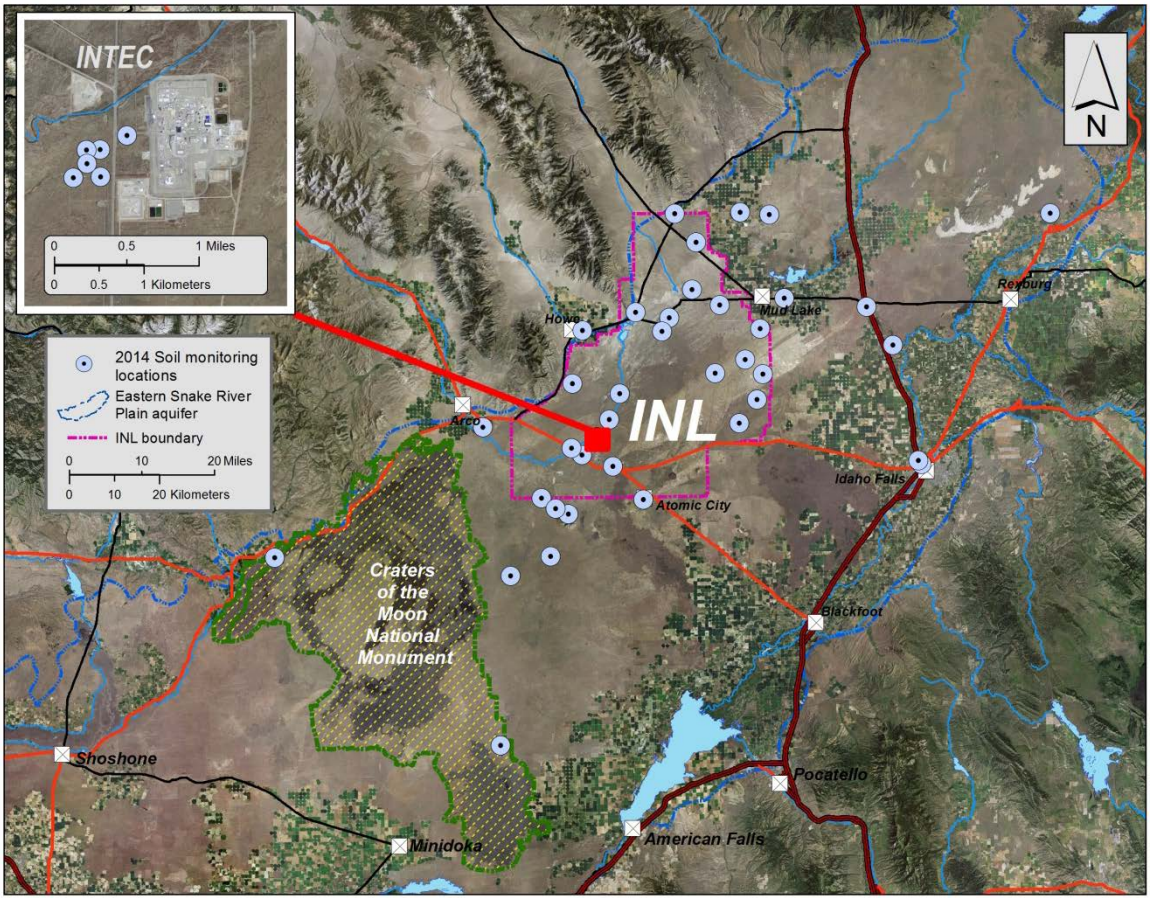

Figure 24. DEQ soil sampling locations for 2014.

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 2014, DEQ made *in-situ* gamma spectrometry measurements to estimate accumulations of gamma-emitting radionuclides in surface soil at 43 locations. Of the 43 measurements, Cesium-137 (^{137}Cs) was the only man-made radionuclide that was detected. The average ^{137}Cs value for *in-situ* measurements was 0.27 picocuries per gram (pCi/g) with a minimum value of 0.02 pCi/g and a maximum of 1.39 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 radioactive iodine is present or absent in the food supply. Radioactive iodine is produced in relatively large quantities during fission reactions (e.g., in nuclear reactors). The chemical nature of iodine makes it mobile under normal conditions. Gaseous radioactive iodine can be dispersed through the atmosphere and carried

along with the wind until it is deposited on plants. Dairy cows and goats that graze on radioiodine-contaminated pasture or feed will accumulate iodine in the milk they produce. Drinking this milk could lead to an accumulation of radioactive iodine in the thyroid gland and a greater risk of thyroid cancer.

During 2014, DEQ analyzed 48 milk samples. Radioactive iodine (^{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 (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}K results obtained by DEQ showed 88% agreement with DOE contractor results, which is considered satisfactory. All ^{131}I results were below the minimum detectable activity for both agencies.

In-situ gamma spectrometry results from soil at six co-located sample sites near INTEC were compared with the DOE contractor's results. DEQ and DOE contractor ^{137}Cs results showed a relative bias, with a DEQ average of 0.92 pCi/g and a contractor average of 0.60 pCi/g. Differences in detector equipment and placement may have contributed to this bias. These results were well below the DEQ action level and the recommended screening limit of 6.8 pCi/g for surface soil (NCRP 129).

Gamma spectrometry results from physical soil samples taken at seven co-located sample sites both on and off-site were compared with the DOE contractor's results. There was 57% agreement between the agencies with the average results for ^{137}Cs of 0.26 pCi/g for DEQ and 0.37 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.

Terrestrial Monitoring Impacts and Conclusions

Based upon terrestrial radiological measurements of soil and milk, there were no discernable impacts to the off-site environment from INL operations. Long-term accumulations of radionuclides observed by soil monitoring in 2014 were consistent with historical measurements. With the exception of measurements near the INTEC facility all measurements were in the range of concentrations expected as a result of historic above-ground testing of nuclear weapons. Higher concentrations of ^{137}Cs are expected around some site facilities due to past INL operations. While these concentrations exceed fallout levels, they are still well below the DEQ action level. In addition, these areas are on-site where access is controlled.

Quality Assurance for the ESP

This section summarizes the results of the quality assurance (QA) assessment of the data collected during calendar year 2014 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 2014, the DEQ submitted 365 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 2014.

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 $\pm$20%, are considered to be statistically in agreement. Paired data sets are considered to be in satisfactory statistical agreement if at least 80% of the individual paired results are in agreement.

Assessing INL Impacts

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

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

1) Transuranic Waste Shipments to the Waste Isolation Pilot Plant
- Advanced Mixed Waste Treatment Project,
- Accelerated Retrieval Project,
- Sludge Repackaging Project, and
- Remote Handled Transuranic Waste Project.

2) Integrated Waste Treatment Unit

3) Calcine Disposition Project

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

5) Occurrence Reporting and Processing System Reviews

6) National Environmental Policy Act Monitoring and Reviews

Transuranic Waste Shipments to the Waste Isolation Pilot Plant

Transuranic radioactive elements are products of nuclear reactions with atomic numbers greater than uranium (such as plutonium, neptunium, americium, curium, and/or californium). Transuranic (TRU) waste generally consists of protective clothing, tools, glassware, equipment, soils, and sludge contaminated with transuranic radioactive elements. Most transuranic waste was created during the production of nuclear weapons, during research on nuclear materials, or during treatment of waste contaminated with transuranic radioactive elements. A large portion of INL's transuranic waste originated at the Rocky Flats weapons production plant in Colorado and is now being treated, repackaged, and shipped to the Waste Isolation Pilot Plant (WIPP) in New Mexico.

WIPP suspended operations on February 5, 2014, following a fire involving an underground vehicle. Nine days later, on February 14, 2014, a radiological event occurred underground, contaminating an underground portion of WIPP and releasing a small amount of radioactive contamination into the environment. WIPP has not received any TRU waste since early February 2014 and is planning to begin very limited waste operations in 2016. Full waste receipt operations are not expected to resume at WIPP until a new ventilation/air filtration system is completed in 2019. The INL Site continues to package TRU waste so it can be sent to WIPP when waste operations resume.

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

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

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

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

Following are details on each of the four projects that ship transuranic waste from INL to WIPP

Advanced Mixed Waste Treatment Project

The Advanced Mixed Waste Treatment Project (AMWTP) treats, packages, and ships waste from the Transuranic Storage Area (TSA) out-of-state (**Figure 25**). Most waste at the TSA came from Rocky Flats in Colorado. In 1999, shipment of TRU waste to WIPP began. Waste from the TSA that is characterized as not being TRU waste is shipped to other out-of-state disposal facilities. Per the 1995 Settlement Agreement, INL must ship TRU waste out-of-state at a rate of at least 2,000 cubic meters per year as averaged over any given consecutive three year period. The volume of this waste is determined as initial volume – meaning prior to compaction. Additionally, the 1995 Settlement Agreement requires that all TRU waste be removed from Idaho no later than 2018. Due to the suspension of operations at WIPP, the “no later than 2018” milestone may be impacted.

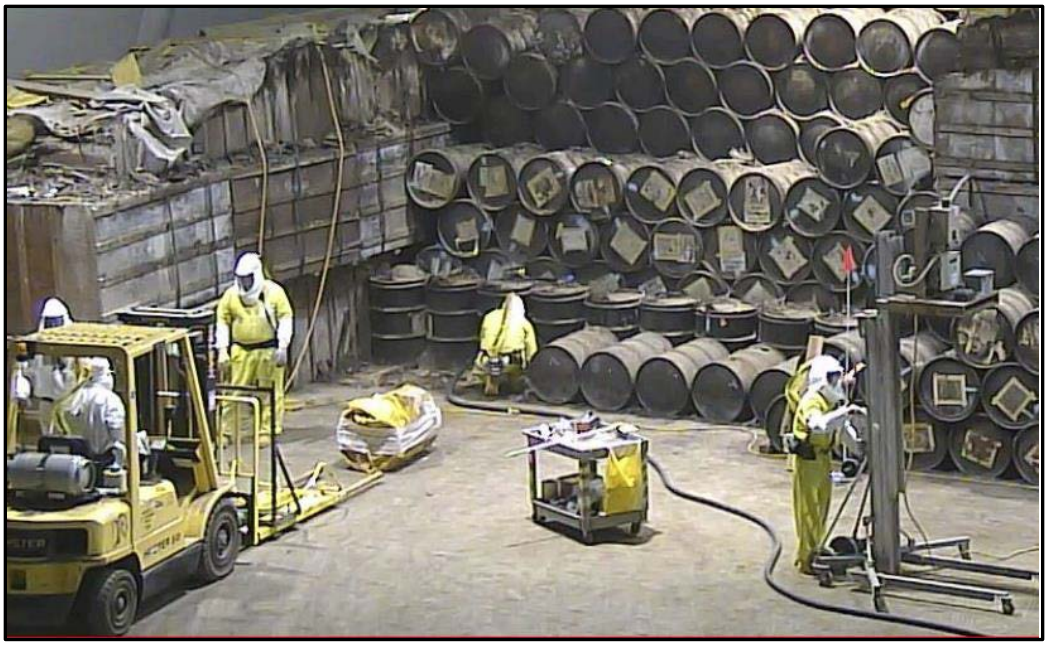

Figure 25. Drum retrieval operations.

Since shipment of TRU waste to WIPP began in 1999, 46,630 cubic meters of TRU waste from the AMWTP and the Accelerated Retrieval Project (ARP) (see next section) have been disposed at WIPP. Shipments to WIPP over the past three calendar years have been:

2012: 2568 cubic meters
2013: 2487 cubic meters
2014: 341 cubic meters

This averages out to 1799 cubic meters per year over three years. This three year average shipment volume does not meet the Settlement Agreement requirement to ship at least 2,000 cubic meters of TRU waste out-of-state each year as averaged over three consecutive years. Therefore, per terms of the 1995 Idaho Settlement Agreement, shipment of DOE (but not Navy) spent fuel to INL is suspended until shipment of TRU waste out of Idaho averages at least 2,000 cubic meters over three consecutive years.

Accelerated Retrieval Project

The Accelerated Retrieval Project (ARP) is a CERCLA activity to remove targeted waste buried prior to 1970 in the Subsurface Disposal Area (SDA) at the INL Site (**Figure 26**). Under a 2008 agreement between DOE, EPA, and the State of Idaho, targeted waste is being excavated and retrieved from a specific 5.69 acres of the SDA. This acreage was chosen because it is expected to contain a large portion of the transuranic waste, hazardous solvents, and depleted uranium that is of concern to the State of Idaho and EPA.

Excavated targeted waste is identified, repackaged, characterized, and shipped to WIPP in New Mexico for disposal.

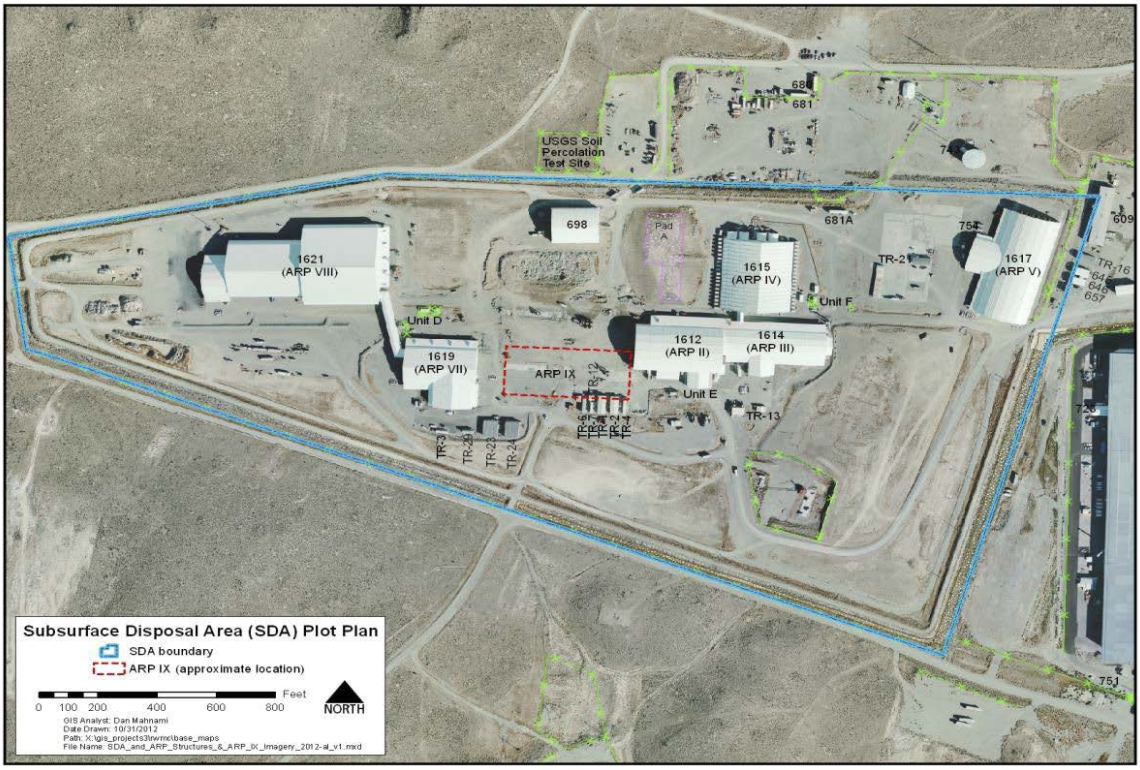

Figure 26. ARP structures at the SDA.

ARP Targeted wastes consist of:

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

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

1) ARP I - completed in 2008 with excavation of 0.50 acres.
2) ARP II - completed in 2009 with excavation of 0.35 acres.
3) ARP III - completed in 2013 with excavation of 0.42 acres.
4) ARP IV - completed in 2011 with excavation of 0.79 acres.
5) ARP V - completed in 2011 with excavation of 0.55 acres.
6) ARP VI - completed in 2011 with excavation of 0.40 acres.
7) ARP VII - completed in 2014 with excavation of 0.27 acres.
8) ARP VIII - construction began in 2011 and was completed in 2013. Excavation of 1.72 acres began in November 2013 with 0.391 acres excavated by the end of 2014.
9) ARP IX - slated to begin construction around 2018 with 0.69 acres planned for excavation.

At the end of 2014, DOE had excavated a total of 3.67 acres of targeted waste and shipped about 5600 cubic meters of transuranic waste to WIPP from ARP activities. (**Figure 27**)

Figure 27. Exhumation of targeted waste taking place in ARP structures.

Sludge Repackaging Project

In June of 2014, DOE completed a sludge drum treatment project that involved repackaging of 6,000 drums (1200 cubic meters) of mixed waste sludge. This project was begun in 2013 when DOE repurposed one of the ARP structures (ARP V) to be used for this treatment project. This waste was originally sent to Idaho in the 1970s from the now closed Rocky Flats nuclear weapons production plant located near Denver and was stored at the TSA. These drums contain free liquid and sludge with the consistency of peanut butter making it among the most difficult materials to remove from drums and treat. These drums had liquids absorbed and prohibited items removed so that this waste is acceptable for disposal at WIPP.

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

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

Remote-Handled Transuranic Waste Project

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

Throughout 2014 DOE continued to prepare RH-TRU waste for shipment to WIPP when it reopens. DOE is currently characterizing, sorting, treating, and packaging RH-TRU waste previously stored in below ground vaults north of the Materials and Fuels Complex (MFC) at the Radioactive Scrap and Waste Facility (RSWF) for future shipment to WIPP. This waste originated from MFC and Argonne National Laboratory-East. DOE modified existing hot-cells at the Idaho Nuclear Technology and Engineering Center (INTEC) CPP-666 Building for processing this RH-TRU waste. Transfer of the RSWF RH-TRU waste from MFC to INTEC began in 2009. Startup of RH-TRU repackaging in CPP-666 began in January 2010 and the first RSWF RH-TRU waste shipment was sent to WIPP in February 2010. Processing of this waste will continue for several more years.

Some of the RH-TRU waste retrieved from RSWF contains elemental sodium. Elemental sodium is very reactive with water and must be removed before the waste can be shipped to WIPP. In 2013, DOE began construction of a sodium distillation system in CPP-666 to remove elemental sodium from RH-TRU waste. This sodium distillation system became operational in June 2014. By the end of 2014, seven treatment runs of sodium-contaminated RH-TRU had been completed using the sodium distillation system.

Some of the activities DEQ performed in 2014 to evaluate safe management of transuranic waste included:

- Tracked WIPP shipments and coordinated WIPP shipment safety with the Idaho State Police (ISP) (who inspect every outgoing truckload) and with other states through the

Western Governors Association (WGA).

- Reviewed DOE reports detailing AMWTP progress on shipping TRU waste out of Idaho.
- Reviewed real-time radiography (RTR) screen shot paperwork for AMWTP box dumping operations to assure proper disposal volume credit was received for TRU waste processed though the AMWTP super compactor.
- Conducted visits to AMWTP to observe waste management activities.
- Observed the DOE Carlsbad Field Office TRU waste recertification audits of AMWTP associated activities.
- Participated in numerous site visits to observe activities at ARP facilities and attended meetings where ARP progress was addressed.
- Toured packaging facilities, attended meetings, and reviewed documents pertaining to the ongoing process of preparing RH-TRU waste for shipment to WIPP.

Figure 28. Idaho State Police (ISP) surveys and performs a safety check on all outgoing WIPP transport trucks.

Integrated Waste Treatment Unit

DOE completed construction of the Integrated Waste Treatment Unit (IWTU) in 2012. This facility was constructed to treat approximately 900,000 gallons of sodium-bearing waste (SBW) currently in four 300,000 gallon tanks (one nearly empty) at the INTEC Tank Farm. Treatment will consist of solidification and preparation of this waste for off-site disposal. Solidification of SBW is required to meet the 1995 Settlement Agreement milestone that states, “DOE shall complete calcination of sodium-bearing liquid high-level waste by December 31, 2012.” SBW

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

On June 16, 2012, during start-up testing (prior to addition of any radioactive or hazardous materials) the IWTU experienced a pressure event that caused the IWTU safety systems to safely shut down operations. The IWTU uses wood-based charcoal to bring the facility up to a temperature of 700 degrees Celsius. A component of the facility, the Carbon Reduction Reformer (CRR), became overloaded with charcoal which only partially burned due to the excess amount of charcoal and lack of adequate oxygen. The CRR ground the excess charcoal into a fine dust which passed through the CRR clogging the down-stream high efficiency particulate air filters (HEPA) and off-gas filters resulting in the pressure event. The IWTU has been modified to prevent a reoccurrence of the pressure event. Modifications made to the facility in 2013 were centered around introducing more oxygen into the CRR for better charcoal combustion; securing filter bundles so they do not move due to pressure changes; ensuring the back-pressure systems operate as designed; installing additional pressure-relief valves; and adding additional layers of monitoring to detect pressure variations. While these modifications were being evaluated, other potential problems were recognized. Much of 2014 was spent performing and testing additional IWTU modifications. In December 2014 the IWTU came up to operating temperature and a non-radioactive SBW-like liquid simulant was successfully run through the plant into early January 2015. A planned outage was then commenced with additional modifications planned to improve plant performance. Once treatment of the SBW begins it is projected to take seven to twelve months for completion.

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

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

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

Calcine Disposition Project

Calcine was produced from spent nuclear fuel reprocessing liquid waste that was solidified at the INL Site from 1953 to 2000. Most of the acidic liquid waste produced during spent nuclear fuel reprocessing was calcined into a dry granular solid using a high temperature process that reduced the volume by about seven-fold. Calcining of the acidic liquid waste also greatly reduced the threat of it contaminating the Snake River Plain Aquifer. About 4,400 cubic meters of calcine is

currently stored in 43 stainless steel bins within six massive shielded and reinforced concrete silos located at INTEC on the INL Site. The calcine is a mixed waste that is highly radioactive with radiation levels up to 6,000 Roentgen per hour. Calcine is currently in the form of a water soluble powder that, prior to disposal, requires treatment into a non-dispersible form. This could be accomplished by vitrification of the calcine.

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

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

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

- Maintained contact with DOE personnel involved with the calcine disposition project.
- Attended meetings where calcine disposition progress was detailed.

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

Spent Nuclear Fuel Receipt at INL

The Idaho Settlement Agreement milestones requiring solidification of sodium bearing waste (SBW) by the end of 2012 and shipment of at least 2,000 cubic meters of TRU waste out-of-state each year as averaged over three consecutive years were not met. Therefore, shipments of DOE Environmental Management (EM) owned SNF and DOE Nuclear Energy (NE) owned SNF to the INL have been suspended until treatment of the SBW is completed and shipment of TRU waste out of Idaho averages at least 2,000 cubic meters over three consecutive years. However, receipt of Navy spent fuel continues under the 1995 Idaho Settlement Agreement.

During 2014, the Navy received six rail shipments containing nine containers of SNF at the Naval Reactors Facility (NRF).

Spent Nuclear Fuel Movement from Wet to Dry Storage

Most of the SNF at INL has been placed in dry storage. Under provisions of the 1995 Settlement Agreement, DOE agreed to complete the transfer of all INL SNF from wet storage to dry storage by the end of 2023 and to remove all SNF from Idaho by 2035. DOE completed transfer of DOE Environmental Management (EM) owned SNF from wet storage in Building CPP-666 to dry

storage in Building CPP-603 in 2010. This leaves only the Navy SNF and DOE NE SNF in wet storage at CPP-666. Navy SNF is currently being moved from CPP-666 to dry storage at NRF. DOE NE SNF includes: 1) Experimental Breeder Reactor II (EBR II) SNF which is being moved to the Materials and Fuels Complex (MFC) for treatment and 2) Advanced Test Reactor (ATR) SNF that is being removed from CPP-666 after it has cooled for about six years and is then cool enough to be moved to dry storage.

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

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

Occurrence Reporting and Processing System Reviews

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

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

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

National Environmental Policy Act Monitoring and Reviews

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

During 2014, the DEQ monitored the status of the following EAs and EISs pertinent to INL:

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

3) Proposed Consolidation of Nuclear Operations Related to the Production of Radioisotope Power Systems (DOE/EIS-0373).
4) Hanford Tank Closure and Waste Management, Richland, Washington (DOE/EIS-0391).
5) Storage and Management of Elemental Mercury (DOE/EIS-0423).
6) EIS Notice of Intent (NOI) for Navy Recapitalization of Infrastructure Supporting Naval Spent Nuclear Fuel Handling and Examination at INL.
7) Resumption of Transient Testing of Nuclear Fuels and Materials at the Idaho National Laboratory (DOE/EA-1954).
8) Proposed Disposition of Five Signature Properties at the Idaho National Laboratory (DOE/EA-1984).

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 radiological materials at the INL or elsewhere in Idaho.

By agreement with DOE, INL radiological incident response planning is based on hazard assessment documents (HADs) developed by DOE contractors. These documents describe potential incidents at INL facilities that could release radionuclides to the environment. Review of current INL HADs is a key element of preparing for INL radiological emergencies. This information allows DEQ to identify scenarios that could potentially result in off-site radiological impacts, and plan appropriate responses. DEQ uses the source inventory and accident scenarios from the HADs to develop input for atmospheric dispersion and dose modeling using the Radiological Assessment System for Consequence Analysis (RASCAL) code. RASCAL uses real time 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 2014

There were no INL radiological incidents in 2014 that required activation of the INL Emergency Operations Center (EOC).

Non-INL Radiological Incidents

1. The State of Utah contacted DEQ about scrap metal shipped by rail from a Pacific Steel and Recycling facility in Grand Junction, CO to their facility in Salt Lake City, UT. The rail car triggered portal monitors and subsequent surveys indicated that the shipment exceeded established guidelines for scrap material. Based on previous experience with similar waste, it was assumed that the rail car contained some scrap that was contaminated with technologically enhanced naturally occurring radioactive material (TENORM). Pacific Steel and Recycling chose not to return the shipment to Grand Junction and instead planned to transfer it to the Pacific Steel and Recycling facility in Pocatello, ID to await disposition with other, similarly contaminated waste. The DEQ contacted the Pacific Steel and Recycling Environment, Safety, and Health (ES&H) officer and arranged to perform definitive measurements to confirm that the radioactivity was TENORM. DEQ coordinated with Pacific Steel and Recycling to perform the survey while the ES&H officer was on site. When the train car arrived in Idaho, the material was evaluated; a pipe with natural thorium-bearing scale was confirmed to be TENORM[2] and was segregated for disposal in a permitted facility.

2. The DEQ Pocatello Regional office staff contacted DEQ-INL OP about potentially radioactive material found in a home in Bern, Idaho, where the homeowners were organizing items owned by a deceased family member and found a container in a box that was initially reported to be uranium. Further discussion with family members indicated that the material was potentially radium paint (**Figure 29**). Notifications were made to the DEQ State Office, Nuclear Regulatory Commission, and Environmental Protection Agency. Two DEQ-INL OP staff members responded to the home in Bern, Idaho and surveys were performed. No radioactivity above background was detected during these surveys. A report of the response was forwarded to the U.S. Nuclear Regulatory Commission (NRC), satisfying their requirements for governmental agency response to potentially uncontrolled radioactive material. The container was left with the homeowner and disposed as non-radioactive waste.

Figure 29. Suspect vial at Bern, Idaho.

3. In June 2014, the DEQ received the final status survey report for cleanup of the Sabia, Inc. facility in Idaho Falls, ID. The NRC – licensed Sabia facility was contaminated with strontium-90 as the result of an incident in 2008. DEQ responded to this incident at that time, and subsequently the facility was cleaned up under NRC's regulatory

[2] For more information on TENORM, see the EPA's website at http://www.epa.gov/radiation/tenorm/index.html.

oversight. Cleanup was completed by 2013, and Sabia Inc. requested release of the facility for unrestricted use that year. The NRC contracted with Oak Ridge Associated Universities (ORAU) to perform the final status survey to determine whether residual radioactivity levels meet NRC's requirements for release. The ORAU concluded that release was acceptable.

Drills and Exercises

DEQ staff received notifications for drills being conducted at multiple INL facilities during 2014. DEQ staff responded to annual exercises conducted by INL contractors Battelle Energy Alliance (BEA) and CH2MHill/WGI (CWI). The 2014 Beyond-Design-Basis Event (BDBE) exercise held by BEA is notable because a general emergency requiring off-site protective actions was simulated. The IBHS participated with DEQ in the INL EOC to provide complete State of Idaho agency participation. DEQ worked with the Radiological Assistance Program (RAP) Region 6 to continue simulating the response after the termination of the INL exercise, because DEQ and RAP would be working together during an actual general emergency to develop consequence assessments through modeling and field measurements. DEQ also requested atmospheric dispersion modeling support, from its Technical Services Division, Modeling/Risk Analysis group. The BDBE exercise was very successful and created a lot of learning opportunities. The opportunity to exercise with RAP Region 6 and other state agency staff was valuable and productive.

The DEQ participated in an IBHS exercise, simulating a wide-scale contamination event at the Idaho State University, Pocatello campus. DEQ took part in the State Communications bridge call, in support of the response.

Waste Isolation Pilot Plant Shipment Safety

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

During 2014, 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 twenty-seven Local Emergency Planning Committee (LEPC) meetings, five INL Emergency Working Group meetings, and the 2014 Wildland Fire meeting. DEQ staff attended the 2014 National Radiological Emergency Preparedness meeting in Salt Lake City, Utah. The staff also participated in the nation-wide RadResponder emergency event webinar and drill, and Semi-Annual Federal Radiological Monitoring and Assessment Committee (FRMAC)

webinar for the States during summer 2014. Hospital outreach meetings were attended in late April 2014.

Classes and Presentations

DEQ staff participated in training for regional response teams in northern Idaho. Training was conducted by the DOE Radiological Assistance Program team and Technical Resources Group, Inc. (a private training contractor).

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 2014, we issued:

- The DEQ Annual Report for 2013.
- 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 2014, 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 30**). The event was attended by over 1,000 students and we presented the Macro Invertebrate Mayhem activity (**Figure 31**) and the Rain Stick activity (**Figure 32**). Idaho Falls Earth Day was a hit with the youth enjoying the Edible Aquifer presentations (**Figure 33**) and the children and adults filling up the DEQ carry-all bags with Earth Day giveaways. (**Figure 34**). 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 35**)

Figure 30. Water Awareness Poetry Contest on display at the Idaho Falls Library.

Figure 31. Children enjoying Macro Invertebrate Mayhem activity at Water Festival 2014.

Figure 32. Children preparing their rainsticks at the Water Festival 2014.

Figure 33. Children participating in the Edible Aquifer activity at the 2014 Earth Day event.

Figure 34. DEQ participating in the 2014 Earth Day event.

Figure 35. 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 36** shows one community monitoring station.

Figure 36. Community monitoring station at the greenbelt in Idaho Falls.