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IDAHO NATIONAL LABORATORY ANNUAL SITE ENVIRONMENTAL REPORT

Idaho National Laboratory

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Hot Rock Penstemon

To Our Readers:

The Idaho National Laboratory (INL) Site Environmental Report for Calendar Year 2023 is an overview of environmental activities conducted on and in the vicinity of the INL Site from January 1 through December 31, 2023. This report includes the following components:

- Effluent monitoring and environmental surveillance of air, water, soil, vegetation, biota, and agricultural products for radioactivity. The results are compared with historical data, background measurements, and applicable standards and requirements to verify that the INL Site does not adversely impact the environment or the health of humans or biota.
- A summary of environmental management systems in place to protect air, water, land, and other natural and cultural resources potentially impacted by INL Site operations.
- Ecological monitoring and other scientific research conducted onsite that may be of interest to the reader.

The report addresses three general levels of reader interest:

- The first level is a brief summary with a take-home conclusion. This is presented in the chapter highlights text box at the beginning of each chapter. There are no tables, figures, or graphs in the highlights. This section is intended to highlight general findings for an audience with a limited scientific background.
- The second level is a more in-depth discussion with figures, summary tables, and summary graphs accompanying the text. The chapters of the annual report represent this level, which requires some familiarity with scientific data and graphs. A person with some scientific background can read and understand this report after reading the section entitled, "Helpful Information."
- The third level includes links to supplemental and technical reports and websites that support the annual report. This level is directed toward scientists who would like to see original data and more in-depth discussions of the methods used and the results.

The links to these reports may be found in the Environmental Publications tab of the webpage at https://inl.gov/aser/.

The INL contractor is responsible for contributing to and producing the annual INL Site Environmental Report.

Other contributors to the INL Site Environmental Report include the ICP contractor, DOE-ID; National Oceanic and Atmospheric Administration, Air Resources Laboratory, Special Operations and Research Division; and the U.S. Geological Survey. Links to their websites are as follows:

- INL (https://www.inl.gov/)
- ICP (https://idaho-environmental.com)
- U.S. Department of Energy–Idaho Operations (https://www.id.energy.gov/)
- Special Operations and Research Division of National Oceanic and Atmospheric Administration's Air Resources Laboratory (https://www.noaa.inl.gov)
- U.S. Geological Survey (https://www.usgs.gov/centers/idaho-water-science-center).

The term INL Site contractors used throughout the report is referring to the INL and ICP contractors.

Horned lark eggs

Executive Summary:

Introduction

The INL Site is a U.S. Department of Energy (DOE) reservation located in the southeastern Idaho desert, approximately 25 miles west of Idaho Falls (Figure ES-1). At 890 square miles (569,135 acres), the INL Site is roughly 85% of the size of Rhode Island. It was established in 1949 as the National Reactor Testing Station, and for many years, it was the site of the largest concentration of nuclear reactors in the world. Fifty-two nuclear reactors were built, including the Experimental Breeder Reactor-I, which, in 1951, produced the first usable amounts of electricity generated by nuclear power. Researchers pioneered many of the world's first nuclear reactor prototypes and advanced safety systems at the INL Site. During the 1970s, the laboratory's mission broadened into other areas such as biotechnology, energy and materials research, and conservation and renewable energy.

Today, INL is a science-based, applied engineering national laboratory dedicated to supporting DOE's nuclear and energy research, science, and national defense missions.

Figure ES-1. Regional location of the INL Site.

INL's mission is to discover, demonstrate, and secure innovative nuclear energy solutions, other clean energy options, and critical infrastructure with a vision to change the world's energy future and secure the nation's critical infrastructure.

To mitigate environmental impacts and clear the way for the facilities required for the new nuclear energy research mission, the ICP has been charged with the environmental cleanup of the legacy wastes generated from World War II-era conventional weapons testing, government-owned reactors, and spent fuel reprocessing. The overarching aim of the project is to reduce risks to workers and production facilities, the public, and the environment and to protect the Snake River Plain Aquifer.

PURPOSE OF THE INL SITE ENVIRONMENTAL REPORT

The INL Site's operations and ongoing cleanup mission involve a commitment to environmental stewardship and full compliance with environmental protection laws. As part of this commitment, the INL Site Environmental Report is prepared annually to inform the public, regulators, stakeholders, and other interested parties of the INL Site's environmental performance during the year. This report is published for the U.S. Department of Energy, Idaho Operations Office (DOE-ID) in compliance with DOE Order 231.1B, "Environment, Safety and Health Reporting." The purpose of the report is to provide the following:

- Present the INL Site, mission, and programs
- Report compliance status with applicable federal, state, and local regulations
- Describe the INL Site environmental programs and activities
- Summarize results of environmental monitoring
- Discuss potential radiation doses to the public residing in the vicinity of the INL Site
- Report on ecological monitoring and research conducted by contractors and affiliated agencies and by independent researchers through the Idaho National Environmental Research Park
- Present property clearance activities
- Describe quality assurance methods used to ensure confidence in monitoring data
- Provide supplemental technical data and reports that support the INL Site Environmental Report (https://inl.gov/environmental-publications).

MAJOR INL SITE PROGRAMS AND FACILITIES

INL is a combination of all operating contractors and DOE-ID, and includes the Idaho Falls campus and the research and industrial complexes termed the "INL Site" that is located 50 miles west of Idaho Falls. For the purpose of this report, INL consists of those facilities operated by Battelle Energy Alliance, LLC (INL contractor), or by the Idaho Environmental Coalition, LLC (Idaho Cleanup Project [ICP] contractor). INL Site contractors are referred to by their noted acronyms and include all facilities under their individual responsibilities.

The INL Site consists of several primary facilities situated on an expanse of otherwise undeveloped terrain. Buildings and structures at the INL Site are clustered within these facilities, which are typically less than a few square miles in size and separated from each other by miles of undeveloped land. In addition, DOE-ID owns or leases laboratories and administrative offices in Idaho Falls, some 25 miles east of the INL Site border. About 30% of employees work in administrative, scientific support, and non-nuclear laboratory programs at offices in Idaho Falls.

The major facilities at the INL Site are the Advanced Test Reactor (ATR) Complex, Central Facilities Area (CFA), Critical Infrastructure Test Range Complex (CITRC), Idaho Nuclear Technology and Engineering Center (INTEC), Materials and Fuels Complex (MFC), Naval Reactors Facility (NRF), Radioactive Waste Management Complex (RWMC), and Test Area North (TAN), which includes the Specific Manufacturing Capability (SMC). The Research and Education Campus (REC) is located in Idaho Falls. The locations of major facilities are shown in Figure 1-6, while their missions are outlined in Table ES-1.

Table ES-1. Major INL Site areas and missions.

MAJOR INL SITE AREA[a]	OPERATED BY	MISSION
Advanced Test Reactor Complex	INL	Research and development of nuclear reactor technologies. Home of the ATR, a DOE Nuclear Science User Facility and the world's most advanced nuclear test reactor. The ATR provides unique irradiation capabilities for nuclear technology research and development.
Central Facilities Area	INL	INL support for the operation of other INL Site facilities and management responsibility for the balance of the INL outside of the facility boundaries.
Critical Infrastructure Test Range Complex	INL	Supports the National and Homeland Security missions of the laboratory, including program and project testing (i.e., critical infrastructure resilience and nonproliferation testing and demonstration).
Idaho Nuclear Technology and Engineering Center	ICP	Dry storage of spent nuclear fuel; management of high-level waste calcine and sodium-bearing liquid waste; and operation of the Idaho Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Disposal Facility, including a landfill, evaporation ponds, and a staging and treatment facility. This is also the location of the Integrated Waste Treatment Unit, a first-of-a-kind, 53,000-square-foot facility that is treating the remaining ~800,000 gallons of liquid radioactive and hazardous waste that has been stored in underground storage tanks.
Materials and Fuels Complex	INL	Research and development of nuclear fuels. Pyro-processing, which uses electricity to separate waste products in the recycling of nuclear fuel, is researched here. Nuclear batteries for use on the nation's space missions are made at MFC.
Radioactive Waste Management Complex	ICP	Environmental remediation and waste treatment, storage, and disposal for wastes generated at the INL Site and other DOE sites. The Advanced Mixed Waste Treatment Project characterizes, treats, and packages transuranic waste for shipment out of Idaho to permanent disposal facilities.
Research and Education Campus	INL	Located in Idaho Falls, the Research and Education Campus is home to DOE's Radiological and Environmental Sciences Laboratory, INL administration, the INL Research Center, the Center for Advanced Energy Studies, and other energy and security research programs. Research is conducted at the INL Research Center in robotics, genetics, biology, chemistry, metallurgy, computational science, and hydropower. The Center for Advanced Energy Studies is a research and education partnership between Boise State University, INL, Idaho State University, and the University of Idaho to conduct energy research and address the looming nuclear energy work-force shortage.
Test Area North/Specific Manufacturing Capability	INL	Several historic nuclear research and development projects were conducted at TAN. Major cleanup and demolition of the facility was completed in 2008, and the current mission is the manufacture of tank armor for the U.S. Army's battle tanks at the Specific Manufacturing Capability for the U.S. Department of Defense.

a. The Naval Reactors Facility (NRF) is also located onsite. It is operated for Naval Reactors by Fluor Marine Propulsion, LLC. The Naval Nuclear Propulsion Program is exempt from DOE requirements and is therefore not addressed in this report.

ENVIRONMENTAL COMPLIANCE (CHAPTER 2)

One measure of the achievement of the environmental programs at the INL Site is compliance with applicable environmental regulations, which have been established to protect human health and the environment. The compliance of INL Site and DOE-ID programs with federal and state environmental protection requirements, such as statutes, acts, agreements, executive orders, and DOE directives are presented in Table 2-1.

ENVIRONMENTAL RESTORATION (CHAPTER 2)

Environmental restoration at the INL Site is conducted under the Federal Facility Agreement and Consent Order (FFA/CO) among DOE, the state of Idaho, and the U.S. Environmental Protection Agency (EPA). The FFA/CO specifies actions that must be completed to safely cleanup sites in compliance with the CERCLA and with the corrective action requirements of the Resource Conservation and Recovery Act. The INL Site is divided into ten Waste Area Groups (WAGs) as a result of the FFA/CO, and each WAG is divided into smaller cleanup areas called operable units. Since the FFA/CO was signed in 1991, the INL Site has cleaned up sites containing asbestos, acids and bases, radionuclides, unexploded ordnance and explosive residues, polychlorinated biphenyls, heavy metals, and other hazardous materials.

Comprehensive remedial investigation/feasibility studies have been conducted at all WAGs and closeout activities have been completed at six WAGs. In 2023, all institutional controls and operational and maintenance requirements were maintained, and active remediation continued on WAGs 1, 3, and 7.

ENVIRONMENTAL PROTECTION PROGRAMS (CHAPTER 2, CHAPTER 3)

Directives, orders, guides, and manuals are DOE's primary means of establishing policies, requirements, responsibilities, and procedures for DOE offices and contractors. Among these are a series of orders directing each DOE site to implement sound stewardship practices that are protective of the public and the environment. These orders require the implementation of an environmental management system (EMS), a Site Sustainability Plan, a radioactive waste management program, and programs addressing radiation protection of the public and the environment. The INL Site contractors have each established and implemented an EMS and have contributed to the INL Site Sustainability Plan, as required by DOE and executive orders. Each EMS integrates environmental protection, environmental compliance, pollution prevention, and waste minimization into work planning and execution throughout all work areas. The INL Site Sustainability Plan contains strategies and activities that will lead to continual greenhouse gas reductions, as well as energy, water, and transportation fuels efficiency at the INL Site. Plan requirements are integrated into each INL Site contractor's Integrated Safety Management System and EMS.

ENVIRONMENTAL MONITORING OF AIR (CHAPTER 4)

Airborne releases of radionuclides from INL Site operations are reported annually in a document prepared in accordance with the 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." An estimated total of 3,341 curies (1.24×10^{14} Bq) of radioactivity, primarily in the form of short-lived noble gas isotopes, were released as airborne effluents in 2023. This represents a significant and expected increase compared to the previous year and was primarily due to the Advanced Test Reactor becoming operational following the completion of the refurbishment of the reactor core. These airborne releases of radionuclides are reported to comply with regulatory requirements and are considered in the design and conduct of INL Site environmental surveillance activities.

The INL Site environmental surveillance monitoring programs, which are conducted by the INL Site contractors, emphasize the measurement of airborne radionuclides because air transport is considered the major potential pathway from INL Site releases to human receptors. During 2023, the INL contractor monitored ambient air at 37 locations (21 onsite, 7 boundary, and 9 offsite). The ICP contractor focused on ambient air surveillance monitoring of waste management facilities, namely INTEC and RWMC.

Air particulate samples were collected weekly by the INL contractor and biweekly by the ICP contractor. These samples were initially analyzed for gross alpha and gross beta activity. The particulate samples were then combined into composite samples and analyzed for gamma-emitting radionuclides and specific alpha- and beta-emitting radionuclides. Air filter composites at MFC collected by the INL contractor were analyzed for chlorine-36 beginning in the second quarter. Charcoal cartridges were also collected weekly by the INL contractor and analyzed for radioiodine.

All radionuclide concentrations in ambient air samples were below DOE radiation protection standards for air. In addition, gross alpha and gross beta concentrations were analyzed statistically, and there were no differences between the samples collected at the onsite, boundary, and offsite locations. All concentrations were within historical measurements made during the past ten years (2013-2022), except for some americium-241 (^{241}Am) and plutonium results collected at RWMC by the INL contractor during the fourth quarter. Plutonium isotopes and ^{241}Am are known to occur in soils at the

Subsurface Disposal Area (SDA). The results observed during the fourth quarter are likely related to work activities being performed at SDA. All concentrations were well below the DOE Derived Concentration Standards for these radionuclides.

The INL contractor collected atmospheric moisture samples at three stations onsite, three stations offsite, and two boundary stations in 2023. Precipitation was collected at one location onsite, two boundary locations, and one offsite location. The samples were all analyzed for tritium. The results were within measurements made historically and below the DOE Derived Concentration Standards. Tritium measured in these samples is most likely the result of natural production in the atmosphere and not the result of INL Site effluent releases.

ENVIRONMENTAL MONITORING OF GROUNDWATER, DRINKING, AND SURFACE WATER (CHAPTER 5, CHAPTER 6)

The INL Site contractors monitor liquid effluents (wastewater), drinking water, groundwater, and storm water runoff at the INL Site, for both radioactive and nonradioactive constituents, and for compliance with applicable laws and regulations, DOE orders, and other requirements. Wastewater is typically discharged from INL Site facilities to infiltration ponds or to evaporation ponds. Wastewater effluent discharges occur at percolation ponds southwest of INTEC, a cold waste pond at the ATR Complex, and an industrial waste pond at MFC. DOE-ID complies with the state of Idaho groundwater quality, wastewater, and reuse rules for these effluents through reuse permits, which provide for monitoring of the wastewater and groundwater in the area. During 2023, liquid effluent and groundwater monitoring were conducted in support of reuse permit requirements. An annual site performance report for each permitted reuse facility was prepared and submitted to the Idaho Department of Environmental Quality. No permit limits were exceeded.

In addition to the monitoring conducted in support of the reuse permits, liquid effluent and groundwater surveillance monitoring was also performed at the ATR Complex Cold Waste Pond, INTEC, and MFC Industrial Waste Pond to comply with environmental protection objectives of DOE orders. The 2023 results were consistent with historical measurements. All radioactive parameters were below applicable health-based levels.

Drinking water parameters are regulated by the state of Idaho under the authority of the Safe Drinking Water Act. The INL Site contractors monitored 11 drinking water systems at the INL Site in 2023. (The NRF contractor monitors an additional drinking water system; those results are reported separately by NRF). The results were below limits for all relevant drinking water standards.

Surface water flows off the Subsurface Disposal Area (SDA) following periods of heavy precipitation or rapid snowmelt. During these times, water may be pumped out of the SDA retention basin into a drainage canal, potentially carrying radionuclides originating from radioactive waste or contaminated surface soil off the SDA. Surface water is collected when it is available. Amounts of ^{241}Am, strontium-90 (^{90}Sr), plutonium-238 (^{238}Pu), and plutonium-239/240 ($^{239/240}$Pu) were detected in 2023 samples collected from the SDA Lift Station. The detected concentrations are well below the standards established by DOE for radiation protection of the public and the environment.

ENVIRONMENTAL MONITORING OF THE EASTERN SNAKE RIVER PLAIN AQUIFER (CHAPTER 6)

The eastern Snake River Plain Aquifer is perhaps the single-most important aquifer in Idaho. Composed of layered basalt lava flows and some sediment, it covers an area of approximately 27,972 km^2 (10,800 square miles). The highly productive aquifer has been declared a sole source aquifer by the EPA due to the nearly complete reliance on the aquifer for drinking water supplies in the area.

The U.S. Geological Survey (USGS) began monitoring the groundwater below the INL Site in 1949. Currently, the USGS performs groundwater monitoring, analyses, and studies of the eastern Snake River Plain Aquifer under and adjacent to the INL Site. These activities use an extensive network of strategically placed monitoring wells on and around the INL Site. In 2023, the USGS continued to monitor localized areas of chemical and radiochemical contamination beneath the INL Site produced by past waste disposal practices, in particular, the direct injection of wastewater into the aquifer at INTEC. Results for monitoring wells sampled within the plumes show nearly all wells had decreasing trends of tritium and ^{90}Sr concentrations over time.

Volatile organic compounds (VOCs) are present in water from the eastern Snake River Plain Aquifer because of historical waste disposal practices at the INL Site. Several purgeable VOCs were detected by USGS in at least one of the 25 groundwater monitoring wells sampled at the INL Site in 2023. Most concentrations of the 61 analyzed compounds were either below the laboratory reporting levels or their respective primary contaminant standards. Trend test results for tetrachloromethane concentrations in water from the RWMC production well show a decreasing trend in that well since 2005. The more recent decreasing trend indicates that remediation efforts designed to reduce VOC movement to the aquifer are having a positive effect. Concentrations of tetrachloromethane from USGS-87 and USGS-120, south of RWMC, have had an increasing trend since 1987; however, concentrations have decreased through time at USGS-88. Trichloroethelene was detected above the maximum contaminant level (MCL) in one well sampled by the USGS at TAN, which was expected as there is a known groundwater plume at this location as well as one perched well.

Groundwater surveillance monitoring continued for the CERCLA WAGs onsite in 2023. At TAN (WAG 1), groundwater monitoring continues to monitor the progress of remediation of the plume of trichloroethylene and to monitor ^{90}Sr and cesium-137 (^{137}Cs). Remedial action consists of three components: in-situ bioremediation, pump and treat, and monitored natural attenuation. Amounts of ^{90}Sr and ^{137}Cs were present in wells in the source area at levels higher than those prior to starting in-situ bioremediation. The elevated concentrations of these radionuclides are due to chemical processes associated with in-situ bioremediation activities. The radionuclide concentrations will continue to be evaluated to determine whether they will meet remedial action objectives by 2095.

Groundwater samples were collected from six aquifer wells in the vicinity of the ATR Complex (WAG 2) during 2023 and were analyzed for ^{90}Sr, cobalt-60 (^{60}Co), tritium, and chromium. Chromium and tritium were the only analytes detected and the concentrations were below the respective drinking water MCL established by the EPA.

Groundwater samples were collected from 17 aquifer monitoring wells at and near INTEC (WAG 3) during 2023 and analyzed for a suite of radionuclides and inorganic constituents. Amounts of ^{90}Sr and technetium-99 (^{99}Tc) exceeded their respective drinking water MCLs in one or more aquifer monitoring wells at or near INTEC, with ^{90}Sr exceeding its MCL by the greatest margin in a well south (downgradient) of the former INTEC injection well. All other well locations showed ^{90}Sr levels similar to or slightly lower than those reported in previous samples.

Monitoring groundwater at CFA (WAG 4) consists of CFA landfill monitoring and monitoring of a nitrate plume south of the CFA. Wells at the landfill were monitored in 2023 for metals (filtered), VOCs, and anions (e.g., nitrate, chloride, fluoride, sulfate). No CFA landfill monitoring samples exceeded a MCL but the iron and lower threshold aluminum secondary maximum contaminant level (SMCL) was exceeded in one well, and two wells exceeded a pH SMCL. Nitrate continued to exceed the EPA MCL in one well in the plume south of the CFA in 2023; however, the data show a downward trend since 2006.

Groundwater samples were collected from monitoring wells near and downgradient of the RWMC (WAG 7) in May 2023, which were analyzed for radionuclides, inorganic constituents, and VOCs. Carbon tetrachloride was detected slightly above the MCL (5 ug/L) in one regular sample from Well M15S. Carbon tetrachloride concentrations in all other well locations were below the MCL and consistent with historical detections.

Groundwater monitoring at MFC as part of WAG 9 CERCLA monitoring was discontinued in 2022 as discussed in Chapter 6. In 2023, groundwater monitoring continued in support of the MFC Industrial Waste Pond Reuse Permit and DOE orders. Three wells were sampled for radionuclides, metals, and other water quality parameters in the spring and fall of 2023. Overall, the results remain below the primary constituent standard/secondary constituent standards and continue to show no evidence of impacts from MFC activities.

Wells along the southern INL Site boundary (as part of WAG 10) are sampled every two years. Groundwater samples were collected in 2023. Seven wells and three intervals from two Westbay® wells were sampled. Groundwater samples from all wells were analyzed for chloride, nitrate/nitrite as nitrogen, gross alpha, and gross beta. Sulfate and volatile organic compounds were collected from a subset of Operable Unit 10-08 monitoring wells. None of the noted analytes exceeded EPA MCLs or SMCLs.

Groundwater is monitored at the Remote-Handled Low-Level Waste Facility for gross alpha, gross beta, carbon-14 (^{14}C), iodine-129 (^{129}I), ^{99}Tc, and tritium. Samples were collected from three monitoring wells in the spring and fall of 2023. The results remain below the primary constituent standard/secondary constituent standard and show no discernible impacts to the aquifer from Remote-Handled Low-Level Waste Facility operations.

Drinking water and surface water samples were sampled downgradient of the INL Site and analyzed for gross alpha and beta activity and tritium. Tritium was detected in two surface water samples and two drinking water samples (one was the control). These results were within historical measurements and well below the EPA MCL of 20,000 pCi/L. Gross alpha and beta results were within historical measurements and below the EPA's screening level. The data appear to show no discernible impacts from activities at the INL Site.

USGS RESEARCH (CHAPTER 6)

The USGS INL Project Office drills and maintains research wells that provide information about subsurface water, rock and sediment, and contaminant movement in the eastern Snake River Plain Aquifer at and near the INL Site. In 2023, the USGS published three research reports, two software releases, and six data releases.

ENVIRONMENTAL SURVEILLANCE MONITORING OF AGRICULTURAL PRODUCTS, WILDLIFE, SOIL, AND DIRECT RADIATION MEASUREMENTS (CHAPTER 7)

To help assess the impact of contaminants released to the environment by operations at the INL Site, agricultural products (e.g., milk, lettuce, alfalfa, grain, potatoes) and wildlife were sampled and analyzed for radionuclides in 2023. The agricultural products were collected onsite, offsite, and at INL Site boundary locations by the INL contractor.

No human-made radionuclides were detected in agricultural products with one exception. Cesium-137 was detected in a milk sample collected in Monteview; however, a review of the result and uncertainty suggest the result was a false positive. Cesium-137 was not detected in any other milk sample collected in 2023. All measurements were consistent with those made historically.

No human-made radionuclides were detected in big game animal samples collected in 2023. Amounts of ^{137}Cs, ^{60}Co, zinc-65 (^{65}Zn), and ^{90}Sr were detected in tissues of waterfowl collected near the ATR Complex ponds, indicating that they accessed the contaminated ponds.

Direct radiation measurements made at onsite, offsite, and boundary locations were consistent with historical and natural background levels.

Soil sampling is conducted on a five-year rotation at the INL Site with the next sampling event scheduled for 2027.

RADIATION DOSE TO THE PUBLIC AND BIOTA FROM INL SITE RELEASES (CHAPTER 8)

Humans, plants, and animals potentially receive radiation doses from various INL Site operations. DOE sets dose limits for the public and biota to ensure that exposure to radiation from site operations is not a health concern. Potential radiological doses to the public from INL Site operations were calculated to determine compliance with pertinent regulations and limits (Table 8-5). The calculated dose to the maximally exposed individual in 2023 from the air pathway was 0.029 mrem (0.29 µSv), which is well below the 10-mrem standard established by the Clean Air Act. The maximally exposed individual is a hypothetical member of the public who could receive the maximum possible dose from INL Site releases as determined by the air dispersion model. This person is assumed to live at a location east of the INL Site's east entrance and south of Highway 20. For comparison, the dose from natural background radiation was estimated in 2023 to be 376 mrem (3.8 mSv) to an individual living on the Snake River Plain.

The maximum potential population dose to the approximately 353,789 people residing within an 80 km (50 mi) radius of any INL Site facility was calculated as 0.031 person-rem (0.00031 person-Sv), below that expected from exposure to background radiation (133,025 person-rem or 1,330 person-Sv).

The maximum potential individual dose from consuming waterfowl contaminated at the INL Site, based on the highest concentrations of radionuclides measured in edible tissue of samples collected near the ATR Complex ponds, was estimated to be 0.026 mrem (0.26 µSv). In 2023, none of the big game samples collected (e.g., four elk, one mule deer) had a detectable concentration of ^{137}Cs or other human-made radionuclides. When the dose estimated for the air pathway was summed with the dose from consuming contaminated waterfowl, assuming that the waterfowl is eaten by the same hypothetical individual, the representative person off the INL Site could potentially receive a total dose of 0.055 mrem (0.55 µSv) in 2023. This is 0.055% of the DOE health-based dose limit of 100 mrem/yr (1 mSv/yr) from all pathways for the INL Site.

Tritium has been previously detected in two USGS monitoring wells located onsite along the southern boundary. A hypothetical individual ingesting the maximum concentration of tritium (3,620 pCi/L) via drinking water from these wells would receive a dose of approximately 0.2 mrem (0.002 mSv) in one year. This is an unrealistic pathway to humans because there are no drinking water wells located along the southern boundary of the INL Site. The maximum contaminant level established by EPA for tritium (20,000 pCi/L) corresponds to a dose of approximately 4 mrem (0.04 mSv [40 µSv/yr]).

A dose to a maximally exposed individual located in Idaho Falls, near the DOE Radiological and Environmental Sciences Laboratory and the INL Research Center, within the REC, was calculated for compliance with the Clean Air Act. For 2023, the dose was conservatively estimated to be 0.005 mrem (0.05 µSv), which is less than 0.1% of the 10-mrem/yr federal standard.

Doses were also evaluated for nonhuman biota at the INL Site using a graded approach. Based on the conservative screening calculations, there is no evidence that INL Site-related radioactivity in soil or water is adversely affecting populations of plants or animals.

NATURAL AND CULTURAL RESOURCES CONSERVATION AND MONITORING (CHAPTER 9)

Natural resources conservation, monitoring, and land stewardship activities onsite are organized in four categories: (1) planning and implementing conservation efforts for high priority natural resources; (2) frequently evaluating the regulatory rankings, distribution, and populations for special status species; (3) ongoing monitoring and research to provide baseline and trend data for specific taxa and broader ecological communities; and (4) conducting land stewardship activities to minimize impacts to natural resources and restore ecological condition, where appropriate.

DOE has developed conservation plans to address species of elevated conservation concern and the valuable ecosystems they inhabit. Conservation plans that are specific to or include the INL Site are the DOE Conservation Action Plan, the Candidate Conservation Agreement for Greater sage-grouse (*Centrocercus urophasianus*), the INL Site Bat Protection Plan, the Sagebrush Steppe Ecosystem Reserve, and the Migratory Bird Conservation Plan and Avian Protection Planning documents. Many of these plans include conservation measures; best management practices; monitoring programs; and annual reports to facilitate, evaluate, and communicate results of conservation efforts for resources with high conservation priority.

To better inform conservation efforts, biologists regularly evaluate the regulatory status of key special status species identified by state or federal agencies. For animals, these include 28 species of birds, 13 species of mammals, one species of reptile, and one species of amphibian. There are also currently 20 special status plant species that have been documented to occur onsite. Many of the plant species are rare and occur very infrequently within their optimal habitats. While several animals and plants listed as threatened or endangered under the Endangered Species Act are present in Idaho, none are known to occur onsite.

Additional ecological monitoring has been conducted for more than 70 years, with some studies dating back to the 1950s. The focus of this work is to better understand the INL Site's ecosystem and biota and to determine the impact on populations of these species from activities conducted at the INL Site. Natural resource monitoring activities include breeding bird surveys, midwinter raptor survey, long-term vegetation transect surveys, and vegetation mapping. Furthermore, the INL Site was designated as a National Environmental Research Park in 1975 and serves as an outdoor laboratory for environmental scientists to study Idaho's native plants and wildlife in an intact and relatively undisturbed ecosystem. Ongoing National Environmental Research Park activities range from characterizing sagebrush steppe ecohydrology to identifying high quality foodscape for sage-grouse.

Land stewardship involves managing ecosystems to increase habitat connectivity and enhance ecosystem services through planning, assessment, restoration and rehabilitation activities, as well as continuing to explore additional nature-based solutions. Areas where DOE-ID is actively employing land stewardship activities include wildland fire protection planning, management, and recovery; restoration and revegetation; weed management; and ecological support for the National Environmental Policy Act.

The INL Cultural Resource Management Office (CRMO) coordinates cultural resource-related activities at the INL Site and implements the INL Cultural Resource Management Plan (DOE-ID 2016) with oversight by DOE-ID's Cultural Resource Coordinator. During 2023, the INL CRMO assisted DOE-ID with continued negotiations and finalization of the Programmatic Agreement (DOE-ID 2023) with the Idaho State Historic Preservation Office, the Advisory Council on Historic Preservation, the Shoshone-Bannock Tribes, and other consulting parties. The Advisory Council on Historic Preservation provided the fully executed Programmatic Agreement to the DOE-ID on May 8, 2023. Cultural resource identification and evaluation studies in fiscal year 2023 included: (1) archaeological field surveys, (2) cultural resource monitoring and site record updates related to INL Site project activities and research, and (3) comprehensive evaluations of built environment resources 45 years of age and older. Additionally, the CRMO supports DOE-ID with their government-to-government consultation and meaningful collaboration with members of the Shoshone-Bannock Tribes to include the Fort Hall Business Council, the Language and Cultural Committee, and the Heritage Tribal Office (known as the HeTO), as well as interested stakeholders. Preservation and stewardship activities in 2023 included: (1) issuance and revisions to seven Management Control Procedures, (2) development of historic context statements (Precontact and Pre-World War II), (3) support to five active research projects, (4) participating in public outreach and education opportunities, (5) archaeological site stabilization and restoration, and (6) improvements to the Archives and Special Collections.

QUALITY ASSURANCE (CHAPTER 10)

Quality assurance and quality control programs are maintained by contractors conducting environmental surveillance monitoring and by laboratories performing environmental analyses to help provide confidence in the data and ensure data completeness. Programs involved in environmental surveillance monitoring developed quality assurance programs and documentation, which follow requirements and criteria established by DOE. Environmental surveillance monitoring programs implemented quality assurance program elements through quality assurance project plans developed for each contractor.

Adherence to procedures and quality assurance project plans was maintained during 2023. Data reported in this document were obtained from several commercial, university, government, and government contractor laboratories. To ensure quality results, these laboratories participated in several laboratory quality check programs. Quality issues that arose with laboratories used by INL Site contractors during 2023 were addressed with the laboratories and have been resolved.

Sagebrush steppe with wildflowers

Helpful Information:

What is Radiation?

Much of the Annual Site Environmental Report deals with radioactivity levels measured in environmental media such as air, water, soil, and plants. The following information is intended for individuals with little or no familiarity with radiological data or radiation dose. It presents terminology and concepts used in the Annual Site Environmental Report to aid the reader.

Matter is composed of atoms. Some atoms are energetically unstable and change to become more stable. During this transformation, unstable or radioactive atoms give off energy called radiation in the form of particles or electromagnetic waves. Generally, we refer to the various radioactive atoms as radionuclides. The radiation released by radionuclides has enough energy to eject electrons from other atoms it encounters. The resulting charged atoms or molecules are called ions, and the energetic radiation that produced the ions is called ionizing radiation. Ionizing radiation is referred to simply as radiation throughout this report. The most common types of radiation are alpha particles, beta particles, X-rays, and gamma-rays. X-rays and gamma-rays, just like visible light and radio waves, are packets of electromagnetic radiation. Collectively, packets of electromagnetic radiation are called photons. One may, for instance, speak of X-ray photons or gamma-ray photons.

Alpha Particles. An alpha particle is a helium nucleus without orbital electrons. It is composed of two protons and two neutrons and has a positive charge of two. Because alpha particles are relatively heavy and have a double charge, they cause intense tracks of ionization but have little penetrating ability, as observed in Figure HI-1. Alpha particles can be stopped by thin layers of materials, such as a sheet of paper or a piece of aluminum foil. Examples of alpha-emitting radionuclides include radioactive atoms of radon, uranium, plutonium, and americium.

Beta Particles. Beta particles are electrons that are ejected from unstable atoms during the transformation or decay process. Beta particles penetrate more than alpha particles but are less penetrating than X-rays or gamma-rays of equivalent energies. A piece of wood or a thin block of plastic can stop beta particles, as can be seen in Figure HI-1. The ability of beta particles to penetrate matter increases with energy. Examples of beta-emitting radionuclides include tritium (^{3}H) and radioactive strontium.

X-Rays and Gamma-Rays. X-rays and gamma-rays are photons with very short wave-lengths compared to other electromagnetic waves such as visible light, heat rays, and radio waves. Gamma-rays and X-rays have identical properties, behavior, and effects but differ in their origin. Gamma-rays originate from an atomic nucleus, and X-rays originate from interactions with the electrons orbiting around atoms. All photons travel at the speed of light. Their energies, however, vary over a large range. The penetration of X-ray or gamma-ray photons depend on the energy of the photons, as well as the thickness, density, and composition of the shielding material. Concrete is a common material used to shield people from gamma-rays and X-rays, as shown in Figure HI-1.

Examples of gamma-emitting radionuclides include radioactive atoms of iodine and cesium. X-rays may be produced by medical X-ray machines in a doctor's office.

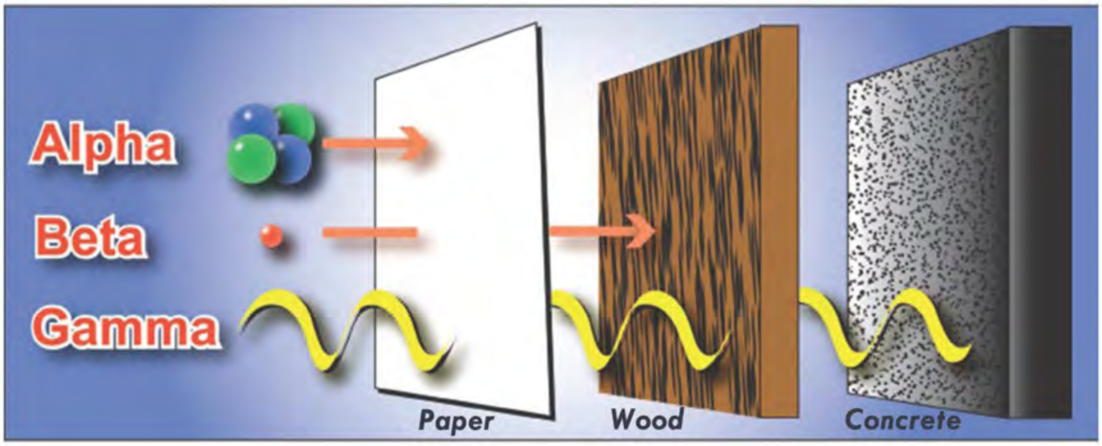

Figure HI-1. Comparison of penetrating ability of alpha, beta, and gamma radiation.

How are Radionuclides Designated?

Radionuclides are frequently expressed with a one or two letter abbreviation for the element and a superscript to the left of the symbol that identifies the atomic weight of the isotope. The atomic weight is the number of protons and neutrons in the nucleus of the atom. Most radionuclide symbols used in this report are shown in Table HI-1. This table also shows the half-life of each radionuclide. Half-life refers to the time in which one-half of the atoms of a radioactive sample transforms or decays in the quest to achieve a more energetically stable nucleus. Most radionuclides do not decay directly to a stable element, but rather undergo a series of decays until a stable element is reached. This series of decays is called a decay chain.

How are Radioactivity and Radionuclides Detected?

Environmental samples of air, water, soil, and plants are collected in the field and then prepared and analyzed for radioactivity in a laboratory. A prepared sample is placed in a radiation-counting system with a detector that converts the ionization produced by the radiation into electrical signals or pulses. The number of electrical pulses recorded over a unit of time is called a count rate. The count rate is proportional to the amount of radioactivity in the sample.

Air and water samples are often analyzed to determine the total amount of alpha-emitting and beta-emitting radioactivity present. This is referred to as a gross measurement because the radiation from all alpha-emitting and beta-emitting radionuclides in the sample is quantified. Such sample analyses measure both human-generated and naturally occurring radioactive material. Gross alpha and beta analyses are generally considered screening measurements since specific radionuclides are not identified. The amount of gross alpha-emitting and beta-emitting radioactivity in air samples is frequently measured to screen for the potential presence of man-made radionuclides. If the results are higher than normal, sources other than background radionuclides may be suspected, and other laboratory techniques may be used to identify the specific radionuclides in the sample. Gross alpha and beta activity also can be examined over time and between locations to detect trends.

The low penetration ability of alpha-emitting particles makes detection by any instrument difficult. Identifying specific alpha-emitting radionuclides typically involves chemical separations in the laboratory to purify the sample prior to analysis with an alpha detection instrument. Radiochemical analysis is very time-consuming and expensive.

Beta particles are easily detected by several types of instruments, including the common Geiger-Mueller counter. However, detection of specific beta-emitting radionuclides, such as ^{3}H and ^{90}Sr, requires chemical separation first.

Table HI-1. Radionuclides and their half-lives.

SYMBOL	RADIONUCLIDE	HALF-LIFE[a,b]	SYMBOL	RADIONUCLIDE	HALF-LIFE[a,b]
^{241}Am	Americium-241	432.2 yr	^{54}Mn	Manganese-54	312.12 d
^{243}Am	Americium-243	7,370 yr	^{59}Ni	Nickel-59	1.01×10^5 yr
^{125}Sb	Antimony-125	2.75856 yr	^{63}Ni	Nickel-63	100.1 yr
^{41}Ar	Argon-41	109.61 min	^{238}Pu	Plutonium-238	87.7 yr
^{137m}Ba	Barium-137m	2.552 min	^{239}Pu	Plutonium-239	2.411×10^4 yr
^{140}Ba	Barium-140	12.752 d	^{240}Pu	Plutonium-240	6,564 yr
^{7}Be	Beryllium-7	53.22 d	^{241}Pu	Plutonium-241	14.35 yr
^{14}C	Carbon-14	5,700 yr	^{242}Pu	Plutonium-242	3.75×10^5 yr
^{141}Ce	Cerium-141	32.508 d	^{40}K	Potassium-40	1.251×10^9 yr
^{144}Ce	Cerium-144	284.91 d	^{226}Ra	Radium-226	1,600 yr
^{134}Cs	Cesium-134	2.0648 yr	^{228}Ra	Radium-228	5.75 yr
^{137}Cs	Cesium-137	30.1671 yr	^{220}Rn	Radon-220	55.6 s
^{36}Cl	Chlorine-36	$3.01 \text{ x } 10^5$ yr	^{222}Rn	Radon-222	3.8235 d
^{51}Cr	Chromium-51	27.7025 d	^{103}Ru	Ruthenium-103	39.26 d
^{60}Co	Cobalt-60	5.2713 yr	^{106}Ru	Ruthenium-106	373.59 d
^{152}Eu	Europium-152	13.537 yr	^{90}Sr	Strontium-90	28.79 yr
^{154}Eu	Europium-154	8.593 yr	^{99}Tc	Technetium-99	2.111×10^5 yr
^{3}H	Tritium	12.32 yr	^{232}Th	Thorium-232	1.405×10^{10} yr
^{129}I	Iodine-129	1.57×10^7 yr	^{233}U	Uranium-233	1.592×10^5 yr
^{131}I	Iodine-131	8.0207 d	^{234}U	Uranium-234	2.455×10^5 yr
^{55}Fe	Iron-55	2.737 yr	^{235}U	Uranium-235	7.04×10^8 yr
^{59}Fe	Iron-59	44.495 d	^{238}U	Uranium-238	4.468×10^9 yr
^{85}Kr	Krypton-85	10.756 yr	^{90}Y	Yttrium-90	64.1 hr
^{87}Kr	Krypton-87	76.3 min	^{65}Zn	Zinc-65	244.06 d
^{88}Kr	Krypton-88	2.84 hr	^{95}Zr	Zirconium-95	64.032 d
^{212}Pb	Lead-212	10.64 hr			

a. From ICRP Publication 107 (ICRP 2008).

b. d = days; hr = hours; min = minutes; s = seconds; yr = years.

The high-energy photons from gamma-emitting radionuclides are relatively easy to detect. Because the photons from each gamma-emitting radionuclide have a characteristic energy, gamma emitters can be simply identified in the laboratory with only minimal sample preparation prior to analysis. Gamma-emitting radionuclides, such as ^{137}Cs, can even be measured in soil by field detectors called in situ detectors.

Gamma radiation originating from naturally occurring radionuclides in soil and rocks on the earth's surface is a primary contributor to the background external radiation exposure measured in the air. Cosmic radiation from outer space is another contributor to the external radiation background. External radiation is easily measured with devices known as environmental dosimeters.

How are Results Reported?

Scientific Notation. Concentrations of radionuclides detected in the environment are typically quite small. Scientific notation is used to express numbers that are very small or very large. A very small number may be expressed with a negative exponent, for example, 1.3×10^{-6} (or 1.3E-06). To convert this number to its decimal form, the decimal point is moved left by the number of places equal to the exponent (in this case, six). The number 1.3×10^{-6} may also be expressed as 0.0000013. When considering large numbers with a positive exponent, such as 1.0×10^{6}, the decimal point is moved to the right by the number of places equal to the exponent. In this case, 1.0×10^{6} represents one million and may also be written as 1,000,000.

Unit Prefixes. Units for very small and very large numbers are often expressed with a prefix. One common example is the prefix kilo (abbreviated k), which means 1,000 of a given unit. One kilometer, therefore, equals 1,000 meters. Table HI-2 defines the values of commonly used prefixes.

Table HI-2. Multiples of units.

MULTIPLE	DECIMAL EQUIVALENT	PREFIX	SYMBOL
10^{6}	1,000,000	mega-	M
10^{3}	1,000	kilo-	k
10^{2}	100	hecto-	h
10	10	deka-	da
10^{-1}	0.1	deci-	d
10^{-2}	0.01	centi-	c
10^{-3}	0.001	milli-	m
10^{-6}	0.000001	micro-	µ
10^{-9}	0.000000001	nano-	n
10^{-12}	0.000000000001	pico-	p
10^{-15}	0.000000000000001	femto-	f
10^{-18}	0.000000000000000001	atto-	a

Units of Radioactivity. The basic unit of radioactivity used in this report is the curie (abbreviated Ci), which is based on the disintegration rate occurring in 1 gram of the radionuclide radium-226 (^{226}Ra) that is 37 billion (3.7×10^{10}) disintegrations per second (becquerels). For any other radionuclide, 1 Ci is the amount of the radionuclide that produces this same decay rate.

Units of Exposure and Dose (Table HI-3). Exposure, or the amount of ionization produced by gamma or X-ray radiation in the air, is measured in terms of the roentgen (R). Dose is a general term to express how much radiation energy is deposited into something. The energy deposited can be expressed in terms of absorbed, equivalent, and effective dose. The term rad, which is short for radiation absorbed dose, is a measure of the energy absorbed in an organ or tissue. The equivalent dose, which considers the effect of different types of radiation on tissues and is therefore the potential for biological effects, is expressed as the R equivalent man or rem. Radiation exposures to the human body, whether from external or internal sources, can involve all or a portion of the body. To enable radiation protection specialists to express partial-body exposures (and the accompanying doses) to portions of the body in terms of an equal dose to the whole body, the concept of effective dose was developed.

Table HI-3. Names and symbols for units of radioactivity and radiological dose used in this report.

SYMBOL	NAME
Bq	Becquerel
Ci	Curie (37,000,000,000 Bq)
mCi	Millicurie (1 × 10^{-3} Ci)
µCi	Microcurie (1 × 10^{-6} Ci)
mrad	Millirad (1 × 10^{-3} rad)
mrem	Millirem (1 × 10^{-3} rem)
R	Roentgen
mR	Milliroentgen (1 × 10^{-3} R)
µR	Microroentgen (1 × 10^{-6} R)
Sv	Sievert (100 rem)
mSv	Millisievert (100 mrem)
µSv	Microsievert (0.1 mrem)

The Système International (SI) is the official system of measurement used internationally to express units of radioactivity and radiation dose. The basic SI unit of radioactivity is the Becquerel (Bq), which is equivalent to one nuclear disintegration per second. The number of curies must be multiplied by 3.7 × 10^{10} to obtain the equivalent number of becquerels. The concept of dose may also be expressed using the SI units, Gray (Gy) for absorbed dose (1 Gy = 100 rad) and sievert (Sv) for effective dose (1 Sv = 100 rem).

Concentrations of Radioactivity in Environmental Sample Media. Table HI-4 shows the units used to identify the concentration of radioactivity in various sample media. There is always uncertainty associated with the measurement of radioactivity in environmental samples. This is mainly because radioactive decay events are inherently random. Thus, when a radioactive sample is counted again and again for the same length of time, the results will differ slightly, but most of the results will be close to the true value of the activity of the radioactive material in the sample. Statistical methods are used to estimate the true value of a single measurement and the associated uncertainty of the measurement. The uncertainty of a measurement is reported by following the result with an uncertainty value that is preceded by the plus or minus symbol, ± (e.g., 10 ± 2 pCi/L). The uncertainty is often referred to as sigma (or σ). For concentrations of greater than or equal to three times the uncertainty, there is 99% probability that the radionuclide was detected in a sample. For example, if a radionuclide is reported for a sample at a concentration of 10 ± 2 pCi/L, then the radionuclide is considered to be detected in that sample because 10 is greater than 3 × 2, or 6. On the other hand, if the reported concentration of a radionuclide (e.g., 10 ± 6 pCi/L) is smaller than three times its associated uncertainty, then the sample probably does not contain that radionuclide (i.e., 10 is less than 3 × 6, or 18). Such low concentrations are considered to be undetected by the method or instrumentation used.

Table HI-4. Units of radioactivity.

MEDIA	UNIT
Air	Microcuries per milliliter (µCi/mL)
Liquid, such as water and milk	Picocuries per liter (pCi/L)
Soil and agricultural products	Picocuries per kilogram (pCi/kg) dry weight
Annual human radiation exposure, measured by environmental dosimeters	Milliroentgens (mR) or millirem (mrem), after being multiplied by an appropriate dose equivalent conversion factor

Mean, Median, Maximum, and Minimum Values. Descriptive statistics are often used to express the patterns and distribution of a group of results. The most common descriptive statistics used in this report are the mean, median, minimum, and maximum values. Mean and median values measure the central tendency of the data. The mean is calculated by adding up all the values in a set of data and then dividing that sum by the number of values in the dataset. The median is the middle value in a group of measurements. When the data are arranged from largest (maximum) to smallest (minimum), the result in the exact center of an odd number of results is the median. If there is an even number of results, the median is the average of the two central values. The maximum and minimum results represent the range of the measurements.

Statistical analysis of many of the air data reported in this annual report indicate that the median is a more appropriate representation of the central tendency of those results. For this reason, some of the figures present the median value of a data group. For example, Figure HI-2 is a box plot showing the minimum, maximum, and median of a set of air measurements.

How are Data Represented Graphically?

Charts and graphs often are used to compare data and to visualize patterns, such as trends over time. Four kinds of graphics are used in this report to represent data: pie charts, column graphs, line plots, and contour lines.

A ***pie chart*** is used in this report to illustrate fractions of a whole. For example, Figure HI-3 shows the approximate contribution to dose that a typical person might receive while living in southeast Idaho. The percentages are derived from the table in the lower left-hand corner of the figure. The medical, consumer, and occupational/industrial portions are from the National Council on Radiation Protection and Measurements Report No. 160 (NCRP 2009). The contribution from background radiation (e.g., natural radiation, mostly radon) is estimated in Table 7-7 of this report.

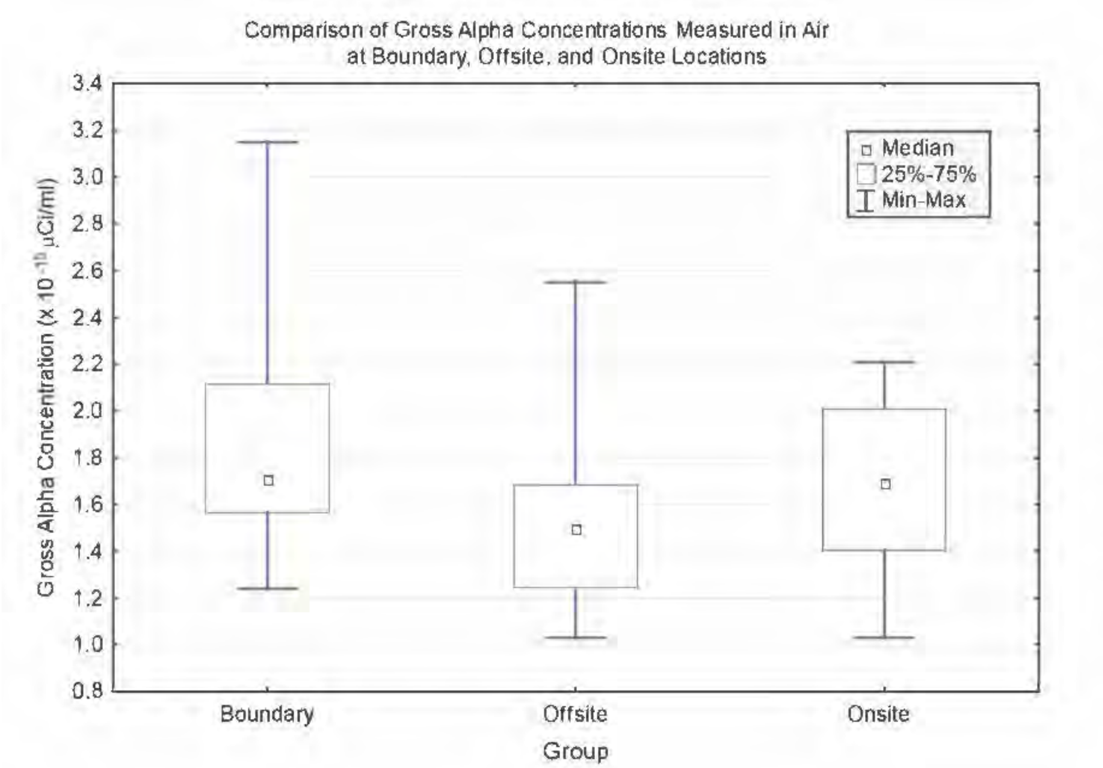

Figure HI-2. A graphical representation of minimum, median, and maximum results with a box plot. *The 25th and 75th percentiles are the values such that 75% of the measurements in the dataset are greater than the 25th percentile, and 75% of the measurements are less than the 75th percentile.*

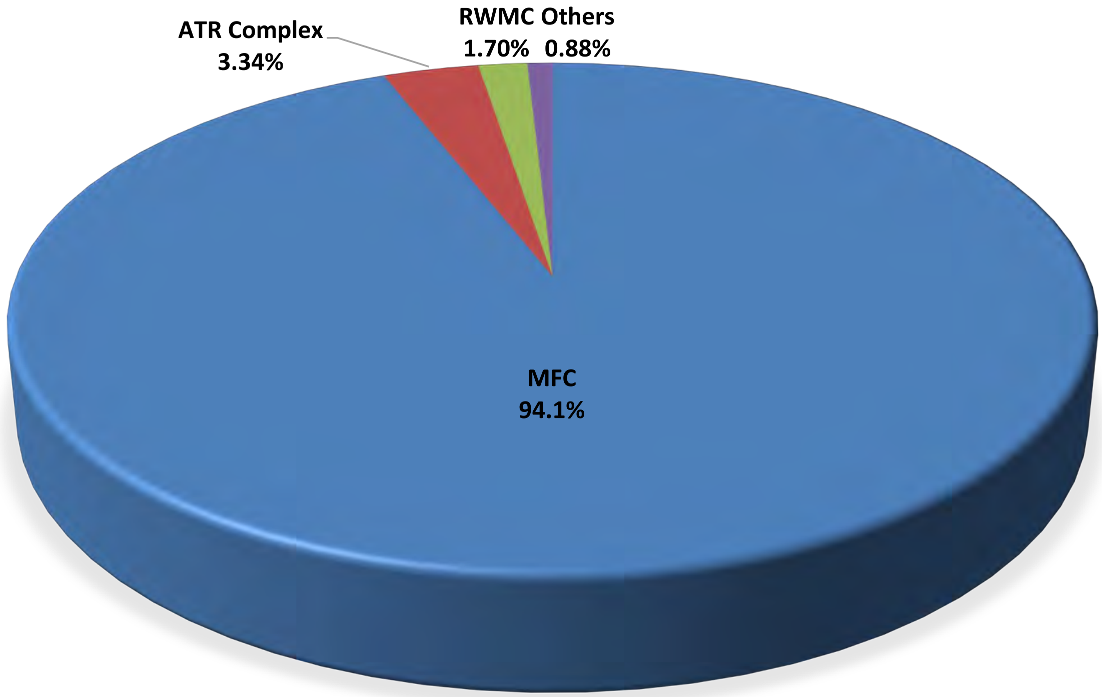

Figure HI-3. Data presented using a pie chart.

A ***column or bar chart*** can show data changes over a period of time or illustrate comparisons among items. Figure HI-4 illustrates the maximum dose (mrem) calculated for the maximally exposed individual from 2014 through 2023. The maximally exposed individual is a hypothetical member of the public who is exposed to radionuclides from airborne releases through various environmental pathways and the media through which the radionuclides are transported (i.e., air, water, and food). The chart shows the general trend of the dose over time.

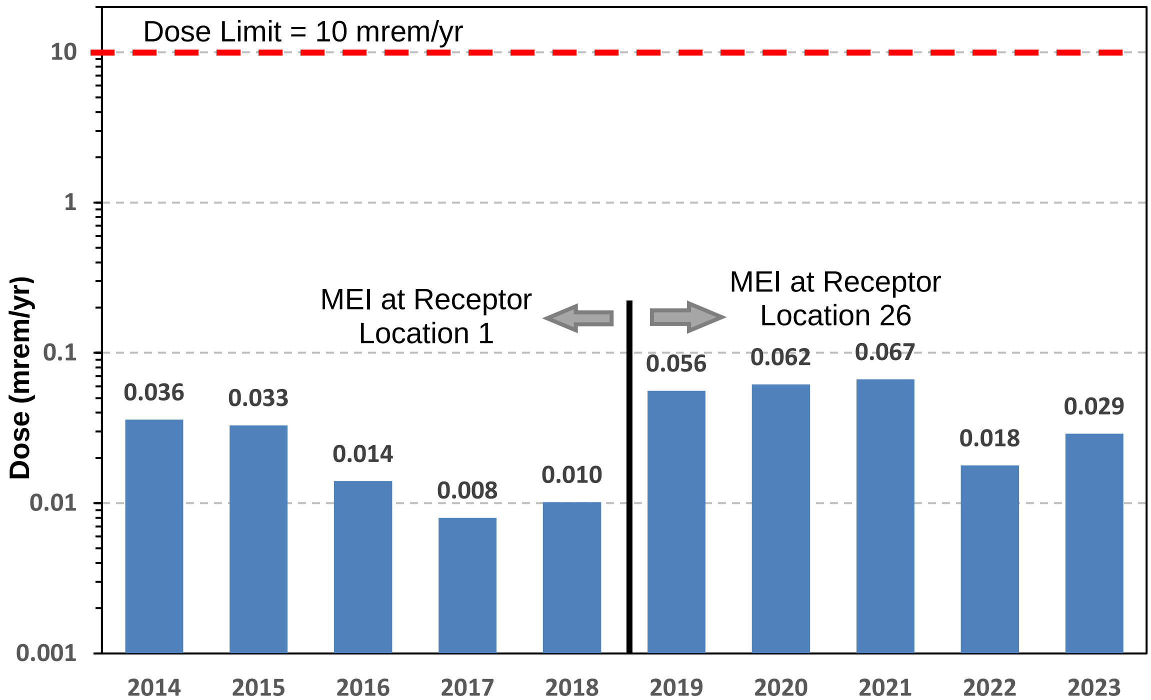

Figure HI-4. Data plotted using a column chart.

A ***plot chart*** can be useful to visualize differences in results over time. Figure HI-5 shows the ^{90}Sr measurements in three wells collected by USGS for 21 years (2003–2023). The results are plotted by year.

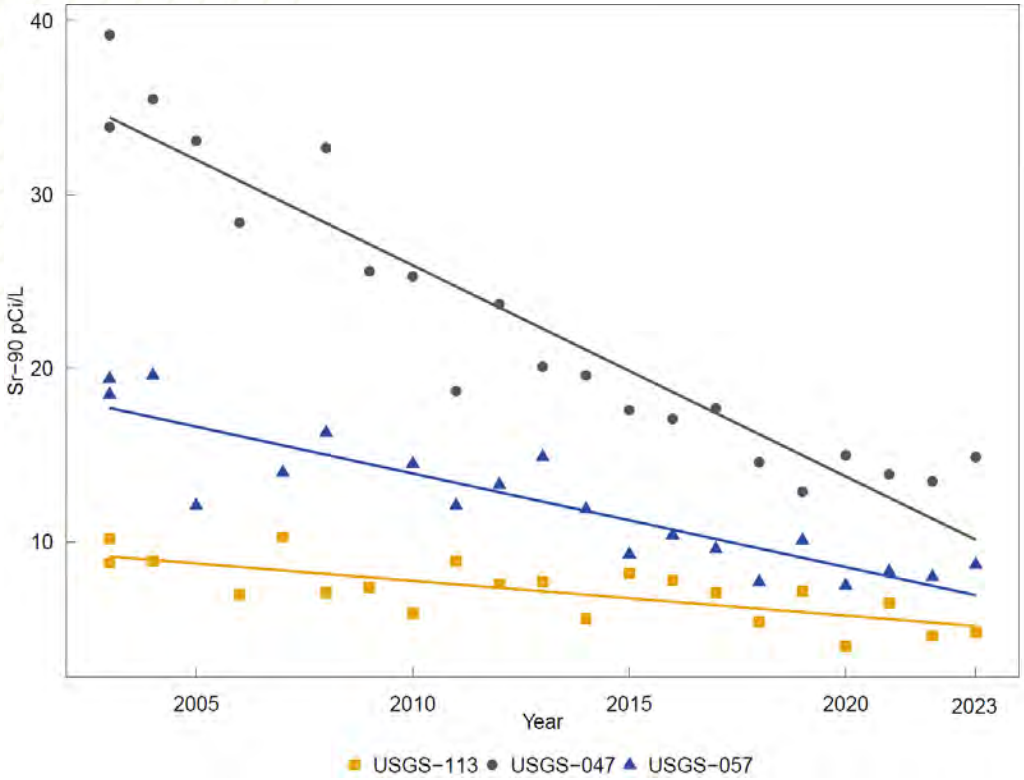

Figure HI-5. Data plotted using a linear plot.

Contour lines are sometimes drawn on a map to discern patterns over a geographical area. For example, Figure HI-6 shows the distribution of ^{90}Sr in groundwater around INTEC. Each contour line, or isopleth, represents a specific concentration of the radionuclide in groundwater. It was estimated from measurements of samples collected from wells around INTEC. Each contour line separates areas that have concentrations above the contour line value from those that have concentrations below that value. The figure shows the highest concentration gradient near INTEC and the lowest farther away. It reflects the movement of the radionuclide in groundwater from INTEC where it was injected into the aquifer in the past.

How Are Results Interpreted?

To better understand data, results are compared in one or more ways, including the following:

- Comparison of results collected at different locations. For example, measurements made at onsite locations are compared with those made at locations near the boundary of the onsite and offsite to find differences that may indicate an impact (Figure HI-2).
- Trends over time or space. Data collected during the year can be compared with data collected at the same location or locations during previous years to see if concentrations are increasing, decreasing, or remaining the same with time. See, for example, Figure HI-4, which shows a general decrease in dose from 2014 to 2018, followed by a slight increase in 2019. Figure HI-6 illustrates a clear spatial pattern of radionuclide concentrations in groundwater decreasing with distance from the source.
- Comparison with background measurements. Humans are now, and always have been, continuously exposed to ionizing radiation from natural background sources. Background sources include natural radiation and radioactivity, as well as radionuclides from human activities. These sources are discussed in the following section.

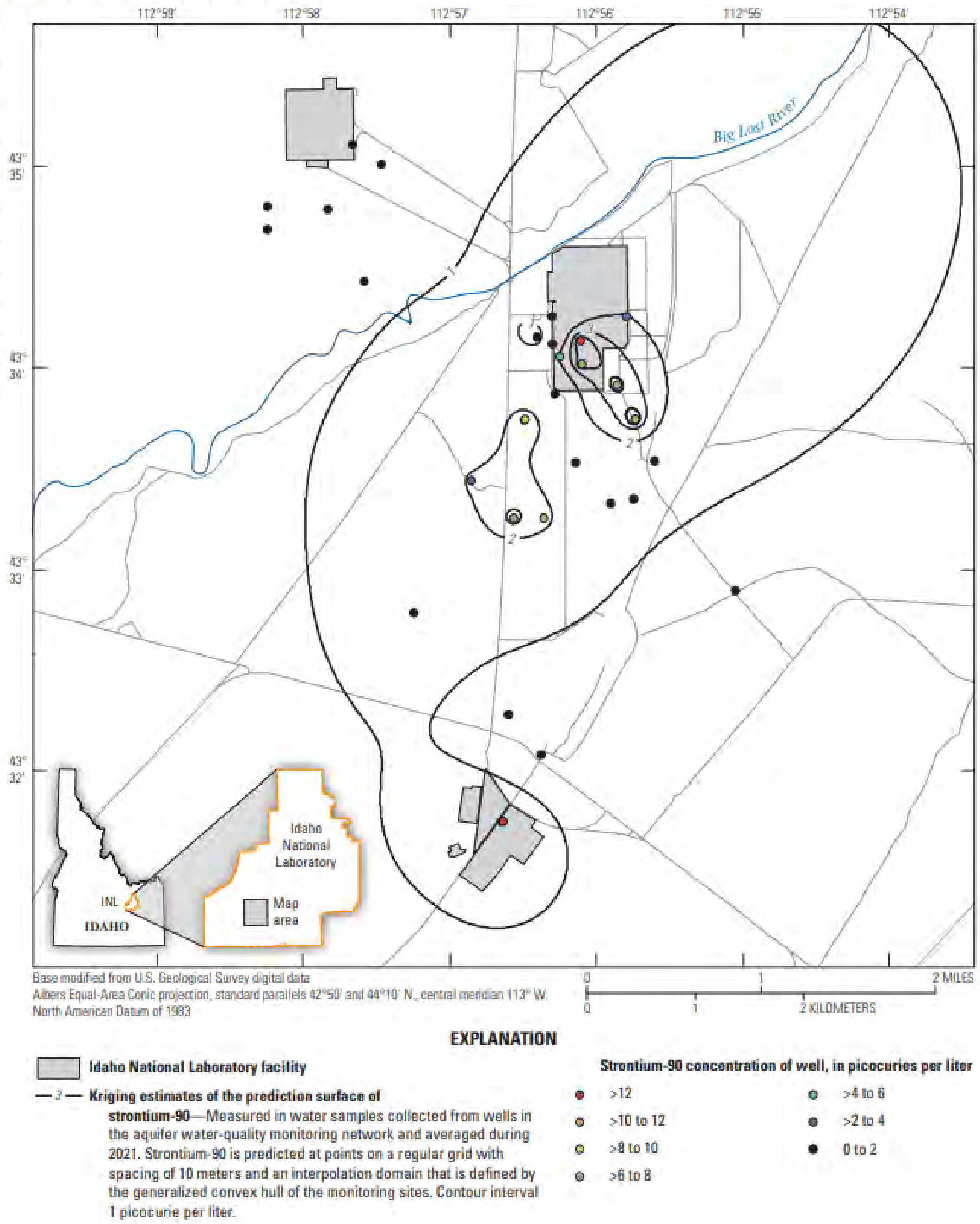

Figure HI-6. Data plotted using contour lines. *Each contour line drawn on this map connects points of equal ^{90}Sr concentration in water samples collected at the same depth from wells onsite.*

What Is Background Radiation?

Radioactivity from natural and fallout sources is detectable as background in all environmental media. Natural sources of radiation include: (1) radiation of extraterrestrial origin (called cosmic rays), (2) radionuclides produced in the atmosphere by cosmic ray interaction with matter (called cosmogenic radionuclides), and (3) radionuclides present at the time of the formation of the earth (called primordial radionuclides). Radiation that has resulted from the activities of modern man is primarily fallout from past atmospheric testing of nuclear weapons. One of the challenges to environmental monitoring on and around the INL Site is to distinguish between what may have been released from the INL Site and what is already present in background from natural and fallout sources. These sources are discussed in more detail below.

Natural radiation and radioactivity in the environment, which is natural background, represent a major source of human radiation exposure (NCRP 1987, 2009). For this reason, natural radiation frequently is used as a standard of comparison for exposure to various human-generated sources of ionizing radiation. An individual living in southeast Idaho was estimated, in 2023, to receive an average dose of about 376 mrem/yr (3.7 mSv/yr) from natural background sources of radiation on earth, as observed in Figure HI-7. These sources include cosmic radiation and naturally occurring radionuclides.

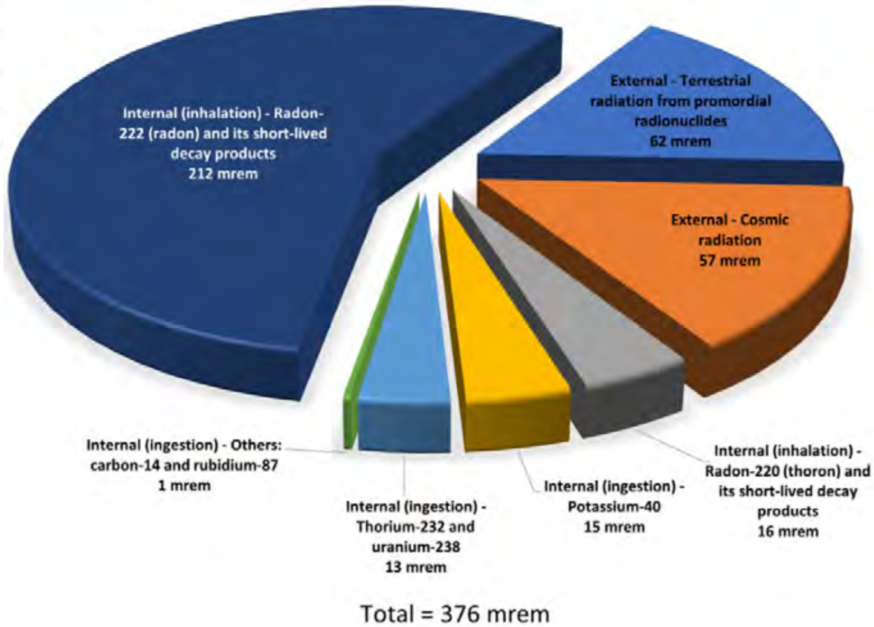

Figure HI-7. Calculated doses (mrem per year) from natural background sources for an average individual living in southeast Idaho (2023).

Cosmic radiation is radiation that constantly bathes the earth in extraterrestrial sources. The atmosphere around the earth absorbs some of the cosmic radiation, so doses are lowest at sea level and increase sharply with altitude. Cosmic radiation is estimated using data in NCRP (2009) to produce a dose of about 62 mrem/yr (0.62 mSv/yr) to a typical individual living in southeast Idaho (Figure HI-7). Cosmic radiation also produces cosmogenic radionuclides, which are found naturally in all environmental media and are discussed in more detail below.

Naturally occurring radionuclides are of two general kinds: cosmogenic and primordial. Cosmogenic radionuclides are produced by the interaction of cosmic radiation within the atmosphere or in the earth. Cosmic rays have high enough energies to blast apart atoms in the earth's atmosphere. The result is the continuous production of radionuclides, such as ^{3}H, beryllium-7 (^{7}Be), sodium-22 (^{22}Na), and ^{14}C. Cosmogenic radionuclides, particularly ^{3}H and ^{14}C, have been measured in humans, animals, plants, soil, polar ice, surface rocks, sediments, the ocean floor, and the atmosphere. Concentrations are generally higher at mid-latitudes than at low- or high-latitudes. Cosmogenic radionuclides contribute only about 1 mrem/yr to the total average dose, mostly from ^{14}C, that might be received by an adult living in the U.S. (NCRP 2009). Tritium and ^{7}Be are routinely detected in environmental samples collected by environmental monitoring programs on and around the INL Site, as observed in Figure HI-5, but these contribute little to the dose that might be received from natural background sources.

Primordial radionuclides are those that were present when the earth was formed. The primordial radionuclides detected today are billions of years old. The radiation dose to a person from primordial radionuclides comes from internally deposited radioactivity, inhaled radioactivity, and external radioactivity in soils and building materials. Three of the primordial radionuclides—potassium-40 (^{40}K), uranium-238 (^{238}U), and thorium-232 (^{232}Th)—are responsible for most of the dose received by people from natural background radioactivity. They have been detected in environmental samples collected on and around the INL Site (Table HI-5). The external dose to an adult living in southeast Idaho from terrestrial natural background radiation exposure (73 mrem/yr or 0.73 mSv/yr) has been estimated using concentrations of ^{40}K, ^{238}U, and ^{232}Th measured in soil samples collected from areas surrounding the INL Site from 1976 through 1993. This number varies slightly from year to year based on the amount of snow cover. Amounts of ^{238}U and ^{232}Th are also estimated to contribute 13 mrem/yr (0.13 mSv/yr) to an average adult through ingestion (NCRP 2009).

Table HI-5. Naturally occurring radionuclides that have been detected in environmental media collected on and around the INL Site.

RADIONUCLIDE	HALF-LIFE	HOW PRODUCED?	DETECTED OR MEASURED IN:
Beryllium-7 (^{7}Be)	53.22 days	Cosmic rays	Rain, air
Potassium-40 (^{40}K)	1.2516×10^{9} yr	Primordial	Water, air, soil, plants, animals
Radium-226 (^{226}Ra)	1,600 yr	^{238}U progeny	Water
Thorium-232 (^{232}Th)	1.405×10^{10} yr	Primordial	Soil
Tritium (^{3}H)	12.32 yr	Cosmic rays	Water, rain, air moisture
Uranium-234 (^{234}U)	2.455×10^{5} yr	^{238}U progeny	Water, air, soil
Uranium-238 (^{238}U)	4.468×10^{9} yr	Primordial	Water, air, soil

Potassium-40 is abundant and measured in living and nonliving matter. It is found in human tissue and is a significant source of internal dose to the human body (approximately 15 mrem/yr [0.15 mSv/yr] according to NCRP [2009]). Rubidium-87 (^{87}Rb), another primordial radionuclide, contributes a small amount (< 1 mrem/yr) to the internal dose received by people but is not typically measured in onsite samples.

Uranium-238 and ^{232}Th initiate a decay chain of radionuclides. A radioactive decay chain starts with one type of radioactive atom called the parent that decays and changes into another type of radioactive atom called a progeny radionuclide. This system repeats, involving several different radionuclides. The parent radionuclide of the uranium decay chain is ^{238}U. The most familiar element in the uranium series is radon, specifically radon-222 (^{222}Rn). This is a gas that can accumulate in buildings. Radon and its progeny are responsible for most of the inhalation dose (e.g., an average of 200 mrem/yr [2.0 mSv/yr] nationwide) produced by naturally occurring radionuclides, as shown in Figure HI-7.

The parent radionuclide of the thorium series is ^{232}Th. Another isotope of radon, called thoron, occurs in the thorium decay chain of radioactive atoms. Amounts of ^{238}U, ^{232}Th, and their progeny are often detected in environmental samples (Table HI-5).

Global Fallout. The U.S., the Union of Soviet Socialist Republics, and China tested nuclear weapons in the Earth's atmosphere in the 1950s and 1960s. This testing resulted in the release of radionuclides into the upper atmosphere, and such a release is referred to as fallout from weapons testing. Concerns over worldwide fallout rates eventually led to the Partial Test Ban Treaty in 1963, which limited signatories to underground testing. Not all countries stopped atmospheric testing with the treaty. France continued atmospheric testing until 1974, and China continued until 1980. Additional fallout, but to a substantially smaller extent, was produced by the Chernobyl and Fukushima nuclear accidents in 1986 and 2011, respectively.

Most of the radionuclides associated with nuclear weapons testing and the Chernobyl and Fukushima accidents have decayed and are no longer detected in environmental samples. Radionuclides that are currently detected in the environment and typically associated with global fallout include ^{90}Sr and ^{137}Cs. Strontium-90, a beta-emitter with a 29-year half-life, is important because it is chemically similar to calcium and tends to accumulate in bone tissues. Cesium-137, which has a 30-year half-life, is chemically similar to potassium and accumulates rather uniformly in muscle tissue throughout the body.

The deposition of these radionuclides on the earth's surface varies by latitude, with most occurring in the northern hemisphere at approximately 40 degrees. Variation within latitudinal belts is a function primarily of precipitation, topography, and wind patterns. The dose produced by global fallout from nuclear weapons testing has decreased steadily since 1970. The annual dose rate from fallout was estimated in 1987 to be less than 1 mrem (0.01 mSv) (NCRP 1987). It has been nearly 34 years since that estimate, so the current dose is assumed to be even lower.

What are the Risks of Exposure to Low Levels of Radiation?

Radiation protection standards for the public have been established by state and federal agencies based mainly on recommendations of the International Commission on Radiological Protection and the National Council on Radiation Protection and Measurements. The International Commission on Radiological Protection is an association of scientists from many countries, including the U.S. The National Council on Radiation Protection and Measurements is a nonprofit corporation chartered by Congress. Through radiation protection standards, exposure of members of the general public to radiation is controlled so that risks are small enough to be considered insignificant compared to the risks undertaken during other activities deemed normal and acceptable in modern life.

A large amount of data exists concerning the effects of acute delivery (all at once) of high doses of radiation, especially in the range of 50–400 rem (0.5 to 4.0 Sv). Most of this information was gathered from the Japanese atomic bombing survivors and patients who were treated with substantial doses of X-rays. Conversely, information is limited, and therefore, it is difficult to estimate risks associated with low-level exposure. Risk can be defined in general as the probability (chance) of injury, illness, or death resulting from some activity. Low-dose effects are those that might be caused by doses of less than 20 rem (0.2 Sv), whether delivered acutely or spread out over a period as long as a year (Taylor 1996). Most of the radiation exposures that humans receive are very close to background levels. Moreover, many sources emit radiation that is well below natural background levels. This makes it extremely difficult to isolate its effects. For this reason, government agencies make the conservative (cautious) assumption that any increase in radiation exposure is accompanied by an increased risk of health effects. Cancer is considered by most scientists to be the primary health effect from long-term exposure to low levels of radiation while each radionuclide represents a somewhat different health risk. A 2011 report by the EPA estimated a 5.8×10^{-2} Gy^{-1} cancer mortality risk coefficient for uniform whole-body exposure throughout life at a constant dose rate. Given a 1 gray (100 rad) ionizing radiation lifetime exposure, this corresponds to 580 deaths, above normal cancer mortality rates, within an exposure group of 10,000 people. For low-linear energy transfer radiation (i.e., beta and gamma radiation) the dose equivalent in Sv (100 rem) is numerically equal to the absorbed dose in Gy (100 rad). Therefore, if each person in a group of 10,000 people is exposed to 1 rem (0.01 Sv) of ionizing radiation in small doses over a lifetime, we would expect around six people to die of cancer than would otherwise. For perspective, most people living on the eastern Snake River Plain receive approximately 376 mrem (3.8 mSv) every year from natural background sources of radiation.

DOE limits the dose to a member of the public from all sources and pathways to 100 mrem (1 mSv) and the dose from the air pathway to 10 mrem (0.1 mSv) (DOE O 458.1). The doses estimated to maximally exposed individuals from INL Site releases are typically well below 1 mrem per year.

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Acronyms:

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AIP	Agreement-in-Principle
ALLWDF	active low-level waste disposal facility
ARIR	Administrative Record Information Repository
ARP	Accelerated Retrieval Project
ATR	Advanced Test Reactor
BBS	breeding bird survey
BCG	Biota Concentration Guide
BEA	Battelle Energy Alliance, LLC
BIL	Bipartisan Infrastructure Law
BLM	Bureau of Land Management
BMP	best management practices
BORAX	Boiling Water Reactor Experiment
BRR	Biological Resource Review
C&D	construction and demolition
CAA	Clean Air Act
CAP	criteria air pollutant
CAP88-PC	Clean Air Act Assessment Package-1988 computer model, PC
CARP	Climate Adaptation and Resilience Plan
CCA	Candidate Conservation Agreement
CEJST	Climate and Economic Justice Screening Tool
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CITRC	Critical Infrastructure Test Range Complex
CRAC	computer room air conditioning
CRDB	Cultural Resources Database
CRMO	Cultural Resource Management Office
CRR	Cultural Resource Review
CTF	Contained Test Facility
CWA	Clean Water Act
CWP	Cold Waste Pond
D&D	decontamination and decommissioning
DCS	Derived Concentration Standard
DEQ	Department of Environmental Quality (state of Idaho)
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOECAP	U.S. Department of Energy Consolidated Audit Program
DOECAP-AP	U.S. Department of Energy Consolidated Audit Program-Accreditation Program
DOE-ID	U.S. Department of Energy, Idaho Operations Office
DOME	Demonstration of Microreactor Experiments
DOSEMM	dose multi-media
DQO	data quality objective
EA	Environmental Assessment
EAD	Environmental Assessment Determination
EBR-I	Experimental Breeder Reactor No. 1
EBR-II	Experimental Breeder Reactor No. 2
EC	Environmental Checklist
ECP	Environmental Compliance Permit
EFS	Experimental Field Station
EIS	Environmental Impact Statement
EJ	environmental justice
EJP	Environmental Justice Program
EMS	Environmental Management System
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EPEAT	Electronic Product Environmental Assessment Tool
ERP	Environmental Review Process
ESA	Endangered Species Act
EV	electric vehicle
FEC	facility emission cap
FFA/CO	Federal Facility Agreement and Consent Order
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FRM	form
FSV	Fort St. Vrain

FY	fiscal year
GHG	greenhouse gas
GIS	geographic information system
GPRS	Global Positioning Radiometric Scanner
HALEU	high-assay low-enriched uranium
HeTO	Heritage Tribal Office
HFC	hydrofluorocarbons
HFEF	Hot Fuel Examination Facility
HLW	high-level waste
HVAC	heating, ventilation, and air conditioning
HYSPLIT	Hybrid Single-particle Lagrangian Integrated Trajectory
ICDF	Idaho CERCLA Disposal Facility
ICP	Idaho Cleanup Project
ICPP	Idaho Chemical Processing Plant
IDAPA	Idaho Administrative Procedures Act
IDFG	Idaho Department of Fish and Game
IEC	Idaho Environmental Coalition, LLC
INEEL	Idaho National Engineering and Environmental Laboratory
INL	Idaho National Laboratory
INL Site Contractors	INL contractor and ICP contractor
INTEC	Idaho Nuclear Technology and Engineering Center (formerly Idaho Chemical Processing Plant)
IPDES	Idaho Pollutant Discharge Elimination System
IRC	INL Research Center
ISA	Idaho Settlement Agreement
ISB	in-situ bioremediation
ISU-EAL	Idaho State University-Environmental Assessment Laboratory
IWCS	Industrial Wastewater Collection System
IWP	Industrial Waste Pond
IWTU	Integrated Waste Treatment Unit
LAN	local area network
LED	light-emitting diode
LLW	low-level waste
LOFT	Loss-of-Fluid Test
LTS	Long-Term Stewardship
LTV	long-term vegetation
MAPEP	Mixed Analyte Performance Evaluation Program
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
MCLG	maximum contaminant level goals
MCP	management control procedure
MCRE	Molten Chloride Reactor Experiment
MEI	maximally exposed individual
MFC	Materials and Fuels Complex
MOU	memorandum of understanding
NA	not applicable
NAIP	National Agricultural Imagery Program
NAREL	National Analytical Radiation Environmental Laboratory
NASA	National Aeronautics and Space Administration
NCRP	National Council on Radiation Protection and Measurements
ND	not detected
NEPA	National Environmental Policy Act
NERP	National Environmental Research Park
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NHS	National and Homeland Security
NM	not measured
NOAA	National Oceanic and Atmospheric Administration
NON/CO	Notice of Noncompliance/Consent Order
NQA	Nuclear Quality Assurance
NRC	Nuclear Regulatory Commission
NRF	Naval Reactors Facility
NRG	Natural Resources Group
NRHP	National Register of Historic Places
NRIC	National Reactor Innovation Center
NRTS	National Reactor Testing Station
NS	no sample
NSUF	National Scientific User Facility
O&M	Operations and Maintenance
OSLD	optically stimulated luminescence dosimeter
OU	Operable Unit
PA	Programmatic Agreement
PCB	polychlorinated biphenyls
PCC	Precontact Context
PCS	primary constituent standard
PE	performance evaluation
PFAS	perfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFHxS	perfluorohexanesulfonic acid
PFOA	perfluorooctanoic acid

PFOS	perfluorooctanesulfonic acid
PL	primary line
PT	performance testing
PTC	permit to construct
PWS	public water system
QA	quality assurance
QC	quality control
RBDA	risk-based disposal approval
RCL	Radioanalytical Chemistry Laboratory
RCRA	Resource Conservation and Recovery Act
REC	Research and Education Campus
RESL	Radiological and Environmental Sciences Laboratory
RHLLW	Remote-Handled Low-level Waste Disposal Facility
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RWMC	Radioactive Waste Management Complex
SARA	Superfund Amendments and Reauthorization Act
SBL	Southwestern Branch Line
SCS	Secondary Constituent Standard
SDA	Subsurface Disposal Area
SDWA	Safe Drinking Water Act
SGCA	Sage-grouse Conservation Area
SGCN	Species of Greatest Conservation Need
SGIN	Species of Greatest Information Need
SHPO	State Historic Preservation Office
SMC	Specific Manufacturing Capability
SMCL	secondary maximum contaminant level
SME	subject matter expert
SNF	spent nuclear fuel
SSER	Sagebrush Steppe Ecosystem Reserve
STEAM	science, technology, engineering, arts, and mathematics
STEM	science, technology, engineering, and mathematics
STP	Sewage Treatment Plant
TAN	Test Area North
TCE	trichloroethylene
TFF	Tank Farm Facility
TMI	Three Mile Island
TRA	Test Reactor Area
TREAT	Transient Reactor Experiment and Test Facility
TRISO	tri-isotropic
TRU	transuranic
TSCA	Toxic Substances Control Act
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTL	upper tolerance limit
VOC	volatile organic compound
WAG	waste area group
WFMC	Wildland Fire Management Committee
WIPP	Waste Isolation Pilot Plan
XRF	x-ray fluorescence spectroscopy
YOY	year-over-year
ZEV	zero-emission vehicle

Sagebrush Rockcress

Units:

Bq	becquerel
C	Celsius
cfm	cubic feet per minute
CFU	colony forming unit
Ci	curie
cm	centimeter
cps	counts per second
d	day
F	Fahrenheit
ft	feet
g	gram
gal	gallon
Gy	gray
ha	hectare
keV	kilo-electron-volts
kg	kilograms (10^{3}) gram
km	kilometer (10^{3}) meter
L	liter
lb	pound
m	meter
µCi	microcurie (10^{-6}) curies
µg	microgram (10^{-6}) grams
µR	microroentgen (10^{-6}) roentgen
µS	microsiemen (10^{-6}) siemen
µSv	microsievert (10^{-6}) sievert
Ma	million years
mCi	millicurie (10^{-3}) curies
MeV	mega electron volt
mg	milligram (10^{-3}) grams
MG	million gallons
mGy	milligray (10^{-3}) gray
Ml	million liters
mi	mile
min	minute
mL	milliliter (10^{-3}) liter
mR	milliroentgen (10^{-3}) roentgen
mrad	milliard (10^{-3}) rad
mSv	millisievert (10^{-3}) sievert
oz	ounce
pCi	picocurie (10^{-12} curies)
R	roentgen
rad	radiation absorbed dose
rem	roentgen equivalent man
Sv	sievert
yd	yard
yr	year

Stacked rock feature found on the INL Site.

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Chapter 1: Introduction

1. INTRODUCTION

This annual report is prepared in compliance with the following United States (U.S.) Department of Energy (DOE) orders:

- DOE O 231.1B, “Environment, Safety, and Health Reporting”
- DOE O 436.1, “Departmental Sustainability”
- DOE O 458.1, “Radiation Protection of the Public and the Environment.”

The purpose of the report, as outlined in DOE O 231.1B, is to present summary environmental data to accomplish the following:

- Characterize site environmental performance
- Summarize environmental occurrences and responses during the calendar year
- Confirm compliance with environmental standards and requirements
- Highlight significant facility programs and efforts
- Property clearance activities.

This report is the principal document that demonstrates compliance with DOE O 458.1 requirements, and therefore, describes the DOE Idaho National Laboratory (INL) Site impact on the public and the environment with an emphasis on radioactive contaminants.

1.1 Site Location

The INL Site encompasses about 2,305 square kilometers (km^2) (890 square miles [mi^2]) of the upper Snake River Plain in southeastern Idaho (Figure 1-1). Over 50% of the INL Site is located in Butte County, and the rest is distributed across Bingham, Bonneville, Clark, and Jefferson counties. The INL Site extends 63 km (39 mi) from north to south and is approximately 61 km (38 mi) at its broadest east-west portion. By highway, the southeast entrance is approximately 40 km (25 mi) west of Idaho Falls. Other towns surrounding the INL Site include Arco, Atomic City, Blackfoot, Rigby, Rexburg, Terreton, and Howe. Pocatello is 85 km (53 mi) to the southeast.

Federal lands surround much of the INL Site, including U.S. Bureau of Land Management lands and Craters of the Moon National Monument and Preserve to the southwest, Salmon-Challis National Forest to the west, and Targhee National Forest to the north. Mud Lake Wildlife Management Area, Camas National Wildlife Refuge, and Market Lake Wildlife Management Area are within 80 km (50 mi) of the INL Site. The Fort Hall Reservation is located approximately 60 km (37 mi) to the southeast.

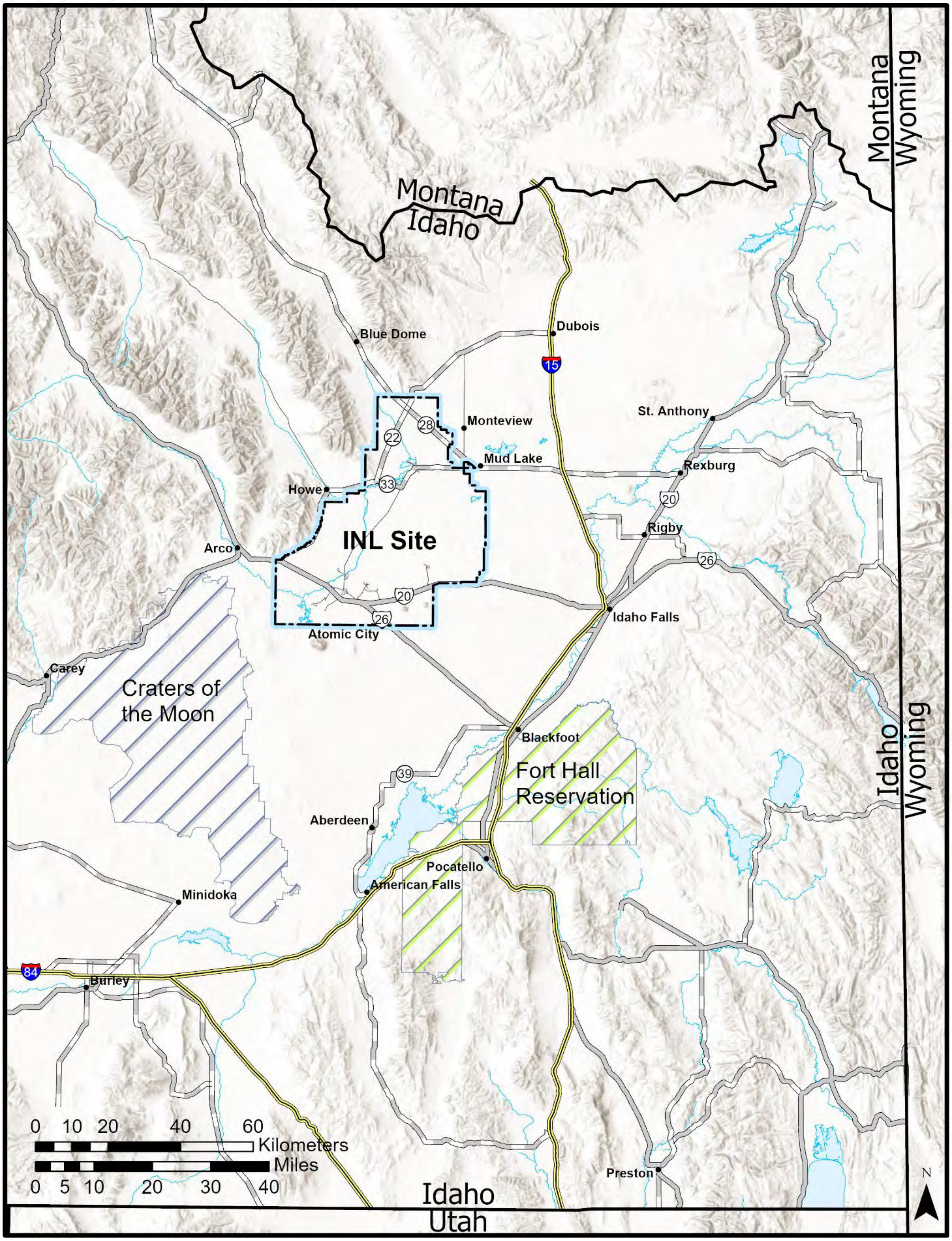

Figure 1-1. Location of the INL Site.

1.2 Environmental Setting

The INL Site is located in a large, relatively undisturbed expanse of sagebrush steppe. Approximately 94% of the land on the INL Site is open and undeveloped. The INL Site has an average elevation of 1,500 m (4,900 ft) above sea level and is bordered on the north and west by mountain ranges and on the south by volcanic buttes and open plain. Lands immediately adjacent to the INL Site are open sagebrush steppe, foothills, or agricultural fields. Agriculture is concentrated in areas northeast of the INL Site.

About 60% of the INL Site is open to livestock grazing. Controlled hunting is permitted but is restricted to a very small portion of the northern half of the INL Site (see Figure 1-2).

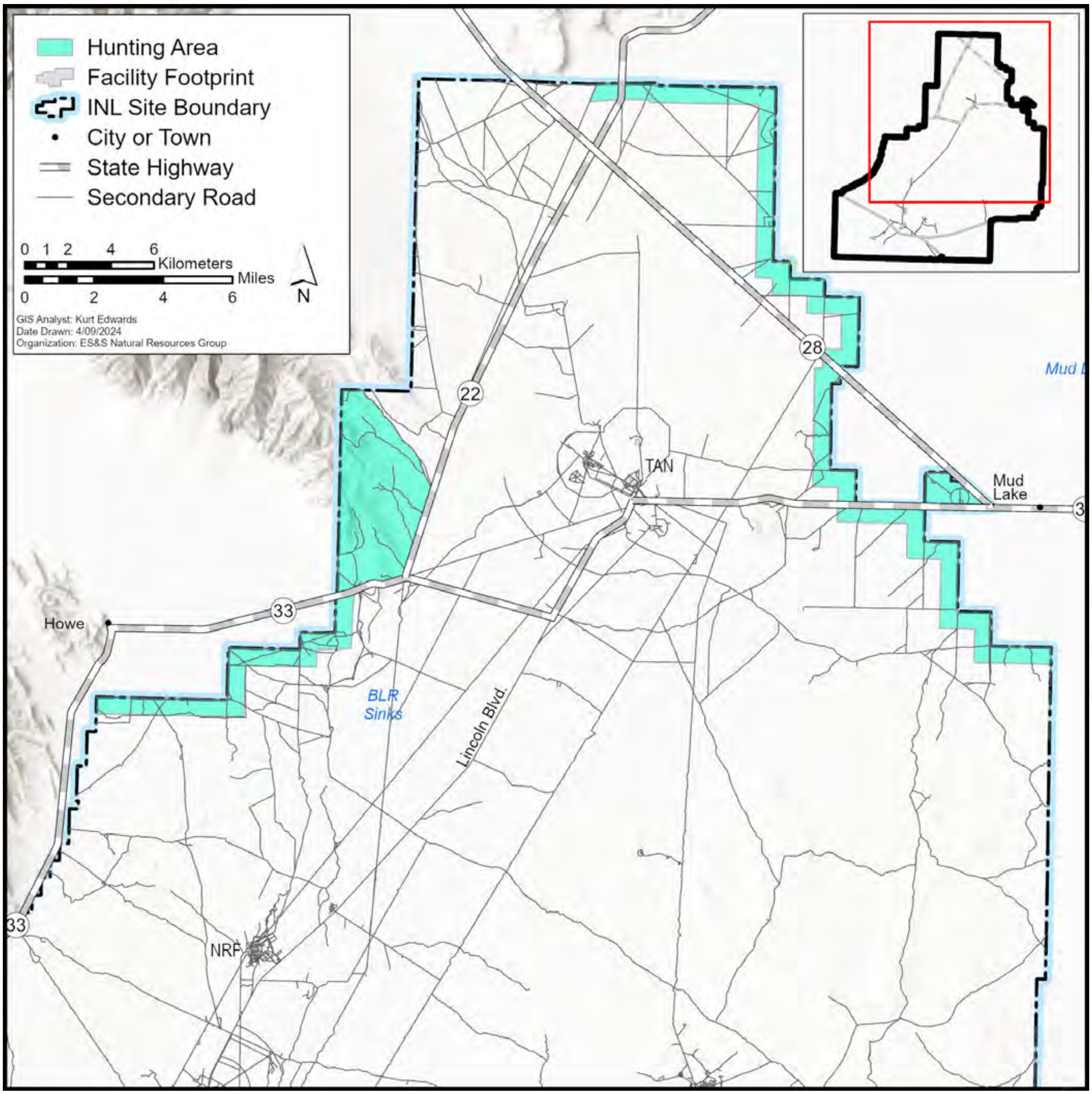

Figure 1-2. Designated elk and pronghorn hunting boundary on the INL Site.

The climate of the high desert environment of the INL Site is characterized by sparse precipitation (about 21.4 cm/yr [8.43 in./yr]), warm summers (with a normal daily temperature of 18.8°C [65.8°F]), and cold winters (with a normal daily temperature of -7.3°C [18.9°F]), based on observations at Central Facilities Area (CFA) from 1991 through 2020 (NOAA 2024). The altitude, intermountain setting, and latitude of the INL Site combine to produce a semi-arid climate. Prevailing weather patterns are from the southwest, moving up the Snake River Plain. Air masses, which gather moisture over the Pacific Ocean, traverse several hundred miles of mountainous terrain before reaching southeastern Idaho. Frequently, the result is dry air and little cloud-cover. Solar heating can be intense, with extreme day-to-night temperature fluctuations.

Basalt flows cover most of the Snake River Plain, producing rolling topography. Over 400 different kinds (taxa) of plants have been recorded on the INL Site (Anderson et al. 1996). Vegetation is dominated by big sagebrush (*Artemisia tridentata*) with grasses and wildflowers beneath that have adapted to the harsh climate.

The INL Site is also home to many kinds of animals. Vertebrate animals found on the INL Site include small burrowing mammals, snakes, birds, and several large mammals. Published species records include six types of fish, one amphibian, nine reptiles, 164 birds, and 39 mammals (Reynolds et al. 1986).

The Big Lost River on the INL Site is diverted, flowing northeast, ending in a playa area on the northwestern portion of the INL Site called the Big Lost River Sinks. Here, the river evaporates or infiltrates to the subsurface, with no surface water moving off the INL Site. The Big Lost River is diverted at the INL Diversion to avoid the potential for flooding on the INL Site. Normally, the riverbed is dry because of upstream irrigation and rapid infiltration into desert soil and underlying basalt (Figure 1-3). The Big Lost River rarely flows onto the INL Site due in part to upstream water demands. However, temporary construction at Mackay Dam resulted in increased surface water outflow from the reservoir system during 2023. Big Lost River flow was recorded from May to July 2023 at three U.S. Geological Survey surface water sites, reaching the northern gage near the Big Lost River Sinks. Additionally, surface water was recorded from October to December 2023 at the southern gage, located just below the INL Diversion.

Fractured volcanic rocks under the INL Site form a portion of the eastern Snake River Plain Aquifer (Figure 1-4), which stretches 320 km (199 mi) from Island Park to King Hill, which is 9.7 km (6 mi) northeast of Glenns Ferry, and stores one of the most bountiful supplies of groundwater in the nation. An estimated 247–370 billion m^3 (200–300 million acre-ft) of water is stored in the aquifer's upper portions. The aquifer is primarily recharged from Henry's Fork and the south fork of the Snake River, and to a lesser extent, the aquifer is recharged from the Big Lost River, Little Lost River, Birch Creek, and irrigation. Beneath the INL Site, the aquifer moves laterally southwest at a rate of 1.5–6 m/day (5–20 ft/day) (Lindholm 1996). The eastern Snake River Plain Aquifer emerges in springs along the Snake River between Milner and Bliss, Idaho. Crop irrigation is the primary use of both surface water and groundwater on the Snake River Plain.

1.3 History of the INL Site

The geologic events that have shaped the modern Snake River Plain took place during the last two million years (Lindholm 1996; ESRF 1996). This plain, which arcs across southern Idaho to Yellowstone National Park, marks the passage of the earth's crust over a plume of melted mantle material.

The volcanic history of the Yellowstone-Snake River Plain volcanic field is based on the time-progressive volcanic origin of the region, characterized by several large calderas in the eastern Snake River Plain, with dimensions similar to those of Yellowstone's three giant Pleistocene calderas. These volcanic centers are located within the topographic depression that encompasses the Snake River drainage. Over the last 16 million years, a series of giant, caldera-forming eruptions occurred, with the most recent occurrence at Yellowstone National Park 630,000 years ago. The youngest silicic volcanic centers correspond to the Yellowstone volcanic field that are less than 2 million years old and are followed by a sequence of silicic centers that occurred about 6 million years ago southwest of Yellowstone. A third group of centers, which occurred approximately 10 million years old, is centered near Pocatello, Idaho. The oldest mapped silicic rocks of the Snake River Plain are approximately 16 million years old and are distributed across a 150-km-wide (93-mi-wide) zone from southwestern Idaho to northern Nevada; they are the suspected origin of the Yellowstone-Snake River Plain (Smith and Siegel 2000).

Figure 1-3. Big Lost River. *Dry riverbed in 2016 (upper). Flowing river in May 2023 (lower).*

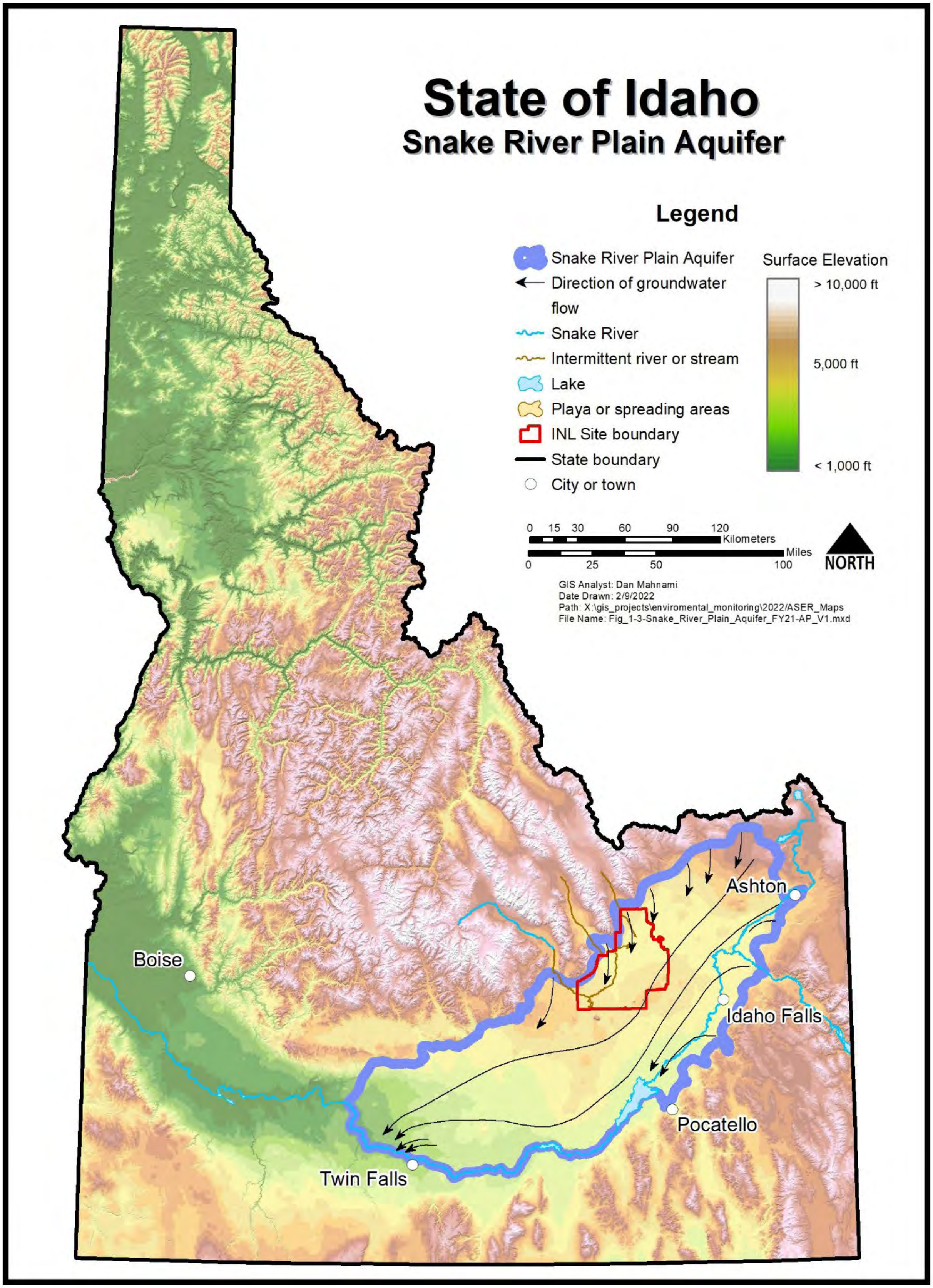

Figure 1-4. INL Site relation to the eastern Snake River Plain Aquifer.

The earliest human occupants of the eastern Snake River Plain were the Shoshone and Bannock people, the ancestors of the present-day Shoshone-Bannock Tribes. Their presence dates back 13,000 years. Tools recovered from this period indicate these occupants were hunters of large game. Plants, animals, geological features, water, and other resources on the INL Site were important to the Shoshone and Bannock people and continue to hold significance to the present-day Shoshone-Bannock Tribes.

People of European descent began exploring the Snake River Plain between 1810 and 1840; these explorers were trappers and fur traders seeking new supplies of beaver pelts.

Between 1840 and 1857, an estimated 240,000 immigrants passed through southern Idaho on the Oregon Trail. The Shoshone and Bannock people entered into peace treaties in 1863 and 1868, known today as the Fort Bridger Treaty. The Fort Hall Reservation was reserved for the various tribes under the treaty agreement. During the 1870s, miners entered the surrounding mountain ranges, followed by ranchers grazing cattle and sheep in the valleys.

In 1901, a railroad was opened between Blackfoot and Arco, Idaho. By this time, a series of acts (e.g., the Homestead Act of 1862, the Desert Claim Act of 1877, the Carey Act of 1894, the Reclamation Act of 1902) provided sufficient incentive for homesteaders to build diversionary canals to claim the desert. Most of these efforts failed because of the extreme porosity of the gravelly soils and underlying basalts.

During World War II, large guns from U.S. Navy warships were retooled at the U.S. Naval Ordnance Plant in Pocatello, Idaho. These guns needed to be tested, and the nearby uninhabited plain was used as a gunnery range, known then as the Arco Naval Proving Ground.

The U.S. Army Air Corps also trained bomber crews out of the Pocatello Airbase and used the area as a bombing range.

After the war ended, the nation turned to peaceful uses of atomic power. DOE’s predecessor, the U.S. Atomic Energy Commission (AEC), needed an isolated location with an ample groundwater supply on which to build and test nuclear power reactors. In 1949, the Arco Naval Proving Ground became the National Reactor Testing Station. To learn more about the history of the INL Site, visit https://inl.gov/history/.

In 1951, the Experimental Breeder Reactor-I (EBR-I) became the first reactor to produce useful electricity. In 1955, the Boiling-Water Reactor Experiments-III reactor provided electricity to Arco, Idaho, which was the first time a nuclear reactor powered an entire community in the U.S. The laboratory also developed prototype nuclear propulsion plants for Navy submarines and aircraft carriers. Over time, the Site evolved into an assembly of 52 reactors, associated research centers, and waste handling areas as shown in Figure 1-5.

The National Reactor Testing Station was renamed the Idaho National Engineering Laboratory in 1974 and was changed to Idaho National Engineering and Environmental Laboratory (INEEL) in 1997 to reflect the Site’s leadership role in environmental management. The AEC was renamed the U.S. Energy Research and Development Administration in 1975 and reorganized to the present-day DOE in 1977.

With renewed interest in nuclear power, DOE announced in 2003 that Argonne National Laboratory-West (ANL-W) and INEEL would be the lead laboratories in developing the next generation of power reactors. On February 1, 2005, Battelle Energy Alliance, LLC (BEA), took over operation of the laboratory and merged with ANL-W. The facility name was changed to Idaho National Laboratory (INL). At this time, the INL Site’s cleanup activities were moved to a separate contract, the Idaho Cleanup Project (ICP), which is currently managed by the Idaho Environmental Coalition, LLC (IEC). Research activities, which include projects other than nuclear research such as National and Homeland Security (NHS) projects, were consolidated in the newly named INL.

1.4 Human Populations Near the INL Site

The population of the region within 80 km (50 mi) of the INL Site is estimated to be 353,789, based on the 2020 census and projected growth. Over half of this estimated population (196,421) resides in the census divisions of Idaho Falls (119,605) and northern Pocatello (76,815). Another 40,064 are projected to live in the Rexburg census division. Approximately 22,070 are estimated to reside in the Rigby census division and 15,408 in the Blackfoot census division. The remaining population resides in small towns and rural communities throughout southeastern Idaho.

Figure 1-5. INL timeline.

1.5 INL Site Primary Program Missions and Facilities

The INL Site mission is to operate a multi-program national research and development laboratory and to complete environmental cleanup activities stemming from past operations. The U.S. Department of Energy, Idaho Operations Office (DOE-ID) receives implementing direction and guidance primarily from two DOE Headquarters offices—the Office of Nuclear Energy (DOE-NE) and the Office of Environmental Management (DOE-EM). DOE-NE is the Lead Program Secretarial Office for all DOE-ID-managed operations on the INL Site.

DOE-EM provides direction and guidance to DOE-ID for environmental cleanup on the INL Site and functions in the capacity of Cognizant Secretarial Office. Naval Reactors operations on the INL Site report to the Pittsburgh Naval Reactors Office. These operations fall outside the purview of DOE-ID and therefore are not included in this report.

1.5.1 Idaho National Laboratory

The INL mission is to discover, demonstrate, and secure innovative nuclear energy solutions, other clean energy options, and critical infrastructure. Its vision is to change the world's energy future and secure our nation's critical infrastructure. To fulfill its assigned duties during the next decade, INL will work to transform itself into a laboratory leader in nuclear energy and homeland security research, development, and demonstration. This transformation will develop nuclear energy and NHS leadership highlighted by achievements such as the demonstration of Generation IV reactor technologies; the creation of national user facilities, including the Advanced Test Reactor (ATR) National Scientific User Facility, Wireless National User Facility, and Biomass Feedstock National User Facility; the Critical Infrastructure Test Range Complex (CITRC); piloting advanced fuel cycle technology; the rise to prominence of the Center for Advanced Energy Studies; and recognition as a regional clean energy resource and world leader in safe operations.

On February 22, 2021, an addendum to the 2019 memorandum of understanding between DOE and the U.S. Nuclear Regulatory Commission (NRC) formalized the coordination between these two federal agencies in regard to National Reactor Innovation Center (NRIC) projects. This addendum specifically focuses on research, development, and demonstration projects, and it solidifies a partnership to deliver successful nuclear reactor demonstrations. The NRIC is a national DOE program led by INL allowing collaborators to harness the world-class capabilities of the U.S. National Laboratory System. The center is charged with and committed to demonstrating advanced reactors by the end of 2025.

BEA is responsible for the management and operation of INL.

1.5.2 Idaho Cleanup Project

The ICP involves the safe environmental cleanup of the INL Site, which was contaminated with waste generated during World War II-era conventional weapons testing, government-owned research and defense reactor operations, laboratory research, fuel reprocessing, and defense missions at other DOE sites. The project focuses on meeting the Idaho Settlement Agreement (DOE 1995) and environmental cleanup milestones while reducing risks to workers. Protection of the Snake River Plain Aquifer, the sole drinking water source for more than 350,000 residents of eastern Idaho, was the principal concern addressed in the Settlement Agreement. IEC is responsible for the ICP.

Most of the cleanup work under the contract is driven by regulatory compliance agreements. The two foundational agreements are (1) the 1991 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-based Federal Facility Agreement and Consent Order (DOE 1991), which governs the cleanup of contaminant releases to the environment, and (2) the 1995 Idaho Settlement Agreement (DOE 1995), which governs the removal of transuranic waste, spent nuclear fuel (SNF), and high-level radioactive waste from the state of Idaho. Other regulatory drivers include the Federal Facility Compliance Act-Based Site Treatment Plan (treatment of hazardous wastes) and other environmental permits, closure plans, federal and state regulations, Records of Decision, and other implementing documents.

The ICP involves treating nearly one million gallons of sodium-bearing liquid waste; removing targeted transuranic waste from the Subsurface Disposal Area (SDA); placing SNF in dry storage; treating high-level waste calcine; treating both remote- and contact-handled transuranic waste for disposal at the Waste Isolation Pilot Plant (WIPP) in New Mexico; and demolishing and disposing of more than 200 contaminated structures, including reactors, SNF storage basins, and laboratories used for radioactive experiments.

1.5.3 Primary INL Site Facilities

Most INL Site buildings and structures are located within developed areas that are typically less than a few square miles in size and are separated from each other by miles of undeveloped land. DOE controls all the land within the INL Site boundary (Figure 1-6). In addition to the INL Site, DOE owns or leases laboratories and administrative offices in Idaho Falls, about 40 km (25 mi) east of the INL Site.

Advanced Test Reactor (ATR) Complex – The ATR Complex was established in the early 1950s and has been the primary operations site for three major test reactors: (1) the Materials Test Reactor (1952–1970), (2) the Engineering Test Reactor (1957–1982), and (3) the ATR (1967–present). The current primary mission at the ATR Complex is the operation of the ATR, the world's premier test reactor used to study the effects of radiation on materials. This reactor also produces rare and valuable medical and industrial isotopes. The ATR is a Nuclear Scientific User Facility. The ATR Complex also features the ATR Critical Facility, the Test Train Assembly Facility, the Radiation Measurements Laboratory, the Radiochemistry Laboratory, and the Safety and Tritium Applied Research Facility, which is a National Scientific User Facility. The ATR Complex is operated by the INL contractor.

Central Facilities Area (CFA) – CFA is the main service and support center for the INL Site's desert facilities. Activities at CFA support transportation, maintenance, medical, construction, radiological monitoring, security, fire protection, warehouses, and instrument calibration activities. It is operated by the INL contractor.

Critical Infrastructure Test Range Complex (CITRC) – CITRC encompasses a collection of specialized test beds and training complexes that create a centralized location where government agencies, utility companies, and military customers can work together to find solutions for many of the nation's most pressing security issues. CITRC provides open landscape, technical employees, and specialized facilities for performing work in three main areas: (1) physical security, (2) contraband detection, and (3) infrastructure testing. It is operated by the INL contractor.

Idaho Nuclear Technology and Engineering Center (INTEC) – The Idaho Chemical Processing Plant was established in the 1950s to recover usable uranium from SNF used in DOE and U.S. Department of Defense (DOD) reactors. Over the years, the facility recovered more than $1 billion worth of highly enriched uranium that was returned to the government fuel cycle. In addition, an innovative high-level liquid waste treatment process, known as calcining, was developed at the plant. Calcining reduced the volume of liquid radioactive waste generated during reprocessing and placed it in a more stable granular solid form. In the 1980s, the facility underwent a modernization, and safer, cleaner, and more efficient structures replaced most major facilities. SNF reprocessing was discontinued in 1992. In 1998, the plant was renamed INTEC. Current operations include the startup and operation of the Integrated Waste Treatment Unit, designed to treat approximately 3,406,871 L (900,000 gal) of sodium-bearing liquid waste; and the closure of the remaining liquid waste storage tanks, SNF storage, environmental remediation, and disposal of excess facilities; and the management of the Idaho CERCLA Disposal Facility. The Idaho CERCLA Disposal Facility is the consolidation point for CERCLA-generated wastes within the INL Site boundaries. INTEC is operated by IEC, the ICP contractor.

Materials and Fuels Complex (MFC) – MFC is the foundation for nuclear research, development, and demonstration testing of advanced reactors. This complex is the nexus of research and development for new reactor fuels and related materials. As such, it will contribute to increasingly efficient reactor fuels and the important work of nonproliferation—harnessing more energy with less risk. Certain facilities at MFC also support the manufacturing and assembling of components for use in space applications. It is operated by the INL contractor.

Transient Reactor Test Facility (TREAT), a Nuclear Scientific User Facility, provides transient testing of nuclear fuels. It is an air-cooled, thermal spectrum test facility specifically designed to evaluate the response of reactor fuels and structural materials to accident conditions ranging from mild upsets to severe accidents. TREAT is used to study fuel melting behavior, interactions between fuel and coolant, and the potential for propagation of failure to adjacent fuel pins. TREAT has an open core design that allows for ease of experiment instrumentation and real-time imaging of fuel motion during irradiation, which also makes TREAT an ideal platform for understanding the irradiation response of materials and fuels on a fundamental level.

Naval Reactors Facility (NRF) – NRF is operated by Fluor Marine Propulsion, LLC. As established in Executive Order 12344 (1982), the Naval Nuclear Propulsion Program is exempt from the requirements of DOE O 436.1, DOE O 458.1,

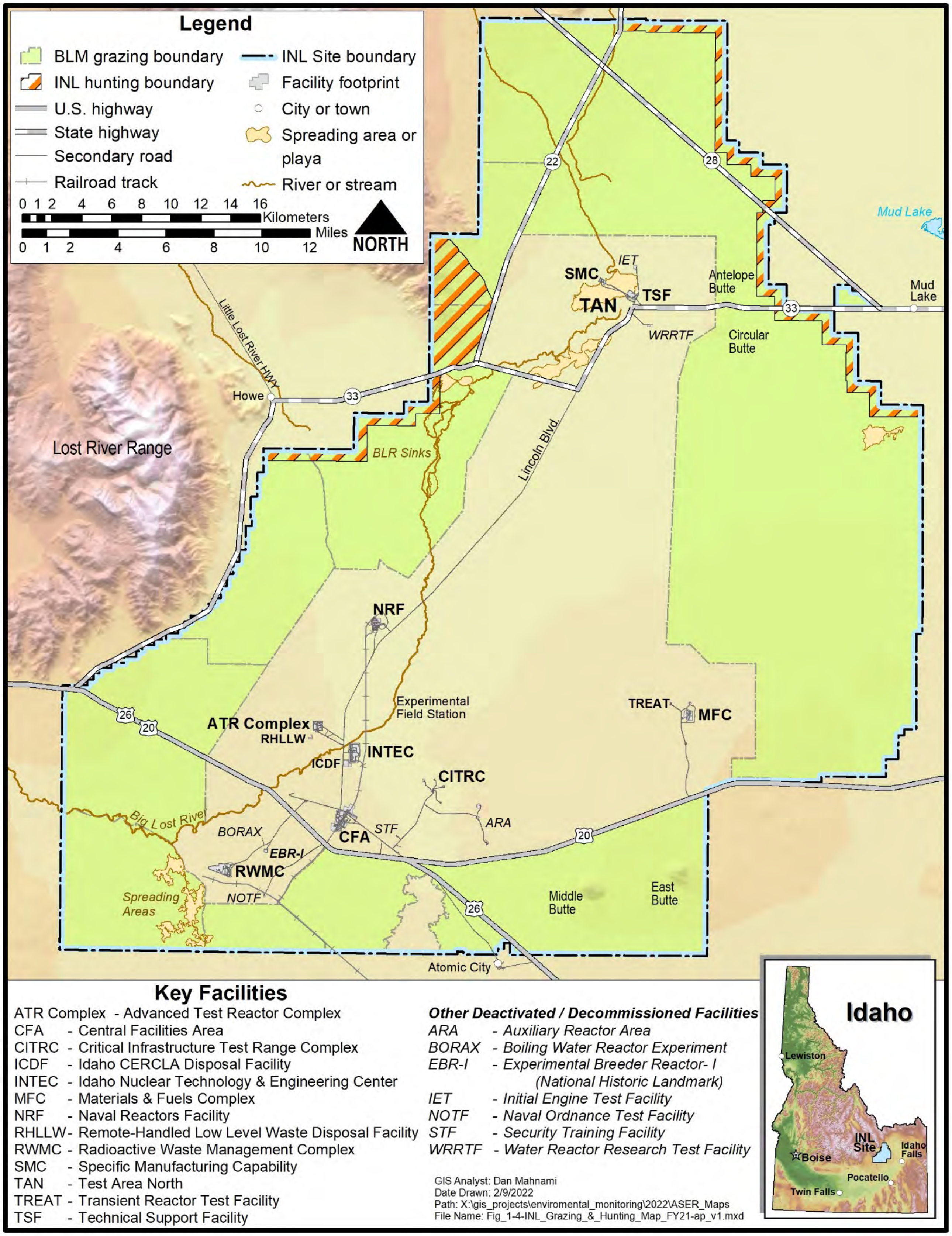

Figure 1-6. Location of the INL Site, showing key facilities.

and DOE O 414.1D. Therefore, NRF is excluded from this report. The director of the Naval Nuclear Propulsion Program establishes reporting requirements and methods implemented within the program, including those necessary to comply with appropriate environmental laws. The NRF program is documented in the NRF Environmental Monitoring Report (FMP 2024).

Radioactive Waste Management Complex (RWMC) – Since the 1950s, DOE has used the RWMC to manage, store, and dispose of waste contaminated with radioactive elements generated in national defense and research programs. RWMC provides treatment, temporary storage, and transportation of transuranic waste destined for WIPP.

The SDA is a 39-ha (96-acre) radioactive waste landfill that was used for more than 50 years. Approximately 14 of the 39 ha (35 of 96 acres) contain waste, including radioactive elements, organic solvents, acids, nitrates, and metals from historical operations such as reactor research at the INL Site and weapons production at other DOE facilities. A CERCLA Record of Decision (OU-7-13/14) was signed in 2008 (DOE-ID 2008) and includes exhumation and offsite disposition of targeted waste. Cleanup of RWMC is managed by the ICP contractor.

Remote-Handled Low-Level Waste Disposal Facility – The Remote-Handled Low-Level Waste Disposal Facility is a Hazard Category 2 nuclear facility providing a below-grade, permanent radioactive waste disposal capability critical for INL nuclear research and Naval Reactors missions at the INL Site. Remote-handled low-level waste is generated from nuclear programs conducted at INL Site facilities, including the NRF, the ATR Complex, and MFC. The facility began operations in 2018 and will support an anticipated 20 years of waste disposal operations with an expansion capability for up to 50 years. The facility comprises an administration building, a maintenance building, and a 175,000-ft^2 vault yard that includes monitoring wells, a robust drainage system, and 446 below-grade concrete waste disposal vaults sized to accommodate 939 stainless steel waste canisters of various configurations depending on the waste type and waste generator facility.

Research and Education Campus (REC) – The REC, operated by the INL contractor, is the collective name for INL's administrative, technical support, and computer facilities in Idaho Falls, Idaho, and the in-town laboratories where researchers work on a wide variety of advanced scientific research and development projects. REC also hosts the Biomass Feedstock National User Facility. As the name implies, the REC uses both basic science research and engineering to apply new knowledge to products and processes that improve the quality of life. This reflects the emphasis INL is placing on strengthening its science base and increasing the commercial success of its products and processes. Two new laboratory facilities—the Energy Systems Laboratory and Energy Innovation Laboratory—were constructed in 2013 and 2014. In 2019, the Idaho Board of Education and INL completed the construction of two new research facilities: the (1) Cybercore Integration Center and the (2) Collaborative Computing Center. The Cybercore Integration Center leads national efforts to secure critical infrastructure control systems from cybersecurity threats, while the Collaborative Computing Center will advance the computational science needs of INL and provide academia and industry with unprecedented access to high-performance computing. These and other facilities are integral to transforming INL into a world-renowned research laboratory.

The DOE Radiological and Environmental Sciences Laboratory (RESL) is located within the REC and provides a technical component to DOE oversight of contractor operations at DOE facilities and sites. As a reference laboratory, RESL conducts cost-effective measurement quality assurance programs that help ensure key DOE missions are completed in a safe and environmentally responsible manner. By ensuring the quality and stability of key laboratory measurement systems throughout DOE and by providing expert technical assistance to improve those systems and programs, RESL ensures the reliability of data on which decisions are based. RESL's core scientific capabilities are in analytical chemistry and radiation calibrations and measurements. In 2015, RESL expanded its presence in the REC with the addition of a new building for the DOE Laboratory Accreditation Program. The new DOE Laboratory Accreditation Program facility adjoins the RESL facility and provides irradiation instruments for the testing and accreditation of dosimetry programs across the DOE Complex.

Test Area North (TAN) – TAN was established in the 1950s to support the government's Aircraft Nuclear Propulsion program and its goal to build and fly a nuclear-powered airplane. When President John F. Kennedy cancelled the nuclear propulsion program in 1961, TAN began to host a variety of other activities. The Loss-of-Fluid Test (LOFT) reactor became part of the new mission. The LOFT reactor, constructed between 1965 and 1975, was a scaled-down version of a commercial pressurized water reactor. Its design allowed engineers, scientists, and operators to create or recreate loss-of-fluid accidents (e.g., reactor fuel meltdowns) under very controlled conditions. The LOFT dome provided containment for a relatively small, mobile test reactor that was moved in and out of the facility on a railroad car. The NRC incorporated data received from these accident tests into commercial reactor operating codes. Before closure, the LOFT facility conducted 38 experiments, including several small loss-of-coolant experiments designed to simulate the type of accident that occurred in 1979 at Three Mile Island (TMI) in the state of Pennsylvania. In October 2006, the LOFT reactor and facilities were decontaminated, decommissioned, and demolished.

Additionally, TAN housed the TMI-2 Core Offsite Examination Program that obtained and studied the technical data necessary for understanding the events leading to the TMI-2 reactor accident. Shipment of TMI-2 Core samples to the INL Site began in 1985, and the program ended in 1990. INL Site scientists used the core samples to develop a database that predicts how nuclear fuel will behave when a reactor core degrades.

In July 2008, the TAN Cleanup Project was completed. The TAN Cleanup Project demolished 44 excess facilities, the TAN Hot Shop, and the LOFT reactor. Environmental monitoring continues at TAN. See Waste Area Group 1 (WAG-1) status in Table 2-2.

The Specific Manufacturing Capability Project is located at TAN. This project is operated for the DOD by the INL contractor and manufactures protective armor for the Army M1-A1 and M1-A2 Abrams tanks.

1.5.4 Independent Oversight and Public Involvement and Outreach

DOE encourages information exchange and public involvement in discussions and decision-making processes regarding INL Site activities. Active participants include the public; Native American tribes; local, state, and federal government agencies; advisory boards; and other entities in the public and private sectors.

The roles and involvement of selected organizations are described in the following sections.

1.5.5 Citizens Advisory Board

The Citizens Advisory Board is a federally appointed citizen panel formed in 1994 that provides advice and recommendations on ICP activities to DOE-ID. The Citizens Advisory Board consists of 12 to 15 members who represent a wide variety of key perspectives on issues of relevance to Idaho citizens. Board members comprise a variety of backgrounds and viewpoints, including environmentalists, natural resource users, previous INL Site workers, Shoshone-Bannock Tribes, representatives of local government, health care, higher education, business, and the general public. These diverse backgrounds assist the ICP Environmental Management program in making decisions and having a greater sense of how cleanup efforts are perceived by the public. Members are appointed by the DOE Environmental Management Assistant Secretary and serve voluntarily without compensation. Three additional nonvoting liaisons include representatives from DOE-ID, Environmental Protection Agency Region 10, and the Idaho Department of Environmental Quality (DEQ). These liaisons provide information to the Citizens Advisory Board on their respective agencies' policies and views.

The Citizens Advisory Board is chartered by DOE through the Federal Advisory Committee Act. The Citizens Advisory Board's charter is to provide input and recommendations to DOE on topics such as cleanup standards and environmental restoration, waste management and disposition, stabilization and disposition of non-stockpile nuclear materials, excess facilities, future land use and long-term stewardship, risk assessment and management, and cleanup science and technology activities. More information about the Citizens Advisory Board's recommendations, membership, and meeting dates and topics can be found at https://www.energy.gov/em/icpcab.

1.5.6 Sitewide Monitoring Committees

Sitewide monitoring committees include the INL Site Monitoring and Surveillance Committee and the INL Site Water Committee. The INL Site Monitoring and Surveillance Committee was formed in March 1997 and meets at least quarterly, or as often as needed, to coordinate activities among groups involved in environmental monitoring on and off the INL Site. This standing committee includes representatives of DOE-ID, INL Site contractors, Shoshone-Bannock Tribes, the State of Idaho DEQ-INL Oversight Program, the National Oceanic and Atmospheric Administration, NRF, and the U.S.

Geological Survey. The INL Site Monitoring and Surveillance Committee has served as a valuable forum to review monitoring, analytical, and quality assurance methodologies; coordinate efforts; and avoid unnecessary duplication.

The INL Site Water Committee was established in 1994 to coordinate drinking-water-related activities across the INL Site and to provide a forum for exchanging information related to drinking water systems. In 2007, the INL Site Water Committee expanded to include all Sitewide water programs—drinking water, wastewater, storm water, and groundwater. The committee includes monitoring personnel, operators, scientists, engineers, management, data entry, and validation representatives of DOE-ID, INL Site contractors, the U.S. Geological Survey, and NRF. The committee serves as a forum for coordinating water-related activities across the INL Site and exchanging technical information, expertise, regulatory issues, data, and training.

The INL Site Water Committee interacts on occasion with other committees that focus on water-related topics or programs, such as the INL Site Monitoring and Surveillance Committee.

1.5.7 Environmental Oversight and Monitoring Agreement

A new five-year Environmental Oversight and Monitoring Agreement (DOE-ID 2021) among DOE-ID, the Naval Reactors Laboratory Field Office/Idaho Branch Office, and the Idaho DEQ was signed in March 2021. The 2021 version is the latest in a succession of agreements that was first implemented in 1990. The new Environmental Oversight and Monitoring Agreement governs the activities of the DEQ-INL Oversight Program and DOE-ID's cooperation in providing access to facilities and information for non-regulatory, independent oversight of INL Site impact to public health and the environment. The first agreement established in 1990 created the State of Idaho INL Oversight Program.

The DEQ-INL Oversight Program's main activities include environmental surveillance, emergency response, and public information. More information can be found on the DEQ-INL Oversight Program website at www.deq.idaho.gov.

1.5.8 Environmental Education Outreach

During 2023, the INL contractor environmental outreach and K-12 science, technology, engineering, and mathematics (STEM) programs continued to focus on reaching rural and remote schools that often have large disadvantaged and minority student populations. A total of 92 environmentally based natural science-related programs were presented to over 1,500 elementary and middle school students. These programs not only reached underserved rural populations, but also Native American students and their families on the Fort Hall Reservation. The K-12 STEM program was also involved in three Hispanic Youth Conferences (Figure 1-7) located in Pocatello, Twin Falls, and Boise, Idaho.

Figure 1-7. Hispanic students building robotic arms.

School programs range from discussions of the geology and hydrology of the Snake River Plain to a wide variety of ecologically based discussions of animal adaptations to their environment and human impact. Given the season, spring and summer programs on plants and insects are popular. These programs focus not just on the biology of the species but the adaptations that make them unique and the role humans play in impacting their populations.

In addition to these programs, ICP also supports STEM education in local communities through the weSTEAM program. weSTEAM is comprised entirely of volunteers in support of educating K-12 students on careers in science, technology, engineering, and math. These volunteers use a range of hands-on demonstrations and activities that also help students understand the vital role art plays in each of these areas, specifically in the areas of innovation and design.

The following provides a summary of education outreach for the INL Site contractors in 2023:

- ***Bring Idaho Alive*.** In collaboration with Museum of Idaho, the Bring Idaho Alive program was offered to statewide educators as a semester-long course. One-hundred-and-fifty teachers participated with the potential to receive two continuing education credits. Archaeology, biology, geology, history, technology, and more were discussed in monthly lectures. Hands-on activity kits were provided to the educators as valuable resources for their classrooms.

- ***Rocky Mountain Adventures summer workshops*****.** Sponsored by Museum of Idaho and the INL contractor, these multi-day workshops took place in the classroom and in the field. Educators could earn a continuing education credit. Certain workshops incorporate curriculum from Project WET and Project WILD. Field segments include field trips to the Snake River, Island Park, and Yellowstone and Grand Teton National Parks. Approximately 75 teachers participated in these workshops.
- ***Museum Summer Camps*****.** Museum of Idaho and the INL contractor environmental program led summer camp programs that reached 150 students from first through eighth grades. Students participated in programs highlighting environmental and natural science components, as well as integration of STEM concepts.
- ***My Amazing Future*****.** The annual "My Amazing Future" event was sponsored by the INL contractor. The event provided an opportunity for eighth-grade young women to explore careers in STEM. Students participated in a full-day of hands-on sessions designed to be educational and engaging. The sessions illustrated how a STEM education translates into exciting career options.
- ***East Idaho Science Bowl*****.** The INL contractor sponsored a math and science quiz-bowl tournament for southeastern Idaho high school and middle school students. Participants were tested on their math and science knowledge (Figure 1-8). ICP contractor employees supported the event as scorekeepers and other key volunteer roles.

Figure 1-8. Science Bowl competition.

- ***Energy Days.*** The ICP contractor, alongside the INL contractor, produced a day-long conference for community members and local high school and college students. The conference highlighted various projects performed at the INL Site that are helping clean up the environment and produce clean energy in the future. Over 100 community members and students attended.
- ***weSTEAM Classroom Visits.*** The ICP contractor encourages employees to volunteer to support classroom visits to schools in Southeastern Idaho to teach students how STEM careers at the INL Site support the continued protection of the Snake River Plain Aquifer.
- ***Roaring Youth Jam.*** In conjunction with the Idaho Falls Arts Council, the ICP contractor sponsored a 3-day art festival in which community members learned about and created art, all at no charge to participants. Hundreds of community members participated in 10 different art projects and were exposed to dozens of art performances designed to enhance art education. Art is an important component of the contractor's weSTEAM educational program.

The following include several community outreach efforts the INL Site contractors education program participated in during 2023:

- ***Idaho Falls Water Festival Day*****.** Over 650 students participated in a hands-on project demonstrating water filtration and had the opportunity to learn about other related environmental topics.
- ***Earth Day*****.** In collaboration with the Idaho Falls Zoo, the INL contractor explained the importance of habitat and the critical role pollinators play at the Earth Day celebration. Thousands of participants created habitats for important pollinators by planting seeds. The ICP contractor also participated in this year's event by leading activities that educated students on groundwater and how different types of soil, rocks, and water support the protection of the Snake River Plain Aquifer.
- ***Science, Technology, Engineering, Arts, and Mathematics (STEAM) Day at the Zoo*****.** In collaboration with the Idaho Falls Zoo, the INL contractor presented science, engineering, art, and innovation in an amazing hands-on experience of interactive STEAM-themed stations throughout the zoo to over 300 elementary students from the

region. The ICP contractor provided a lesson on stored energy. Students built rubber band helicopters to help demonstrate how stored energy supports equipment used in our environmental protection efforts.

- ***Bat Night at the Zoo*.** Four bat night events were held at the Idaho Falls Zoo. INL contractor biologists and education programs, along with faculty from BYU-Idaho presented to over 400 participants why bats are important, and how the Idaho Falls Zoo is helping to protect their natural habitat. Participants can view and hear bats in the first known permanent chiroptarium in the world at the Idaho Falls Zoo.
- ***Family Nuclear Night.*** Families were able to meet scientists and engineers, engage in hands-on activities and demonstrations, and learn more about the science happening at INL.
- ***Night at the Museum.*** Engineers with the ICP contractor led students in an activity to build flashlights using popsicle sticks. The principles used to energize these flashlights can also be applied to technologies used in the environmental cleanup work at the INL Site.

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Great horned owl.

Chapter 2: Environmental Compliance Summary

CHAPTER 2

Operations at the Idaho National Laboratory (INL) Site are subject to numerous federal and state environmental statutes, regulations, executive orders, and U.S. Department of Energy (DOE) directives. As a requirement of many of these regulations, the status of compliance with the regulations and releases of non-permitted hazardous materials to the environment must be documented. Environmental permits have been issued to the INL Site, primarily by the state of Idaho (Table 2-5). There were two reportable environmental spill releases at the INL Site during calendar year 2023. In 2023, the U.S. Department of Energy Idaho Operations Office (DOE-ID) operated in compliance with most of the requirements defined in governing documents. Instances of noncompliance were reported to regulatory agencies and resolved. Environmental compliance status for 2023 is provided in Table 2-1.

2. ENVIRONMENTAL COMPLIANCE SUMMARY

This chapter presents the compliance status for operations at the INL Site and DOE-ID programs that are subject to federal and state environmental protection requirements, such as statutes, regulations, acts, agreements, executive orders, and DOE directives.

2.1 Enforcement and Compliance History Online Database

The U.S. Environmental Protection Agency (EPA) developed the Enforcement and Compliance History Online website (https://echo.epa.gov/) that provides integrated compliance and enforcement that can be used to search and view information on permit data, inspection dates and findings, violations, enforcement actions, and penalties assessed for INL Site operations. The Enforcement and Compliance History Online website also allows users to sort and analyze data in many ways, according to their individual needs.

2.2 Compliance with Requirements

INL Site activities must adhere to environmental standards established by federal, state, and local regulations; DOE directives, permits, and compliance; and settlement agreements where applicable. The EPA and Idaho Department of Environmental Quality (DEQ) are the principal regulating agencies that issue permits, review compliance reports, and participate in joint monitoring programs, inspect facilities and operations, and enforce compliance with applicable requirements as identified in Table 2-1.

Table 2-1. Federal, state, and local laws and regulations established for protection of human health and the environment.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
AIR QUALITY AND PROTECTION		
40 Code of Federal Regulations (CFR) 61, "National Emission Standards for Hazardous Air Pollutants," 42 USC 7401 et seq. The Clean Air Act (CAA) is the basis for national air pollution control. Emissions of radioactive hazardous air pollutants are regulated by the EPA via the National Emission Standards for Hazardous Air Pollutant (40 CFR 61, Subpart H).	The EPA has not delegated the 40 CFR Part 61, Subpart H, regulations, and is the primary agency to which DOE-ID reports compliance. Idaho DEQ incorporates the requirements of the subpart into the site-wide permit to construct (PTC)-facility emission cap (FEC) and is therefore included in all reporting and noncompliance occurrences. The INL Site is in compliance, as reported in compliance report, "National Emission Standards for Hazardous Air Pollutants – Calendar Year 2023" (DOE-ID 2024a).	4.2 4.3 8.2.1
40 CFR 84, "Phasedown of Hydrofluorocarbons" In October 2021, EPA issued regulations to decrease the production of hydrofluorocarbons (HFCs) over the next 15 years, thereby decreasing the supply. HFCs were developed and manufactured to replace chlorofluorocarbons, which damage the stratospheric ozone layer. HFC uses include refrigerants, solvents, fire suppressants, and aerosols. Through these regulations, EPA seeks to reduce HFC consumption and production to 15% of a 2011–2013 baseline by 2036. These regulations do not prevent entities from using equipment containing HFCs that have already been purchased and are currently in use. However, as the phasedown progresses, these HFCs will become less available and more expensive. In October 2023, the EPA issued regulations to restrict the use of some HFCs in specific applications; compliance dates vary depending on the application.	A summary of the INL Site contractors' HFC uses, replacements, procurement, and proactive measures taken as a result of the HFC phasedown can be found in Section 4.5.	4.5
Clean Air Act (1970), 42 USC 7401 et seq. The CAA provides the EPA with broad authority to implement and enforce regulations to reduce air pollutant emissions with an emphasis on cost-effective methods. In addition to the EPA, states, tribes, and local governments play a key role in the implementation of the CAA.	Idaho DEQ has been delegated authority to implement the CAA through the development of an EPA-approved state implementation plan and is codified in Idaho Administrative Code, Rules for the Control of Air Pollution in Idaho (IDAPA 58.01.01). DOE-ID holds a synthetic minor, site-wide, air quality permit from Idaho DEQ. This PTC contains an FEC component that enforces a limit on emissions of criteria air pollutants (CAP) and hazardous air pollutants to less than major source	4.3 8.2

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
Other environmental statutes and regulations apply, in whole or in part: • 40 CFR 50, "National Primary and Secondary Ambient Air Quality Standards."	thresholds. Without the synthetic limits on site-wide CAP emissions, the INL Site would be considered a major source for CAP emissions and would require a Tier I/Title V permit. This permit covers all the non-exempt air emission sources located on the INL Site but does not cover air-emitting sources located at the Research and Education Campus (REC) in Idaho Falls, Idaho. All air emission sources located at the REC have been determined to be minor and have been exempted from the permitting requirements in IDAPA 58.01.01. As reported in the annual compliance report required by the PTC-FEC, the INL Site emitted CAP and hazardous air pollutants emissions significantly below the permitted limits in calendar year 2023. Idaho DEQ performed an air quality inspection of the Idaho Nuclear Technology and Engineering Center (INTEC) facility on October 30, 2023; Central Facilities Area (CFA) on November 16, 2023; and Specific Manufacturing Capability facility on December 5, 2023. Sources inspected were found to be in compliance for these facilities.	
CULTURAL AND ENVIRONMENTAL RESOURCES PROGRAMS		
Endangered Species Act (1973), 16 USC 1531-1544 The Endangered Species Act requires that all federal departments and agencies seek to conserve endangered and threatened species and use their authorities to further the purposes of this act. *Other environmental statutes and regulations apply, in whole or in part:* • 50 CFR 17, "Endangered and Threatened Wildlife and Plants" • 50 CFR 226, "Designated Critical Habitat" • 50 CFR 402, "Interagency Cooperation – Endangered Species Act of 1973, as Amended"	There are currently no resident INL Site species listed as threatened or endangered under the Endangered Species Act and there is no designated critical habitat on the INL Site. In 2014, DOE-ID entered into a voluntary candidate conservation agreement with the U.S. Fish and Wildlife Service to conserve and protect Greater sage-grouse and sagebrush habitat on the INL Site prior to the Service determining the species was not warranted for listing. In 2023, DOE-ID published an annual report of sage-grouse and sagebrush monitoring activities and held an annual meeting with the U.S. Fish and Wildlife Service and other stakeholders to discuss the report and progress towards achieving conservation objectives. In 2018, the DOE-ID produced a Bat Protection Plan for the INL Site and has since produced an annual report providing current information on the conservation of bats and their habitat on the INL Site. The INL Natural Resources Group also conducts ecological research, field surveys, and National Environmental Policy Act (NEPA) evaluations regarding resources on the INL Site.	9.1.2 9.1.3

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
• 50 CFR 424, "Listing Endangered and Threatened Species and Designating Critical Habitat" • 50 CFR 450-453, "Endangered Species Exemption Process."	These program activities complied with all requirements. Details of related activities can be found in Chapter 9.	
Executive Order 11988, "Floodplain Management" Executive Order (EO) 11988 requires federal agencies to consider, evaluate, and avoid to the extent possible, adverse impacts associated with the occupancy and modification of floodplains, to reduce the risk of flood loss, to minimize the impacts of flood on human safety, health, and welfare, and to restore and preserve the natural and beneficial values of floodplains. *Other environmental statutes and regulations apply, in whole or in part:* • 10 CFR 1022, "Compliance with Floodplain and Wetland Environmental Review Requirements."	It is the intent of EO 11988 that federal agencies implement floodplain requirements through existing procedures, such as those established to implement NEPA. The 10 CFR 1022 contains DOE policy and floodplain environmental review and assessment requirements through the applicable NEPA procedures. In those instances where impacts of actions in floodplains are not significant enough to require the preparation of an Environmental Impact Statement under NEPA, alternative floodplain evaluation requirements are established through the INL Site Environmental Checklist (EC) process. DOE-ID has accepted the "Big Lost River Flood Hazard Study" (Bureau of Reclamation 2005). This flood hazard report is based on geomorphological models and has undergone peer review. All activities on the INL Site requiring characterization of flows and hazards are expected to use this report. A study titled "Estimated 100-Year Peak Flows and Flow Volumes in the Big Lost River and Birch Creek at the Idaho National Engineering Laboratory, Idaho" (Kjelstrom and Berenbrok 1996), was conducted by the U.S. Geological Survey. This study provided an estimated extent of the 100-year floodplain for the Big Lost River (BLR) and Birch Creek on the INL Site. The facility that was included in this study was Test Area North (TAN). A few years later, another study was completed by Bureau of Reclamation on the INL Site, titled "Big Lost River Flood Hazard Study" (Ostenaa and O'Connell 2005). The objective of this study was to develop probabilistic flood stage estimates for specific facility locations at INTEC and Test Reactor Area (TRA). According to the study, CFA and Materials and Fuels Complex (MFC) are not within the 100-year or 500-year floodplain of the BLR. The probabilistic flood stage estimates that were created from this study are to be used for all future BLR flood hazard characterization efforts for INTEC and TRA. Together, the above-mentioned studies are to be used to characterize and identify the floodplains for their respective facilities on the INL Site.	N/A

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
Executive Order 11990, "Protection of Wetlands" EO 11990 requires federal agencies to identify potential impacts on wetlands resulting from proposed activities and to minimize the destruction, loss, or degradation of wetlands and preserve and enhance the natural and beneficial values of wetlands.	The only areas of the INL Site currently identified as potentially jurisdictional wetland are the BLR corridor and BLR Sinks. The U.S. Fish and Wildlife Service National Wetlands Inventory Map is used to identify potential jurisdictional wetlands and non-regulated sites with ecological, environmental, and future development significance. In 2023, there were no reviews or evaluations performed by the U.S. Army Corps of Engineers for the INL Site. No new actions have taken place within potential wetland areas on the INL Site that would require additional review by the U.S. Army Corps of Engineers or an update to an existing Jurisdictional Determination.	N/A
Executive Order 13751, "Safeguarding the Nation from the Impacts of Invasive Species" This EO calls on federal agencies to prevent the introduction, establishment, and spread of invasive species, as well as to eradicate and control populations of invasive species that are established. *Other environmental statutes and regulations apply, in whole or in part:* • Federal Noxious Weed Act (1974), 7 USC 2801 • IDAPA 02.06.09, "Rules Governing Invasive Species and Noxious Weeds" • Idaho Statute Title 22, Chapter 19, "The Idaho Invasive Species Act of 2008" • Idaho Statute Title 22, Chapter 24, "Noxious Weeds."	INL Site contractors implement a site-wide plan for managing invasive species. This site-wide plan addresses each requirement of federal agencies as outlined in EO 13112, as amended by EO 13751. Additionally, federal agency requirements outlined in The Federal Noxious Weed Act of 1974 and state of Idaho requirements related to invasive species and noxious weeds are met with compliance of EO 13112, as amended by EO 13751. For more detail on how this plan is carried out and how requirements are met, see Section 9.4.3.	9.4.3
Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad" The purpose of EO 14008, "Tackling the Climate Crisis at Home and Abroad," is to make climate considerations an essential element of U.S. foreign policy and national security planning, and to understand how domestic policy can address the implications of climate change. Overarching goals for domestic policy include strengthening clean air and water protections,	At INL, EO 14008 is addressed with multiple methods. This includes activities as diverse as evaluating infrastructure to identify opportunities to increase efficiency in electricity and water use, assessing the materials supply chain to reduce INL's carbon footprint, aligning land use/land stewardship objectives with ecosystems resilience and ecosystem services priorities. The evolving priorities for sustainability are incorporated into the annual update of sustainability are incorporated into the annual update of the "Idaho National Laboratory Site Sustainability Plan" (DOE-ID 2023a) at the beginning of each new	Chapter 3 Chapter 9

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
holding polluters accountable, delivering environmental justice, and driving the mitigation of climate-related risks in our economy.	fiscal year (FY). It describes the overall sustainability strategy for the INL Site contractors during the current FY and includes a performance status in the areas of greenhouse gas (GHG) emission reduction, energy management, water management, waste management, fleet management, clean and renewable energy, sustainable buildings, and other areas for the completed FY. With respect to ecological resource conservation, INL implements several conservation plans. Land stewardship activities prioritize conserving and restoring native communities to maximize ecosystem services such as carbon sequestration. Ecological monitoring activities are conducted to continuously evaluate the condition of natural resources and ensure the local sagebrush steppe ecosystem remains healthy and resilient in its ability to respond to the stresses associated with climate change. See Chapter 9 for a more thorough discussion of the ecological aspects of implementing EO 14008 on the INL Site. Concerning site resiliency, INL is taking actions to bolster adaptation and increase the resilience of DOE-ID facilities and operations as documented in the issued "Vulnerability Assessment and Resiliency Plan" (INL 2022), which documents climate vulnerabilities and implementable solutions, lays out a path to institutionalize climate adaptation policies, provides climate adaptation tools, and socializes the need to deploy emerging climate technologies. Idaho Cleanup Project (ICP) contractor is taking similar measures, as documented in its "Climate Change Vulnerability and Resilience Plan for the IEC-Managed Facilities at INL" (Burton, B., memorandum to J. Anderson, CCN 329542). The performance status of current sustainable activities and additional details of new initiatives are further discussed in Chapter 3.	
Migratory Bird Treaty Act (1918), 16 USC 703-712 The Migratory Bird Treaty Act prohibits taking any migratory bird, or any part, nest, or egg of any such bird, without authorization from the U.S. Department of the Interior. Permits may be issued for scientific collecting, banding and marking, falconry, raptor propagation, depredation, import, export, taxidermy, waterfowl sale and disposal, and special purposes.	DOE-ID has a U.S. Fish and Wildlife Service Special Purpose Permit for limited nest relocation and destruction and the associated take of migratory birds for mission-critical activities if all other means to prevent such take have been explored and/or exhausted. DOE-ID and INL Site contractors also have permits from the Idaho Department of Fish and Game to manage migratory birds and collect other wildlife specimens for scientific research. All stipulated reporting requirements were met for 2023.	7.2.8 7.2.9 9.1.5 9.4.4

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
Other environmental statutes and regulations apply, in whole or in part: • EO 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds" • Bald and Golden Eagle Protection Act (1940), 16 USC 668-668d • Idaho Statute Title 36, Chapter 1, 106 e.5.	One instance of a take was reported in 2023 and is further discussed in Chapter 9.	
National Environmental Policy Act (1969), 42 USC 4332(2) NEPA requires federal agencies to consider potential environmental impacts of proposed actions in the decision-making process. Federal agencies are required to provide a detailed statement on proposals for major federal actions significantly affecting the quality of the human environment. The purpose and function of NEPA is satisfied if federal agencies have considered relevant environmental information and the public has been informed regarding the decision-making process. *Other environmental statutes and regulations apply, in whole or in part:* • 10 CFR 1021, "National Environmental Policy Act Implementing Procedures" • 40 CFR 1500-1508, "National Environmental Policy Act (NEPA) Purpose, Policy, and Mandate."	As a federal agency, DOE complies with the NEPA requirements (procedural provisions, 40 CFR 1500 through 1508) as outlined in DOE's "NEPA Implementing Procedures" (10 CFR 1021). DOE fulfills its obligation to comply with NEPA by providing timely and appropriate analysis of proposed activities in accordance with current guidance and implementing regulations. The analysis undertaken is always dependent on the action being proposed. DOE NEPA compliance officers work closely with INL NEPA subject matter experts, program environmental leads, environmental subject matter experts, and project personnel to determine the appropriate level of review for each proposed action. The collective processes in place to help facilitate these reviews to provide the most effective and timely outcomes are referred to as the INL Environmental Review Process (ERP). The ERP is in place to both ensure compliance to statutory compliance to NEPA and other environmental requirements, and to be used as a planning tool providing useful and relevant information that can help professionals achieve the best possible project outcomes. Project initiators from the INL contractor enter the scope for proposed projects into the ERP electronic workflow, an electronic system developed specifically for INL, in which project personnel, laboratory environmental staff, and other identified personnel can review the scope to determine/recommend coverage under DOE NEPA Implementing Regulations, identify potential impacts, prescribe hold points and project-specific instructions, and ensure the project is compliant with applicable environmental and cultural laws and policies. In 2023, 704 activities were entered into the ERP for review.	9.4.1

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
	The output of the ERP is documentation of a review which may result in the issuance of an Environmental Compliance Permit (ECP) if required. An ECP states the INL NEPA team's recommended level of NEPA compliance for the proposed activity, as well as project-specific instructions that project personnel must follow, to ensure regulatory compliance. Of the approximately 704 projects reviewed in 2023, 80 were issued a new ECP and DOE categorical exclusion determination under NEPA. Other projects were covered under existing categorical exclusion determinations (i.e., facility improvements), existing Environmental Assessments (EAs) or Environmental Impact Statements (EISs) (i.e., "Environmental Assessment for Use of DOE-Owned High-Assay Low-Enriched Uranium Stored at Idaho National Laboratory" [DOE-ID 2019]), or were determined to be administrative actions that did not require further NEPA review (see 10 CFR 1021 subpart D, Appendix A). DOE-ID actions categorically excluded from EA- or EIS-level review can be viewed at https://www.energy.gov/nepa/categorical-exclusion-determinations-idaho-operations-office. The ICP contractor uses an EC that captures the purpose and need of a project proposal and identifies environmental aspects associated with the project. The EC identifies project-specific instructions the project is required to follow to meet NEPA compliance to regulatory requirements. The ICP contractor reviewed 17 ECs, all of which were covered by existing EAs, EISs, Records of Decision, or other previously approved NEPA documents. DOE signed a Finding of No Significant Impact for the Molten Chloride Reactor Experiment (MCRE) EA in 2023. MCRE is intended to confirm key physics phenomena relevant to the design and safe operation of fast-spectrum molten salt reactors and reduce the uncertainty associated with predicting those phenomena. The experiment will be located within existing facilities at the MFC on the INL Site. The MCRE EA Finding of No Significant Impact was signed October 12, 2023.	

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
National Historic Preservation Act (NHPA) (1966), as amended, 54 USC 300101 et seq. The NHPA requires federal agencies to establish programs to identify, record, and protect cultural resources and to assess the impacts of proposed projects on historic or culturally important sites, structures, or objects within the area of potential effect for a proposed project. The NHPA further requires federal agencies to assess archaeological sites, historical buildings, and objects on such sites to determine their qualification for inclusion in the National Register of Historic Places. In addition, NHPA requires federal agencies to consult with State Historic Preservation Offices, affected Indian tribes, the Federal Advisory Council on Historic Preservation, and other interested parties, as appropriate, when determining whether the proposed actions would adversely affect properties eligible for listing on the National Register of Historic Places. Compliance is achieved via adherence to Sections 106 and 110 of the NHPA. *Other environmental statutes and regulations apply, in whole or in part:* • The Archaeological Resources Protection Act (1979), 16 USC §470aa-470mm • 36 CFR 79, "Curation of Federally Owned and Administered Archaeological Collections" • 36 CFR 800, "Protection of Historic Properties" • 43 CFR 7, "Protection of Archaeological Resources" • Native American Graves Protection and Repatriation Act (1990), as amended, 25 USC 3001-3013 • American Indian Religious Freedom Act (1996), 42 USC 1996 Religious Freedom Restoration Act (1993), 42 USC §200bb-200bb4	The INL Cultural Resource Management Office (CRMO) works with DOE-ID's Cultural Resource Coordinator to steward archaeological and architectural cultural resources across INL. During 2023, the CRMO continued to operate under the "Idaho National Laboratory Cultural Resource Management Plan" (DOE-ID 2016a), which was developed through a programmatic agreement with the Idaho State Historic Preservation Office and the Advisory Council on Historic Preservation in 2004. A new programmatic agreement was executed on May 8, 2023. The programmatic agreement was negotiated among DOE-ID, Idaho State Historic Preservation Office, Advisory Council on Historic Preservation, the Shoshone-Bannock Tribes, and other consulting parties to tailor the Section 106 process to the current needs of the INL Site. The CRMO has been integrated into the NEPA ERP since April 2022, allowing better coordination with NEPA reviews and greater streamlining of the Section 106 review process. Archaeologists conducted multiple field surveys to identify and record or re-record archaeological resources that would be impacted by proposed INL activities under Section 106. Additionally, archaeologists surveyed 444 acres and recorded 12 isolates and 28 sites, and re-recorded eight archaeological resources pursuant to Section 110. Work continued on the built environment inventory update. Individual resources and historic districts constructed prior to 1980 were surveyed, recorded, and evaluated to determine which were eligible for inclusion on the National Register. Inventory updates for the Advanced Test Reactor (ATR) Complex, CFA, Critical Infrastructure Test Range Complex, Experimental Breeder Reactor-I, Boiling Water Reactor Experiment Facilities, INTEC, and the MFC were completed by the Center for Environmental Management of Military Lands, with final revisions made by the INL CRMO staff. DOE-ID submitted these inventories to the State Historic Preservation Office on April 30, 2023. Concurrence was received on May 23, 2023. The CRMO continues to support DOE-ID with their government-to-government consultation efforts with the Shoshone-Bannock Tribes under the Agreement-in-Principle (AIP). DOE-ID, CRMO, and the Shoshone-Bannock Heritage Tribal Office collaborate regularly and tribal representatives contribute to Sections 106 and 110 projects in the field, as report co-authors and reviewers, and lead visits for tribal members. DOE-ID and CRMO provided an annual program update to	9.5

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
• EO 13007, "Indian Sacred Sites" • EO 13175, "Consultation and Coordination with Indian Tribal Governments."	the Fort Hall Business Council on June 29, 2023, and facilitated meetings of the INL Site Cultural Resource Working Group.	
HAZARDOUS MATERIALS AND WASTE MANAGEMENT		
Comprehensive Environmental Response, Compensation, and Liability Act (1980), (amended by the Superfund Amendments and Reauthorization Act [SARA]), 40 CFR 300, 42 USC 9601 et seq The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides the process to assess and remediate areas contaminated by the release or threat of release of chemically hazardous, radioactive substances, or both. *Other environmental statutes and regulations apply, in whole or in part:* • 40 CFR 300, "National Oil and Hazardous Substance Pollution Contingency Plan."	Nuclear research and other operations at the INL Site left behind contaminants that pose a potential risk to human health and the environment. The INL Site was placed on the National Priorities List under CERCLA on November 29, 1989. The DOE-ID, Idaho DEQ, and the EPA Region 10 signed the Federal Facility Agreement and Consent Order (FFA/CO) in December of 1991 (DOE 1991). Environmental restoration is conducted under the FFA/CO, which outlines how the INL Site will comply with CERCLA. It identifies a process for DOE-ID to work with its regulatory agencies to safely execute the cleanup of past release sites. The INL Site is divided into ten Waste Area Groups (WAGs) as a result of the FFA/CO, and each WAG is further divided into smaller cleanup areas called operable units (OUs). Field investigations are used to evaluate potential release sites within each WAG and OU when existing data are insufficient to determine the extent and nature of contamination. After each investigation is completed, a determination is made regarding whether a "No Action" or "No Further Action" listing is possible, or whether it is appropriate to proceed with an interim cleanup action, the OU 10-08 Plug-In Remedy action, or further investigation using a remedial investigation/feasibility study (RI/FS). Results from the RI/FS form the basis for risk assessments and alternative cleanup actions. This information, along with the regulatory agencies' proposed cleanup plan, is presented to the public in a document called a proposed plan. After consideration of public comments, DOE, EPA, and Idaho DEQ develop a record of decision (ROD) that selects a cleanup approach from the alternatives evaluated. Cleanup activities can then be designed, implemented, and completed. Since the FFA/CO was signed in December of 1991, the INL Site has cleaned up release sites containing asbestos, petroleum products, acids and bases, radionuclides, unexploded ordnance and explosive residues, polychlorinated biphenyls, heavy metals, and other hazardous materials. All 24 RODs that were	Table 2-2 6.5

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
	scheduled have been signed and are being implemented or have been completed. Comprehensive RI/FSs have been completed for WAGs 1–5, 7–9, and 6/10 (6 is combined with 10). Active remediation is completed at WAGs 2, 4, 5, 6, 8, and 9. Institutional controls (ICs) and operations and maintenance activities at these sites (except for WAG 8, which is managed by the Naval Reactors Facility) are ongoing and will continue to be monitored under the "Site-Wide Institutional Controls and Operations and Maintenance Plan for CERCLA Response Actions" (DOE-ID 2024b). The status of ongoing active remediation activities at WAGs 1, 3, 7, and 10 are described in Table 2-2. Documentation associated with the remedial actions and other removal actions are publicly available in the CERCLA Administrative Record and can be accessed at https://idahoenvironmental.com/ARIR/. Decontamination and decommissioning activities are also performed at the INL Site in accordance with the CERCLA (42 USC 9601 et seq.), as amended by the "Superfund Amendments and Reauthorization Act of 1986" (Public Law 99-499), and in accordance with the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300). Decontamination and decommissioning activities are consistent with the joint DOE and EPA "Policy on Decommissioning of Department of Energy Facilities Under the Comprehensive Environmental Response, Compensation, and Liability Act" (DOE and EPA 1995), which establishes the CERCLA non-time critical removal action process as an approach for decommissioning pursuant to CERCLA, Section 104(a), and EO 12580, "Superfund Implementation," as recognized by Section 5.3 of the FFA/CO (DOE 1991). In accordance with 40 CFR 300.415(j) and DOE guidance, INL Site removal actions conducted under CERCLA are required to meet applicable or relevant and appropriate requirements to the extent practicable considering the exigencies of the situation. This approach satisfies environmental review requirements and provides for stakeholder involvement, while providing a framework for selecting the decommissioning alternative.	
DOE Order 435.1 The Atomic Energy Act of 1954 (42 U.S.C § 2011 1954) Section 161(i) authorizes DOE to regulate activity involving certain	The INL contractors manage all radioactive waste generated at INL facilities. The Waste Management Program provides the structure for integrating/dispositioning radioactive waste and is the lead organization for ensuring compliant cradle-to-	2.5

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
radioactive materials, including radioactive waste, to "protect human health and minimize danger to life or property." This authority is implemented through DOE O 435.1, "Radioactive Waste Management," and the accompanying DOE Manual 435.1-1, "Radioactive Waste Management Manual," which set forth the requirements for assuring the safety of the generation, treatment, storage, and disposal of DOE-owned radioactive waste. These DOE directives ensure that radioactive waste management activities are systematically planned, documented, executed, and evaluated. Specifically, the Order and the manual: • Establish requirements to implement DOE regulating authority and responsibilities for radioactive waste management • Define DOE radioactive waste types: (1) high-level waste (HLW), (2) transuranic (TRU) waste, and (3) low-level waste (LLW) • Emphasize management for disposal and establish requirements for waste characterization, waste certification, and waste acceptance criteria • Identify performance-based requirements • Require life-cycle management (i.e., from generation planning to disposal) • Rely on existing nuclear safety philosophies (e.g., Integrated Safety Management System, Graded Approach, Defense-in-Depth) • Require a DOE-approved Radioactive Waste Management Basis to ensure hazards have been identified, analyzed, and mitigated.	grave waste management of containerized waste as described in PDD-17000, "Waste Management Program." The INL contractor maintains facility-specific Radioactive Waste Management Basis documents to demonstrate DOE O 435.1 compliance. The INL Site contractors manage all hazardous, mixed low-level waste, LLW, TRU waste, HLW, remote-handled, recyclable waste, waste with no identified path to disposal, industrial, Toxic Substances Control Act (TSCA), Comprehensive Environmental Response Compensation, and Liability (CERCLA) waste, and universal waste streams that are generated and stored at the INL Site and approved offsite-INL Site waste streams. Management activities include, but are not limited to, controls for waste characterization, waste certification, waste acceptance criteria compliance, storing waste, treating waste, and transporting and disposing of waste. The overall responsibility for managing waste at INL contractor facilities resides in the INL contractor's Waste Management Programs organization, according to LWP-17000, "Waste Management" and the ICP contractor manages waste that is generated and stored at the ICP facilities, and approved offsite waste streams per PDD-234, "Waste Management Program." All waste management activities described herein are conducted in compliance with all applicable provisions of DOE O 435.1. The ICP uses DOE M 435.1, Change 2, to meet contractual requirements. The contract will be updated in the future to reflect Change 3. See Table 2-3 for information on wastes managed at the INL Site by INL Site contractors. See Table 2-3 for the status of each phase of the LLW management process for facilities managed at the INL Site by INL Site contractors.	

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
Other environmental statutes and regulations apply, in whole or in part: – DOE O 435.1, Change 2, "Radioactive Waste Management" – DOE Manual 435.1, Change 3, "Radioactive Waste Management Manual (January 2021)."		
Federal Facility Compliance Act of 1992, as amended. Enacted by Congress on October 6, 1992, the *Federal Facility Compliance Act of 1992* amends Section 6001 of the Resource Conservation and Recovery Act of 1976 (RCRA) to specify that the U.S. waives sovereign immunity from civil and administrative fines and penalties for RCRA violations. In addition, RCRA requires EPA to conduct annual inspections of all federal facilities. Authorized states are given authority to conduct inspections of federal facilities to enforce compliance with state hazardous waste programs. DOE-ID is required to submit and receive approval of the INL Site Treatment Plan from Idaho DEQ.	The INL Site contractors manage all mixed waste generated at their respective facilities. The Waste Management Program is the lead organization for ensuring compliant cradle-to-grave management of INL containerized mixed waste as described in PDD-17000, "Waste Management Program." Waste Management at ICP facilities is described in PDD-234, "Waste Management Program." The INL Site contractors maintain facility-specific Radioactive Waste Management Basis documents to demonstrate DOE O 435.1 compliance. DOE-ID submitted the FY 2024 "Site Treatment Plan Annual Update and FY 2023 Site Treatment Plan Annual Report" to Idaho DEQ in November 2023 in accordance with Sections 2.3.3 and 2.3.4. DOE-ID and INL Site contractors met quarterly with Idaho DEQ to discuss the status of milestones, treatment projects, and other activities conducted under the Site Treatment Plan.	2.5
Federal Insecticide, Fungicide, and Rodenticide Act (1996), 7 USC 136 et seq. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is the federal statute that governs the registration, distribution, sale, and use of pesticides in the U.S. The FIFRA regulations found in 40 CFR parts 150-189 are promulgated and administered by the EPA. *Other environmental statutes and regulations apply, in whole or in part:* • IDAPA 02.03.03, "Rules Governing Pesticide and Chemigation Use and Application" • Idaho Statute Title 22 Chapter 34, "Idaho Pesticides and Chemigation Law."	All pesticide applications on the INL Site are conducted in accordance with the specific pesticide label instructions in accordance with the FIFRA. Additionally, all appropriate records associated with pesticide applications are kept for a minimum of three years by each pesticide applicator in accordance with IDAPA 02.03.03, "Rules Governing Pesticide and Chemigation Use and Application." For details on pesticide application on the INL Site, see Section 9.4.3.	9.4.3

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
Resource Conservation and Recovery Act (1976), 40 CFR 259-282, 42 USC 6901 et seq. The RCRA established regulatory standards for generation, transportation, storage, treatment, and disposal of hazardous waste. *Other environmental statutes and regulations apply, in whole or in part:* • 40 CFR 270.13, "Contents of Part A of the Permit Application" • 40 CFR 262, "Standard Applicable to Generators of Hazardous Waste" • 40 CFR 263, "Standards Applicable to Transporters of Hazardous Waste" • 40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" • 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" • 40 CFR 266, "Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Units" • 40 CFR 267, "Standard for Owners and Operators of Hazardous Waste Facilities Operating Under a Standardized Permit" • 40 CFR 268, "Land Disposal Restrictions" • 40 CFR 270, "EPA Administered Permit Programs: The Hazardous Waste Permit Program"	*RCRA Permits:* Form 8700-23, along with maps, drawings, and photographs, as required by 40 CFR 270.13, is included with the Part A permit application (Volume 1) and in each Part A application included with the partial Part B permits. The INL Site currently has one RCRA permit (Volume 1) for the interim status unit, INTEC Tank Farm Facility (Volume 1). An interim status unit is a Part A (interim status) unit that has not been RCRA closed or has not been permitted under a Part B hazardous waste permit application. The INL Part B permits are considered a single RCRA permit that comprises several volumes, all under a single EPA ID number, ID 4890008952. Therefore, each of the six Part B Permit volumes is called a partial permit. Each partial Part B Permit includes the Part A application specific to the permitted units in that Part B and the Part B of the RCRA hazardous waste permit that contains detailed, site-specific information and hazardous waste operations as described in applicable Sections of 40 CFR 262 through 270.27. The INL currently has one RCRA post-closure permit. Post-closure permits ensure that appropriate monitoring and maintenance activities will be conducted on those units/land disposal units that leave hazardous waste in place closure (i.e., cannot clean close). *RCRA Reports.* As required by Idaho DEQ, the INL Site submitted the 2023 Idaho Hazardous Waste Generator Annual Report (CCN 332128) on the types and quantities of hazardous wastes generated, shipped for treatment and disposal, and remain in storage. Federal regulations require large quantity generators to submit a report every two years regarding the nature, quantities, and disposition of hazardous waste generated at their facility. The EPA refers to this as the National Biennial RCRA Hazardous Waste Report or biennial report. The biennial report form (EPA form 8700-13A/B) is submitted to Idaho DEQ by March 1 of every even-numbered year for the previous calendar year. The biennial report was submitted to the electronic RCRA Info Industry Application (Reno [CCN 332285]) for 2023. *RCRA Closure Plan.* The "Sodium Components Maintenance Shop Carbonation Vessel Partial HWMA/RCRA Closure Certification Report," EPA ID No. ID 48900008952, was submitted (CCN 254825) to and subsequently approved by	N/A

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
• 40 CFR 273, "Standards for Universal Waste Management" • 40 CFR 279, "Standards for the Management of Used Oil."	Idaho DEQ in 2023. Idaho DEQ also approved closure of the Advanced Mixed Waste Treatment Project (AMWTP) Transuranic Storage Area (TSA) Retrieval Enclosure Interim Status Unit (WMF-636, TSA 1/R) on May 23, 2023. Additionally, Idaho DEQ approved closure of the Radioactive Waste Management Complex (RWMC) - Accelerated Retrieval Project (ARP) Hazardous Waste Management Act (HWMA)/RCRA storage and treatment units on November 24, 2023. *RCRA Inspection.* For FY 2023, Idaho DEQ performed a RCRA inspection from May 8–11, 2023. On July 19, 2023, Idaho DEQ issued a warning letter to DOE-ID and ICP related to five previously self-disclosed events resulting in permit noncompliances noted by Idaho DEQ during the May inspection. *RCRA Consent Order.* Due to DOE-ID's inability to meet commitments to initiate waste treatment in the Integrated Waste Treatment Unit (IWTU) and cease the use of the INTEC interim status tanks, Idaho DEQ assessed a penalty to DOE-ID pursuant to the provisions under Section VII of the fifth modification to the Notice of Noncompliance-Consent Order, in the amount of $2,190,000 for the period of noncompliance from March 31, 2022, to March 30, 2023. Supplemental environmental projects were utilized in lieu of the original payment.	
OTHER ENVIRONMENTAL REQUIREMENTS		
DOE Order 231.1B, "Environmental, Safety, and Health Reporting" Environmental, Safety, and Health Reporting requires the timely collection and reporting of information on environmental issues that could adversely affect humans and the safety of the public and the environment at DOE sites. *Other environmental statutes, regulations, and directives apply, in whole or in part:* • DOE O 458.1, Change 4, "Radiation Protection of the Public and the Environment."	This report, "2023 Idaho National Laboratory Annual Site Environmental Report," fulfills DOE O 231.1B, the radiation protection requirements of DOE O 458.1, and documents and communicates the environmental performance to members of the public living near the INL Site and to other interested parties.	All chapters

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
DOE Order 232.2A, "Occurrence Reporting and Processing of Operations Information" In accordance with DOE O 232.2A, Occurrence Reporting and Processing of Operations Information, the INL Site ensures DOE personnel are notified of events that could adversely affect the health and safety of workers, the public, the environment, DOE's missions, or the credibility of DOE. Events are provided report levels (e.g., High, Low, Informational) to reflect the impact associated with a given occurrence in terms of health, safety and security. INL has a Tailoring Agreement in place that allows reporting most Informational events to DOE-ID through the INL issues management software (LabWay). Other events are also reported to DOE Headquarters through the Occurrence Reporting and Processing System (ORPS).	From January 1, 2023, to December 31, 2023, INL Site contractors did not report any events related to an environmental release under ORPS criteria in Group 5 – Environmental.	N/A
Emergency Planning and Community Right-to-Know Act (1986), 42 USC 11001, et seq. The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 was created to help communities plan for emergencies involving hazardous substances. The Act helps increase the public's knowledge and access to information on chemicals at individual facilities, their uses, and releases into the environment. States and communities, working with facilities, can use the information to improve chemical safety and protect public health and the environment. *Other environmental statutes and regulations apply, in whole or in part:* • IDAPA 58.01.02.851, "Petroleum Release Reporting, Investigation, and Confirmation."	The INL Site's 2023 compliance with key EPCRA provisions is summarized below. • *Section 304: Extremely Hazardous Substance Release Notification* – There were no CERCLA-reportable chemicals released at the INL Site during 2023. Section 304 requires owners and operators of facilities where hazardous chemicals are produced, used, or stored to report releases of CERCLA hazardous substances or extremely hazardous substances that exceed reportable quantity limits to state and local authorities (i.e., state emergency response commissions and local emergency planning committees). • *Section 311-312: Safety Data Sheet/Chemical Inventory* – Extremely hazardous substances, such as cyclohexylamine, nitric acid, nitrogen dioxide, and sulfuric acid were among the chemicals reported in 2023. Sections 311 and 312 require facilities manufacturing, processing, or storing designated hazardous chemicals to make safety data sheets describing the properties and health effects of these chemicals available to state and local officials and local fire departments. Facilities are also required to report inventories of all chemicals that have safety data sheets to state and local officials and local fire departments. The INL Site satisfies the requirements of	2.6.1

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
	Section 311 by submitting a quarterly report to state and local officials and fire departments, identifying chemicals that exceed regulatory thresholds. In compliance with Section 312, the annual Emergency and Hazardous Chemical Inventory (Tier II) Report is provided to local emergency planning committees, the state emergency response commission, and local fire departments by the regulatory due date of March 1. This report includes the types, quantities, and locations of hazardous chemicals and extremely hazardous substances stored at the INL Site and Idaho Falls facilities that exceed regulatory thresholds. In 2023, the chemical inventory report included 77 individual chemicals at INL Site facilities and 9 at Idaho Falls facilities. The INL Site also stores extremely hazardous substances, a category of chemicals that could cause serious irreversible health effects from accidental releases. • *Section 313: Toxic Chemical Release Inventory Reporting* – The INL Site submitted Toxics Release Inventory Forms for chromium, lead, manganese, mercury, naphthalene, nickel, nitrate compounds, and nitric acid, to the EPA by the regulatory due date of July 1. Section 313 requires facilities to submit a Toxics Release Inventory Form annually for regulated chemicals that are manufactured, processed, or otherwise used above applicable threshold quantities. Releases under EPCRA 313 reporting include transfers to waste treatment and disposal facilities off the INL Site, air emissions, recycling, and other activities. • *Reportable Environmental Releases* – INL had two reportable spills for INL Site contractors in 2023. See Section 2.6.1.	
DOE Order 436.1A, "Departmental Sustainability" The Order defines requirements and responsibilities for managing sustainability withing DOE and to ensure that the department carries out its missions in a sustainable manner that addresses national energy security and global environmental challenges, and advances sustainable, efficient and reliable energy for the future. *Other environmental statutes and regulations apply, in whole or in part:*	In 2023, DOE Order 436.1A, "Departmental Sustainability," was issued. The EO advances sustainable, efficient, reliable, and resilient energy for the future; promotes conservation of natural resources; and ensures DOE achieves its sustainability goals pursuant to applicable law, regulations, and EOs. DOE Order 436.1A requires INL Site contractors to maintain an Environmental Management System (EMS) either by being certified for use or in conformance with the ISO 14001:2015 standard following the accredited registrar provisions or self-declaration instructions. The ISO 14001:2015 model uses a system of policy	Chapter 3

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
• EO 13990, "Protecting Public Health and the Environmental and Restoring Science to Tackle the Climate Crisis" • EO 14008, "Tracking Climate Crisis at Home and Abroad" • EO 14057, "Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability" • Energy Act of 2020 • Energy Independence and Security Act of 2007.	development, planning, implementation, operation, checking, corrective action, and management review. Each contractor's EMS has been certified to the ISO 14001 Standard since 2005 and is certified by an external registrar every three years. Chapter 3 contains details on contractor EMS.	
Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations" The purpose of this EO is to focus federal attention on the environmental and human health effects of federal actions on minority and low-income populations with the goal of achieving environmental protection for all communities. *Other environmental statutes and regulations apply, in whole or in part:* • EO 14008, "Tackling the Climate Crisis at Home and Abroad" • EO 14057, "Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability."	DOE-ID and INL evaluate the potential for environmental justice (EJ) matters as part of the review processes implemented to identify potential environmental impacts from any and all proposed federal actions routinely as part of the NEPA compliance program. Consideration of EJ in NEPA analysis is driven by EO 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," and is further supported by EO 14008. The EOs effectively direct federal agencies to identify disproportionately high and adverse human health or environmental effects of federal programs, policies, and activities on minority, low-income, and minority and low-income populations and to take action to address such impacts. Section 2.3 contains details of DOE-ID and INL Site promotion of EJ and the outreach efforts that were taken in 2023.	2.3
RADIATION PROTECTION		
DOE Order 458.1, Change 4, "Radiation Protection of the Public and the Environment" "Radiation Protection of the Public and the Environment" was established to protect the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of DOE and DOE contractors.	The Order sets the public dose limit at a total effective dose not to exceed 100 mrem/yr (1 mSv/yr) above background radiation levels. Chapter 8 presents dose calculations for INL Site releases for 2023. The annual dose to the maximally exposed individual in 2023, as determined using CAA Assessment Package 88-PC, was 0.029 mrem (0.29 µSv).	Chapter 4 Chapter 5 Chapter 6 Chapter 7 Chapter 8 Appendix A

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Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
	DOE standard DOE-STD-1196-2022 (DOE 2022), "Derived Concentration Technical Standard," supports the implementation of DOE O 458.1. The standard defines the quantities used in the design and conduct of radiological environmental protection programs at DOE facilities and sites. These quantities, known as Derived Concentration Standards, represent the concentration of a given radionuclide in either water or air that results in a member of the public receiving 100 mrem (1 mSv) effective dose following continuous exposure for one year via each of the following pathways: (1) ingestion of water, (2) submersion in air, and (3) inhalation. Measurements of radionuclides in environmental media sampled on and around the INL Site were all below applicable Derived Concentration Standards. DOE O 458.1 specifies the limits for unrestricted release of property to the public. INL Site contractors use a graded approach for release of material and equipment for unrestricted public use. Material has been categorized so that in some cases an administrative release can be accomplished without a radiological survey. Such material originates from controlled areas and includes the following: • Personal items or materials • Documents, mail, diskettes, compact disks, and other office media • Paper, cardboard, plastic products, aluminum beverage cans, toner cartridges, and other items for recycling • Office trash • Non-radiological area housekeeping materials and associated waste • Breakroom, cafeteria, and medical wastes • Medical and bioassay samples • Other items with an approved release plan. Items originating from radiological areas within the INL Site's controlled areas not in listed categories are either surveyed prior to release to the public, or a process knowledge evaluation is conducted to verify the item has not been exposed to radioactive material or beams of radiation capable of creating radioactive material. In some cases, both a radiological survey and a process knowledge evaluation are	

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
	performed (e.g., a radiological survey is conducted on the outside of the item, and a process knowledge form is signed by the custodian for inaccessible surfaces). When the process knowledge approach is employed, the history of the material confirms that no radioactive material has passed through or contacted the item. Items advertised for public sale via an auction are also surveyed by the contractor prior to shipment to the INL Site property/excess warehouse, where the materials are again resurveyed on a random basis by personnel prior to release, giving further assurance this material is not released with inadvertent contamination. All contractors complete material surveys prior to release and transport to the state-permitted landfill at CFA. The only exception is for items that could be internally contaminated; these items are submitted to Waste Generator Services for disposal using one of the offsite treatment, storage, and disposal facilities that can accept low-level contamination. DOE-ID, using a graded approach, provides oversight of the INL clearance processes. For the 2023 calendar year, the INL contractor had 1,326 releases of personal property items with over 99% of these releases being for reuse at INL (i.e., instruments for calibration, miscellaneous tools, and equipment). Those that were not released for reuse were released for appropriate disposal. The ICP contractor diverted 158,920 lbs of carbon steel and aluminum scrap and 479,440 lbs of mixed-metal scrap from onsite landfills in 2023 by sending it to an offsite recycling facility. The scrap metal was accumulated during the deactivation and decommissioning of the Submarine 1st Generation Westinghouse prototype at the Naval Reactors Facility. Before their release, these materials were characterized to ensure they were not a hazardous waste and that they were deemed free of radioactive contamination based on surveys performed by Radiological Protection personnel. On January 12, 2000, the Secretary of Energy established a DOE moratorium on the unrestricted release of all volumetrically contaminated metals. On July 13, 2000, DOE suspended “the unrestricted release for recycling of scrap metal from radiological areas within DOE facilities” (DOE Secretarial	

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
	Memorandum: Release of Surplus and Scrap Materials; Memorandum from Bill Richardson to Heads of Departmental Elements). The moratorium and suspension of the release of metals from DOE sites remain in effect. INL Site contractors continue to follow the requirements of these Secretarial Memorandums. No scrap metal directly released from radiological areas is recycled.	
Toxic Substance Control Act (1976), 15 USC 2601 et seq The TSCA, which is administered by the EPA, requires the regulation of production, use, or disposal of chemicals. TSCA supplements sections of the CAA, Clean Water Act (CWA), and Occupational Safety and Health Act. *Other environmental statutes and regulations apply, in whole or in part:* • 40 CFR 761, Subpart J, "General Records and Reports."	Because the INL Site does not produce chemicals, compliance with the TSCA is primarily directed towards the use and management of certain chemicals—particularly polychlorinated biphenyls (PCBs). The INL Site manages radioactive mixed waste containing PCBs received from other DOE sites many years ago for disposal. Environmental remediation activities include the reprocessing of these waste materials for disposition offsite. In addition, PCBs were used in the manufacture of many different items and materials, including liquid-filled electrical equipment such as transformers and capacitors, paint, and caulking. Whenever any of these items or materials are discovered, they are disposed of off the INL Site at a TSCA-approved disposal facility. Requirements for the reporting of PCB-related activities are found in 40 CFR 761, Subpart J, "General Records and Reports." The INL contractor manages TSCA Risk-based Disposal Approvals (RBDAs) at the ATR Complex, which establishes an agreement with the EPA to properly dispose of and/or decontaminate PCB waste in accordance with 40 CFR 761. TSCA RBDAs are situational based off discovery with the intention of minimizing risk to human health and the environment. TRA-641 was developed to address painted surfaces in the empty canal under 40 CFR 761.62(c) for paint, and under 40 CFR 761.61(c) for PCBs, that may have penetrated the concrete. TRA-619 was developed to address the short-term cleanup and disposal of applied PCB paint and interim cleanup of PCBs that have penetrated the concrete flooring from the application of PCB paint under 40 CFR 761.61(c). The ICP contractor holds RBDAs, granted by EPA Region 10, which allow for processing of PCB-contaminated legacy sludge wastes from the Rocky Flats Plant	N/A

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
	at two of the facilities located at RWMC; however, the RBDA for ARP VIII was closed in 2023. Per 40 CFR 761.20(c)(2)(ii), processing activities that are primarily associated with and facilitate treatment or disposal require TSCA PCB approval. Work performed under these RBDAs ensures that these wastes can be accepted for disposal at the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico.	
WATER QUALITY AND PROTECTION		
Clean Water Act (1972), 40 CFR 109-140, 33 USC 1251, et seq. The CWA established goals to control pollutants discharged to U.S. surface waters. Among the main elements of the CWA are effluent limitations for specific industry categories set by EPA, as well as regulating water quality standards for surface water. The CWA also provided for the National Pollutant Discharge Elimination System permit program, requiring permits for discharges into regulated surface waters. *Other environmental statutes and regulations apply, in whole or in part:* • IDAPA 58.01.16, "Wastewater Rules" • IDAPA 58.01.25, "Rules Regulating the Idaho Pollutant Discharge Elimination System Program."	Idaho DEQ is authorized by the EPA as the permitting authority over the National Pollutant Discharge Elimination System program. The Idaho DEQ program is called the Idaho Pollutant Discharge Elimination System (IPDES). INL Site contractors do not currently hold any IPDES permits but in-town facilities discharge to the city of Idaho Falls wastewater treatment plant, which is required by the IPDES permit program to set pretreatment standards for nondomestic discharges to publicly-owned treatment works. The INL Research Center (IRC) complied with an Industrial Wastewater Acceptance permit that was in effect until March 15, 2023, for discharges to the city of Idaho Falls. This program is set out in Title 8, Chapter 1 of the Municipal Code of the city of Idaho Falls. All discharges in 2023 were within levels established in the IRC Industrial Wastewater Acceptance permit. The city of Idaho Falls did not perform an inspection in 2023. On March 15, 2023, the city of Idaho Falls notified INL that based on review of INL's flow data, sampling data, water savings, and low pollutant levels, the city no longer considers IRC to be a Significant Industrial User, so a permit is no longer required for discharge into the city of Idaho Falls publicly-owned treatment works (Henricksen 2023).	N/A
Idaho Reuse Permits Idaho defines recycled water as water that has been treated by a wastewater treatment system and is used in accordance with the Recycled Water Rules. *Other environmental statutes and regulations apply, in whole or in part:* • IDAPA 58.01.11, "Ground Water Quality Rule"	Wastewater is the spent water or effluent from activities and processes occurring in dwellings, commercial buildings, industrial plants, institutions, and other establishments. If the wastewater contains sewage, it is considered municipal wastewater. If it does not contain sewage, it is considered industrial wastewater. Recycled water is wastewater effluent that is treated, if necessary, and then reused for other purposes. Idaho DEQ encourages reuse, which is the practice of using recycled water for irrigation, ground water recharge, landscape	Chapter 5 Chapter 6 Appendix A

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
• IDAPA 58.01.16, "Wastewater Rules" • IDAPA 58.01.17, "Recycled Water Rules."	impoundments, toilet flushing in commercial buildings, dust control, and other beneficial uses. Idaho DEQ requires anyone choosing to use recycled water to obtain a reuse permit. Reuse permits consider the site-specific conditions of each facility and include site-specific limits and conditions, as applicable, to protect public health and the environment, including groundwater. Idaho DEQ issues these permits in accordance with IDAPA 58.01.17, "Recycled Water Rules;" IDAPA 58.01.16, "Wastewater Rules;" and IDAPA 58.01.11, "Ground Water Quality Rule." The following facilities have reuse permits at the INL Site: • ATR Complex Cold Waste Ponds (I-161-03) • INTEC New Percolation Ponds (M-130-06) • MFC Industrial Waste Pond (I-160-02). Idaho DEQ did not inspect the INL Site contractors reuse systems in 2023. All reuse systems at the INL Site were operated in substantial compliance with permit requirements during 2023.	
Safe Drinking Water Act (1974), 40 CFR 141-143, 42 USC 300f, et seq. The Safe Drinking Water Act establishes primary standards for public water supplies to ensure it is safe for consumption. *Other environmental statutes and regulations apply, in whole or in part:* • 40 CFR 141, "National Primary Drinking Water Regulations" • 40 CFR 143, "National Secondary Drinking Water Regulations" • IDAPA 58.01.08, "Idaho Rules for Public Drinking Water Systems."	INL Site drinking water complied with all applicable federal and state water quality standards in 2023. Eleven potable water systems are permitted by Idaho DEQ. Each potable water system is sampled according to a monitoring cycle that identifies specific contaminants and sampling frequency, ranging from monthly, quarterly, or once every 1, 3, 6, or 9 years. In addition to regulatorily required sampling, INL Site contractors performed additional surveillance monitoring for bacteriological contaminants, radiological contaminants, and per- and poly-fluoroalkyl substances in 2023. DEQ conducted sanitary surveys of the ATR Complex, MFC, TAN Contained Test Facility, INTEC, and NRF D&D public water systems in 2023. No significant deficiencies were found.	6.7

Table 2-1. continued.

REGULATORY PROGRAM DESCRIPTION	2023 COMPLIANCE STATUS	REPORT SECTIONS
QUALITY ASSURANCE		
10 CFR 830, Subpart A, "Quality Assurance Requirements" 10 CFR 830, Subpart A, establishes quality assurance requirements for contractors conducting activities, including providing items or service that affect, or may affect, the nuclear safety of DOE nuclear facilities. *Other environmental statutes and regulations apply, in whole or in part:* • DOE O 414.1D, Change 2, "Quality Assurance."	Quality assurance and quality control programs for environmental surveillance monitoring were maintained in 2023 by INL Site contractors and laboratories performing environmental analyses. Results are summarized in Chapter 10, Section 10.4. Field sampling elements, laboratory measurements, and performance evaluation samples were reviewed and evaluated for each INL contractor laboratory. Together, this information was used to assess the quality of data provided to INL Site contractors, and to follow-up and/or conduct corrective action to improve processes when necessary. This multi-faceted approach to quality assurance and quality control added value to each INL Site contractor's monitoring program by providing confidence that all laboratory data reported in this report are reliable and of acceptable quality.	Chapter 10

Table 2-2. 2023 status of active WAGs.

WAG	FACILITY	STATUS
1	Test Area North	Groundwater cleanup of trichloroethene for OU 1-07B continued through 2023 in accordance with EPA- and Idaho DEQ-approved plans (DOE-ID 2022a, 2022b). The New Pump and Treat Facility generally operated four days per week, except for downtime due to maintenance, to maintain trichloroethene concentrations in the medial zone below specified targets. The in-situ bioremediation (ISB) transitioned into a rebound test in 2012 to determine the effectiveness of the remedy to date. The revised test plan was finalized in early 2017 to establish how the groundwater cleanup at TAN will continue. Two ISB injection wells were constructed in 2015 to further ISB efforts, while one monitoring well was constructed in 2017 to better monitor the plume at its distal edge. During 2021, one ISB injection well was constructed, and further ISB continues in a specific area where previous efforts had not achieved the desired reduction in contaminant levels. All ICs and operations and maintenance (O&M) requirements were maintained during 2023 (DOE-ID 2024c).
3	Idaho Nuclear Technology and Engineering Center	The Idaho CERCLA Disposal Facility, located southwest of INTEC, disposes of contaminated soils and debris from CERCLA remediation operations for the protection of human health and the environment. Operations and monitoring at the Idaho CERCLA Disposal Facility (ICDF) are carried out in accordance with EPA- and Idaho DEQ-approved plans (DOE-ID 2018a, 2023a, 2023b). The consolidation of waste at the ICDF reduces the risk of exposure to contaminants for human and ecological receptors, and the use of an engineered facility with leachate collection protects the underlying Snake River Plain Aquifer. The ICDF functions as an INL Site-wide disposal facility for CERCLA soils and debris from other WAGs in compliance with strict waste acceptance criteria. The facility continues to receive small amounts of liquid and solid waste periodically for disposal in the ICDF evaporation ponds and disposal cells, respectively. The ICDF evaporation ponds and the Snake River Plain Aquifer are sampled annually; results are sent to the EPA and Idaho DEQ. Remedial actions and monitoring required by the WAG 3, OU 3-14 ROD (DOE-ID 2007a) are implemented through EPA- and Idaho DEQ-approved plans (DOE-ID 2018b, 2018c). Remedial actions at the Tank Farm Facility (TFF) are designed to reduce water infiltration that potentially could transport contaminants from the vadose zone and the perched water to the underlying aquifer. An interim low-permeability asphalt barrier was placed over the western two-thirds of the TFF during 2017 to further reduce infiltration of precipitation water until a final cover is constructed over the TFF after closure of the final four tanks. Perched and groundwater monitoring under and near the TFF will continue until the risk posed by contamination left in place is below target levels. All ICs and O&M requirements were maintained in 2023.
7	Radioactive Waste Management Complex	WAG 7 includes the Subsurface Disposal Area (SDA), a 97-acre radioactive waste landfill that is the major focus of remedial response actions at RWMC (Figure 2-3). Waste was buried in approximately 35 of the 97 acres within 21 unlined pits, 58 trenches, 21 soil vault rows, and, on Pad A, an above-grade disposal area. Disposal requirements have changed in accordance with laws and practices current at the disposal time. Initial operations began in 1952 and were limited to shallow, landfill disposal of waste generated at the INL Site. Beginning in 1954, the DOE Rocky Flats Plant near Boulder, Colorado, was authorized to send waste to RWMC for disposal. The Rocky Flats Plant was a nuclear weapons production facility with peak operations during the Cold War era. Various types of radioactive waste streams were disposed of, including process waste (e.g., sludge, graphite molds and fines, roaster oxides, evaporator salts), equipment, and other waste incidental to production (e.g., contaminated gloves, paper, clothing,

Table 2-2. continued.

WAG	FACILITY	STATUS
		other industrial trash). Much of the Rocky Flats Plant waste was contaminated with TRU isotopes and solvents (e.g., carbon tetrachloride). In 1970, burial of TRU waste was prohibited. In 1984, disposal practices were modified to eliminate disposal of mixed waste. Since 1984, only LLW was disposed of in the SDA at the Active LLW Disposal Facility (ALLWDF). Disposal of waste from offsite generators was discontinued in the early 1990s, and disposal of contact-handled waste was discontinued at the end of FY 2008. Disposal operations at the ALLWDF were completed in May 2021, and interim closure of the ALLWDF was completed in August 2022 (MacRae 2022). Final closure of the SDA and ALLWDF is addressed under the OU 7-13/14 ROD. The OU 7-13/14 ROD (DOE-ID 2008a) is consistent with DOE's obligations for TRU waste removal under the "Agreement to Implement U.S. District Court Order Dated May 25, 2006," between the Idaho DEQ and DOE-ID, effective July 3, 2008 (U.S. District Court 2008). The ROD calls for exhuming and packaging a minimum of 6,238 m^3 (8,159 yd^3) of targeted waste from a minimum combined area of 5.69 acres. Targeted waste for retrieval contains TRU elements (e.g., plutonium), uranium, and collocated organic solvents (e.g., carbon tetrachloride). Targeted waste retrievals in specific areas of the SDA commenced in 2005 and were completed in December 2021. The retrieved targeted waste is packaged, certified, and shipped out of Idaho. A total of 10,417.5 m^3 (13,625.58 yd^3) of targeted waste was retrieved and packaged for offsite shipment. In addition to targeted waste retrieval, the ROD addresses the remaining contamination in the SDA through a combination of vapor-vacuum extraction and treatment of solvent vapors from the subsurface (completed in August 2020; RPT-1904) and in-situ grouting of specified waste forms containing mobile contaminants (completed in 2010; DOE-ID 2011a). Quarterly monitoring of the solvent vapors in the vadose zone will continue in accordance with the Operations & Maintenance Plan (DOE-ID 2023c). However, most of the vapor ports used for monitoring within the SDA footprint have been removed in preparation for the third phase of the ROD. The third and final phase of the ROD includes constructing an evapotranspiration surface barrier over the entire SDA landfill, followed by long-term management and control after construction is complete. Demolition and decommissioning of structures within the SDA have commenced in preparation for construction of the SDA cap.
10	10-04 INL Site-wide Miscellaneous Sites and Comprehensive RI/FS	OU 10-04 addresses long-term stewardship functions—ICs and O&M for sites that do not qualify for Unlimited Use/Unrestricted Exposure—and explosive hazards associated with historical military operations on the INL Site. All ICs and O&M requirements were maintained in 2023, under the Site-wide IC/O&M Plan (DOE-ID 2022c). The fourth Site-wide CERCLA five-year review covering the period from 2015 through 2019 was finalized in January 2021. The purpose of the CERCLA 5-year review is to verify that implemented cleanup actions continue to meet cleanup objectives documented in the RODs. The next CERCLA 5-year review will begin in late 2024.
	10-08 INL Site-wide Groundwater, Miscellaneous Sites, and Future Sites	OU 10-08 addresses Site-wide groundwater, miscellaneous sites, and future sites (DOE-ID 2009). Response actions for OU 10-08 are mostly complete, and ongoing activities include groundwater monitoring and evaluating and remediating potential new sites that are discovered. Biennial groundwater monitoring was performed in 2023 (DOE-ID 2021) to verify there is no unacceptable threat to human health or the environment from commingled plumes or along the southern INL Site boundary.

2.3 Environmental and Energy Justice

DOE defines EJ as the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (energy.gov). Several EOs require federal departments to address EJ: EO 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," Section 1-1; EO 14008, "Tackling the Climate Crisis at Home and Abroad," Section 219; and EO 14057, "Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability," Section 402.

Additionally, the federal government established the Justice Initiative with a goal that 40% of the overall benefits of certain federal investments flow to disadvantaged communities, which have been marginalized, underserved, and overburdened by pollution. The seven categories of investment include (1) climate change, (2) clean energy and energy efficiency, (3) clean transit, (4) affordable and sustainable housing, (5) training and workforce development, (6) remediation and reduction of legacy pollution, and the (7) development of critical clean water and wastewater infrastructure. Through the Inflation Reduction Act, Bipartisan Infrastructure Law, and the American Rescue Plan, federal agencies are making historic levels of investment to advance EJ.

DOE and INL identify disadvantaged communities using the methodology prescribed by the President's Council on Environmental Quality. The Council on Environmental Quality Climate and Economic Justice Screening Tool (CEJST) methodology identifies a community (2010 U.S. census tract) as disadvantaged if it meets both a socioeconomic burden threshold and an environmental burden threshold. Types of environmental burdens include climate change, health, housing, transportation, pollution, energy, workforce development, and water. A tract is also considered disadvantaged if it overlaps an Indian reservation. Of the eighty 2010 U.S. census tracts in the INL region of influence, 27 of them are identified as disadvantaged. Tracts surrounding and overlapping the INL Site, as well as the tract encompassing the INL REC are considered disadvantaged. There are also several tracts in Pocatello, Idaho Falls, and rural unincorporated areas that exceed one or more of the burden thresholds (Figure 2-1). Although many tracts meet more than one threshold, and there are a variety of burdens impacting the INL region of influence, climate change impacts more communities than any other threshold. Much of this is due to the economic risks facing agriculture in the area (i.e., cold snaps, wind, and drought) and the health risks facing lower-income communities (older houses at risk of flood or with inadequate heating and cooling). Notably, there are no communities that meet any water thresholds within the region of influence. Common socioeconomic burdens in the INL region of influence include a high percentage of households below 100% of the federal poverty line and a large number of individuals who do not hold a high school diploma or equivalent. For more information on methodology and sources, please visit the CEJST website.

2.3.1 Initiatives

The INL Site established an Environmental Justice Program in 2021, which recognizes that communities across the globe will be tackling similar challenges in the transition to clean energy. The INL Site aspires to be an EJ leader, setting an example of how to incorporate multiple voices and viewpoints in efforts to ensure a just energy transition inclusive of EJ priorities and community engagement. The program focuses on the sustainable stewardship of natural resources through relationships between humans and environmental systems.

In support of INL's EJ efforts, a two-day Intertribal Engagement Meeting was held on September 13-14, 2023. This collaborative event involved the INL's Center for Advanced Energy Studies (CAES), University of Idaho, and three out of five Idaho Tribes, as well as one Oregon Tribe. The purpose of the meeting was to explore the inclusion of Indigenous science and knowledge in INL Research. The Tribes had the opportunity to introduce their culture, traditions, and thoughts on incorporating Indigenous science into research methods. The INL contractor, in turn, provided tours of the CAES center, INL Site, Energy Systems Laboratory, and Collaborative Computing Center to showcase scientific research. Representatives from the university also shared research and work related to Indigenous and local knowledge in science. Breakout sessions were held to foster collaborative discussions about Indigenous science and western science efforts, and whether inclusion is feasible. The discussions were impactful, and all attendees expressed enthusiasm for continuing this effort and expressed hope that INL will move forward with this endeavor.

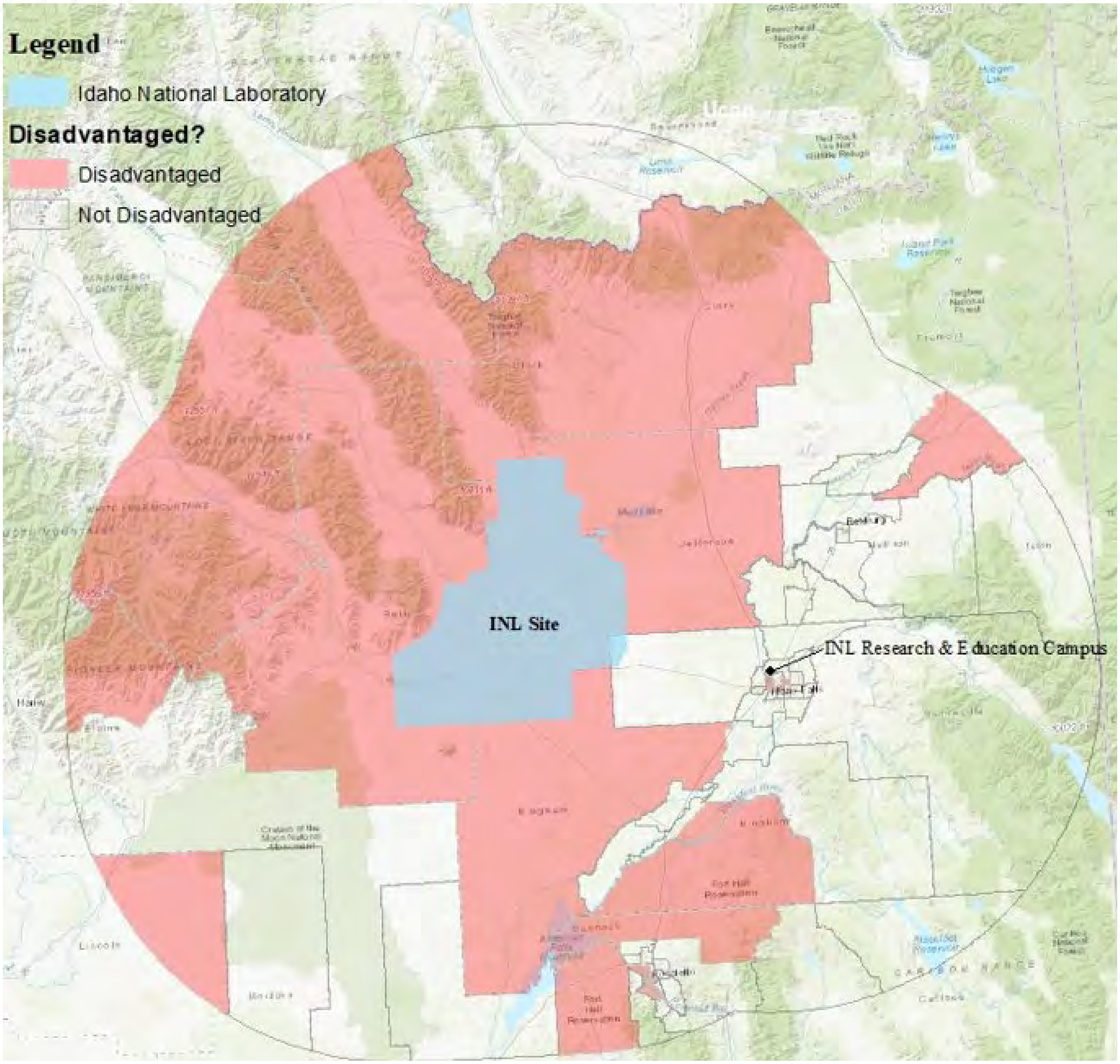

Figure 2-1. Disadvantaged communities near the INL region.

DOE-ID established a Working Agreement with the Shoshone-Bannock Tribes in 1992 that was later developed into an AIP. DOE-ID and the Tribes have negotiated multiple five-year AIPs since that initial Working Agreement, the latest of which was signed in September 2022 (https://idweb.id.doe.lcl/IDMSOther/PDF/AIP_Signed.pdf). The AIP is designed to promote increased interaction and cooperation on issues of mutual concern. This AIP reflects the understanding and commitment between the parties to increase the tribes' level of assurance that activities conducted at the INL Site protect the health, safety, environment, and cultural resources and address the tribal interests in DOE-administered programs. It is applicable to actions and operations of DOE-ID and its contractors on the lands of the INL Site that affect original ancestral territory and tribal lands. DOE-ID considers the AIP as an important mechanism through which environmental and energy justice matters are addressed. Annual funding from DOE-ID through Cooperative Agreements support the Tribal DOE and Office of Emergency Management programs.

The INL Site made significant progress toward meeting the goals and milestones of the laboratory's memorandum of understanding (MOU) with the Shoshone-Bannock Tribes in three main topics areas: (1) science, technology, engineering, and mathematics (STEM)-adjacent workforce development; (2) STEM school designation; and (3) STEM internships and scholarships. Established in 2021, the MOU with the Shoshone-Bannock School District #537 is a close collaboration with the Tribes to create meaningful education and career pathways for tribal students. This MOU creates a place-based, culturally responsive program designed to both bring opportunities to tribal schools and bring students to the laboratory for work-based learning. The K–12 Education team assisted the faculty and administration of the Shoshone-Bannock School District #537 to design culturally responsive teaching and learning through project-based, place-based, and service-learning approaches as they worked towards STEM school designation:

- Built a sweat lodge and surrounding seating, enhancing opportunities for the Shoshone-Bannock community to participate in traditional customs.
- Built a gazebo and picnic benches for students to eat lunch at, refurbished portions of various athletics facilities, and built a memorial bench to commemorate a teacher who recently passed away. All of these projects improved accessibility and enhanced the student experience at Shoshone-Bannock Jr./Sr. High School.
- Designed and built a display box to hold a scale model of traditional Shoshone-Bannock structures and lands designed by eighth-grade students.
- Performed maintenance and repairs on school buses and community members' vehicles, improving transportation reliability for students and the community.

Second year coursework was successfully delivered in both the industrial mechanics and construction trades pathways. Shoshone-Bannock High School Career technical students studying either industrial mechanics or construction trades were eligible to participate in a six-week paid summer internship at the INL Site, working under the supervision of instructors and safety personnel through the INL Site Future Corps Program. In 2023, the second cohort of nine Shoshone-Bannock-High School students for the Work-Based Learning Program spent six weeks working onsite with mentors from INL Site's Facilities and Site Services and MFC directorates to explore trades, crafts, fabrication, and operations. The coursework and Work-Based Learning Program prepares students with the skills and experience necessary for entry-level trades and crafts positions at the INL Site.

The INL Site K–12 Education team collaborated with the INL Site's CRMO to sponsor Earth Day activities for every age group, including an art contest, a traditional native ceremony, a cultural resource tour of the Middle Butte Cave, and a Shoshone-Bannock-led dancing exhibition at CFA for nearly 85 Shoshone-Bannock Tribal members and students (Figure 2-2).

Figure 2-2. Traditional Shoshone-Bannock tribal dancer celebrating Earth Day at CFA.

INL partnered with the Tribes for the annual Shoshone-Bannock Indian Festival, a celebration of Shoshone-Bannock culture and traditions. The event attracts thousands of attendees from both Indian country and other populations.

The INL Site's K–12 Education team hosted community STEM nights at the Shoshone-Bannock High School and staged career exploration events for Tribal Youth Education Programs on the Fort Hall Indian Reservation for students and their families with interactive STEM-learning activities.

The DOE-ICP is working towards the end-state and long-term stewardship (LTS) of the INL Site. It is commonly accepted amongst DOE, tribes, and stakeholders that LTS is the actions that survey/monitor and maintain Land Use Controls and ensures the protection of human and health and the environment is accomplished in perpetuity. In FY 2022, DOE-ICP provided funding for the Shoshone-Bannock Tribal DOE and Air Quality Program and Heritage Tribal Office cultural resources program involvement in LTS activities to develop and implement a Tribal LTS Program on the INL Site. The Tribal LTS Program will work to integrate culturally based knowledge and principles into existing ICP LTS plans and activities. The Tribal LTS Program will form a “Tribal LTS Collaborative Group” to ensure the Tribes’ goals are implemented in coordination with the Fort Hall Business Council, Tribal Departments, and the DOE-ICP.

The DOE-ID and INL Site evaluate the potential for EJ matters as part of the review processes implemented to identify potential environmental impacts from all proposed federal actions routinely as part of the NEPA compliance program. Consideration of EJ in NEPA analysis is driven by EO 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” and is further supported by EO 14008. The EOs effectively direct federal agencies to identify disproportionately high and adverse human health or environmental effects of federal programs, policies, and activities on minority populations and low-income populations and to take action to address such impacts. Although EJ has been a part of the INL Site NEPA processes since President Clinton signed EO 12898 in 1994, the INL Site’s NEPA team and EJ program have made significant efforts in recent months to become a leader in EJ within the national laboratory system.

In the sustainability realm, the DOE Bioenergy Technologies Office, Argonne National Laboratory, and the INL Site K–12 Education Team created and promoted a bioenergy toolkit for educators as part of the Bioenergy Research and Education BRIDGES project. The toolkit translates DOE scientific bioenergy research to the classroom, providing equitable access to high-quality learning materials and easing the transition from academics to industry as part of a workforce development and diversity, equity, and inclusion initiative. The INL Site field-tested two case studies aligned to the laboratory’s Bioenergy Science and Technology portfolio and industry needs, called “Regional Feedstocks: Are They the Answer to Achieving Net Zero?” and “Solid Waste to Energy: Traditional Ecology and Environmental Justice,” and trained teachers on how to implement the case studies in their classrooms. The case studies draw inspiration from Bioenergy Technologies Office science and technology research for long-term adaptation, resiliency, and sustainable practices and policies for historically marginalized communities across the U.S. BRIDGES is built on a framework that allows for place-based learning and culturally responsive teaching, supporting diversity, equity, and inclusion initiative.

2.4 INL Site Agreements

DOE-ID has four major site agreements that contain regulatory commitments and milestones. These major site agreements are known as the Federal Facility Agreement and Consent Order (FFA/CO) (DOE 1991), Site Treatment Plan (DOE-ID 2023d), the Idaho Settlement Agreement (ISA) (DOE 1995), and the Notice of Noncompliance/Consent Order (NON/CO) (CCN 317575).

Federal Facility Agreement and Consent Order

Past INL Site activities, since its inception in 1949, resulted in suspected and confirmed releases of contaminants to the environment. As a result, the INL was added to the EPA’s National Priority List of CERCLA sites in 1989. The FFA/CO is a CERCLA-based legally binding cleanup agreement that was signed in 1991 by Idaho DEQ, EPA, and DOE.

As a CERCLA site, DOE conducts risk-based cleanup, which is subject to DEQ and EPA approval in accordance with the FFA/CO. This means that if a confirmed contaminant release to soil and/or groundwater poses an unacceptable risk to either humans or the environment, it requires cleanup or the establishment of controls to keep people, plants, or animals from coming into contact with the waste. If a site poses little to no risk, either limited action or no action is taken.

Since 1991, EPA, DEQ, and DOE have signed 25 RODs on individual contaminant release sites and entire facilities at the INL. Cleanup actions continue at TAN, INTEC, and RWMC. The FFA/CO subdivided the INL into 10 WAGs to facilitate remediation. These groups contain individual sites that are organized into OUs based on proximity or similar characteristics. WAGs 1-9 comprise the major facilities at the INL, while WAG 10 encompasses the remaining portions of the INL Site and INL Site-wide groundwater issues. Each WAG has a comprehensive ROD that addresses human and ecological risk and has actions to restore or protect groundwater within 100 years.

Site Treatment Plan

The Federal Facility Compliance Act of 1992 requires the preparation of site treatment plans for the treatment of mixed waste stored or generated at DOE facilities. Mixed waste contains both hazardous and radioactive components. The Federal Facility Compliance Act Consent Order and Site Treatment Plan was finalized and signed by the state of Idaho on November 1, 1995, and is updated annually (DEQ 1995). This plan outlines DOE-ID's proposed treatment strategy for mixed waste streams, called the backlog, and identifies onsite and offsite mixed LLW treatment capabilities.

During 2023, DOE-ID completed two Site Treatment Plan milestones, including one associated with the treatment of remote-handled waste and the other to commence operation of the Sodium Bearing Waste Facility. DOE-ID made a request to Idaho DEQ to extend milestones for the Sodium Bearing Waste Treatment Facility, original volume transuranic reclassified as mixed LLW (associated with sludge reprocessing), the original volume transuranic waste certification, and the Calcine Disposition Project. All milestone requests were determined to have good cause and were subsequently approved. Current milestones can be seen in the FY 2024 Site Treatment Plan.

Idaho Settlement Agreement (ISA)

On October 16, 1995, DOE-ID, the U.S. Navy, and Idaho DEQ entered into an agreement (also known as the ISA) that guides management of spent nuclear fuel (SNF), HLW, and TRU waste at the INL Site. The agreement (DOE 1995) limits shipments of DOE-ID and Naval SNF into the state and sets milestones for shipments of SNF and radioactive waste out of the state.

The ISA, as related to requirements found in the agreement, dated May 25, 2006, required the exhumation of TRU waste from the SDA at the RWMC. The DOE and ICP workforce safely completed the required 5.69-acre exhumation and removal of associated targeted waste ahead of the regulatory milestone due date.

The Site Treatment Plan and ISA required DOE-ID to process and ship all covered waste out of Idaho by December 31, 2018, respectively, stored as TRU waste on the INL Site in 1995, when the agreements were signed. The estimated volume of that waste was 65,000 m^3 (85,016 yd^3). This milestone was not achieved; however, revised Site Treatment Plan milestones were agreed upon with Idaho DEQ; an addendum to the ISA was signed on November 6, 2019, to address the milestone.

As of December 31, 2023, approximately 5,600 m^3 of original volume TRU-contaminated waste remains onsite. DOE-ID made 386 shipments of TRU waste to WIPP in calendar year 2023, comprised of 53 shipments of ISA legacy waste and 333 shipments of ARP exhumed waste.

The ICP contractor manages and operates several projects to facilitate the disposition of radioactive waste as required by the ISA and Site Treatment Plan. The AMWTP performs retrieval, characterization, treatment, packaging, and shipment of TRU waste currently stored at the INL Site. Most of the waste processed at the AMWTP resulted from the manufacture of nuclear components at DOE's Rocky Flats Plant in Colorado. This waste is contaminated with TRU radioactive elements (primarily plutonium).

Notice of Noncompliance/Consent Order (NON/CO)

The final agreement, the NON/CO and recent modification, in conjunction with the Site Treatment Plan, requires the treatment of sodium-bearing waste to be stored at the INTEC Tank Farm at the IWTU. To meet the milestones in the NON/CO and Site Treatment Plan, DOE-ID and its ICP contractor implemented a methodical approach to start-up the IWTU in early 2017 which was completed in 2023 when the facility began processing the remaining 3,407,000 L (900,000 gal) of liquid waste stored at INTEC. This waste is stored in three stainless steel underground tanks, while a fourth is always kept empty as a spare. All four tanks will be closed in compliance with hazardous waste regulations. A total of 11 other liquid storage tanks have been emptied, cleaned, and closed. The waste was originally scheduled to begin processing in 2012, but several technical problems delayed the IWTU.

The IWTU completed a facility outage implementing needed facility modifications in preparation for supporting sustained radiological waste treatment operations in July 2021. Following successful completion of readiness verification activities, the IWTU commenced a final confirmatory run-on simulant waste feed in late 2021. Technical challenges delayed completion of the final confirmatory run until mid-2022. These issues were adequately resolved, and the facility re-commenced its test run-in May. The facility successfully completed the final confirmatory run-in late July 2022 along with a final round of readiness assessments for radiological operations. The facility processed 137,000 gallons of simulated waste over 65 days of continuous operation filling 125 product canisters. The facility shut down and entered a planned outage to inspect process vessels/components, conduct maintenance, and make minor modifications, which concluded in November. The facility-initiated plant start-up for simulant testing in late 2022 and radiological operations began in April 2023. With completion of system performance testing in August 2023, IWTU transitioned out of interim operation status. From April to September 2023, IWTU safely treated ~ 68,000 gallons of sodium-bearing waste from the INTEC TFF. IWTU suspended operations, shut down and entered a maintenance period in September 2023 to replace expended media (which had become saturated with mercury) in the granular activated carbon vessels in accordance with operating permit requirements.

2.5 Low-Level and Mixed Radioactive Waste

In 2023, approximately 306 m^3 (400 yd^3) of mixed low-level waste and 211 m^3 (276 yd^3) of LLW was shipped off the INL Site for treatment, disposal, or both, by the ICP contractor. In 2023, no LLW was disposed of at the SDA (Figure 2-3).

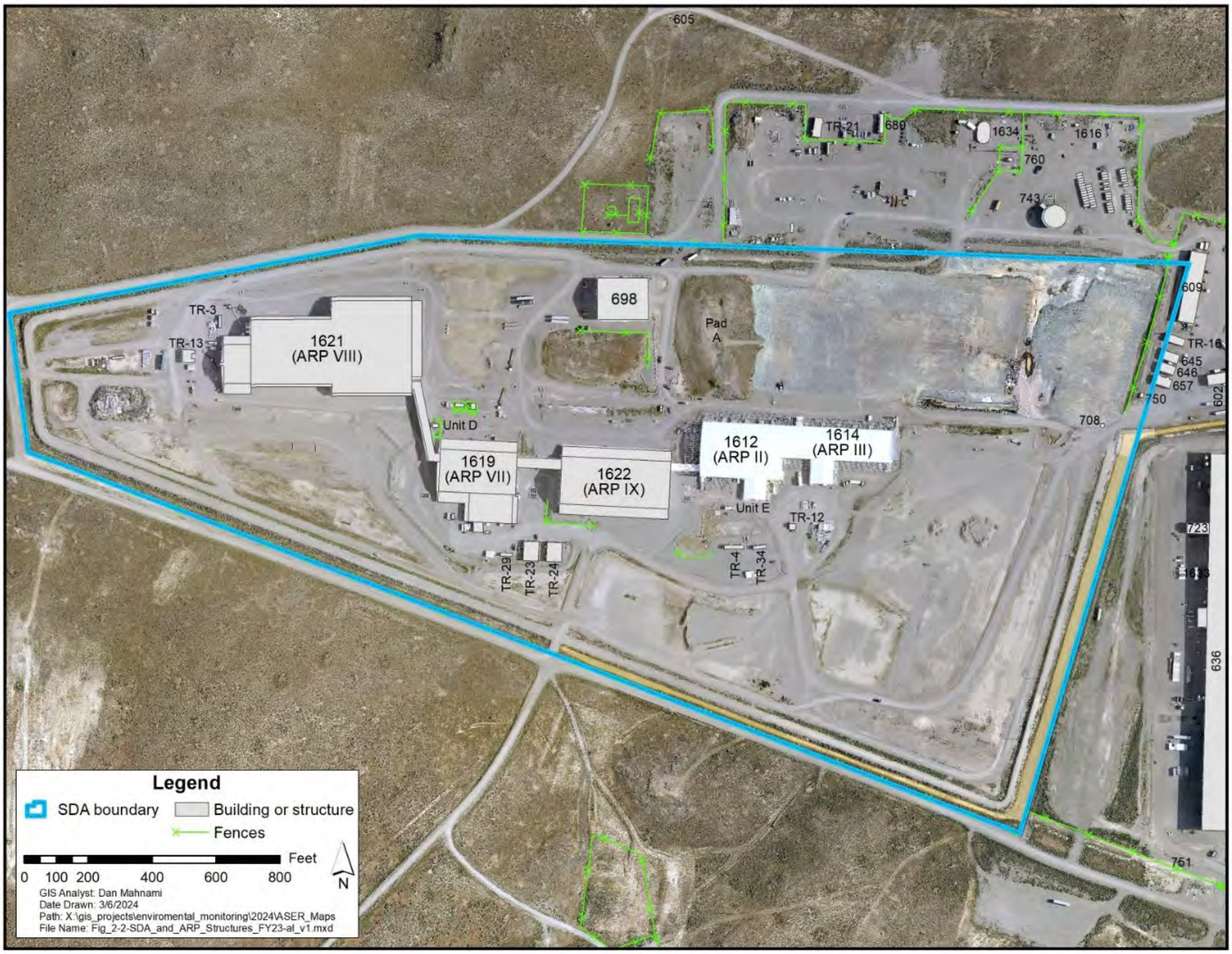

Figure 2-3. RWMC SDA (2023).

Table 2-3 lists waste types managed at the INL Site by INL Site contractors.

Table 2-3. Radioactive wastes managed at the INL Site.

FACILITY	GENERATION	TREATMENT	STORAGE	DISPOSAL
INL CONTRACTOR				
ATR Complex	LLW, RHLLW	—	LLW, RHLLW	—
CFA	LLW	—	LLW	—
MFC/INTEC	TRU, LLW, RHLLW	LLW	TRU, LLW, RHLLW	—
Material Security and Consolidation Complex	LLW	—	LLW	—
RHLLW Disposal Facility	RHLLW	—	RHLLW	RHLLW
REC	LLW	—	LLW	—
Specific Manufacturing Capability	LLW	LLW	LLW	—
ICP CONTRACTOR				
AMWTP	TRU, LLW	TRU, LLW	TRU, LLW	—
ICDF	—	—	—	LLW
INTEC Calcined Solids Storage Facility	—	RHLLW	HLW, RHLLW	—
INTEC Interim Storage Areas			RH-TRU/LLW	
INTEC TFF	—	—	HLW	—
INTEC Waste Management Facilities		RH-TRU/LLW	RH-TRU/LLW	
IWTU	—	HLW	HLW	—
RWMC Accelerated Retrieval Project	TRU, LLW	TRU, LLW	TRU, LLW	—
RWMC ALLWDF	—	—	—	LLW

The status of each phase of the LLW management process for facilities managed at the INL Site by the INL Site contractors is shown in Table 2-4.

Table 2-4. Status of each phase of the LLW management process for sites authorized to manage a LLW facility.

PHASE	RHLLW DISPOSAL FACILITY	RWMC ACTIVE LLW DISPOSAL FACILITY	ICDF
Performance Assessment	DOE/ID-11421 (DOE-ID 2018d), “Performance Assessment for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility”	DOE/NE-ID-11243 (DOE-ID 2007b), “Performance Assessment for the RWMC Active Low-Level Waste Disposal Facility at the Idaho National Laboratory Site”	DOE/ID-10978 (DOE-ID 2011b), “Performance Assessment for the Idaho CERCLA Disposal Facility Landfill”
Composite Analysis	DOE/ID-11422 (DOE-ID 2016b), “Composite Analysis for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility”	DOE/NE-ID-11244 (DOE-ID 2008b), “Composite Analysis for the RWMC Active Low-Level Waste Disposal Facility at the Idaho National Laboratory Site”	DOE/ID-10979 (DOE-ID 2003), “Composite Analysis for the INEEL CERCLA Disposal Facility Landfill”

Table 2-4. continued.

PHASE	RHLLW DISPOSAL FACILITY	RWMC ACTIVE LLW DISPOSAL FACILITY	ICDF
Closure Plan	PLN-3370, "Preliminary Closure Plan for the Idaho National Laboratory Remote-Handled Low-Level Waste Disposal Facility"	RPT-576, "Interim Closure Plan for the RWMC Active Low-Level Waste Disposal Facility at the Idaho National Laboratory Site"	A preliminary closure plan was developed for the entire ICDF Complex closure. This plan was included in the "ICDF Complex Remedial Action Work Plan" (DOE/ID-10984) (DOE-ID 2012)
Performance Assessment/ Composite Analysis Maintenance Program	PLN-3368, "Maintenance Plan for the Remote-Handled Low-Level Waste Disposal Facility Performance Assessment and Composite Analysis"	RPT-431, "Performance Assessment and Composite Analysis Maintenance Plan for the RWMC Active Low-Level Waste Disposal Facility"	RPT-791, "Performance Assessment and Composite Analysis Maintenance Plan for the Idaho CERCLA Disposal Facility"
Latest Annual Performance Assessment/ Composite Analysis Summary Report	INL/RPT-23-70876 (INL 2023), "Annual Summary Report for the Remote-Handled Low-Level Waste Disposal Facility – FY 2022"	RPT-2160, "Annual Summary Report: Review for Continued Adequacy of the Performance Assessment, Composite Analysis, and Supporting Documents for the Active Low-Level Waste Disposal Facility at the RWMC – FY 2023"	RPT-2161, "Annual Summary Report: Review for Continued Adequacy of the Performance Assessment, Composite Analysis, and Supporting Documents for the ICDF Landfill – FY 2023"
Disposal Authorization Statement	Bishop, T., memorandum to R. Provencher, May 22, 2018, "Operating Disposal Authorization Statement for the Remote-Handled Low-Level Waste Disposal Facility Idaho National Environmental Laboratory, Idaho," U.S. DOE-NE, May 22, 2018	Marcinowski, F., memorandum to E. Sellers, January 30, 2008, "Revision of the Disposal Authorization Statement for the Idaho National Laboratory Active Low-Level Waste Disposal Facility within the Radioactive Waste Management Complex," CCN 323845	Kristen G. Ellis, memorandum to Connie M. Flohr, September 22, 2023, "Revision of the Disposal Authorization Statement for the Idaho Comprehensive Environmental Response, Compensation, and Liability Act Disposal Facility," 9266728

2.5.1 Spent Nuclear Fuel

SNF is nuclear fuel that has been withdrawn from a nuclear reactor following irradiation and the constituent elements have not been separated. SNF contains unreacted uranium and radioactive fission products. Because of its radioactivity (primarily from gamma rays), it must be properly shielded. DOE-ID's SNF is from the development of nuclear energy technology (including foreign and domestic research reactors), national defense, and other programmatic missions. At the INL Site, SNF is managed by the ICP contractor at INTEC, the Naval Nuclear Propulsion Program at the Naval Reactors Facility, and the INL contractor at the ATR Complex and MFC.

The ISA put milestones into place for the management of SNF at the INL Site:

- DOE-ID shall complete the transfer of spent fuel from wet storage facilities by December 31, 2023 (Paragraph E.8). This milestone was completed March 17, 2023.
- DOE-ID shall remove all spent fuel, including naval spent fuel and Three Mile Island spent fuel, from Idaho by January 1, 2035 (Paragraph C.1).

Meeting these remaining milestones comprise the major objectives of the SNF program.

2.6 Environmental Releases, Response, and Reporting at the INL Site

Federal guidelines stipulate that certain environmental discharges and spills must be communicated to regulatory agencies. Releases that are subject to reporting are those discharges of hazardous substances to the environment that are not authorized by state or federal regulations. Per CERCLA Section 103, any release of a hazardous substance that reaches or surpasses predetermined reportable quantities must be reported. This includes ongoing releases that have a consistent quantity and rate, yet surpass established thresholds. These reporting obligations cover releases into the soil, groundwater or surface water, or into the atmosphere, in instances where such releases pose a threat to human health or the environment.

2.6.1 Spills

INL Site contractors had two reportable spills in 2023. Approximately 44 gallons of gasoline leaked from a 15,000-gallon, double-walled, fiberglass-reinforced underground storage tank to the soil at CFA-1607. The leak was confirmed on February 27, 2023, after a tightness test failed. Idaho DEQ was notified February 28, 2023, and initial site characterization efforts commenced. Final cleanup and disposal of contaminated soil occurred December 7, 2023. A Site-Specific Risk Evaluation report was revised in January 2024 (CCN 254848).

On February 5, 2023, an estimated 150 gallons of diesel fuel were discovered to have been released to the gravel and soil west of CPP-1696. During the response, it was concluded that a fuel pump had been left on while a subcontractor was filling a 2,000-gallon day tank. Idaho DEQ was notified the day the release was discovered. It was established that no immediate impact occurred to INTEC stormwater systems, monitoring wells, surface water, or water supply wells. The surface spill was contained and cleaned up in accordance with ICP contractor safety procedures. Forty cubic yards of contaminated soil were sent for disposal at the ICDF during the initial excavation, which occurred on March 7, in August 2023. With Idaho DEQ concurrence, final excavation activities were delayed until July 2023 when the area of the spill was excavated to a depth of 6 ft. A clean-up summary and confirmation sample results were submitted to Idaho DEQ on September 28, 2023 (Francis 2023 [CCN 331587]). Idaho DEQ determined that no additional assessment or corrective action was required on December 1, 2023 (Summers 2023 [CCN 331899]).

2.6.2 Unplanned Releases

INL Site contractors had no unplanned releases of hazardous substances or any events that resulted in emissions exceeding reporting thresholds that would require notification to be made to regulatory agencies in 2023. All radiological emissions were accounted for in the dose received by the MEI (see Chapter 8).

2.7 Environmental Permits/Agreements

Table 2-5 presents the complete list of all active federal and state permits and/or agreements during 2023 for INL Site operations. This table includes those pertaining to air emissions, ecological, groundwater, RCRA, and surface water.

Table 2-5. Environmental permits/agreements for the INL Site (2023).

ACTIVE PERMIT/AGREEMENT NAME	PERMIT/ AGREEMENT NUMBER	REGULATORY AGENCY	EXPIRATION DATE
AIR EMISSIONS			
INL Permit to Construct (PTC) with a Facility Emissions Cap (FEC)	P-2020.0045	DEQ	01/29/2026
ECOLOGICAL			
Special Purpose – Miscellaneous	MB04294B	USFWS	03/31/2025
Scientific Collecting	MB13633C	USFWS	03/31/2025
Scientific Collecting	31612	IDFG	12/31/2023
Scientific Collecting	30400	IDFG	12/31/2023

Table 2-5. continued.

ACTIVE PERMIT/AGREEMENT NAME	PERMIT/ AGREEMENT NUMBER	REGULATORY AGENCY	EXPIRATION DATE
GROUNDWATER			
Permit for the Operation of Injection Well	25W-062-001	IDWR	02/14/2028
Water Right Agreement	PER[a]-154	IDWR	NA
RCRA[b]			
Advanced Mixed Waste Treatment Project HWMA/RCRA Permit	PER[a]-153	DEQ	03/19/2029
HWMA/RCRA Partial Permit for Storage at the Calcined Solids Storage Facility at the INTEC on the INL	PER[a]-114	DEQ	06/26/2027
HWMA/RCRA Post-closure Permit for the INTEC on the INL	PER[a]-112	DEQ	03/14/2034
HWMA/RCRA Storage and Treatment Permit for the MFC	PER[a]-116	DEQ	10/01/2025
HWMA Storage and Treatment Permit for the INTEC Waste Management Operations on the INL	PER[a]-109	DEQ	06/27/2034
Part A Permit App, Interim Status Facility, Tank Farm Facility at INTEC	PER[a]-101	DEQ	NA
Partial Permit for HWMA Storage and Treatment for the Liquid Waste Management System at the INTEC on the INL	PER[a]-111	DEQ	11/20/2024
RECYCLED WATER			
ATR Complex Cold Waste Ponds Reuse Permit	I-161-03	DEQ	10/10/2029
MFC Industrial Waste Pond Reuse Permit	I-160-02	DEQ	01/25/2027
Reuse Permit for the INTEC New Percolation Pond	M-130-07	DEQ	06/25/2025
SURFACE WATER			
Idaho National Laboratory Research Center, city of Idaho Falls Industrial Wastewater Acceptance Permit	IF-8733-54171-1	city of Idaho Falls	03/15/2023[c]
TOXIC SUBSTANCES CONTROL ACT			
Advanced Test Reactor Complex's (ATR) Test Reactor Area Raw Water Pumphouse Building RBDA (TRA-619)	NA[d]	EPA	NA[e]
TSCA RBDA for the Risk-Based Disposal Plan for PCB Paint in the TRA Fluorinel Dissolution Process Mockup and Gamma Facilities Canal at the INL Site	NA[d]	EPA	NA
Toxic Substance(s) Control Act Risk-Based Disposal Approval for Management of Transuranic Polychlorinated Biphenyl Remediation Waste at the Advanced Mixed Waste Treatment Project Facility	NA[d]	EPA	NA

a. PER is the INL document-type used for regulatory permits.
b. Part A interim status units are those units with Part A permit applications (interim status) that have not been RCRA closed. Partial Part B permits include the Part A application and Part B application. Part A addresses each of the permitted units in Part B, while Part B includes specific details and permit operating requirements. A partial permit that includes the unit-specific Part A and Part B is considered a RCRA partial Part B permit. There are six RCRA partial Part B permits for the INL Site.
c. On March 15, 2023, the city of Idaho Falls notified INL that the city no longer considers IRC to be a Significant Industrial User and a permit is not required to discharge into the city of Idaho Falls publicly-owned treatment works (Henricksen 2023).
d. RBDAs are permit-like documents granted by the EPA.
e. In effect until the buildings are decommissioned and dispositioned.

2.8 References

10 CFR 830, Subpart A, 2024, “Quality Assurance Requirements,” Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, D.C., https://www.ecfr.gov/cgi-bin/text-idx?SID=074233709c29153b42bc0e7e25e68307&mc=true&node=sp40.10.61.a&rgn=div6.

10 CFR 1021, 2024, “National Environmental Policy Act Implementing Procedures,” Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, D.C., https://www.energy.gov/sites/prod/files/10CFRPart1021.pdf.

10 CFR 1022, 2024, “Compliance with Floodplain and Wetland Environmental Review Requirements,” Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, D.C., https://www.energy.gov/sites/prod/files/10CFRPart1022.pdf.

36 CFR 79, 2024, “Curation of Federally Owned and Administered Archeological Collections,” Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, D.C., https://www.ecfr.gov/current/title-36/chapter-I/part-79.

36 CFR 800, 2024, “Protection of Historic Properties,” Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, D.C., https://www.ecfr.gov/current/title-36/chapter-VIII/part-800?toc=1.

40 CFR 50, 2024, “National Primary and Secondary Ambient Air Quality Standards,” Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, D.C., https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50?toc=1.

40 CFR 61, Subpart H, 2024, “National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities,” Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, D.C., https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-61#ap40.10.61_1359.c.

40 CFR 84, 2024, “Phasedown of Hydrofluorocarbons,” Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, United States (U.S.) Washington, D.C., https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-84.

40 CFR 141, 2024, “National Primary Drinking Water Regulations,” Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, D.C., https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-141.

40 CFR 143, 2024, “National Primary Drinking Water Standards,” Code of Federal Regulations, Office of the Federal Register, National Archives and Records Administration, Washington, D.C., https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-143.

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Chapter 3: Environmental Management Systems

CHAPTER 3

The Idaho National Laboratory (INL) and Idaho Cleanup Project (ICP) Environmental Management Systems implement the U.S. Department of Energy (DOE) commitments for the protection of the environment and human health. DOE strives to be in full compliance with environmental laws, regulations, and other requirements that protect the air, water, land, natural, archeological, and cultural resources potentially affected by operations and activities conducted at the INL Site. This policy is implemented by integrating environmental requirements, pollution prevention, and sustainable practices into work planning and execution and by taking actions to minimize the impact of INL Site operations and activities.

3. ENVIRONMENTAL MANAGEMENT SYSTEMS

The framework that DOE has chosen to use for Environmental Management Systems (EMSs) and sustainable practices is the International Organization for Standardization (ISO) Standard 14001:2015, "Environmental Management Systems – Requirements with Guidance for Use." The ISO 14001:2015 model uses a system of policy development, planning, implementation, operation, checking, corrective action, and management review. Ultimately, ISO 14001:2015 aims to improve performance as the management cycle repeats. The EMS must also meet the criteria of Executive Order 14057, "Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability," and DOE O 436.1A, "Departmental Sustainability," which require federal facilities to put EMSs into practice. Sites must maintain their EMS either by being certified for use or in conformance with the ISO 14001:2015 standard following the accredited registrar provisions or self-declaration instructions.

INL balances research, development, and demonstration; waste management; decontamination and decommissioning activities; environmental cleanup; and long-term stewardship in support of the INL mission with the protection and preservation of human health and the environment. INL complies with applicable laws, regulations, and other requirements. INL's EMS integrates environmental protection, environmental compliance, pollution prevention, and continual improvement into work planning and execution throughout work areas as a part of the Integrated Safety Management System.

INL is a combination of all operating contractors and the U.S. Department of Energy, Idaho Operations Office (DOE-ID), and includes the Idaho Falls campus and the research and industrial complexes termed the "INL Site" located 50 miles west of Idaho Falls, Idaho. For this report, INL consists of those facilities operated by Battelle Energy Alliance, LLC the INL contractor, or by the Idaho Environmental Coalition, LLC, the ICP contractor. INL Site contractors are referred to by their noted acronyms and include all facilities under their individual responsibilities.

The two main contractors have established EMSs for their respective operations. The INL Site contractors have been certified to meet the requirements of ISO 14001 since 2005. In 2019, the INL contractor became the first DOE national laboratory to be certified by the Nuclear Quality Assurance (NQA) Certification Program. Many elements of NQA-1 align with and complement the ISO 14001:2015 standard.

INL Site contractors have established EMSs for their respective operations. Accredited auditors are used to obtain ISO 14001:2015 Certification, which is required every three years. Evaluation audits are conducted annually to evaluate the contractor's conformance with the standards called out in ISO 14001:2015 and to confirm all applicable requirements of the standard have been met and effectively implement. During 2023, both INL Site contractors were audited and ISO 14001:2015 Certification of each EMSs continued. Results from the INL contractor audit showed no nonconformities, six management system strengths, and two opportunities for improvement. Results from the ICP audit showed no nonconformities and five management system strengths.

3.1 Environmental Policy

INL Site contractors state their commitments to the environment through an overarching policy that is displayed to employees. The policies commit to incorporate sound environmental management policies and practices into all work planning and execution in a safe, compliant, and cost-effective manner that protects human health and the environment. Environmental policies apply to all persons and encourages all personnel to report environmental concerns to management. The INL contractor policy commits specifically to do the following:

- *Environmental Protection:*
  - The practice of conserving and preserving the natural environment and its resources for the benefit of present and future generations.
- *Environmental Compliance:*
  - The adherence and conformity to laws, regulations, standards, and other requirements set by governmental bodies and delegated authorities in order to promote and ensure environmentally responsible behavior and practices by businesses and organizations.
- *Pollution Prevention:*
  - The practice of reducing or eliminating pollution at its source, rather than treating it after it has been created. This approach aims to minimize the release of harmful substances into the environment, thereby protecting human health and ecosystems.
- *Continual Improvement:*
  - The ongoing process of making incremental advancements and enhancements in various aspects of environmental protection. It involves continuously identifying areas for growth and implementing changes to achieve better results over time.

INL contractor employees integrate environmental requirements and pollution prevention techniques into work planning and execution to minimize the environmental impacts of their activities.

The ICP contractor policy commits to do the following:

- *Leadership Commitment:*
  - Integrate appropriate environmental practices into all project operations; document environmental objectives and targets; measure progress; and report performance through the EMS.
  - Educate employees on their environmental responsibilities and train them to ensure they comply with requirements.
  - Continuously improve their EMS through self-assessments and corrective actions.
  - Promote environmental stewardship, take prompt action to address concerns and issues, and have zero tolerance for noncompliance.
- *Environmental Compliance and Protection:*
  - Identify and comply with all applicable, relevant, and appropriate environmental laws, regulations, and permits.

- Assess the effects of operations on the environment through a comprehensive environmental monitoring program.
- Provide full disclosure and openness with DOE and regulatory agencies regarding any noncompliance with regulatory requirements.

- *Environmental Stewardship:*
  - Protect the unique natural, biological, and cultural resources associated with the INL Site contractors.
  - Minimize the effects of our operations on the environment and conserve natural resources by reusing and recycling materials, purchasing recycled materials, and performing other pollution prevention practices.
  - Use all means practicable to minimize or eliminate any newly generated wastes—whenever possible, newly generated wastes shall have a clear disposition path before they are generated.
- *Client, Employee, and Stakeholder Engagement:*
  - Communicate openly and honestly with all parties and stakeholders.
  - Share their respective Environmental Policy with all employees and subcontractors and make it available to the public.
  - Consider the input of all stakeholders when weighing alternative courses of action.
  - Measure their environmental performance, monitor their impact on the environment, and communicate the results to all parties.

The ICP contractor's policies are available to the public through the ICP Internet address at https://idaho-environmental.com/Community/.

3.2 Environmental Management System Structure

The INL Site contractors' EMSs incorporate a Plan-Do-Check-Act approach to provide a framework under which the environmental, safety, and health programs are managed.

Plan – Defines work scope, identifies environmental aspects, analyzes hazards, and develops hold points and mitigations

Do – Implements defined controls and performs the work scope

Check – Evaluates performance, management reviews, and contractor's assurance practices

Act – Incorporates corrective actions, improvements, and lessons learned into practices.

This approach is interactive and iterative through the various work activities and functions, including policies, programs, and processes. The approach is also an integral part of the overall management of the Site's environmental compliance and performance. The main focuses of this cycle are (1) environmental policy, (2) planning, (3) implementation and operation, (4) checking and corrective action, and (5) management review.

3.3 Plan

3.3.1 Environmental Aspects

INL Site contractors have evaluated activities, products, and services to identify the environmental aspects of work activities that could affect the environment, the public, or result in noncompliance with regulatory requirements. INL Site contractors perform these evaluations against all applicable federal and state regulations, state permits, and local laws. These regulations and permits are the foundation for environmental standard operating procedures and implementing documents. INL Site contractors use the National Environmental Policy Act planning tool for all proposed actions that would take place onsite. INL uses the Environmental Compliance Permit Process, while ICP uses the Environmental

Checklist process to evaluate all activities and projects to ensure the proposed actions consider and mitigate environmental aspects as necessary. Environmental aspects are listed below:

Air Emissions. Air emissions applies to operations or activities that have the potential to generate air pollutants in the form of radionuclides, chemical and combustion emissions, fugitive dust, asbestos, and refrigerants. INL Site contractors have an Environmental As Low As Reasonably Achievable review process per DOE O 458.1, "Radiation Protection of the Public and the Environment," that protects the public and the environment against undue risk of radiation. The Environmental As Low As Reasonably Achievable Committee evaluates activities that have the potential for radiological impact on the environment and the public and determines the requirements for radiological emissions.

Chemical Use and Storage. Chemical use and storage apply to activities that purchase, store, or use laboratory or industrial chemicals, pesticides, or fertilizers. INL Site contractors have processes in place to maintain adequate inventory of appropriate emergency response equipment and to report inventories and releases.

Contaminated Sites Disturbance. Contaminated site disturbance applies to activities in Comprehensive Environmental Response, Compensation, and Liability Act areas of contamination or Resource Conservation and Recovery Act corrective action sites. INL Site contractors have processes to properly identify contaminated sites.

Discharging to Surface, Storm, or Groundwater. Discharging to surface water, storm water, or groundwater applies to activities that have the potential to contaminate groundwater or water. INL Site contractors have spill prevention and response plans in place for areas that have the potential to contaminate groundwater or water.

Drinking Water Contamination. Drinking water contamination activities are related to constructing, operating, and maintaining drinking water supply systems and equipment or activities with the potential to contaminate drinking water supplies. This includes bacteriological, radiological, or chemical contamination of drinking water.

Disturbing Cultural Resources. Cultural resource disturbance applies to activities that have the potential to adversely affect cultural resources, such as disturbing soils by grading, excavating, sampling, off-road vehicle use, or removing vegetation. It also applies to the protection of sensitive cultural or biological resources from disturbance. The potential for adverse effects also applies to modifying or demolishing historical buildings or structures that are 50 years old or older. INL has a cultural resources management team that evaluates work activities at INL to minimize the impact on historical buildings and cultural sites before an activity begins.

Environmental Justice. The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. It seeks to ensure that all individuals have equal access to a healthy environment and are not disproportionately burdened by environmental hazards.

Generating and Managing Waste. Regulated, hazardous, or radioactive material and waste packaging and transportation applies to activities that generate, store, treat, or dispose of hazardous, radioactive, or industrial waste. INL Site contractors have a waste management program that integrates and dispositions containerized hazardous, radioactive, or industrial waste and gives guidance on how to minimize the amount of regulated waste generated.

Releasing Contaminants. Releasing contaminants applies to activities that may release potentially hazardous contaminants into water, soil, or other noncontaminated or previously contaminated locations. All INL Site contractors' employees are trained to report any release to either their Program Environmental Lead or to the Spill Notification Team. Releases are tracked to verify proper cleanup is performed. Planned operations and research with the potential to release contaminants are evaluated to mitigate any significant environmental impacts.

Polychlorinated biphenyls (PCB) Contamination. PCB contamination applies to activities that use PCB-contaminated equipment or store and dispose of PCB-contaminated waste. INL Site contractors have processes in place to identify PCBs in excess equipment and to comply with regulatory requirements related to the use, marking, storage, and disposal of PCB equipment or waste.

Interaction with Wildlife/Habitat. Interaction with wildlife/habitat activities includes the potential to disturb or affect wildlife or their habitat or activities involving revegetation and weed control. INL Site contractors have processes in place to ensure that identification and consideration is given to the cumulative impacts required by the National Environmental Policy Act, the Endangered Species Act, or the Migratory Bird Treaty Act. Procedures and processes are also implemented to control noxious weeds and revegetation of disturbed sites.

Using, Reusing, and Conserving Natural Resources. Using, reusing, and conserving natural resources applies to activities that use or recycle resources such as water, energy, fuels, minerals, borrow material, wood, or paper products and other materials derived from natural resources. This beneficial aspect also applies to waste disposition activities, including building demolition and activities implementing sustainable practices and conserving natural resources.

3.4 Do (Implementation and Operations)

3.4.1 Structure and Responsibility

The organizational structures INL Site contractors have in place establish roles and responsibilities for environmental management within research, development, and demonstration; operations; waste management; decontamination and decommissioning; and other support organizations within Environmental, Safety, Health, and Quality. Identified technical points of contacts communicate environmental regulatory requirements and required document submittals to the U.S. Environmental Protection Agency (EPA), the Idaho Department of Environmental Quality (DEQ), and other stakeholders. The technical points of contact work with the projects, researchers, and facilities to ensure the requirements are implemented.

3.4.2 Competence, Training, and Awareness

INL Site contractors training directorates conduct training analysis, designs, develop, and evaluate environmental training. Environmental training gives personnel the opportunity to gain experience, knowledge, skills, and the abilities necessary to accomplish the following:

- Perform jobs in a safe and environmentally responsible manner
- Comply with federal, state, and local environmental laws; regulations and permits; and INL requirements and policies
- Increase awareness of environmental protection practices and pollution and prevention/waste minimization opportunities
- Take action in an emergency.

3.4.3 Communication

INL Site contractors implement comprehensive communication programs that distribute timely information to interested parties such as the public, news media, regulatory agencies, and other government agencies. These programs provide communications about the environmental aspects of work activities, among other topics. Examples include the Media and Community Relations Program and the Strategic Initiatives Program, which distribute information to the public through public briefings, workshops, personal contacts, news releases, media tours, public tours, and news conferences. The programs also coordinate tours of INL for schools, members of the public, special interest groups, and government and elected officials. Internal communications regarding environmental aspects are available via intranet sites, procedures, emails, posters, brochures, booklets, trainings, and personal interaction with environmental staff.

3.4.4 Operational Control

Environmental personnel evaluate each work activity at INL to determine the level of environmental review needed. Environmental personnel also apply administrative and engineering controls. Administrative controls include procedures and best management practices. Engineering controls include using protective equipment and barriers to minimize or avoid environmental impact.

3.4.5 Document and Record Control

Environmental documents are prepared, reviewed, revised, and issued per INL Site contractors' standards and procedures. INL's document control system maintains the current version of documents and makes legible and dated copies available to employees.

3.5 Check

INL Site contractors internally monitor compliance with environmental laws and regulations through the Assurance Portfolio process in the Contractor Assurance System. INL Site contractors conduct assurance activities through performance metrics, observations, and assessments. Issues, trends, or improvements identified through these activities are rolled into the INL issues management database where corrective actions are assigned and tracked to completion. Examples of contractor assurance activities include monitoring progress toward environmental objectives for each organization and an internal assessment of the EMS against the ISO 14001:2015 standard. Contractor assurance activities in the environmental organization are documented in a management review.

Various regulators also perform external assessments. Idaho DEQ conducts several inspections annually to verify that INL is complying with state permits. EPA also participates in Federal Facility Act-driven inspections and, on a determined frequency, participates alongside Idaho DEQ in compliance evaluation inspections. Chapter 2, "Environmental Compliance Summary," provides results of the annual external agency audits and inspections of INL's Environmental Program.

Annually, INL Site contractors perform a surveillance audit as required by the ISO 14001 standard. Additionally, every three years, INL Site contractors are audited for recertification to the ISO 14001 standard. A qualified party outside the control or scope of the EMS must perform the formal recertification of the EMS audit. INL Site contractors have been certified to the ISO 14001 standard since 2005.

3.6 Act

INL Site contractors establish, implement, and maintain an issues management program in accordance with an internal procedure for contractor assurance. It deals with actual or potential conditions of nonconformity, such as Notices of Violation, nonconformities with regulation, and opportunities for improvement from internal assessments and audits. All employees have access to the issues management software and the authority to identify and document any conceived issue. Communication of these identified issues is performed through the management review process. Throughout all operations, environmental concerns, safety, and emergency preparedness issues are documented and submitted for management review.

INL Site contractors' management review of EMS occurs through a process that includes weekly, monthly, quarterly, and annual meetings with committees and councils. Management review identifies issues that carry the largest environmental risks and provides mitigations and hold points. Through the Contractor Assurance System, EMS performance trends, audit findings, objectives and targets, improvements, and risks are documented in a management review that is sent to senior management. Through this process, senior management is aware of the largest environmental risks to the INL Site. Senior management evaluates the management review and recommends actions to continually improve environmental performance.

3.7 INL Contractor Environmental Operating Experience

The INL EMS for 2023 achieved a "Green" score in the DOE EMS Site Information Database, showcasing its commitment to environmental performance and operational excellence. Environmental operating experience and performance measurement is an integral component of an EMS. Many best practices, initiatives, and implementation challenges were identified and summarized, as outlined in the following sections.

3.7.1 EMS Best Practices

During the EMS ISO 14001 audits, best practices are identified. The following system strengths were identified during the 2023 ISO 14001 recertification audit:

- Participating in internal audits at other laboratory locations provides an avenue to benchmark the EMS, provides best practices, and allows other internal auditors to participate in INL's internal audit program.
- The EMS Technical Points of Contact List provides a means for quick access to environmental subject matter experts (SMEs), which facilitates readily obtaining the information needed for making informed decisions.
- The risk management process includes searching for all relevant risks, which are then tracked and dealt with when a risk level rises to an unacceptable level. This facilitates effectively managing risks so that they do not interfere with the goals of a project.
- Management participation in the review of corrective actions contributes to ensuring effective corrective action plans.
- An extremely robust and thorough system for identifying new compliance regulations to ensure the organization is aware of and addresses each new relevant requirement.
- The organization maintains a great handle on document control.

These best practices demonstrate a strong commitment to environmental management and continuous improvement. Participating in internal audits at other laboratory locations not only allows for benchmarking and sharing of best practices but also enriches the internal audit program by involving auditors from different areas within the DOE complex. The EMS Technical Points of Contact List allows easy access to relevant information and empowers decision-makers with the necessary knowledge to make informed choices promptly, thus enhancing overall environmental performance. The robust risk management process that involves identifying, tracking, and addressing risks effectively is crucial for ensuring project success. By proactively managing risks and intervening, when necessary, potential obstacles are mitigated, safeguarding project goals and environmental objectives. Management's active involvement in reviewing corrective actions underscores a culture of accountability and a commitment to continuous improvement. This participation ensures that action plans are thorough, effective, and aligned with organizational goals, driving positive outcomes. These strengths reflect a proactive approach towards environmental management excellence and showcase a dedication to sustainability principles within the organization.

3.7.2 EMS Initiatives

Internal Audit Improvements

ISO 14001 clause 9.2 requires an internal audit program where DOE sites must audit themselves for nonconformities and opportunities for improvement. INL collaborated with the Battelle community of practice to exchange SMEs to assist with internal ISO 14001 audits both at INL and other Battelle locations. This collaboration allows for knowledge-sharing across Battelle-operated national laboratories to enhance the EMS. INL actively participated in internal audits at Pacific Northwest National Laboratory and Brookhaven National Laboratory while inviting experts from Oak Ridge National Laboratory to INL to perform INL's internal audit. The collaboration between INL and the Battelle community of practice to exchange SMEs for internal ISO-14001 audits demonstrates a proactive approach to enhancing the EMS within Battelle-operated national laboratories. This collaborative effort aligns well with the requirements of ISO 14001 clause 9.2, emphasizing the importance of self-auditing for nonconformities and opportunities for improvement within DOE sites. Such initiatives not only help ensure compliance but also foster a culture of excellence and shared lessons learned within the DOE national laboratory complex.

Environmental Justice

INL has continued efforts to integrate Environmental Justice (EJ) into the INL EMS by considering EJ as a significant environmental aspect and incorporating it into its Environmental Review Process (ERP). INL has considered EJ in past environmental assessments and environmental impact statements for large projects, but the addition to the ERP will now include every project to determine whether any disadvantaged communities would be affected. It ensures that all communities surrounding the INL Site are not negatively impacted by INL's activities. By integrating EJ into the INL EMS and the ERP, INL is taking a proactive step towards ensuring that all communities are considered and protected from any potential negative impacts. This commitment reflects a strong environmental stewardship ethos and demonstrates a genuine concern for the well-being of surrounding communities. Further details on INL's initiatives concerning EJ are found in Chapter 2, Section 2.3.

3.7.3 EMS Implementation Challenges

There were two identified major challenges working against the EMS system during 2023.

- During the 2023 ISO recertification audit, a chance for enhancement to the EMS objectives and targets was recognized. The implementation of EMS objectives and targets proved to be successful as multiple line organizations from across INL participated in the effort. The auditors suggested INL could gain advantages by introducing a "best practice" format that would enable standardization in objective management across line organizations. This standardization would ensure the objectives are measurable and aligned with INL's enterprise environmental goals, including Net-Zero.
- The EMS continues to face challenges related to an aging infrastructure. Throughout 2023, specific parts of the infrastructure have deteriorated or experienced failures, resulting in distinct compliance problems. INL encountered a situation where a pipe connected to an underground storage tank system failed, leading to a release of petroleum. Additionally, an aged firewater service line broke under the Test Area North Fire Station. The notification, reporting, and mitigation of these incidents allowed INL staff-members to navigate complex issues and test procedures related to problem management. Although the mitigations were successful, INL anticipates that aging infrastructure will continue to deteriorate and fail, requiring resources and staff time for mitigation efforts.

3.8 ICP Environmental Operating Experience

The ICP EMS for 2023 also achieved a "Green" score in the DOE EMS Site Information Database. The ICP contractors' high-level of commitment to the environment is reflected in their strong Environmental Policy.

3.8.1 EMS Best Practices

The recently awarded ICP contract includes activities at the Fort St. Vrain (FSV) Independent Spent Fuel Storage Installation located in Platteville, Colorado. In 2023, an EMS ISO 14001 recertification audit was conducted independently at both facilities in preparation to combine future audits under one contract. Five noteworthy practices were documented at the INL facility and one at FSV. An opportunity for improvement was also suggested for operations at FSV. Noteworthy practices identified during the 2023 ISO 14001 recertification audits are:

- The Management Worksite Visit program provides managers with a good mechanism for observing how the organization functions by going to where the work is done. This provides managers with the knowledge needed to make informed and prudent decisions.
- ICP's sustainability program is robust, current, and well-documented. Efficient and accurate documentation provides the information needed to make informed decisions for implementing an enduring sustainability program.
- The Environmental Data Systems Warehouse uses ICP-developed software. The software development processes are well-executed. This ensures a quality and reliable product that is well-aligned with the user's needs to ensure ease of maintainability and evolution.
- The Environmental Checklist is an effective tool for ensuring that the full project life-cycle environmental impacts are minimized, and that compliance matters are addressed.
- ICP personnel were found to have a keen awareness of their cleanup mission, and of the necessity to follow their established procedures in order to minimize the negative environmental impact of their cleanup activities.
- The management team at FSV Independent Spent Fuel Storage Installation has a desire to improve and support the integration process with ICP.

3.8.2 EMS Challenges

The ICP contractor has a robust and mature EMS program, however, as with many companies, ICP is experiencing a large exodus of seasoned employees, primarily due to retirement. This leaves gaps in historical and institutional knowledge. An opportunity for improvement identified during the recertification audit was to provide ISO 14001 awareness refresher training and ISO 14001 Lead Auditor training as part of the ICP integration plan to those who are back-filling those roles.

3.9 INL Site Resiliency

Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents. Energy resiliency is the ability to prepare, prevent, and recover from energy and water disruptions that impact mission assurance on federal installations. This means providing reliable power under routine and off-normal conditions, including those caused by extreme weather events. Adaptation refers to actions taken to reduce risks from changed climate conditions and to prepare for expected future changes.

As outlined in Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad," the DOE Climate Adaptation and Resilience Plan issued in August of 2021 and the Climate Adaptation Policy Statement build upon prior DOE actions that were taken to bolster adaptation and increase the resilience of DOE facilities and operations. INL Site contractors completed the studies for the Climate Vulnerability Assessment and Resilience Plan (VARP) (INL 2022) in 2022 as a tool for decision-makers to establish resilient priorities across INL and its associated communities.

3.9.1 Performance Status

Resilient solutions in 18 categories were identified during the vulnerability assessment and resilience planning completed by the INL contractor in fiscal year (FY) 2023. These solution categories include almost 300 individual measures to secure additional adaptive capacity for assets of high-impact. Resilient solutions in five categories were identified during the ICP contractor vulnerability assessment and resilience planning ahead of FY 2023. These solution categories include nine individual measures to secure additional adaptive capacity for high-impact assets. Resilience projects completed by the INL Site contractors in FY 2023 are shown in Table 3-1.

Table 3-1. FY 2023 resiliency improvement projects.

SOLUTION CATEGORY	PROJECT DESCRIPTION	COST
Infrastructure Upgrades	Replaced heating, ventilation, and air conditioning (HVAC) units on five buildings	$1,590k
Infrastructure Upgrades	Replaced windows and doors on four buildings	$750k
Fire-Safe Design	Replaced nine fire hydrants that were more than 50 years old	$361k
Harden Road Infrastructure	Installed solar lighting panels at two intersections	$675k
Harden Road Infrastructure	Resurfaced three large parking lots	N/A
Infrastructure Upgrades	Performed light-emitting diode (LED) lighting upgrades in 29 CFA buildings	N/A
Harden Energy Supply	Completed the design for the Power Utility Building	N/A

The Power Utility Building is essential to meeting the mission needs of the laboratory as it grows. This building will help address the most important mission needs for managing forecasted electricity growth and load demands on the INL-owned power grid by providing a state-of-the-art power dispatch center from which to dispatch resources, perform dynamic load management, maintain safe operating conditions, manage faults and outages, and respond to emergencies in real-time, 24 hours a day, and 365 days a year. The project is fully funded at $22.5M.

Ecosystem resiliency is also an integral component of sustainability. Because much of the INL Site is managed as a native sagebrush steppe ecosystem, it is vulnerable to the effects of climate change. Proactive land stewardship practices can mitigate the effects of climate change and preserve natural ecosystem services such as water balance, nutrient cycling, wildlife habitat availability, and carbon sequestration. Additional information can be found in Chapter 9.

3.9.2 Plans and Projected Performance

The concept of resiliency is evolving in real-time. The Net-Zero era will require professionals to be strategic overseers with a lens for long-term outcomes. In this season of change, all built environments will require careful reconsideration, and facility management will be responsible to promote a building culture that stands on the pillars of safety, quality, and efficiency.

INL plans to implement a formalized tracking process to capture large-scale resilience projects. Enhanced tracking abilities will aid in ensuring that vulnerability assessment and resilience planning solutions are considered and implemented in all identified projects planning. Continued collaboration across organizations and campuses will be critical in achieving a formalized tracking process where periodic updates will inform resilience solutions status and implementation. Budget remains the greatest challenge for large-scale resilience projects.

INL will be guided by science to build resilience into DOE-ID-managed lands, facilities, and equipment. A general framework used in resiliency planning includes identifying exposure, translating exposure into potential impacts, prioritizing risk, devising solutions, and securing funding. INL will work with internal and external stakeholders to address threats to missions and programs.

3.10 Sustainability Goals

In 2023, DOE Order 436.1A, “Departmental Sustainability,” was issued. The order advances sustainable, efficient, reliable, and resilient energy for the future; promotes conservation of natural resources; and ensures DOE achieves its sustainability goals pursuant to applicable law, regulations, and Executive Orders.

The evolving priorities for sustainability are incorporated into the annual update of the “Idaho National Laboratory Site Sustainability Plan“ (DOE-ID 2023) at the beginning of each new FY. It describes the overall sustainability strategy for the INL Site contractors during the current FY and includes a performance status in the areas of greenhouse gas (GHG) emission reduction, energy management, water management, waste management, fleet management, clean and renewable energy, sustainable buildings, and other areas for the completed FY. Each sustainability goal, INL Site contractors’ performance status, and planned actions are detailed in Table 3-2.

3.11 Environmental Operating Objectives and Targets

The INL Site contractors establish objectives based on the environmental policy, legal, ISO 14001, environmental aspects, INL’s Strategic Plan, and the perspectives of its stakeholders. The INL contractor plans, implements, monitors, and reports triannually on these objectives and targets in management review reports and in an annual Performance Evaluation and Measurement Plan. The ICP contractor develops its objectives and targets annually and reports the status biannually to senior management through the Executive Safety Review Board.

The INL contractor completed 86% of the EMS objectives and targets in FY 2023.

Each year, the ICP contractor identifies environmental objectives and targets to be met during the FY. During FY 2023, the ICP contractor identified 12 objectives implemented by 14 targets. All objectives and targets were completed during the FY.

3.12 Accomplishments, Awards, and Recognition

The INL Site contractors were both audited in 2023 by an external, accredited auditor and achieved recertification for conformance to the ISO 14001:2015 standard. The results from the INL contractor audit found no nonconformities, six management system strengths, and two opportunities for improvement. Results from the ICP audit showed no nonconformities and five management system strengths.

The INL Site contractors' EMS performance data was submitted to DOE's EMS Database Application and received a "green" for the EMS performance metrics listed below:

- Environmental aspects were identified or reevaluated using an established procedure and were updated as appropriate.
- Measurable environmental goals, objectives, and targets were identified, reviewed, and updated as appropriate.
- Operational controls were documented to address how significant environmental aspects that were consistent with objectives and targets were fully implemented.
- Environmental training procedures were established to ensure that training requirements for individual competence and responsibility were identified, conducted, monitored, tracked, recorded, and refreshed, as appropriate, to maintain competence.
- EMS requirements were included in all appropriate contracts. Contractors fulfilled defined roles and specified responsibilities.
- EMS audit/evaluation procedures were established, audits were conducted, and nonconformities were addressed or corrected. Senior leadership review of the EMS was conducted, and management responded to recommendations for continual improvement.
- Using an established procedure(s), previously identified activities, products, and services (and their associated environmental aspects) and all newly identified activities, products, and services (and their associated environmental aspects) were evaluated for significance within the past FY. In addition, the results of the analysis were documented, and any necessary changes were made or are scheduled to be made. Documented, measurable environmental objectives are in place at relevant functions and levels, and by the end of FY 2023, at least 80% of the objectives had either already been accomplished or scheduled to be met.
- Within the past FY, operational controls associated with identified significant environmental aspects are established, implemented, controlled, and maintained in accordance with operating criteria.
- Within the past FY, an environmental compliance audit program was in place, audits were completed according to schedule, audit findings were documented, and corrective and preventative actions were defined/documented and on schedule for completion by an established date.

INL was named one of 76 winners nationwide for the 2023 Electronic Product Environmental Assessment Tool (EPEAT) Purchaser Awards. The EPEAT awards recognize leadership in the procurement of sustainable electronics. INL has earned the prestigious annual award since 2015 and earned the 5-star award level two years in a row.

Now in the award program's ninth year, the Green Electronics Council—the organization that manages the EPEAT ecolabel—recognized INL for contributing to DOE reaching a savings of $10.8 million from their purchases of IT products. Winners were recognized for their purchases from six EPEAT product categories: (1) computers and displays, (2) imaging equipment, (3) mobile phones, (4) servers, (5) televisions, and (6) photovoltaic modules.

The council honored the 2023 EPEAT winners on July 27, 2023, at a virtual ceremony. Award winners earned one star for each product category in which they purchased EPEAT registered products, and INL was recognized as a 4-star winner.

Table 3-2. Summary table of DOE sustainability goals (DOE-ID 2023).

DOE GOAL	CURRENT PERFORMANCE STATUS	PLANNED ACTIONS AND CONTRIBUTIONS	OVERALL RISK OF NON-ATTAINMENT
ENERGY MANAGEMENT			
Reduce energy-use intensity (Btu per gross square foot) in goal-subject buildings by 50% by the end of FY 2030.	Energy-use intensity was 153,272.6 Btu/gross square feet (GSF) for FY 2023, which represents a decrease of 0.7% from FY 2015 and an increase of 5.0% from FY 2022.	Seventeen LED lighting and other projects are planned for FY 2024, providing an estimated $66K (1,076 megawatt hours [MWh]) in annual energy savings at a total cost of $224K.	**Medium/Financial** Low-cost of energy and water make project payback difficult to justify on a life-cycle basis.
Achieve a Net-Zero emissions building portfolio by 2045 through building electrification and other efforts.	The IF-655 HVAC system was electrified in FY 2023, and work started on the IF-657 building.	Complete the electrification project for IF-657.	**Medium/Financial** Funding has yet to be secured for all planned electrification projects.
Energy Independence and Security Act Section 432 continuous (four-year cycle) energy and water evaluations.	Energy and water evaluations were completed in 58 covered buildings in FY 2023. These audits represent 43% of the current covered buildings for the third year of the third four-year audit cycle (June 1, 2020, through May 31, 2024). INL is on track with its planned and scheduled audits.	Complete annual energy audits in FY 2024 for the remaining 21 buildings of the 135 covered buildings of the third four-year audit cycle (June 1, 2020, through May 31, 2024).	**Low/None** INL contractor's building audit program is fully established.
Meter individual buildings for electricity, natural gas, steam, and water to adhere to federal metering guidance.	In Idaho Falls, 36 buildings are metered for electricity with either standard or advanced metering. Twenty-eight buildings use and are metered for natural gas with standard meters. Twenty-five buildings are metered for water with standard meters. In the research and industrial complexes, 76 buildings have electric meters, 55 of which have advanced meters.	New INL buildings planned for completion will have advanced metering. Advanced electric and natural gas meters are planned in INL's Idaho Falls buildings (approximately 36 meters) to connect to the SkySpark energy management system. This activity is planned for FY 2024.	**Low/Medium** New INL buildings are specified for advanced metering. The cost to meter all utilities for buildings at the INL research and industrial complexes remains a challenge.

Table 3-2. continued.

DOE GOAL	CURRENT PERFORMANCE STATUS	PLANNED ACTIONS AND CONTRIBUTIONS	OVERALL RISK OF NON-ATTAINMENT
Reduce potable water-use intensity (gal per gross square foot).	Water intensity was 121.8 gal/GSF in FY 2023, which represents a decrease of 30% from FY 2007 and an increase of 1.8% compared to FY 2022.	A detailed water assessment will be completed in FY 2024. Investigate funding to implement audit-identified low and moderate cost water conservation measures, including high-efficiency water technologies.	**Medium** Water usage is highly dependent upon process water consumption at the Advanced Test Reactor Complex and Idaho Nuclear Technology and Engineering Center.
WASTE MANAGEMENT			
Reduce nonhazardous solid waste sent to treatment and disposal facilities.	Generated 2,921,342.01 lbs (1,325.1 metric tons [MT]) of nonhazardous municipal solid waste in FY 2023. In FY 2022, 2,748,832.5 lbs (1,246.9 MT) was generated, resulting in an increase of 6.3% year-over-year (YOY). Diverted 50.2% of nonhazardous solid waste in FY 2023 by recycling 1,466,632.1 lbs (665.3 MT) of materials. INL initiated a new waste reduction initiative that includes reusable to-go containers in the cafeterias.	Continue to educate personnel emphasizing the priority of waste reduction. Explore a glass recycling partnership with the City of Idaho Falls. INL will have a consultant assess waste processes and help identify a strategy to increase waste diversion. INL will install two new, modern digital signage waste and recycle bins to help with employee education and engagement in the waste diversion program.	**Medium** Fluctuations in building use, including classified spaces, employee engagement, and market forces, greatly affect this goal.
Reduce construction and demolition materials and debris sent to treatment and disposal facilities.	Generated 16,431.4 MT of construction and demolition (C&D) waste in FY 2023, compared to 11,794.4 MT in FY 2022, resulting in an increase of 39.32% of C&D waste generated YOY. Diverted 47.6% (17,233,255.4 lbs or 7,816.9 MT) of its C&D waste in FY 2023.	Continue employee education and contract language inclusion and incorporate additional materials into current C&D waste diversion processes. Work with regional industrial recycle entities and develop a strategy to recycle two construction waste streams: concrete and gypsum.	**Medium** Construction continues to increase while markets accepting construction debris are limited. The cost of transporting to an acceptable recycler is a major factor in the decision process.

Table 3-2. continued.

DOE GOAL	CURRENT PERFORMANCE STATUS	PLANNED ACTIONS AND CONTRIBUTIONS	OVERALL RISK OF NON-ATTAINMENT
FLEET MANAGEMENT			
Reduce petroleum consumption.	Fuel usage data indicate 544,313 gasoline-gal equivalents of petroleum-based fuels was used in FY 2023, which is a 42.0% reduction from FY 2005. INL resumed its use of R99 renewable diesel as a sustainable alternative to aid INL in reaching its zero-emission goals.	Optimize and right-size fleet composition by reducing vehicle size, eliminating underutilized vehicles, and acquiring vehicles to match local fuel infrastructure.	**Medium** The petroleum reduction goal will be challenging due to the cost and availability of alternative fueled motor coaches and heavy equipment.
Increase alternative fuel consumption.	Data indicates 276,977 gasoline-gal equivalents of alternative fuels were used in FY 2023, which is a 262.4% increase from FY 2005. INL contractor installed three additional electric vehicle (EV) charging stations for a total of 23 and installed one electric bus charging station.	As INL implements its Net-Zero Plan, a greater emphasis will be placed on acquiring zero-emission light-duty vehicles and installing supporting charging stations. Hydrogen-powered vehicles are also being considered.	**Medium** The alternative fuel increase goal will be challenging due to the cost and availability of EVs and the high-cost of renewable diesel.
Achieve 100% zero-emission vehicle (ZEV) acquisitions by 2035, including 100% zero-emission light-duty vehicle acquisitions by 2027.	Acquired 14 new light-duty EVs and one electric motor coach in FY 2023, for a total of 25 ZEVs. A total of 74 light-duty vehicles were acquired in FY 2023 resulting in 18.9% of those being ZEV acquisitions.	Identify the next group of petroleum-fueled vehicles for replacement with ZEVs.	**Medium** This goal may be difficult to meet due to the availability of appropriate ZEV light-duty vehicle fuel types supplied by the General Services Administration.
CLEAN AND RENEWABLE ENERGY			
Achieve 100% carbon pollution-free electricity on a net annual basis by 2030, including 50% 24/7 carbon pollution-free electricity.	Procured 16,292 MWh of Renewable Energy Credits (REC) in FY 2023 at a total cost of $97,753. This purchase of RECs, in addition to the 83.4 MWh of onsite generation (microgrid and small photovoltaic) and bonuses, totals 16,876 MWh (7.1%) of renewable energy for FY 2023.	As INL implements its Net-Zero Plan, a greater emphasis will be placed on internal applications of renewable energy generation to meet this goal. Purchased RECs will continue to be made along with onsite generation to meet the 7.5% annual goal.	**Low** Established a process for procuring RECs. Explored multiple paths with local utility providers for 100% carbon pollution-free electricity.

Table 3-2. continued.

DOE GOAL	CURRENT PERFORMANCE STATUS	PLANNED ACTIONS AND CONTRIBUTIONS	OVERALL RISK OF NON-ATTAINMENT
Increase consumption of clean and renewable non-electric thermal energy.	Two buildings have solar-transpired walls to provide make-up air preheating.	Investigate the additional use of solar water heating, make-up air preheating, or ground source heat pumps in select locations.	**Medium** Due to the low cost of electric energy, it is challenging to justify the installation of thermal renewable energy.
SUSTAINABLE BUILDINGS			
Increase the number of owned buildings that are compliant with the Guiding Principles for Sustainable Buildings.	At the end of FY 2023, 26 DOE-owned buildings were compliant with the Guiding Principles for Sustainable Federal Buildings (Guiding Principles), which represents 45.6% of applicable buildings. This includes 21 buildings that are less than 25,000 GSF. None of the new construction buildings planned to achieve the Guiding Principles were completed in FY 2023. Completed update to *INL High Performance and Sustainable Building Strategy*.	Document Guiding Principles compliance on new construction buildings completed in FY 2024. Implement a program to reassess buildings on a four-year cycle per the 2020 Guiding Principles.	**Low** The goal was achieved.
ACQUISITIONS AND PROCUREMENT			
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring all sustainability clauses are included as appropriate.	A total of 98.7% of the contracts in FY 2023 contained applicable clauses.	Achieve 100% compliance. Continue to incorporate improvements to the Sustainable Acquisition Program, including procedures, policies, and enhanced work processes that increase visibility, availability, and use of sustainable products.	**Low** The goal continues to be achieved.

Table 3-2. continued.

DOE GOAL	CURRENT PERFORMANCE STATUS	PLANNED ACTIONS AND CONTRIBUTIONS	OVERALL RISK OF NON-ATTAINMENT
INVESTMENTS: IMPROVEMENT MEASURES, WORKFORCE, & COMMUNITY			
Implement life-cycle cost-effective efficiency and conservation measures with appropriated funds or performance contracts.	Twenty-one energy-reduction projects were completed in FY 2023, providing $41K in energy cost-savings. No additional Energy Savings Performance Contract projects were developed in FY 2023.	LED lighting and other projects are planned for 17 buildings. Use the results of an internal assessment tool to engage energy service companies on the viability of an energy-savings performance contract project based on INL energy and water audits.	**Low** Low utility rates and budgeting for energy and water projects remain a challenge.
ELECTRONIC STEWARDSHIP			
Increase the acquisition of sustainable electronics and promote sustainable operations and end-of-life practices.	In FY 2023, 100% of electronic devices were reused or recycled; however, only 97.9% were recycled with a certified recycler, by weight. INL received the Electronics Council's 2023 EPEAT Purchaser Award for the eighth year in a row.	Unless federal requirements dictate otherwise, 100% of electronics are reused or recycled. Continue to partner with Information Technology and Property Disposal Services to improve electronics end-of-life disposition.	**Low** This goal continues to be achieved.
Increase energy and water-efficiency in high-performance computing and data centers.	INL enterprise operations data center hardware has been consolidated and virtualized where possible.	INL enterprise operations data center will engage INL organizations to promote the benefits of co-locating small data center equipment. Study to right-size/decommission oversized cooling towers.	**Medium** Low-energy costs and long construction times may prohibit major investments in updated resiliency measures.

Table 3-2. continued.

DOE GOAL	CURRENT PERFORMANCE STATUS	PLANNED ACTIONS AND CONTRIBUTIONS	OVERALL RISK OF NON-ATTAINMENT
ORGANIZATIONAL RESILIENCE			
Implement climate adaptation and resilience measures.	INL completed over $3M in resilience projects in FY 2023. Infrastructure upgrades include LED lighting in 29 buildings, HVAC systems being replaced in five buildings, and an improved envelope on four buildings. Harden Road Infrastructure: resurfaced three parking lots and installed solar road lighting. Fire-Safe Design: nine fire hydrants replaced that were more than 50 years old.	Continue to implement life-cycle cost-effective energy/resilience solutions that improve the reliability and energy efficiency of critical mission operations.	**Low to Medium** Investment upgrades in existing buildings are a long-term process. New buildings are being built to include resiliency measures.
MULTIPLE CATEGORIES			
Reduce Scopes 1 and 2 GHG emissions.	Scopes 1 and 2 emissions were 87,376.1 MT of carbon dioxide equivalent (MT CO2e) in FY 2023, which was 12.2% higher compared to 77,847.8 MT CO2e in FY 2022. FY 2023 was 38.0% lower than the baseline year FY 2008 value of 141,005.1 MT CO2e.	Refine targeted list of high-value, low-cost energy conservation measure projects with a focus on those reducing total emissions 45% by the end of FY 2025. INL will complete a landfill gas monitoring study, which will identify emitted gases and volumes to better inform the fugitive emissions from the onsite landfill.	**Medium** INL contractor has committed to be carbon Net-Zero by the end of FY 2031.
Reduce Scope 3 GHG emissions.	FY 2023 Scope 3 emissions were 24,329.4 MT CO2e compared to 20,366.8 MT CO2e in FY 2022, for a YOY increase of 19.5% and a 31.0% reduction from the FY 2008 baseline. The increase from the previous year is due mainly to lifting restrictions on business travel.	Continue to encourage teleworking, video conferencing, bike-commuting, and carpooling as they are effective ways to reduce the amount of air and ground travel, including employee commuting.	**Medium** Progress has been made toward exceeding the overall goal, primarily due to ongoing telework. YOY Scope 3 GHG emissions may continue to vary.

3.13 References

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Chapter 4: Environmental Monitoring Programs – Air

CHAPTER 4

An estimated total of 3,341Ci (1.24×10^{14} Bq) of radioactivity, primarily in the form of short-lived noble gas isotopes, was released as airborne effluents from Idaho National Laboratory (INL) Site facilities in 2023. The highest contributors to the total release were the Advanced Test Reactor (ATR) Complex at 86.6%, the Materials and Fuel Complex (MFC) at 11.8%, and the Radioactive Waste Management Complex (RWMC) at 1.29%. Other INL Site facilities contributed 0.28% to the total. The estimated maximum potential dose to a member of the public from all INL Site air emissions (0.029 mrem/yr) is below the regulatory standard of 10 mrem/yr (see Chapter 8 for details).

The INL Site environmental surveillance monitoring programs emphasize measurements of airborne contaminants in the environment because air is the most important transport pathway from the INL Site to receptors living outside the INL Site boundary. Because of this pathway, samples of airborne particulates, atmospheric moisture, and precipitation were collected onsite, at INL Site boundary locations, and at offsite communities. These samples were analyzed for radioactivity in 2023.

Particulates were filtered from the air using a network of low-volume air samplers, and the filters were analyzed for gross alpha activity, gross beta activity, and these specific radionuclides—cesium-137 (^{137}Cs), americium-241 (^{241}Am), plutonium-239/240 ($^{239/240}$Pu), plutonium-238 (^{238}Pu), uranium-234 (^{234}U), uranium-238 (^{238}U), zinc-65 (^{65}Zn), chlorine-36 (^{36}Cl), and strontium-90 (^{90}Sr). Results were compared to detection levels, background measurements, historical results, and radionuclide-specific Derived Concentration Standards (DCS) established by the U.S. Department of Energy (DOE) to protect human health and the environment. Gross alpha and gross beta activities were used primarily for trend analyses, which indicated fluctuations were observable that correlate with seasonal variations in natural radioactivity.

Amounts of ^{137}Cs, $^{239/240}$Pu, and ^{241}Am were detected in some quarterly composited samples collected during 2023. All concentrations were within historical measurements made during the past ten years (2013-2022), except for some ^{241}Am and plutonium results collected at RWMC during the fourth quarter. Plutonium isotopes and ^{241}Am are known to occur in soils at the Subsurface Disposal Area (SDA). The results observed during the fourth quarter are likely related to work activities being performed at SDA. All concentrations were well below the DCSs for these radionuclides.

Airborne particulates were also collected biweekly around the perimeters of the SDA at the RWMC and the Idaho Comprehensive Environmental Response, Compensation, and Liability Act Disposal Facility (ICDF) near the Idaho Nuclear Technology and Engineering Center (INTEC). Detections of americium and plutonium isotopes were comparable to past measurements and are likely due to resuspended soils contaminated from past burial practices at the SDA. The results were below the DCSs established for those radionuclides.

Atmospheric moisture and precipitation samples were analyzed for tritium. Tritium was detected in some samples and was most likely from natural production in the atmosphere rather than INL Site releases. All measured results were below health-based regulatory limits.

Idaho National Laboratory

4. ENVIRONMENTAL MONITORING PROGRAMS – AIR

Although all INL Site facilities are carefully managed and controlled, the potential exists to release radioactive and nonradioactive hazardous constituents in amounts above regulatory limits during an operational upset or emergency incident situation. In such an event, pathway vectors, such as air, soil, plants, animals, and groundwater, may transport these constituents to nearby populations. Figure 4-1 is a conceptual model showing potential routes of exposure for these potential releases. Reviews of historical environmental data and environmental transport modeling indicate that air is a key pathway from INL Site releases to members of the general public. The ambient air monitoring network operates constantly and is a critical component of the INL Site's environmental monitoring programs. It monitors for routine and unforeseen releases, provides verification the INL Site complies with regulatory standards and limits, and can be used to assess impact to the environment over time.

This chapter presents the results of radiological analyses of airborne effluents and ambient air samples collected both on and off the INL Site. The results include those from both the INL and Idaho Cleanup Project (ICP) contractors. Table 4-1 summarizes the radiological air monitoring activities relative to INL's major radiological sources, as well as the minor onsite and offsite radiological sources. Details may be found in the INL Site Environmental Monitoring Plan (DOE-ID 2021).

4.1 Organization of Air Monitoring Programs

The INL Site contractors document airborne radiological effluents at all INL Site facilities in an annual report prepared in accordance with the 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities." Section 4.2 summarizes the emissions reported in "National Emission Standards for Hazardous Air Pollutants—Calendar Year 2023 INL Report for Radionuclides" (DOE-ID 2024), referred to hereafter as the National Emission Standards for Hazardous Air Pollutants (NESHAP) Report. The report also documents the estimated potential dose received by the general public due to INL Site activities.

Ambient air monitoring is conducted by the INL contractor to ensure the INL Site remains in compliance with DOE O 458.1, "Radiation Protection of the Public and the Environment."

The INL contractor collects air samples primarily around the INL Site encompassing a region of 23,390 km^2 (9,000 mi^2) that extends to Jackson, Wyoming, as observed in Figure 4-2. In 2023, the INL contractor collected approximately 1,900 air samples (including duplicate samples and blanks) for various radionuclide analyses. The INL contractor collected air moisture at eight locations and precipitation samples at four locations for tritium analysis. Section 4.3 summarizes the results for ambient air monitoring conducted in 2023.

The ICP contractor monitors air around waste management facilities to comply with DOE O 435.1, "Radioactive Waste Management." These facilities are the SDA at the RWMC and the ICDF near the INTEC. These locations are shown in Figure 4-2. Section 4.4 discusses the air sampling that the ICP contractor performs in support of waste management activities. In 2023, the ICP contractor collected approximately 230 air samples (including duplicate samples) for various radiological analyses.

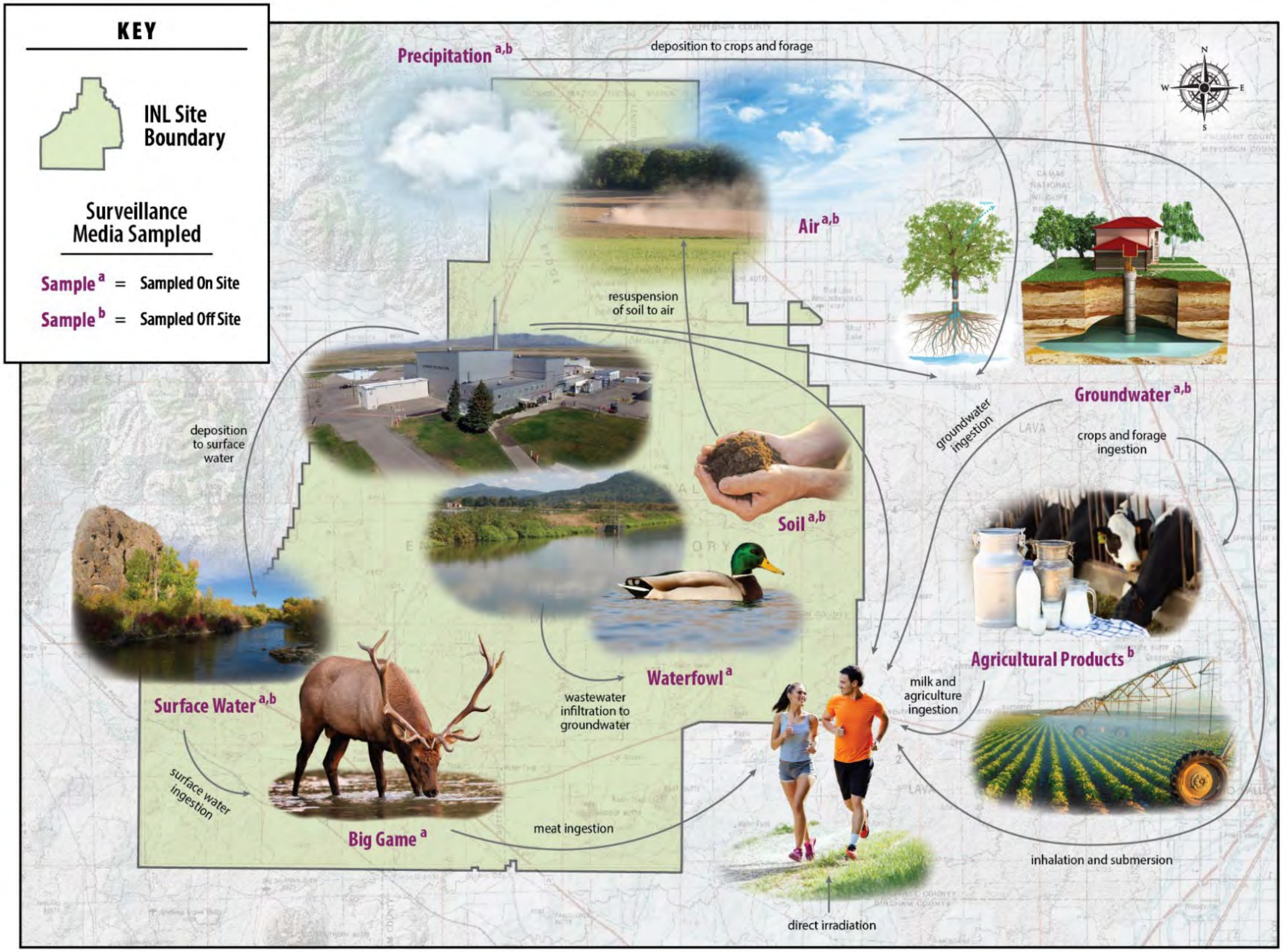

Figure 4-1. INL Site conceptual model.

Table 4-1. Radiological air monitoring activities by organization.

AREA/FACILITY	AIRBORNE EFFLUENT MONITORING PROGRAMS	ENVIRONMENTAL SURVEILLANCE PROGRAMS					
	AIRBORNE EFFLUENTS[a]	LOW-VOLUME CHARCOAL CARTRIDGES (^{131}I)	LOW-VOLUME GROSS ALPHA	LOW-VOLUME GROSS BETA	SPECIFIC RADIONUCLIDES[b]	ATMOSPHERIC MOISTURE	PRECIPITATION
ICP CONTRACTOR[c]							
INTEC	●		●	●	●		
RWMC	●		●	●	●		
INL CONTRACTOR[d]							
MFC	●						
INL Site/Regional		●	●	●	●	●	●

a. Facilities that required monitoring during 2023 for compliance with 40 CFR 61, Subpart H, “National Emissions Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities.”

b. Gamma-emitting radionuclides are measured by the ICP contractor monthly and by the INL contractor quarterly. Amounts of ^{137}Cs, ^{241}Am, $^{239/240}$Pu, ^{238}Pu, ^{234}U, ^{238}U, ^{65}Zn, ^{36}Cl, and ^{90}Sr are measured by the INL Site contractors quarterly.

c. The ICP contractor monitors waste management facilities to demonstrate compliance with DOE O 435.1, “Radioactive Waste Management.” A combination of continuous monitoring and ambient air sampling are used to demonstrate compliance with 40 CFR 61, Subpart H.

d. The INL contractor monitors airborne effluents at the MFC and collects samples onsite, around, and offsite the INL Site to demonstrate compliance with DOE O 458.1, “Radiation Protection of the Public and the Environment.”

The National Oceanic and Atmospheric Administration (NOAA) has collected meteorological data at the INL Site since 1950. The data have historically been tabulated, summarized, and reported in several climatography reports and used by scientists to evaluate atmospheric transport and dispersion. The latest report, “Climatography of the Idaho National Laboratory,” 4th Edition (Clawson et al. 2018), was prepared by the NOAA Field Research Division (since renamed the Special Operations and Research Division) of the Air Resources Laboratory and presents over 20 years (1994–2015) of quality-controlled data from the NOAA INL mesonet meteorological monitoring network found at: https://niwc.noaa.inl.gov/climate/INL_Climate4th_Final2.pdf. More recent data are provided by the Special Operations and Research Division to scientists modeling the dispersion of INL Site releases (see Chapter 8 in this annual report and “Meteorological Monitoring,” a supplement to this annual report for more information).

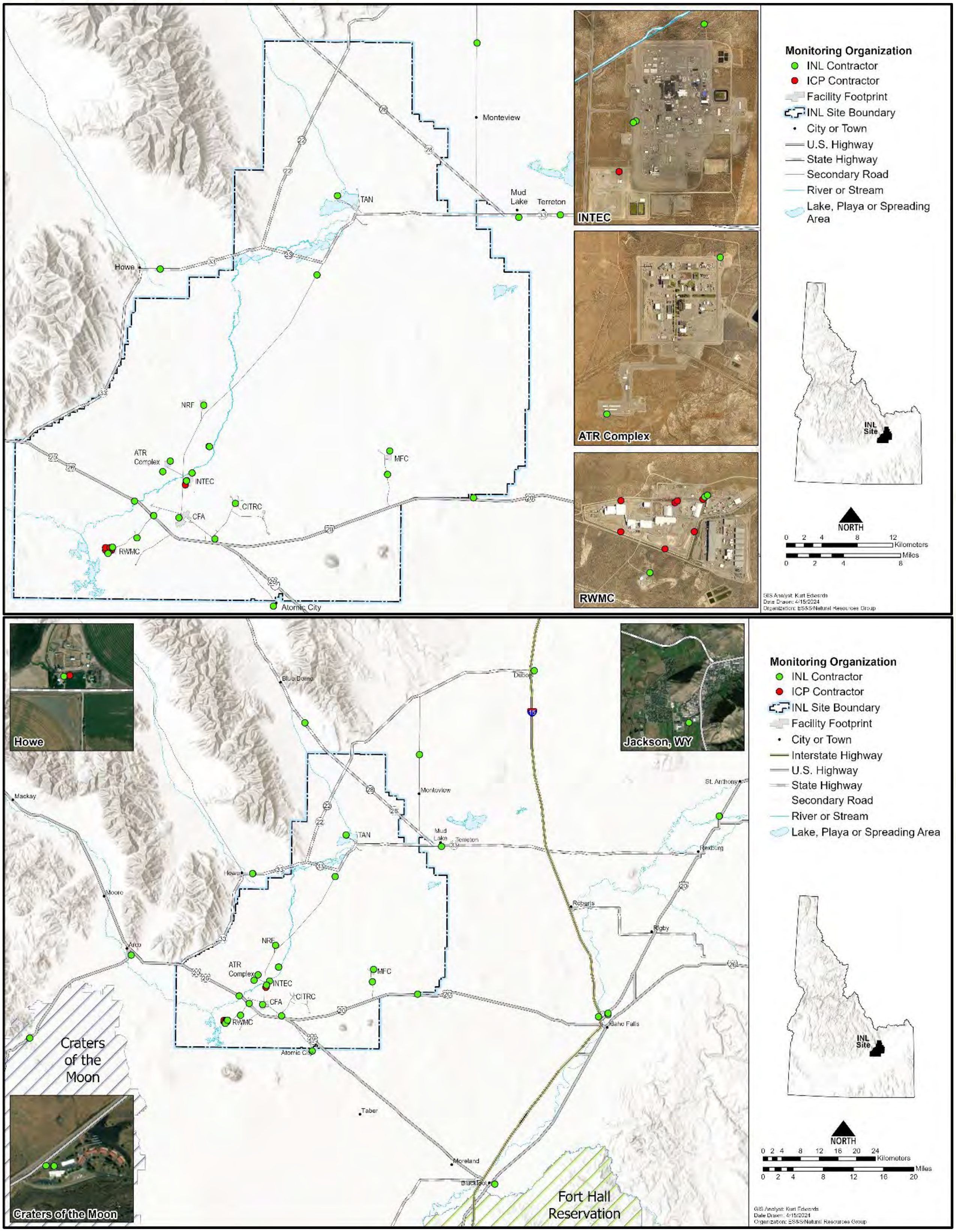

Figure 4-2. INL Site environmental surveillance radiological air sampling locations (onsite [top] and regional [bottom]).

4.2 Airborne Effluent Monitoring

Each regulated INL Site facility determines airborne effluent concentrations from its regulated emission sources as required under state and federal regulations. Radiological air emissions from INL Site facilities are also used to estimate the potential dose to a hypothetical maximally exposed individual (MEI), who is a member of the public (see Chapter 8 of this report). Radiological effluents and the resulting potential dose for 2023 are reported in the NESHAP Modeling Report (INL 2024a) and the NESHAP Report (DOE-ID 2024).

The NESHAP Report includes three categories of airborne emissions:

- Sources that require continuous monitoring under the NESHAP regulation are primarily the stacks at MFC, the Advanced Mixed Waste Treatment Project, and INTEC
- Releases from all other point sources (stacks and exhaust vents)
- Nonpoint—or diffuse—sources, otherwise referred to as fugitive sources, which include radioactive waste ponds, buried waste, contaminated soil areas, radiological test ranges, and decontamination and decommissioning operations.

INL Site emissions include all three airborne emission categories and are summarized in Table 4-2. The radionuclides included in this table were selected because they contribute 99.9% of the cumulative dose to the MEI estimated for each facility area. During 2023, an estimated 3,341 Ci (1.24×10^{14} Bq) of radioactivity was released to the atmosphere from all INL Site sources. The 2023 release is 936% higher than the estimated total of 357 Ci (1.32×10^{13} Bq) released in 2022. Th increase is primarily the result of the ATR becoming operational again in 2023 after refurbishment of the reactor core was completed, bringing emissions levels back up to historical averages.

The following facilities were major contributors to the total emissions, as observed in Figure 4-3:

- ***ATR Complex Emissions Sources (86.6% of total INL Site source term).*** Emissions from the ATR Complex rose in comparison to 2022 due to the ATR once again becoming operational after the completion of core internal changeout, bringing the emissions levels back up to historical averages. Radiological air emissions from the ATR Complex are primarily associated with the operational of the ATR. These emissions include noble gases, radioiodine, and other mixed fission and activation products. Other radiological air emissions are associated with sample analysis, site remediation, and research and development activities. The INL Radioanalytical Chemistry Laboratory (RCL), which has been in operation since 2011, is another emission source at the ATR Complex. Activities at the RCL include inorganic, general purpose analytical chemistry, and wet chemical analysis for trace and high-level radionuclide determination. RCL contains high-efficiency particulate air-filtered hoods that are used for the analysis of contaminated samples. There are no sources at the ATR Complex that require continuous emissions monitoring due to the low dose contribution (see Section 8.2). On a regular basis, the ATR effluent stream is sampled and analyzed for particulate, radioiodine, and noble gas radionuclides. Effluent from the Safety and Tritium Applied Research Facility (TRA-666) is sampled and analyzed for tritium.
- ***MFC Emissions Sources (11.8% of total INL Site source term).*** Emissions from MFC increased by 78% in 2023 compared to 2022, however with the ATR becoming operation again in 2023, the percent contributed by MFC to total INL emissions was proportionally reduced. Radiological air emissions are primarily associated with spent fuel treatment at the Fuel Conditioning Facility, waste characterization and fuel research development at the Hot Fuel Examination Facility, fuel research and development at the Fuel Manufacturing Facility, and post-irradiation examination at the Irradiated Materials Characterization Laboratory. To satisfy the requirements of 40 CFR 61 Subpart H, stack filters from the effluent streams of these four facilities are sampled and analyzed for particulate radionuclides on a regular basis due to their potential to discharge radionuclides into the air in quantities that could cause an effective dose of more than 1% of the standard. Other effluent streams with a smaller potential dose (less than 1% of the standard), such as the Transient Reactor Test Facility, are sampled and analyzed periodically to confirm the lower emissions. Gaseous and particulate radionuclides may also be released from other MFC facilities during laboratory research activities, sample analysis, waste handling and storage, and maintenance operations.

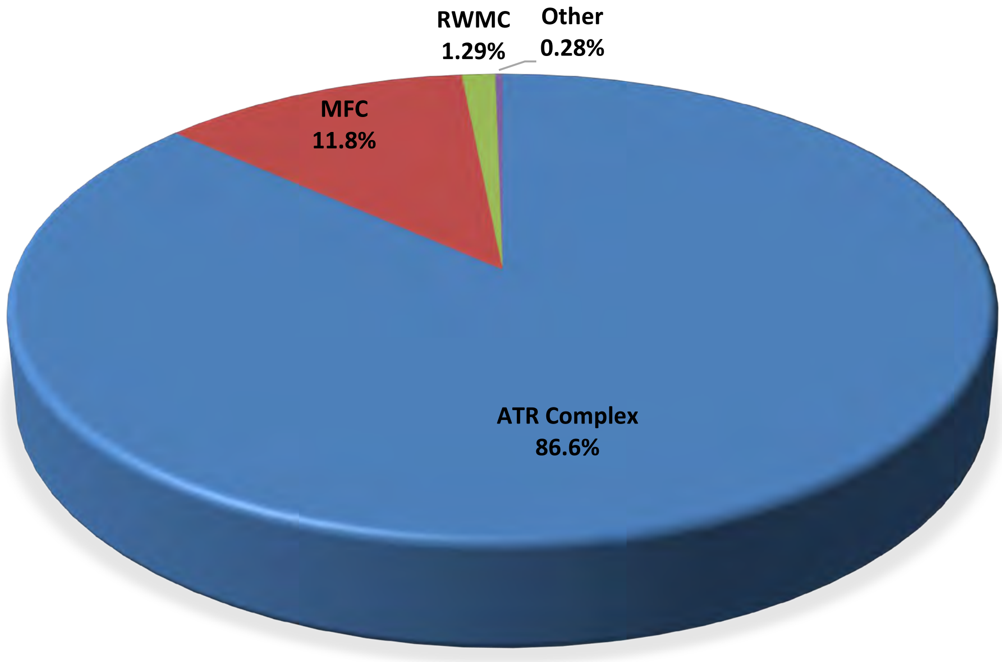

Figure 4-3. Percent contributions in Ci, by facility, to total INL Site airborne radiological releases (2023).

- ***RWMC Emissions Sources (1.29% of total INL Site source term).*** Emissions from RWMC decreased from 48.1 Ci in 2022 to 42.9 Ci in 2023, and with the emissions from the ATR coming back up to historical averages due to the completion of core internal changeout, the relative percent contribution from RWMC to total INL Site emissions values also decreased in comparison to the 2022 percent contribution (13.5% to 1.29%). Emissions at RWMC result from various activities associated with the facility's mission to complete environmental cleanup of the area, as well as to store, characterize, and treat contact-handled transuranic waste and mixed low-level waste prior to shipment to offsite licensed disposal facilities. Various projects are being conducted to achieve these objectives: (1) waste retrieval activities at the Accelerated Retrieval Projects (ARPs), (2) operation of the Resource Conservation and Recovery Act (RCRA)-permitted Sludge Repackage waste processing project, (3) storage of waste within the Type II storage modules at the Advanced Mixed Waste Treatment Project, (4) storage and characterization of waste at the Drum Vent and Characterization facilities, (5) storage of wastes at the Transuranic Storage Area-Retrieval Enclosure (WMF-636), and (6) treatment of wastes at the Advanced Mixed Waste Treatment Facility (WMF-676). Data from 18 emission sources (both point and diffuse) at RWMC were reported in the 2023 NESHAP Report for Radionuclides (DOE-ID 2024), including three continuously monitored point sources. WMF-676 has two continuously monitored stacks, while WMF-636 had one continuously monitored stack, for which monitoring was ceased during 2022. Radionuclide emissions monitoring from the Comprehensive Environmental Response, Compensation, and Liability Act ARP facilities and the two RCRA facilities (WMF-1617 and WMF-1619) is achieved with the U.S. Environmental Protection Agency (EPA)-approved ambient air monitoring program, which has been in place since 2008. Radiological emissions at RWMC include tritium and carbon-14 (^{14}C) associated with buried beryllium blocks at the SDA. Transuranic radionuclides released from ARP facilities, including ^{241}Am, ^{238}Pu, $^{239/240}Pu$, and ^{241}Pu, have declined in recent years as waste exhumation and processing activities progress to completion.
- ***Radiological Response Training Range (RRTR) Emissions Sources (0.19% of total INL Site source term).*** The north RRTR is located 1.6 km (1 mile) NNE of the Specific Manufacturing Capability (SMC) and began operations in July 2011 to support federal agencies responsible for the nuclear forensics mission. These sites are used to train personnel, test sensors, and develop both aerial- and ground-based detection capabilities under a variety of scenarios in which radioactive materials are used to create a radioactive field for training in activities, such as contamination control, site characterization, and field sample collection activities. Previously, emissions from RRTR were reported in combination with emissions from SMC. As described in "Update of Receptor Locations for INL NESHAP

Assessments” (INL 2023a), a number of facilities that were once modeled as collocated emission sources are now modeled as separate sources, resulting in a more realistic modeling scenario. Estimated emissions from RRTR were fewer in 2023 (6.46 Ci) as compared to 2022 (33.2 Ci) due to variances in operations.

- ***INTEC Emissions Sources (0.038% of total INL Site source term).*** Radiological air emissions at INTEC are primarily from the operation of the ICDF landfill and ponds (located outside the fenced boundary of INTEC) and storage and containment of the Three Mile Island Unit 2 (TMI-2) core debris within the Independent Spent Fuel Storage Installation (CPP-1774), which is licensed under the U.S. Nuclear Regulatory Commission. These sources contribute gaseous radionuclides, including tritium, iodine-129, and krypton-85, with contributions of particulate radionuclides ^{137}Cs and ^{90}Sr from ICDF. INTEC has one stack continuously monitored for radionuclide emissions (resulting from Waste Management activities) located outside of CPP-666 (Fluorinel Dissolution Process and Fuel Storage Facility). Additional sources include the INTEC Main Stack (CPP-708), which emits gaseous and particulate radionuclides associated with liquid waste operations, including effluents from the Tank Farm Facility, Process Equipment Waste Evaporator, and Liquid Effluent Treatment and Disposal facility. Other radioactive emissions are associated with remote-handled transuranic and mixed-waste management operations, dry storage of spent nuclear fuel, and maintenance and servicing of contaminated equipment.
- ***Central Facilities Area (CFA) Emissions Sources (0.032% of total INL Site source term).*** Minor emissions occur from CFA where work with small quantities of radioactive materials is routinely conducted. This includes sample preparation and verification and radiochemical research and development. Other minor emissions result from groundwater usage via evapotranspiration from irrigation or evaporation from sewage lagoons.
- ***Critical Infrastructure Test Range Complex (CITRC) Emissions Sources (0.0066% of total INL Site source term).*** Emissions from CITRC are primarily the result of activity related to National and Homeland Security missions. Activities at CITRC include program and project testing for critical infrastructure resilience, nonproliferation, wireless test bed operations, power line and grid testing, unmanned aerial vehicles, explosives detection, and training radiological counter-terrorism emergency response.
- ***Test Area North Emissions Sources (0.00043% of total INL Site source term).*** Emissions sources at Test Area North are primarily from the New Pump and Treat Facility, which serves to reduce concentrations of trichloroethylene and other volatile organic compounds in the medial zone portion of the OU 1-07B contamination groundwater plume to below drinking water standards. Low levels of ^{90}Sr and tritium are present in the treated water from the New Pump and Treat Facility and are released to the atmosphere by the treatment process.
- ***SMC Emissions Sources (3.28E-14% of total INL Site source term).*** Operations at SMC include material development, fabrication, and assembly work to produce armor packages. The operation uses standard metal-working equipment in fabrication and assembly. Other activities include developing tools and fixtures and preparing and testing metallurgical specimens. Radiological air emissions from SMC are associated with processing depleted uranium. Potential emissions are uranium isotopes and associated radioactive progeny.

The estimated radionuclide releases (Ci/yr) from INL Site facilities, shown in Table 4-2, were used to calculate the dose to the hypothetical MEI member of the public, who is assumed to reside near the INL Site perimeter. To calculate dose to the MEI, radionuclides with very short half-lives must be converted to the first progeny with a suitable half-life for modeling. The estimated emissions are then scaled based on the difference in activity between the parent and progeny. The estimated dose to the MEI in calendar year 2023 was 0.029 mrem/yr (0.29 µSv/yr) which is below the regulatory standard of 10 mrem/yr. Six radionuclides—uranium-238 (^{238}U) ^{234}U, chlorine-36 (^{36}Cl), tritium (^{3}H), ^{137}Cs, and ^{90}Sr—are responsible for more than 90% of the MEI dose. Potential radiation doses to the public are discussed in more detail in Chapter 8 of this report.

Table 4-2. Radionuclide composition of INL Site airborne effluents (2023).[a]

		AIRBORNE EFFLUENT (Ci)[b]										
RADIONUCLIDE[c]	HALF-LIFE[d]	ATR COMPLEX	CFA[e]	CITRC[e]	INTEC	MFC	NRF[e]	RRTR	RWMC	SMC[e]	TAN[e]	TOTAL
Americium-241	432.2 y	2.22E-05	NS[f]	—[g]	1.30E-05	NS	—	—	5.49E-05	—	—	9.01E-05
Argon-41	1.83 h	1.97E+03	NS	—	—	7.46E+01	—	NS	—	—	—	2.04E+03
Bromine-82	1.47 d	—	NS	—	—	NS	—	6.29E+00	—	—	—	6.29E+00
Carbon-14	5730 y	NS	NS	—	2.43E-03	—	2.10E-01	—	2.22E-02	—	—	2.35E-01
Cesium-134	2.06 y	NS	NS	—	—	8.59E-04	—	—	—	—	—	8.59E-04
Cesium-137	30.2 y	5.29E-03	4.16E-06	—	3.78E-04	7.64E-03	8.04E-05	—	NS	—	—	1.34E-02
Chlorine-36	3.01×10^5 y	—	NS	—	NS	7.17E-03	—	NS	—	—	—	7.17E-03
Cobalt-60	5.271 y	5.90E-03	NS	—	NS	—	—	—	NS	—	—	5.90E-03
Hydrogen-3	12.3 y	5.29E+02	3.62E-01	2.20E-01	1.87E-01	2.17E+02	NS	—	4.29E+01	—	NS	7.90E+02
Iodine-129	1.57×10^7 y	NS	NS	—	1.43E-04	—	NS	—	—	—	—	1.43E-04
Iodine-131	8.02 d	NS	1.41E-02	—	—	NS	NS	—	—	—	—	1.41E-02
Iodine-132	2.30 h	NS	4.74E-02	—	—	—	—	—	—	—	—	4.74E-02
Iodine-133	20.8 h	NS	1.56E-01	—	—	—	—	—	—	—	—	1.56E-01
Iodine-135	6.57 h	NS	1.60E-01	—	—	—	—	—	—	—	—	1.60E-01
Krypton-85	10.756 y	—	NS	—	1.09E+00	NS	NS	NS	—	—	—	1.09E+00
Krypton-87	76.3 min	NS	NS	—	—	9.65E+00	—	NS	—	—	—	9.65E+00
Krypton-88	2.84 h	3.82E+00	1.92E-02	—	—	8.77E+00	—	—	—	—	—	1.26E+01
Plutonium-238	87.7 y	NS	NS	—	7.76E-07	NS	—	—	NS	—	—	7.76E-07
Plutonium-239	24,065 y	8.46E-06	NS	—	4.93E-06	NS	2.70E-06	—	2.57E-05	—	—	4.18E-05
Plutonium-240	6,537 y	NS	NS	—	4.78E-06	NS	—	—	5.89E-06	—	—	1.07E-05
Sodium-22	2.60 y	NS	8.28E-06	—	—	NS	—	—	—	—	—	8.28E-06
Strontium-90	29.12 y	2.82E-02	NS	—	3.00E-04	1.22E-03	5.60E-05	—	NS	—	3.01E-05	2.98E-02
Uranium-234	2.46×10^5 y	NS	NS	—	NS	7.66E-02	—	—	—	2.03E-13	—	7.66E-02
Uranium-235	7.04×10^8 y	NS	NS	—	NS	3.49E-03	—	—	NS	NS	—	3.49E-03
Uranium-238	4.5×10^9 y	NS	NS	—	NS	1.45E-01	—	—	NS	8.83E-13	—	1.45E-01
Xenon-133	5.23 d	3.44E+02	NS	—	—	NS	—	—	—	—	—	3.44E+02
Xenon-135	9.09 h	1.83E+01	2.29E-01	—	—	NS	—	—	—	—	—	1.85E+01
Xenon-138	14.1 min	NS	—	—	—	1.49E+01	—	—	—	—	—	1.49E+01
TOTAL CURIES RELEASED[h]		2.86E+03	9.88E-01	2.20E-01	1.28E+00	3.26E+02	2.10E-01	6.29E+00	4.29E+01	1.09E-12	3.01E-05	3.24E+03
TOTAL DOSE (mrem)[i]		9.68E-04	6.06E-06	1.10E-06	1.79E-05	2.73E-02	3.11E-05	2.02E-04	5.21E-04	3.41E-14	1.26E-06	2.91E-02

Table 4-2. continued.

AIRBORNE EFFLUENT (Ci)[b]												
RADIONUCLIDE[c]	HALF-LIFE[d]	ATR COMPLEX[e]	CFA[e]	CITRC[e]	INTEC[e]	MFC[e]	NRF[e]	RRTR[e]	RWMC[e]	SMC[e]	TAN[e]	TOTAL

a. Radionuclide release information provided by the INL contractor (INL 2023a).

b. One curie (Ci) = 3.7 × 10^{10} becquerels (Bq).

c. Includes only those radionuclides that collectively contribute 99.9% of the total dose to the MEI estimated for each INL Site facility. Other radionuclides not shown in this table account for less than 0.1% of the dose estimated for each facility.

d. Half-life units: m = minutes, h=hours, d = days, y = years.

e. ATR = Advanced Test Reactor, CFA = Central Facilities Area, CITRC = Critical Infrastructure Test Range Complex, INTEC = Idaho Nuclear Technology and Engineering Center, MFC = Materials and Fuels Complex, NRF = Naval Reactors Facility, RRTR = Radiological Response Training Range, RWMC = Radioactive Waste Management Complex, SMC = Specific Manufacturing Capability, TAN = Test Area North.

f. NS = not significant. The radionuclide was estimated to not be one of the top 99.9% contributors to the total MEI dose from that facility.

g. A long dash signifies the radionuclide was not reported to be released to the air from the facility in 2023.

h. Total curies may be less than the total curies in Table 8-1 in Chapter 8 because Table 4-2 accounts only for radionuclides that collectively contribute 99.9% of the total dose to the MEI estimated for each INL Site facility. Total curies may be less than the originally reported amounts due to changes in total activity associated with conversion from short-lived radionuclides into progeny with half-lives long enough to be modeled, and for dose to be calculated.

i. The annual dose (mrem) for each facility was calculated at the location of the MEI using estimated radionuclide releases and methodology recommended by the EPA. See Chapter 8 for details.

4.3 Ambient Air Surveillance Monitoring

Ambient air surveillance monitoring is conducted onsite and offsite to identify regional and historical trends, to detect accidental and unplanned releases, and to determine if air concentrations are below DCSs established by DOE for inhaled air (DOE 2021). Each radionuclide-specific DCS corresponds to a dose of 100 mrem for continuous exposure during the year. The Clean Air Act NESHAP regulatory standard is 10 mrem/yr (0.1 mSv/yr) (40 CFR 61, Subpart H). All ambient air surveillance monitoring sample results for 2023 are provided in quarterly surveillance reports (INL 2024b, INL 2024c, INL 2024d, and INL 2024e).

4.3.1 Ambient Air Surveillance Monitoring System Design

Figure 4-2 shows the regional and INL Site routine air surveillance monitoring locations. A total of 37 low-volume air samplers (including four quality assurance samplers), one high-volume air sampler, eight atmospheric moisture samplers, and four precipitation samplers operated in the network in 2023, as shown in Table 4-3.

Historically, air samplers were positioned near INL Site facilities or sources of contamination, in predominant downwind directions from sources of radionuclide air emissions, at potential offsite receptor population centers, and at background locations. In 2015, the network was evaluated quantitatively, using atmospheric transport modeling and frequency of detection methods (Rood, Sondrup, and Ritter 2016). A Lagrangian Puff air dispersion model (CALPUFF) with three years of meteorological data was used to model atmospheric transport of radionuclides released from six major facilities and to predict air concentrations at each sampler location for a given release time and duration. Frequency of detection is defined as the fraction of events resulting in a detection at either a single sampler or network. The frequency of detection methodology allowed for an evaluation of short-term releases that included effects of short-term variability in meteorological conditions. Results showed the detection frequency was over 97.5% for the entire network considering all sources and radionuclides. Network intensity results (i.e., the fraction of samplers in the network that have a positive detection for a given event) ranged from 3.75% to 62.7%. An evaluation of individual samplers indicated some samplers were poorly located and added little to the overall effectiveness of the network. Using this information, some monitors were relocated to improve the performance of the network. In 2019, the frequency of detection method was used to evaluate the Idaho Falls facilities (INL 2019), which resulted in the installation of an additional monitor at the INL Research Center (IRC).

Tritium is present in air moisture due to natural production in the atmosphere, the remnants of global fallout from historical nuclear weapons testing, and releases from INL Site facilities. Historical emissions data show that most tritium is released from the ATR Complex, INTEC, and RWMC. Tritium enters the environment as tritiated water and behaves like water in the environment. The air surveillance monitoring network evaluation described in the previous paragraph was used to locate atmospheric moisture samplers. The Experimental Field Station (EFS) and Van Buren Boulevard samplers are located onsite and appear to be in or near the areas of the highest projected air concentration. Atomic City and Howe are Idaho communities located close to the INL Site boundary. Idaho Falls and Craters of the Moon are good offsite locations for measuring background concentrations because they do not appear to be impacted by modeled dispersion of tritium. Thus, one or two atmospheric moisture samplers are currently placed at each of the seven locations: Atomic City, Craters of the Moon, EFS, Howe, Idaho Falls (two samplers), the Remote-Handled Low-Level Waste (RHLLW) Disposal Facility, and Van Buren Boulevard. Although there are more particulate air surveillance monitoring stations, additional atmospheric moisture and precipitation surveillance monitoring stations are not warranted because the estimated potential dose for INL Site releases is less than 0.1 mrem/yr, which is the recommended DOE limit for routine surveillance (DOE 2015). See Chapter 8 for additional information on dose.

Historical tritium concentrations in precipitation and atmospheric moisture samples collected by the INL contractor during the 10-year period from 2013 through 2022 were compared statistically; results indicate there are no differences between the datasets. For this reason, INL contractor precipitation samplers were placed at the same locations as the atmospheric moisture samplers at Atomic City, EFS, Howe, and Idaho Falls. In addition, the Idaho Falls sampler can be readily accessed by the INL contractor personnel after a precipitation event. The EPA has a precipitation sampler in Idaho Falls and subsamples are collected for the INL contractor.

To support emergency response, the INL contractor maintains 16 high-volume event air samplers at NOAA weather towers, as shown in Figure 4-4. These event monitors are only turned on as needed for sampling if an event occurs, such as a range fire or unplanned release of radioactivity.

Table 4-3. INL Site and regional ambient air surveillance monitoring summary (2023).

MEDIUM SAMPLED	TYPE OF ANALYSIS	FREQUENCY	NUMBER OF LOCATIONS		MINIMUM DETECTABLE CONCENTRATION
			ONSITE	OFFSITE	
Air (low-volume)[a,b,c]	Gross alpha	Weekly	21	16	7E-16 µCi/mL
	Gross beta	Weekly	21	16	1E-15 µCi/mL
	Specific gamma[d]	Quarterly	21	16	1.2E-16 µCi/mL
	Plutonium-238	Quarterly	21	16	8.9E-18 µCi/mL
	Plutonium-239/240	Quarterly	21	16	8.8E-18 µCi/mL
	Americium-241	Quarterly	21	16	9.9E-18 µCi/mL
	Chlorine-36[e]	Quarterly	2	0	5.0E-17 µCi/mL
	Strontium-90	Quarterly	21	16	1.1E-16 µCi/mL
	Uranium-233/234[e]	Quarterly	21	16	1.9E-17 µCi/mL
	Uranium-238[e]	Quarterly	21	16	1.3E-17 µCi/mL
	Iodine-131	Weekly	21	16	3.7E-13 µCi/mL
Air (high-volume)[f]	Gross beta scan	Biweekly	–	1	1E-15 µCi/mL
	Gamma scan	Continuous	–	1	Not applicable
	Specific gamma[d]	Annually[g]	–	1	1E-14 µCi/mL
	Isotopic Uranium and Plutonium	Every 4 Years	–	1	2E-18 µCi/mL
Air (atmospheric moisture)[h]	Tritium	3–6/Quarter	3	5	5E-12 µCi/mL (air)
Air (precipitation)[i]	Tritium	Monthly	0	1	95 pCi/L
		Weekly	1	2	

a. Low-volume air samplers are operated on the INL Site by the INL contractor at the following locations: ATR Complex, CFA, Experimental Breeder Reactor No. 1 (EBR-I), EFS, Gate 4, Highway 26 Rest Area, INTEC (two air samplers), Main Gate, MFC (two air samplers), NRF, Power Burst Facility (PBF), RHLLW, RWMC (two air samplers), SMC, and Van Buren Boulevard. Additionally, there are rotating duplicate samplers for quality assurance. In 2023, the samplers were located at INTEC, RWMC, and Van Buren Boulevard. This table does not include high-volume 'event' surveillance monitoring by the INL contractor.

b. The INL contractor operates low-volume samplers at INL Site boundary locations. These include Arco, Atomic City, Blue Dome, Federal Aviation Administration Tower, Howe, Monteview, and Terreton.

c. The INL contractor operates low-volume samplers offsite at Blackfoot, Craters of the Moon, Dubois, Idaho Falls, IRC (two air samplers), Jackson (WY), and Sugar City. In addition, there is a rotating duplicate sampler for quality assurance. In 2023, the sampler was placed in Dubois.

d. The minimum detectable concentration shown is for ^{137}Cs.

e. The radionuclide is a contributor to the estimated MEI dose and was not routinely analyzed for in the past. As a result, analysis for the radionuclide began in 2023.

f. The EPA RadNet stationary monitor at Idaho Falls runs 24 hours a day, seven days a week, and sends near-real-time measurements of gamma radiation to EPA's National Analytical Radiation Environmental Laboratory (NAREL). Filters are collected by INL personnel for the EPA RadNet program and sent to NAREL. Data are reported by the EPA's RadNet at http://www.epa.gov/radnet/radnet-databases-and-reports.

g. If gross beta activity is greater than 1 pCi/m^3, then a gamma scan is performed at NAREL. Otherwise, an annual composite is analyzed.

h. Atmospheric moisture samples are collected onsite at EFS, RHLLW, and Van Buren Boulevard by the INL contractor. Samples are collected offsite at Atomic City, Craters of the Moon, Howe, and Idaho Falls (two samplers) by the INL contractor.

i. Precipitation samples are currently collected onsite at EFS and offsite at Atomic City, Howe, and Idaho Falls (also used as the EPA RadNet precipitation location) by the INL contractor.

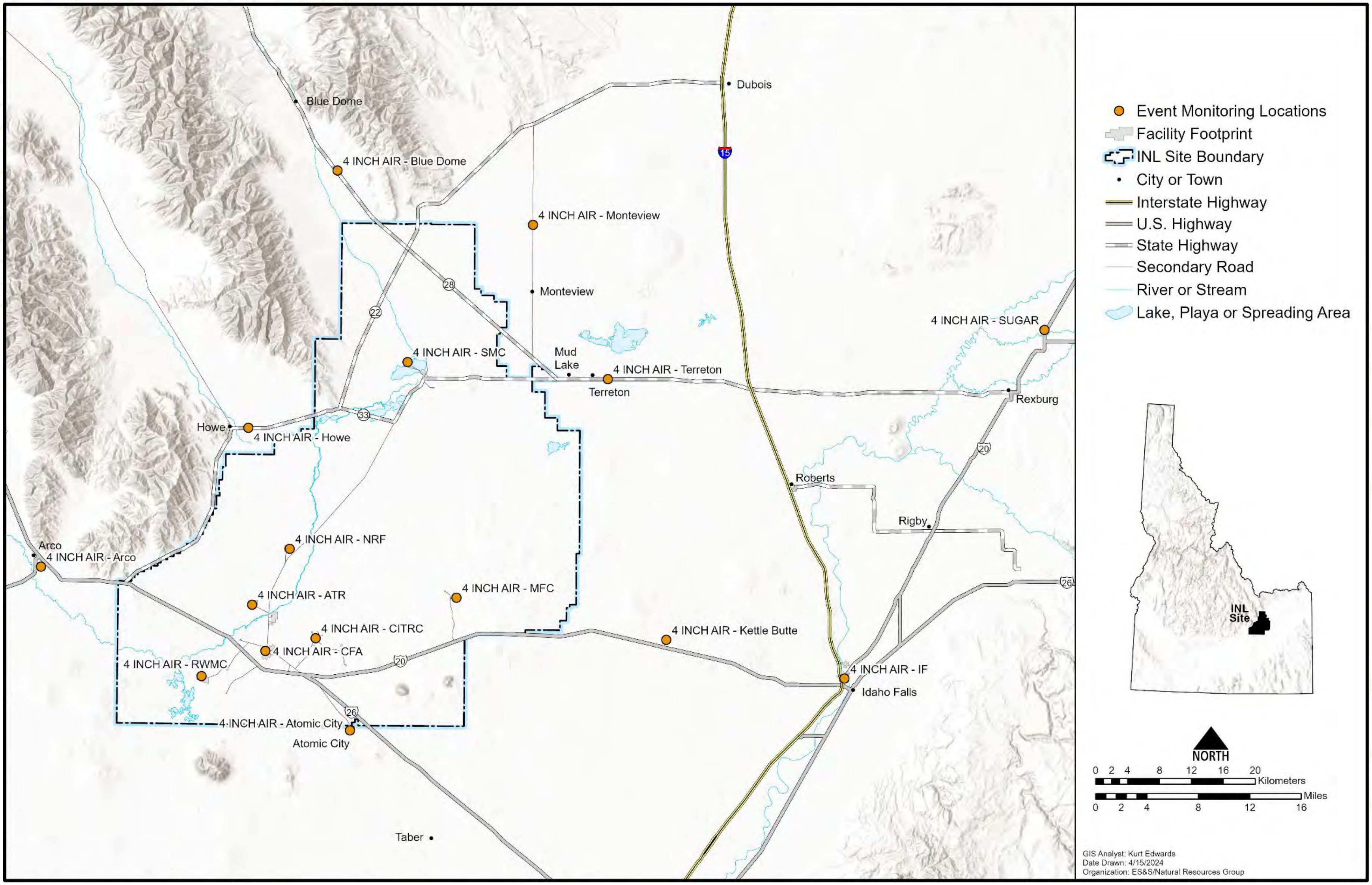

Figure 4-4. Locations of INL contractor high-volume event monitors at NOAA weather stations.

4.3.2 Air Particulate, Radioiodine, and Tritium Sampling Methods

Air Particulates

Filters are collected weekly by the INL contractor from a network of low-volume air samplers, as shown in Table 4-3. A pump pulls air (about 57 L/min [2 ft^3/min]) through a 5-cm (2-in.), 1.2-µm particulate filter and a charcoal cartridge, as seen in Figure 4-5, at each low-volume air sampler. After a five-day holding time to allow for the decay of naturally occurring radon progeny, the filters are analyzed in a laboratory for gross alpha and gross beta activity. Gross alpha and gross beta results are considered screenings because specific radionuclides are not identified. Rather, the results reflect a mix of alpha- and beta-emitting radionuclides. Gross alpha and gross beta radioactivity in air samples is typically dominated by the presence of naturally occurring radionuclides. Gross beta radioactivity is, with rare exceptions, detected in each air filter collected. Gross alpha activity is only irregularly detected, but it becomes more commonly detected during wildfires and temperature inversions. If the results are higher than those typically observed, sources other than background radionuclides may be suspected, and other analytical techniques are used to identify specific radionuclides of concern. Gross alpha and gross beta activity are also examined over time and between locations to detect trends, which might indicate the need for more specific analyses.

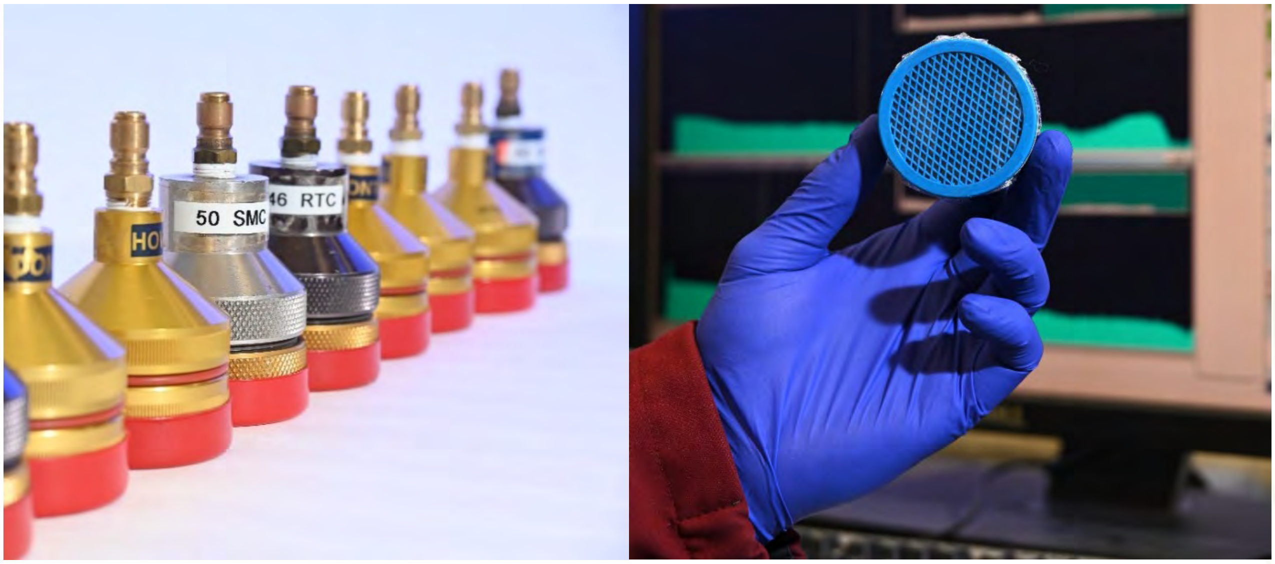

Figure 4-5. Air filter heads (left photo). Charcoal cartridge (right photo).

The filters are composited quarterly for each location by the analytical laboratory prior to analysis for gamma-emitting radionuclides, such as ^{137}Cs, which is a man-made radionuclide present in soil both onsite and offsite due to historical INL Site activities and global fallout. The contaminated soil particles can become airborne and subsequently filtered by air samplers. Naturally occurring gamma-emitting radionuclides that are typically detected in air filters include beryllium-7 (^{7}Be) and potassium-40 (^{40}K).

The INL contractor also uses a contracted laboratory to radiochemically analyze quarterly composited samples for selected alpha- and beta-emitting radionuclides. These radionuclides include ^{241}Am, ^{36}Cl, ^{238}Pu, $^{239/240}$Pu, ^{238}Pu, $^{233/234}$U, ^{238}U, ^{65}Zn, and ^{90}Sr. In 2023, analysis of quarterly composite samples for ^{36}Cl, $^{233/234}$U, and ^{238}U began as a result of the radionuclides being listed as contributors to the estimated annual dose to the MEI (Chapter 8, Section 8.2.1). MFC was listed as the location with a ^{36}Cl source term that contributed >0.005%, therefore analysis for ^{36}Cl was only performed on samples collected from MFC. Additional radionuclides were selected for analysis because they have been detected historically in air samples and may be present due to site releases or to the resuspension of surface soil particles contaminated by INL Site activities or global fallout.

Radioiodine

Charcoal cartridges are collected and analyzed weekly for iodine-131 (^{131}I) by the INL contractor at the locations shown in Table 4-3. Iodine-131 is of particular interest because it is produced in relatively large quantities by nuclear fission, is readily accumulated in human and animal thyroids, and has a half-life of eight days. This means that any elevated level of ^{131}I in the environment could be from a recent release of fission products.

Tritium

The INL contractor monitors tritium in atmospheric water vapor in ambient air onsite at EFS, RHLLW, and Van Buren Boulevard and offsite at Atomic City, Howe, Craters of the Moon, and Idaho Falls. Air passes through a column of molecular sieve, which is a material that adsorbs water vapor. The molecular sieve is sent to a laboratory for analysis once the material has adsorbed sufficient moisture to obtain a sample. The laboratory extracts water from the material by distillation and determines tritium concentrations through liquid scintillation counting.

Precipitation samples are collected by the INL contractor at Atomic City, EFS, Howe, and Idaho Falls and are analyzed for tritium using liquid scintillation counting.

4.3.3 Ambient Air Surveillance Monitoring Results

Gaseous Radioiodines

The INL contractor collected and analyzed approximately 1,900 charcoal cartridges (including blanks and duplicates) in 2023. There were no statistically positive measurements of ^{131}I.

Gross Activity

Gross alpha and gross beta results cannot provide concentrations of specific radionuclides. Because these radioactivity measurements include naturally occurring radionuclides (such as ^{40}K, ^{7}Be, uranium, thorium, and the daughter isotopes of uranium, and thorium) in uncertain proportions, a meaningful limit cannot be adopted or constructed. However, elevated gross alpha and gross beta results can be used to indicate a potential problem, such as an unplanned release, on a timely basis. Weekly results are reviewed for changes in patterns between locations and groups (i.e., onsite, boundary, and offsite locations) and for unusually elevated results. Anomalies are further investigated by reviewing sample or laboratory issues, meteorological events (e.g., inversions), and INL Site activities that are possibly related. If indicated, analyses for specific radionuclides may be performed. This data provides useful information for trending of the total activity over time.

Concentrations of gross alpha and gross beta radioactivity detected by ambient air surveillance monitoring conducted by the INL contractor are summarized in Table 4-4. Results are further discussed below.

Gross Alpha – Gross alpha concentrations are measured on a weekly basis in individual air samples ranged from a low of $(-1.5 \pm 2.7) \times 10^{-16}$ μCi/mL, collected by the INL contractor at IRC North on October 17, 2023, to a high of $(4.9 \pm 0.2) \times 10^{-14}$ μCi/mL, collected by the INL contractor at RWMC on October 10, 2023, as shown in Table 4-4. The elevated alpha result for the air filter collected at RWMC on October 10, 2023, is likely the result of work activities occurring at RWMC. The radiochemical analysis results support this idea since ^{241}Am and plutonium isotopes were detected in fourth quarter 2023 composite samples collected from RWMC (INL 2024e). Further discussion of radiochemical results are presented in Specific Radionuclides.

The median annual gross alpha concentrations were typical of previous measurements. The maximum result is less than the DCS (DOE 2022) of 1.1×10^{-13} μCi/mL for $^{239/240}Pu$, which is the most conservative specific radionuclide DCS that could be—although unrealistically—applied to gross alpha activity.

Gross Beta – Weekly gross beta concentrations measured in air samples ranged from a low of $(0.8 \pm 1.7) \times 10^{-16}$ μCi/mL at RWMC South, collected by the INL contractor on January 10, 2023, to a high of $(3.7 \pm 0.1) \times 10^{-13}$ μCi/mL collected by the INL contractor at the Blue Dome on January 31, 2023, as observed in Table 4-4. The lowest detected value (i.e., greater than three sigma [3σ]) was $(3.6 \pm 0.5) \times 10^{-15}$ μCi/mL collected by the INL contractor at Atomic City on March 14, 2023. In general, median airborne radioactivity levels for the onsite, boundary, and offsite locations tracked each other closely throughout the year. The typical temporal fluctuations for natural gross beta concentrations in the air were

Table 4-4. Median annual gross alpha and gross beta concentrations in ambient air samples collected by the INL contractor in 2023.

GROUP	LOCATION	NO. OF SAMPLES[a]	GROSS ALPHA RANGE OF CONCENTRATIONS[b] ($\times 10^{-15}$ µCi/mL)	GROSS ALPHA ANNUAL MEDIAN CONCENTRATION[b] ($\times 10^{-15}$ µCi/mL)	GROSS BETA RANGE OF CONCENTRATIONS[b] ($\times 10^{-14}$ µCi/mL)	GROSS BETA ANNUAL MEDIAN CONCENTRATION[b] ($\times 10^{-14}$ µCi/mL)
BOUNDARY	Arco	50	0.13 – 3.29	1.4	0.95 – 5.94	2.3
	Atomic City	50	-0.12 – 3.43	1.3	0.36 – 5.98	2.4
	Blue Dome	50	0.61 – 27.40	1.5	1.11 – 37.30	2.3
	FAA[c] Tower	49	0.32 – 2.91	1.5	1.07 – 4.17	2.3
	Howe	51	0.24 – 3.28	1.5	0.83 – 5.96	2.3
	Monteview	51	0.48 – 3.40	1.6	0.76 – 5.66	2.4
	Terreton	51	0.33 – 3.27	1.4	1.46 – 5.85	2.5
			Boundary Median:	***1.5***		***2.3***
OFFSITE	Blackfoot	51	0.11 – 2.66	1.6	1.13 – 4.64	2.3
	Craters of the Moon	49	-0.04 – 2.92	1.1	0.10 – 6.02	2.2
	Dubois	51	0.37 – 4.55	1.4	1.00 – 4.51	2.4
	Idaho Falls	51	0.72 – 3.05	1.7	1.07 – 4.77	2.6
	IRC[d]	51	0.47 – 3.38	1.7	1.19 – 4.80	2.4
	IRC (north)	47	-0.15 – 3.91	1.6	1.04 – 5.60	2.5
	Jackson, WY	51	0.37 – 2.70	1.4	0.49 – 4.00	2.2
	Sugar City	49	0.24 – 3.27	1.5	1.08 – 4.17	2.6
			Offsite Median:	***1.5***		***2.4***
ONSITE	ATR Complex	50	0.62 – 3.29	1.8	1.34 – 5.75	2.6
	CFA	50	0.37 – 2.88	1.5	1.37 – 5.94	2.5
	EBR-I	50	0.11 – 2.94	1.6	1.45 – 6.44	2.6
	EFS	45	-0.09 – 3.49	1.6	0.06 – 6.21	2.5
	Gate 4	51	0.22 – 4.44	1.6	1.30 – 6.49	2.6
	Highway 26 Rest Area	51	0.17 – 3.17	1.4	1.02 – 7.14	2.6
	INTEC (NE corner)	18	0.32 – 3.09	1.3	1.07 – 6.11	2.4
	INTEC (west side)	50	0.06 – 3.37	1.5	0.93 – 6.02	2.5
	Main Gate	51	0.25 – 3.72	1.5	0.68 – 6.14	2.3

Table 4-4. continued.

GROUP	LOCATION	NO. OF SAMPLES[a]	GROSS ALPHA RANGE OF CONCENTRATIONS[b] (× 10^{-15} µCi/mL)	GROSS ALPHA ANNUAL MEDIAN CONCENTRATION[b] (× 10^{-15} µCi/mL)	GROSS BETA RANGE OF CONCENTRATIONS[b] (× 10^{-14} µCi/mL)	GROSS BETA ANNUAL MEDIAN CONCENTRATION[b] (× 10^{-14} µCi/mL)
	MFC (north)	50	0.27 – 2.96	1.5	1.12 – 5.34	2.3
	MFC (south)	50	0.24 – 3.92	1.3	1.22 – 5.11	2.5
	NRF	51	0.59 – 2.82	1.4	1.44 – 5.69	2.7
	PBF	51	0.21 – 3.51	1.3	0.97 – 5.92	2.4
	RHLLW[c]	49	0.60 – 3.27	1.6	1.46 – 6.38	2.7
	RWMC	51	0.49 – 49.40	1.7	1.51 – 5.84	2.6
	RWMC (South)	49	-0.06 – 2.96	1.4	0.01 – 6.44	2.7
	SMC	49	0.27 – 3.19	1.7	1.35 – 6.29	2.7
	Van Buren Boulevard	51	0.06 – 3.79	1.6	1.14 – 5.39	2.7
			Onsite Median:	***1.5***		***2.5***

a. Includes valid (i.e., sufficient volume) samples only. Does not include duplicate measurements, which are made for quality assurance purposes.

b. All measurements made by the INL contractor, except for duplicate measurements made for quality assurance purposes, are included in this table and in computation of median annual values. A negative result indicates the measurement was less than the laboratory background measurement.

c. FAA = Federal Aviation Administration, RHLLW = Remote-Handled Low-Level Waste Disposal Facility. See Figure 4-2 for locations on INL Site.

d. IRC is an in-town (Idaho Falls) facility within the Research and Education Campus.

observed, with higher values usually occurring at the beginning and end of the calendar year during winter inversion conditions (see sidebar). This pattern occurs over the entire sampling network, is representative of natural conditions, and is not caused by a localized source, such as a facility or activity at the INL Site. An inversion can lead to natural radionuclides being trapped close to the ground. The maximum weekly gross beta concentration is significantly below the DCS of 9.6 × 10^{-12} µCi/mL for the most restrictive beta-emitting radionuclide in the air, ^{90}Sr.

What is an inversion?

Usually within the lower atmosphere, the air temperature decreases with height above the ground. This is largely because the atmosphere is heated from below as solar radiation warms the earth's surface, which, in turn, warms the layer of the atmosphere directly above it. A meteorological inversion is a deviation from this normal vertical temperature gradient such that the temperature increases with height above the ground. A meteorological inversion is typically produced whenever radiation from the earth's surface exceeds the amount of radiation received from the sun. This commonly occurs at night or during the winter when the sun's angle is very low in the sky.

Gross Activity Statistical Comparisons

Statistical comparisons were made using the gross alpha and gross beta radioactivity data collected by the INL contractor from the onsite, boundary, and offsite locations. For these analyses, uncensored analytical results (i.e., values less than their analysis-specific minimum detectable concentrations) were included. There were a few statistical differences between the monthly boundary and offsite datasets collected by the INL contractor during 2023 that can be attributed to expected statistical variation in the data and not to INL Site releases. Quarterly reports detailing these analyses are provided at https://idahoeser.inl.gov/publications.html.

The INL contractor compared gross beta concentrations from samples collected at onsite and boundary locations. Statistical evaluation revealed no significant differences between onsite and boundary concentrations. Onsite and boundary mean concentrations (2.7 ± 1.0 × 10^{-14} and 2.6 ± 2.1 × 10^{-14} µCi/mL, respectively) showed equivalence at one sigma (1σ) uncertainty and are attributable to natural data variation.

Specific Radionuclides

The INL contractor observed five detections of ^{137}Cs in quarterly composited samples, as indicated in Table 4-5. The detectable concentrations ranged from 13.4 x 10^{-17} µCi/mL at Van Buren during the first quarter to 29.4 x 10^{-17} µCi/mL at EFS during the first quarter. Strontium-90 was detected in five quarterly composited samples. The detectable concentrations ranged from 2.7 x 10^{-17} µCi/mL at Van Buren (duplicate) during the third quarter to 24.7 x 10^{-17} µCi/mL at SMC in the first quarter. Americium-241 was detected in six quarterly composited samples. The detectable concentrations ranged from 1.4 x 10^{-17} µCi/mL at the ATR Complex during the fourth quarter to 49.7 x 10^{-17} µCi/mL at RWMC during the fourth quarter. Plutonium-239/240 was detected in six quarterly composited samples. The detectable concentrations ranged from 1.7 x 10^{-17} µCi/mL at RWMC south during the fourth quarter to 189.0 x 10^{-17} µCi/mL at RWMC during the fourth quarter. Plutonium-238 was detected in one sample collected at RWMC during the fourth quarter. The observed detection for ^{238}Pu was 3.1 x 10^{-17} µCi/mL. All results were within historical measurements made during the past ten years (2013–2022) except for ^{241}Am and plutonium results collected at RWMC during the fourth quarter. Plutonium isotopes and ^{241}Am are known to occur in soils at the SDA. The results observed during the fourth quarter are likely related to work activities occurring at SDA. All results were well below the DCSs for these radionuclides in air (i.e., 3.8 x 10^{-11} µCi/mL for ^{137}Cs, 9.6 × 10^{-12} µCi/mL for ^{90}Sr, 1.1 × 10^{-13} µCi/mL for $^{239/240}$Pu, and 1.3 × 10^{-13} µCi/mL for ^{241}Am). In addition to the radionuclides discussed earlier, the INL contractor began surveillance monitoring for uranium during 2023. While not enumerated in Table 4-5, detections of uranium radionuclides occur routinely at concentrations that suggest a natural origin (INL 2024c, INL 2024d, INL 2024e). Chlorine-36 was not detected in quarterly composite samples collected from samplers located at MFC in 2023. Natural ^{7}Be was detected in numerous INL contractor composite samples at concentrations consistent with past concentrations. Atmospheric ^{7}Be results from reactions of galactic cosmic rays and solar energetic particles with nitrogen and oxygen nuclei in Earth's atmosphere.

Table 4-5. Human-made radionuclides detected in ambient air samples collected by the INL contractor in 2023.

RADIONUCLIDE	RESULT[a] (µCi/mL)	LOCATION	GROUP	QUARTER DETECTED
Americium-241	$(1.4 \pm 0.4) \times 10^{-17}$	ATR Complex	Onsite	4th
Americium-241	$(4.5 \pm 0.5) \times 10^{-17}$	RWMC	Onsite	3rd
Americium-241	$(49.7 \pm 4.6) \times 10^{-17}$	RWMC	Onsite	4th
Americium-241	$(3.5 \pm 0.4) \times 10^{-17}$	RWMC (duplicate)	Onsite	3rd
Americium-241	$(23.1 \pm 2.8) \times 10^{-17}$	RWMC (duplicate)	Onsite	4th
Americium-241	$(3.8 \pm 1.0) \times 10^{-17}$	RWMC South	Onsite	4th
Cesium-137	$(29.4 \pm 7.2) \times 10^{-17}$	EFS	Onsite	1st
Cesium-137	$(24.3 \pm 5.4) \times 10^{-17}$	Highway 26 Rest Area	Onsite	1st
Cesium-137	$(21.0 \pm 5.3) \times 10^{-17}$	RWMC South	Onsite	1st
Cesium-137	$(16.7 \pm 5.0) \times 10^{-17}$	SMC	Onsite	1st
Cesium-137	$(13.4 \pm 4.4) \times 10^{-17}$	Van Buren	Onsite	1st
Plutonium-238	$(3.1 \pm 0.7) \times 10^{-17}$	RWMC	Onsite	4th
Plutonium-239/240	$(13.9 \pm 1.9) \times 10^{-17}$	INTEC (duplicate)	Onsite	2nd
Plutonium-239/240	$(10.7 \pm 0.9) \times 10^{-17}$	RWMC	Onsite	3rd
Plutonium-239/240	$(189.0 \pm 12.1) \times 10^{-17}$	RWMC	Onsite	4th
Plutonium-239/240	$(2.8 \pm 0.4) \times 10^{-17}$	RWMC (duplicate)	Onsite	3rd
Plutonium-239/240	$(5.8 \pm 0.8) \times 10^{-17}$	RWMC (duplicate)	Onsite	4th
Plutonium-239/240	$(1.7 \pm 0.4) \times 10^{-17}$	RWMC south	Onsite	4th
Strontium-90	$(5.1 \pm 1.6) \times 10^{-17}$	Arco	Boundary	2nd
Strontium-90	$(9.7 \pm 3.1) \times 10^{-17}$	Blue Dome	Boundary	1st
Strontium-90	$(20.9 \pm 4.4) \times 10^{-17}$	INTEC (west side)	Onsite	2nd
Strontium-90	$(24.7 \pm 4.8) \times 10^{-17}$	SMC	Onsite	1st
Strontium-90	$(2.7 \pm 0.9) \times 10^{-17}$	Van Buren (duplicate)	Onsite	3rd

a. Results ± 1σ. Results shown are ≥ 3σ and below the DCS values for these radionuclides in air.

4.3.4 Atmospheric Moisture Surveillance Monitoring Results

Tritium is monitored in conjunction with the ambient air surveillance monitoring program at specific locations across the INL Site. With a half-life of approximately 12 years, tritium is an important radionuclide because it is a radioactive form of hydrogen, which combines with oxygen to form tritiated water. The most common forms of tritium in air are tritium gas and tritiated water (ANL 2007). The environmental behavior of tritiated water is like that of water, and it can be present in surface water, precipitation, and atmospheric moisture.

Tritium enters the food chain through surface water that animals drink, as well as from plants that contain water (DOE-ID 2021). Tritium can be taken into the body by drinking water, eating food, or breathing air. It can also be taken in through the skin.

During 2023, the INL contractor collected 76 atmospheric moisture samples, as shown in Figure 4-6, at six locations. Tritium was detected in one INL sample $(11.8 \pm 2.3) \times 10^{-13}$ µCi/mL$_{air}$ at RHLLW on November 14, 2023. The observed tritium concentration is far below the DCS for tritium in air (as water vapor) of 1.3×10^{-7} µCi/mL$_{air}$.

The source of tritium measured in atmospheric moisture samples collected on and around the INL Site is probably of cosmogenic origin and, to some extent, global fallout (see Section 4.3.4). Tritium releases from non-fugitive sources are highly localized and although they may be detected immediately adjacent to the facility, they are unlikely to be detected at current air surveillance monitoring stations because of atmospheric dispersion.

Figure 4-6. Atmospheric moisture collection columns.

4.3.5 Precipitation Surveillance Monitoring Results

Tritium exists in the global atmosphere primarily from nuclear weapons testing and from natural production in the upper atmosphere by the interaction of galactic cosmic rays with atmospheric gases and can be detected in precipitation. Since the Nuclear Test Ban Treaty in 1963, the level of tritium measured in precipitation has been steadily decreasing due to radioactive decay and dilution in the world oceans. The International Atomic Energy Agency has participated in surveying tritium compositions in precipitation around the globe since 1961 (https://www.iaea.org/services/networks/gnip). Long-term data suggest that tritium levels in precipitation are close to their pre-nuclear test values (Cauquoin et al. 2015). The tritium measured in precipitation at the INL Site is most likely cosmogenic in origin and not from weapons testing.

Sampling precipitation for radioactive contaminants is a good way to determine the amount of contamination that is stripped from the air by rain or snow and deposited at ground level (INL 2023b).

The INL contractor collects precipitation samples weekly, when available, at Atomic City, EFS, and Howe. Precipitation is collected monthly at Idaho Falls for EPA RadNet monitoring (https://www.epa.gov/radnet) and a subsample is taken by the INL contractor for analysis. A total of 79 precipitation samples were collected during 2023 from the four sites. Tritium was detected in eleven samples, and detectable results ranged from 79.7 pCi/L in March to 168 pCi/L in February in Howe. Most detections were near the approximate detection level of 95 pCi/L. Table 4-6 shows the percentage of detections, the concentration range, and the mean and median concentration for each location. The highest concentration is well below the DCS level of 2.6×10^6 pCi/L for tritium in water and within the historical range (-173 to 413 pCi/L) measured from 2013–2022.

Table 4-6. Tritium concentrations in precipitation samples collected by the INL contractor in 2023.[a,b]

	ATOMIC CITY	EFS	HOWE	IDAHO FALLS
Number of samples	20	25	23	11
Number of detections	3	2	3	3
Detection percentage	15%	8%	13%	27%
Concentration range (pCi/L)	-57.1 ± 24.3 – 115 ± 30	-36.1 ± 24.2 – 145 ± 35.2	-28.2 ± 25.2 – 168 ± 32.4	-31.2± 24.7 – 126 ± 30.7
Mean concentration (pCi/L)	23.4	20.1	30.3	35.4
Median concentration (pCi/L)	25.5	14.9	12.6	20.5
Mean detection level (pCi/L)	94.5	94.2	95.2	95.7

a. Results ± 1σ.
b. All measurements are included in this table and in computation of mean annual values. A negative result indicates that the measurement was less than the laboratory background measurement.

The results were also compared with tritium concentrations reported by EPA for precipitation during the 10-year period from 2002–2011 (measurements discontinued after 2011) based on the query of available data (https://enviro.epa.gov/enviro/erams_query_v2.simple_query). Concentrations reported by EPA for Idaho Falls during that period ranged from 0–1720 pCi/L and averaged 35.1 pCi/L.

Annual tritium concentrations in atmospheric moisture and precipitation have no discernable statistical distribution, so non-parametric statistical methods were used to assess both datasets (see "Statistical Methods Used in the Idaho National Laboratory Annual Site Environmental Report," a supplement to this annual report). To summarize the results, box plots were constructed illustrating annual tritium concentrations measured in atmospheric moisture (as water) and precipitation samples collected by the INL contractor for the past 10 years, as can be seen in Figure 4-7. The results appear to be similar for each year. A statistical comparison of both datasets (using the non-parametric Wilcoxon Matched Pairs Test) shows there are no differences between median annual tritium concentrations measured in atmospheric moisture and in precipitation samples. Because low levels of tritium exist in the environment at all times as a result of cosmic ray reactions with atmospheric gases in the upper atmosphere and the decreasing influence of fallout from nuclear weapons testing in the atmosphere and because tritium concentrations do not appear to differ between precipitation and atmospheric moisture samples, the source of tritium measured in precipitation and atmospheric moisture is most likely of natural origin and past nuclear tests and not from INL Site releases.

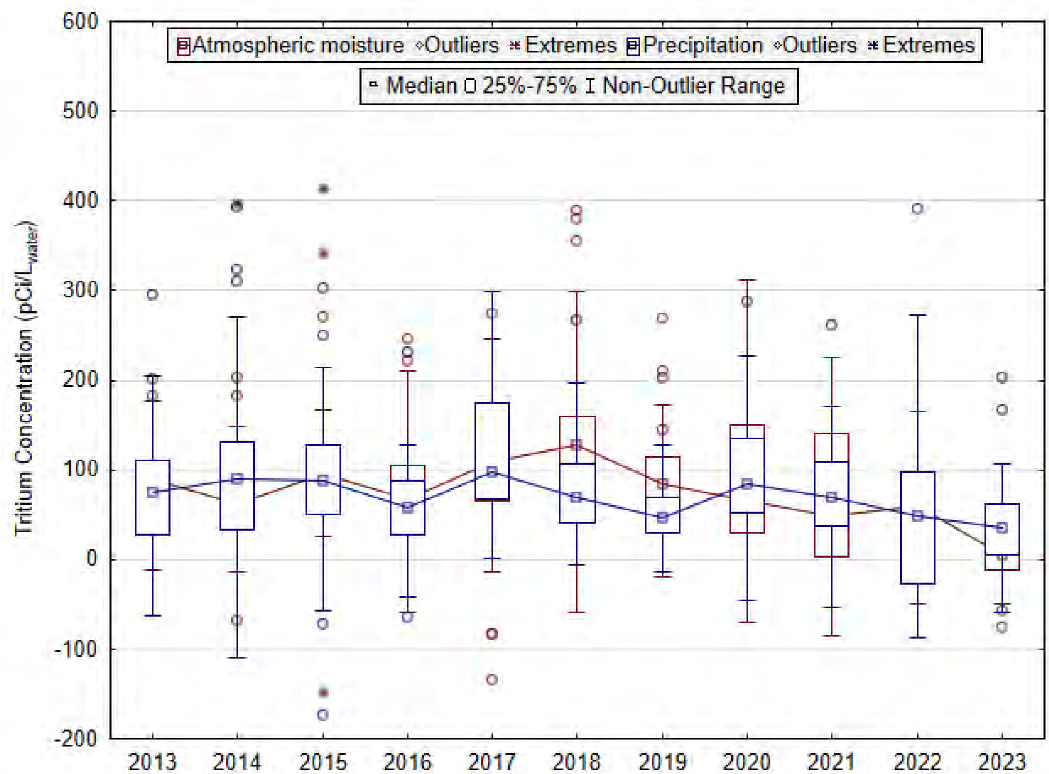

Figure 4-7. Box plots of tritium concentrations measured in atmospheric moisture and in precipitation from 2013–2023.

4.4 Waste Management Environmental Air Surveillance Monitoring

4.4.1 Gross Activity

The ICP contractor conducts environmental surveillance monitoring in and around waste management facilities to comply with DOE O 435.1, "Radioactive Waste Management." Currently, ICP waste management operations are performed at the SDA at RWMC and the ICDF at INTEC. These operations have the potential to emit radioactive airborne particulates. The ICP contractor collected samples of airborne particulate material from the perimeters of these waste management areas in 2023, as observed in Figure 4-8. Samples were also collected at a control location at Howe as shown in Figure 4-2, to compare with the results of the SDA and ICDF.

Samples were obtained using suspended particulate monitors similar to those used by the INL contractor. The air filters have a 4-in. diameter and are changed out on the closest working day to the first and 15th of each month. Gross alpha and gross beta activity were determined on all suspended particulate samples. Table 4-7 shows the median annual and range of gross alpha concentrations at each location. Gross alpha concentrations ranged from a low of (0.15 ± 0.09) × 10^{-16} µCi/mL collected at location SDA 9.3 on September 14, 2023, to a high of (9.18 ± 0.68) × 10^{-16} µCi/mL, collected at location SDA 11.3 on February 2, 2023.

Table 4-7. Median annual gross alpha concentration in air samples collected at waste management sites in 2023. [a]

GROUP	LOCATION	NO. OF SAMPLES COLLECTED	RANGE OF CONCENTRATIONS (× 10^{-16} µCi/mL)	ANNUAL MEDIAN (× 10^{-16} µCi/mL)
SDA	SDA 1.3	23	0.19 – 6.80	4.46
	SDA 2.3	23	3.35 – 6.18	5.58
	SDA 4.2B/C and 4.3B/C[a]	46	0.82 – 7.09	4.93
	SDA 6.3	23	0.48 – 7.72	4.76
	SDA 9.3	23	0.15 – 6.28	4.90
	SDA 11.3	23	0.65 – 9.18	6.38
ICDF	INT 100.3	23	3.54 – 8.53	5.57
Boundary	HOWE 400.4	23	3.35 – 5.25	4.95

a. Results for SDA 4.2B/C, a replicate of SDA 4.3B/C, are included in the table for 2023 because of mechanical issues with SDA 4.3B/C occurring in 2023.

Table 4-8 shows the annual median and range of gross beta concentrations at each location. Gross beta concentrations ranged from a low of (3.20 ± 0.01) × 10^{-16} µCi/mL at location HOWE 400.4 on October 2, 2023, to a high of (1.0 ± 0.47) x 10^{-14} µCi/mL at location SDA 4.3 on December 14, 2023.

Table 4-8. Median annual gross beta concentration in air samples collected at waste management sites in 2023. [a]

GROUP	LOCATION	NO. OF SAMPLES COLLECTED	RANGE OF CONCENTRATIONS (× 10^{-15} µCi/mL)	ANNUAL MEDIAN (× 10^{-15}µCi/mL)
SDA	SDA 1.3	23	0.52 – 8.06	5.92
	SDA 2.3	23	0.49 – 8.55	5.46
	SDA 4.2B/C and 4.3B/C[a]	46	1.90 – 10.08	6.15
	SDA 6.3	23	0.56 – 9.40	5.90
	SDA 9.3	23	0.40 – 7.07	6.12
	SDA 11.3	23	0.52 – 9.06	5.92
ICDF	INT 100.3	23	0.60 – 8.30	6.60
Boundary	HOWE 400.4	23	0.32 – 9.41	6.17

a. Results for SDA 4.2B/C, a replicate of SDA 4.3B/C, are included in the table for 2023 because of mechanical issues with SDA 4.3B/C occurring in 2023.

The 2023 results for the SDA and ICDF are well below their respective DCS values. Results from the SDA and ICDF were compared with the results collected from the background monitoring location in Howe. The ranges of concentrations measured at the SDA and ICDF were aligned with the range measured at the Howe (background) monitoring location.

4.4.2 Specific Radionuclides

Air filters collected by the ICP contractor are shown in Figure 4-8 and composited in a laboratory and analyzed for human-made, gamma-emitting radionuclides and specific alpha-emitting and beta-emitting radionuclides. Gamma spectroscopy analyses are performed monthly, and radiochemical analyses are performed quarterly.

In 2023, no human-made, beta-emitting, gamma-emitting, or alpha-emitting radionuclides were detected in air samples at ICDF at INTEC. No gamma emitting or beta-emitting radionuclides were detected in air samples at the RWMC SDA.

Table 4-9 shows human-made specific radionuclides detected at the SDA in 2023. There were no human-made radionuclides detected at INTEC in 2023. These detections are consistent with levels measured in the air at the SDA in previous years. All detections were three to four orders of magnitude below the DCS (stipulated in DOE 2022) and statistically false positives at the 95% confidence error are possible.

In addition to the human-made, gamma-emitting radionuclides discussed above, the ICP contractor also monitors for uranium. While not enumerated in Table 4-9, detections of uranium radionuclides occur routinely at concentrations that suggest a natural origin.

Radionuclides were not analyzed in the first, second, or third quarters of 2023 because of a miscommunication in the contract with GEL when lab analysis changed from ALS. Radionuclide analysis was written as requested instead of being composited quarterly by default. Fourth quarter results are referenced in Table 4-9. Corrective actions have been set in place to ensure the lab knows which samples to composite and the appropriate schedule. Power supply issues to the monitoring locations are being addressed. Bi-weekly gross alpha and gross beta results of samples collected during the quarters for which radionuclide-specific composites were missing were comparable with historical results, which suggest that concentrations of specific radionuclides were well below DCSs for that period. Additionally, monthly NESHAP environmental air measurement samples located in the predominant downwind direction were analyzed to determine that no statistically positive detections were observed.

Table 4-9. Fourth quarter radionuclide concentrations in air samples collected at waste management sites in 2023.

RADIONUCLIDE	LOCATION	RESULT (μCi/mL)	UNCERTAINTY (1 SIGMA)
Americium-241	SDA 1.3	1.31E-15	1.37E-15
	SDA 11.3	3.10E-16	5.37E-16
	SDA 2.3	7.04E-17	1.69E-17
Plutonium-238	SDA 4.3C	1.02E-16	8.98E-17
Plutonium-239/240	SDA 2.3	8.29E-17	1.04E-17
	SDA 4.2C	5.18E-17	8.29E-18
Strontium-90	SDA 6.3	2.35E-16	1.32E-16

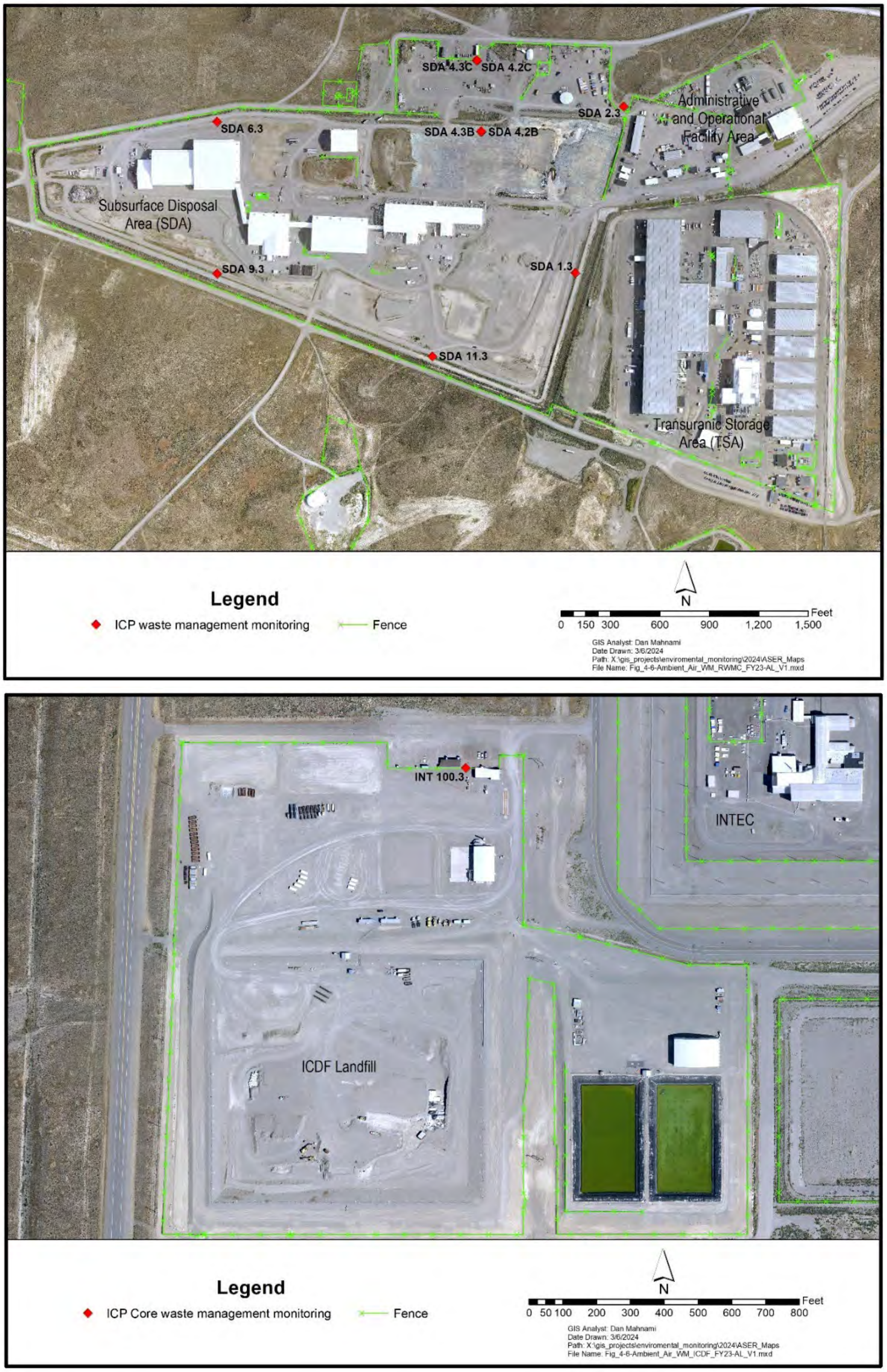

Figure 4-8. Locations of ICP contractor low-volume air samplers at waste management areas (SDA [top] and ICDF [bottom]).

4.5 Hydrofluorocarbon Phasedown

Hydrofluorocarbons (HFC) are the third generation of refrigerants; they were developed to replace Class II ozone-depleting substances. HFCs are used in the same applications in which ozone-depleting substances have historically been used, such as refrigeration and air conditioning, foam blowing agents, solvents, aerosols, and fire suppression. HFCs are non-ozone-depleting; however, they are also potent greenhouse gases with 100-year global warming potentials (a measure of the relative climatic impact of greenhouse gases) that can be hundreds to thousands of times more potent than carbon dioxide.

Atmospheric observations of most currently measured HFCs confirm their amounts are increasing in the global atmosphere at accelerating rates. Total emissions of HFCs increased by 23% from 2012 to 2016. The four most abundant HFCs in the atmosphere—in global warming potential-weighted terms—are HFC-134a, HFC-125, HFC-23, and HFC-143a (Federal Register Volume 86, Number 95 published May 19, 2021). The American Innovation and Manufacturing Act of 2020 included reductions for the production and consumption of HFCs. This is not a phaseout of HFC production, it is a phasedown. The end goal is an 85% reduction in production by 2036 as compared to the 2013 production baseline (OE-3 2021-06) (Table 4-10). This will decrease the availability of HFCs and increase the cost but HFCs will still be available. The EPA recently finalized regulations restricting the use of some HFCs in certain applications; the compliance dates vary depending on the application. As with the phasedown regulations, the EPA is not prohibiting or restricting the use of existing equipment.

Table 4-10. HFC Phasedown Schedule (OE-3 2021-06).

YEARS	PERCENT OF BASELINE	PERCENT REDUCTION
2011–2013 (Baseline)	100%	0%
2020–2023	90%	10%
2024–2028	60%	40%
2029–2033	30%	70%
2034–2035	20%	80%
2036 onwards	15%	85%

4.5.1 INL Contractor

The INL contractor compiled a list of equipment at its facilities that contains HFCs and completed an impact analysis to better understand the potential impacts of this HFC phasedown. This list was obtained from a variety of sources: facility/operations personnel, laboratory personnel, fire protection personnel, organizations, engineer personnel, maintenance personnel, and environmental support and services personnel. The list includes heating, ventilation, and air conditioning systems that contain 50 pounds or more of refrigerant and computer room air conditioning units that contain 50 pounds or more of refrigerant, fire protection systems, and laboratory equipment. Most of the laboratory equipment that contained HFCs were chillers used to cool specific pieces of equipment. Other laboratory equipment that contains HFCs includes environmental chambers, a microwave digester, non-rad and rad separator ion sources, non-rad and rad separator magnets, and a laser flash. The list does not include small heating, ventilation, and air conditioning equipment (units containing less than 50 pounds of refrigerant), refrigerators, drinking water fountains, or other small appliances. The INL contractor manages thousands of these small appliances at the facilities; most would be operated until failure and then replaced. The INL contractor identified 236 pieces of equipment and systems.

A list of equipment containing HFCs was obtained in March 2022. The list includes 46 HVAC systems that contain 50 pounds or more of refrigerant, 26 computer room air conditioning units, six fire protection systems, and 158 chillers, condensing units, etc., for laboratory equipment. There are currently no changes to operations because this is a phasedown, not a phaseout and the EPA is not prohibiting the use of existing equipment.

Additionally, the INL contractor is participating in the voluntary HFC Task Team led by AU-21, National Nuclear Security Administration. The goal of the task team is to better understand and address DOE's needs and determine next steps. The HFC Task Team wrote an Operating Experience Summary for the DOE complex that provides information on operational impacts to critical systems from these regulations that will decrease the amount of HFCs manufactured in the future (OES-2022-03, HFC Phasedown Impacts Critical Operations). The task team is currently exploring methods for documenting and sharing the review of alternatives within the DOE Complex.

4.5.2 ICP Contractor

An inventory of refrigeration equipment at ICP facilities, using HFCs scheduled for phasedown, was conducted in December 2021. This activity identified two chillers (four circuits total) using HFC-134a at the Integrated Waste Treatment Unit (IWTU). The total charge for both chillers is approximately 830 lb. These units will continue to be used for the IWTU mission. ICP preventative maintenance practices will minimize the potential for leaks. ICP possesses an inventory of recovery cylinders dedicated to these units, ensuring that refrigerant recovered during maintenance is available to recharge the equipment. Should there be a major failure resulting in a loss of HFC-134a that renders the units inoperable, they would be replaced or retrofitted. New equipment at ICP will be specified to use refrigerants that are not subject to the HFC phasedown.

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Sage thrasher (special status bird)

Chapter 5: Environmental Monitoring Programs – Liquid Effluents Monitoring

CHAPTER 5

Wastewater discharged to land surfaces and infiltration basins (percolation ponds) at the Idaho National Laboratory (INL) Site is regulated by the state of Idaho groundwater quality and recycled water rules and requires a reuse permit. Liquid effluents and surface water runoff were monitored in 2023 by the INL contractor and the Idaho Cleanup Project (ICP) contractor for compliance with permit requirements and applicable Department of Energy (DOE) orders established to protect human health and the environment.

During 2023, permitted reuse facilities included the Advanced Test Reactor (ATR) Complex Cold Waste Ponds (CWP), Idaho Nuclear Technology and Engineering Center (INTEC) New Percolation Ponds and Sewage Treatment Plant (STP), and the Materials and Fuels Complex (MFC) Industrial Waste Pond (IWP). Liquid effluent and groundwater at these facilities were sampled for parameters required by their facility-specific permits. No permit limits were exceeded in 2023.

Additional liquid effluent and groundwater surveillance monitoring was also performed in 2023 at the ATR Complex, INTEC, and MFC to comply with the DOE environmental protection objectives. All parameters were below applicable health-based standards in 2023.

Surface water that runs off the Subsurface Disposal Area (SDA) at the Radioactive Waste Management Complex (RWMC) during periods of rapid snowmelt or heavy precipitation was sampled and analyzed for radionuclides. Additionally, water sheet flowed across asphalt surfaces and infiltrated around/under door seals at Waste Management Facility-636 at the Advanced Mixed Waste Treatment Project (AMWTP) and collected in catch tanks. Specific human-made gamma-emitting radionuclides were not detected. Detected concentrations of americium-241 (^{241}Am), plutonium-239/240 ($^{239/240}$Pu), and uranium isotopes did not exceed DOE Derived Concentration Standards (DCS).

5. ENVIRONMENTAL MONITORING PROGRAMS – LIQUID EFFLUENTS MONITORING

Some INL Site operations retain wastewater in lined, total containment evaporative ponds constructed to eliminate liquid effluent discharges to the environment. Other INL Site operations discharge liquid effluents to unlined infiltration basins or ponds that may potentially contain nonhazardous levels of radioactive, or nonradioactive, contaminants. Effluent discharges are subject to specified discharge limits, permit limits, or maximum contaminant levels (MCLs). INL Site contractor personnel conduct liquid effluent monitoring through liquid effluent and surface water runoff sampling and surveillance programs to ensure compliance with applicable permits, limits, and MCLs. These programs also sample groundwater related to liquid effluent.

Table 5-1 presents the requirements for liquid effluent monitoring and surveillance performed at the INL Site. Maps and a comprehensive discussion of environmental monitoring, including liquid effluent monitoring and surveillance programs performed by various organizations within and around the INL Site, can be found in the "INL Environmental Monitoring Plan" (DOE-ID 2021). To improve the readability of this chapter, data tables are only included when monitoring results exceed specified discharge limits, permit limits, or MCLs. Data tables for other monitoring results are provided in Appendix A.

Table 5-1. Liquid effluent monitoring and surveillance at the INL Site.

MONITORING REQUIREMENTS			
AREA/FACILITY	IDAHO REUSE PERMIT[a]	DOE O 458.1[b] LIQUID EFFLUENT MONITORING	DOE O 435.1[c] SURFACE RUNOFF SURVEILLANCE
INL CONTRACTOR			
ATR[d] Complex Cold Waste Ponds	●	●	
MFC[d] Industrial Waste Pond	●	●	
ICP CONTRACTOR			
INTEC[d] New Percolation Ponds and Sewage Treatment Plant	●	●	
RWMC[d] SDA[d] surface water runoff		●	●

a. Required by permits issued according to the Idaho Department of Environmental Quality Rules, IDAPA 58.01.17, "Recycled Water Rules." This includes wastewater effluent monitoring and related groundwater monitoring.

b. Paragraph 4(g) of DOE Order 458.1, "Radiation Protection of the Public and the Environment," establishes specific requirements related to control and management of radionuclides from DOE activities in liquid discharges. Radiological liquid effluent monitoring recommendations in DOE Handbook Environmental Radiological Effluent Monitoring and Environmental Surveillance (DOE-HDBK-1216-2015) (DOE 2015) are followed to ensure quality. DOE Standard DOE-STD-1196-2022, "Derived Concentration Technical Standard," (DOE 2022) supports the implementation of DOE O 458.1 and provides DCSs as reference values to control effluent releases from DOE facilities.

c. The objective of DOE O 435.1, "Radioactive Waste Management," is to ensure that all DOE radioactive waste is managed in a manner that is protective of worker and public health and safety and the environment. This order requires that radioactive waste management facilities, operations, and activities meet the environmental monitoring requirements of DOE O 458.1. DOE Handbook DOE-HDBK-1216-2015 suggests that potential impacts of stormwater runoff as a pathway to humans or biota should be evaluated.

d. Advanced Test Reactor (ATR), Materials and Fuels Complex (MFC), Idaho Nuclear Technology and Engineering Center (INTEC), and Radioactive Waste Management Complex (RWMC), Subsurface Disposal Area (SDA).

5.1 Liquid Effluent and Related Groundwater Compliance Monitoring

Discharge of liquid effluent to the land surface for treatment or disposal is known as "reuse" in the state of Idaho and is regulated by the Recycled Water Rules (IDAPA 58.01.17), Wastewater Rules (IDAPA 58.01.16), and Ground Water Quality Rule (IDAPA 58.01.11) promulgated according to the Idaho Administrative Procedures Act. The Idaho Department of Environmental Quality (DEQ) issues reuse permits for operation of the reuse systems. Reuse permits may require monitoring of nonradioactive constituents in the effluent and groundwater in accordance with the monitoring requirements specified within each permit. Some facilities may have specified radiological constituents monitored for surveillance purposes to comply with DOE orders (but are not required by regulations). The reuse permits may specify annual discharge volumes, application rates, and effluent quality limits. Annual reports (ICP 2024a and 2024b; INL 2024a, 2024b, 2024c, and 2024d) were prepared and submitted to the Idaho DEQ.

During 2023, the INL Site contractors monitored, as required by the permits, the following reuse facilities shown in Table 5-2:

- ATR Complex Cold Waste Ponds (Section 5.1.1)
- INTEC New Percolation Ponds and STP (Section 5.1.2)
- MFC Industrial Waste Pond (Section 5.1.3).

Table 5-2. 2023 status of reuse permits.

FACILITY	PERMIT STATUS AT END OF 2023	PERMIT EXPIRATION DATE	EXPLANATION
ATR Complex Cold Waste Ponds	Active	October 29, 2029	Idaho DEQ issued Reuse Permit I-161-03 on October 30, 2019 (DEQ 2019), with Modifications issued May 23, 2022 (DEQ 2022a); and October 24, 2023 (DEQ 2023a).
INTEC New Percolation Ponds	Active	June 25, 2034	Idaho DEQ issued Permit M-130-07 on June 25, 2024 (DEQ 2024).
MFC Industrial Waste Pond	Active	January 25, 2027	Idaho DEQ issued Reuse Permit I-160-02 on January 26, 2017, with modifications issued March 7, 2017; May 8, 2019; May 21, 2020 (DEQ 2020); May 23, 2022 (DEQ 2022b); and October 24, 2023 (DEQ 2023b).

Additional effluent constituents are monitored at these facilities to comply with environmental protection objectives of DOE O 458.1 and are discussed in Section 5.2. Surface water monitoring at the RWMC is presented in Section 5.3.

5.1.1 Advanced Test Reactor Complex Cold Waste Ponds

Description. The Cold Waste Ponds (CWP) are located approximately 137 m (450 ft) from the southeast corner of the ATR Complex compound and approximately 1.2 km (0.75 mi) northwest of the Big Lost River channel, as shown in Figure 5-1. The CWP was excavated in 1982 and consists of two unlined cells, each with dimensions of 55 × 131 m (180 × 430 ft) across the top of the berms and with a depth of 3 m (10 ft). Total surface area for the two cells at the top of the berms is approximately 1.44 ha (3.55 acres). Maximum capacity is approximately 38.69 ML (10.22 MG).

The CWP function as percolation basins for the infiltration of nonhazardous industrial liquid effluent consisting primarily of noncontact cooling tower blowdown, once-through cooling water for air conditioning units, coolant water from air compressors, and wastewater from secondary system drains and other nonradioactive drains throughout the ATR Complex. Chemicals used in the cooling tower and other effluent streams discharged to the CWP include commercial biocides and corrosion inhibitors. The cold waste effluent reports through collection piping to a monitoring location where flow rates to the CWP are measured using a v-notch weir and effluent samples are collected using an automated composite sampler.

Effluent Monitoring Results for the Reuse Permit. Reuse Permit I-161-03 Modifications 1 and 2 require monthly sampling of the effluent to the CWP (DEQ 2022a; DEQ 2023a). The 2023 permit reporting year monitoring results are presented in the 2023 annual reuse report (INL 2024c) and the 2023 calendar year monitoring results are summarized in Table A-1 in Appendix A. The total dissolved solids concentrations ranged from 192 mg/L to 1,200 mg/L. Sulfate ranged from 20.9 mg/L to 667 mg/L. Concentrations of sulfate and total dissolved solids are higher during reactor operation because of the evaporative concentration of the corrosion inhibitors and biocides added to the reactor cooling water. Due to the composition and characteristics of the effluent, the reuse permit does not require pre-treatment or specify maximum constituent loading limits or concentration limits for the cold waste effluent discharged to the CWP. The 2023 constituent concentrations continue to remain consistent with historical results.

The permit specifies the maximum annual and five-year moving average hydraulic loading rate limits of 300 MG/yr and 375 MG/yr, respectively, based on the annual reporting year of the permits. As shown in Table A-2, the 2023 annual reporting year flow of 215.60 MG did not exceed either of these hydraulic loading limits.

Groundwater Monitoring Results for the Reuse Permit. The permit requires groundwater monitoring twice annually in April/May and September/October, at seven groundwater wells (see Figure 5-1), to measure potential impacts from the CWP. In 2023, none of the constituents exceeded their respective primary or secondary constituent standards. The constituents are presented in Table A-3a and Table A-3b. Nitrate + nitrite as nitrogen continues to show a minor increasing trend in both the upgradient and downgradient wells but remain well below the primary constituent standard. Sulfate and total dissolved solids continue to gradually trend downward. The metals concentrations continue to remain at low levels and are consistent with historical ranges.

5.1.2 Idaho Nuclear Technology and Engineering Center New Percolation Ponds and Sewage Treatment Plant

Description. The INTEC New Percolation Ponds are composed of two rapid infiltration ponds excavated into the surficial alluvium and surrounded by bermed alluvial material, as observed in Figure 5-2. The rapid infiltration system uses the soil ecosystem to treat wastewater. Each pond is 93 m × 93 m (305 ft × 305 ft) at the top of the berm and is approximately 3 m (10 ft) deep. Each pond is designed to accommodate a continuous wastewater discharge rate of 11.36 ML (3 MG) per day.

The INTEC New Percolation Ponds receive discharge of only industrial and municipal wastewater. Industrial wastewater (i.e., service waste) from INTEC operations consists of steam condensates, noncontact cooling water, water treatment effluent, boiler blowdown wastewater, stormwater, and small volumes of other nonhazardous/nonradiological liquids. Municipal wastewater (i.e., sanitary waste) is treated at the INTEC STP.

The STP is located east of INTEC, outside the INTEC security fence, and treats and disposes of sewage, septage, and other nonhazardous industrial wastewater at INTEC. The sanitary waste is treated by natural biological and physical processes (e.g., digestion, oxidation, photosynthesis, respiration, aeration, evaporation) in four lagoons. After treatment in the lagoons, the effluent is combined with the service waste and discharged to the INTEC New Percolation Ponds.

The INTEC New Percolation Ponds were permitted by Idaho DEQ to operate as a reuse facility under Reuse Permit M-130-06 (DEQ 2017).

Wastewater Monitoring Results for the Reuse Permit. Monthly samples were collected from CPP-769 (influent to STP), CPP-773 (effluent from STP), and CPP-797 (effluent to the INTEC New Percolation Ponds), as shown in Figure 5-3. As required by the permit, all samples are collected as 24-hour composites, except pH, fecal coliform, and total coliform, which are collected as grab samples. The permit specifies the constituents that must be monitored at each location. The permit does not specify any wastewater discharge limits at these three locations. The 2023 reporting year monitoring results for CPP-769, CPP-773, and CPP-797 are provided in the 2023 Wastewater Reuse Report (ICP 2024a), and the 2023 calendar year monitoring results are summarized in Tables A-4, A-5, and A-6 (in Appendix A).

The permit specifies maximum daily and yearly hydraulic loading rates for the INTEC New Percolation Ponds. As shown in Table A-7, the maximum daily flow and yearly total flow to the INTEC New Percolation Ponds were below the permit limits in 2023.

Groundwater Monitoring Results for the Reuse Permit. To measure the potential impact on groundwater from wastewater discharges to the INTEC New Percolation Ponds, the permit requires that groundwater samples are collected from six monitoring wells, as shown in Figure 5-2.

The permit requires that groundwater samples are collected semiannually during April/May and September/October and lists which constituents must be analyzed. Contaminant concentrations in the monitoring wells are limited by primary constituent standards and secondary constituent standards specified in IDAPA 58.01.11, "Ground Water Quality Rules."

Table A-8 shows the 2023 water table elevations and depth-to-water table, determined prior to purging and sampling, and the analytical results for all constituents specified by the permit for the aquifer wells. Table A-9 presents similar information for the perched water wells.

Tables A-8 and A-9 show all permit-required constituents associated with the aquifer monitoring wells were below their respective primary constituent standards and secondary constituent standards in 2023.

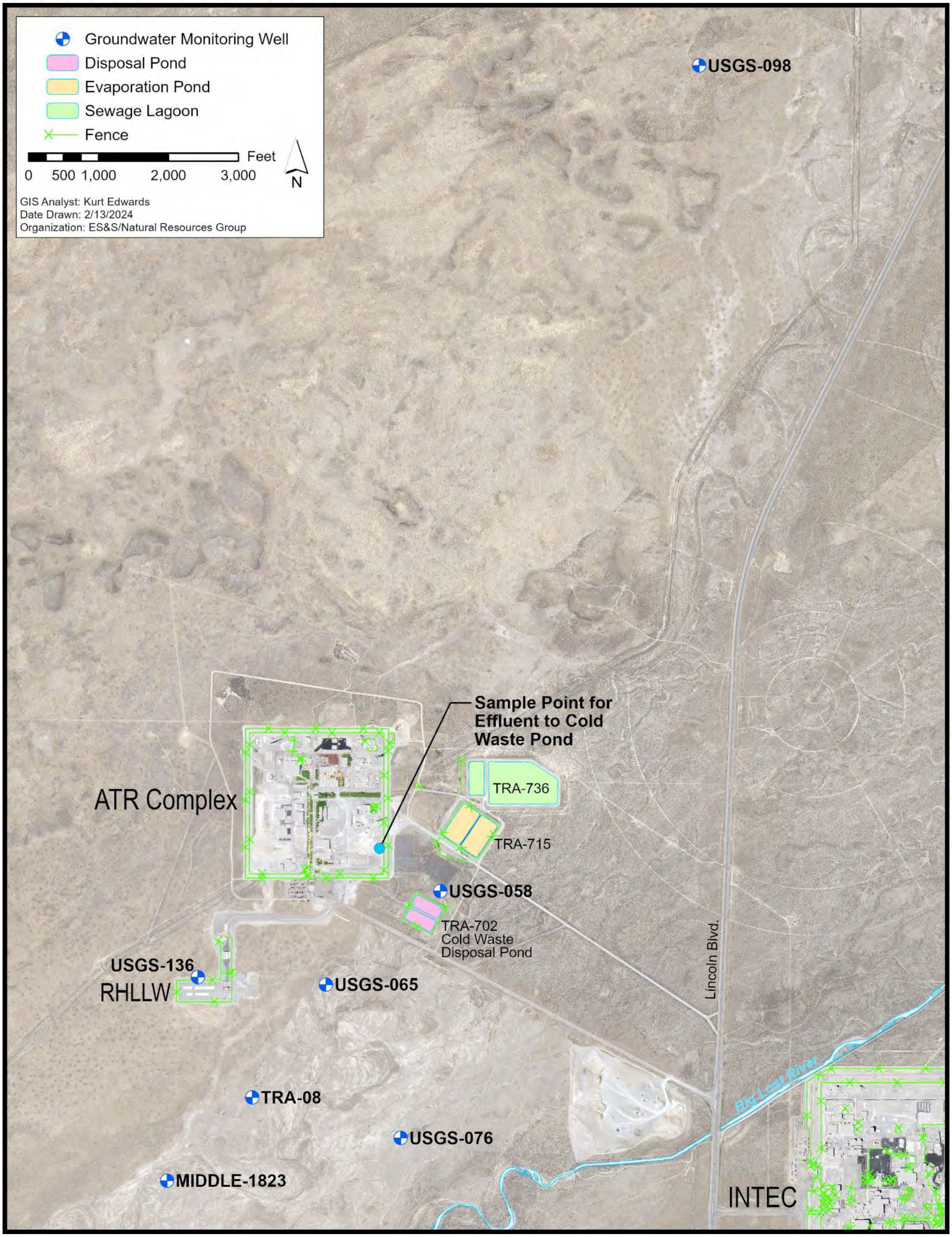

Figure 5-1. Permit monitoring locations for the ATR Complex Cold Waste Pond.

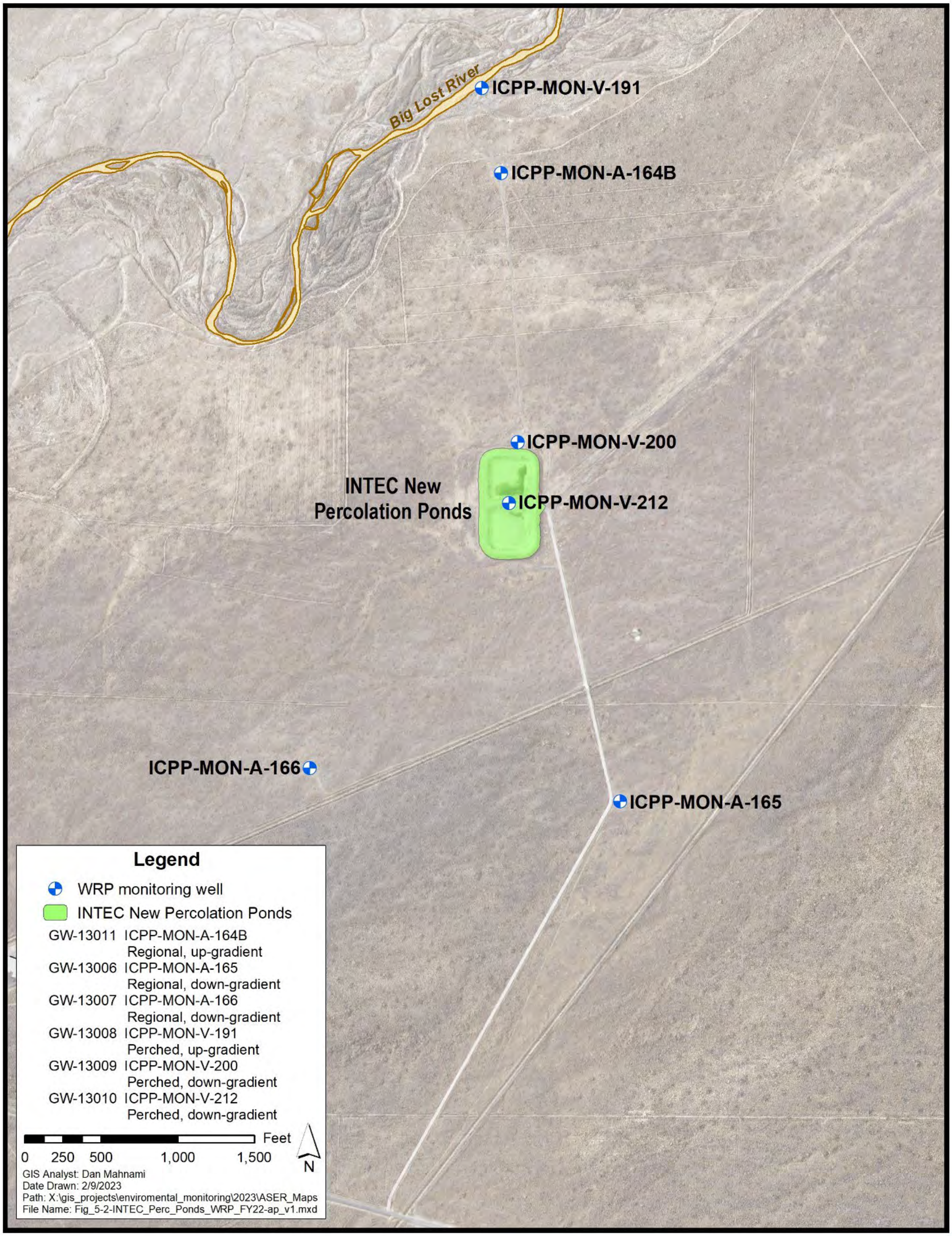

Figure 5-2. Reuse permit groundwater monitoring locations for INTEC New Percolation Ponds.

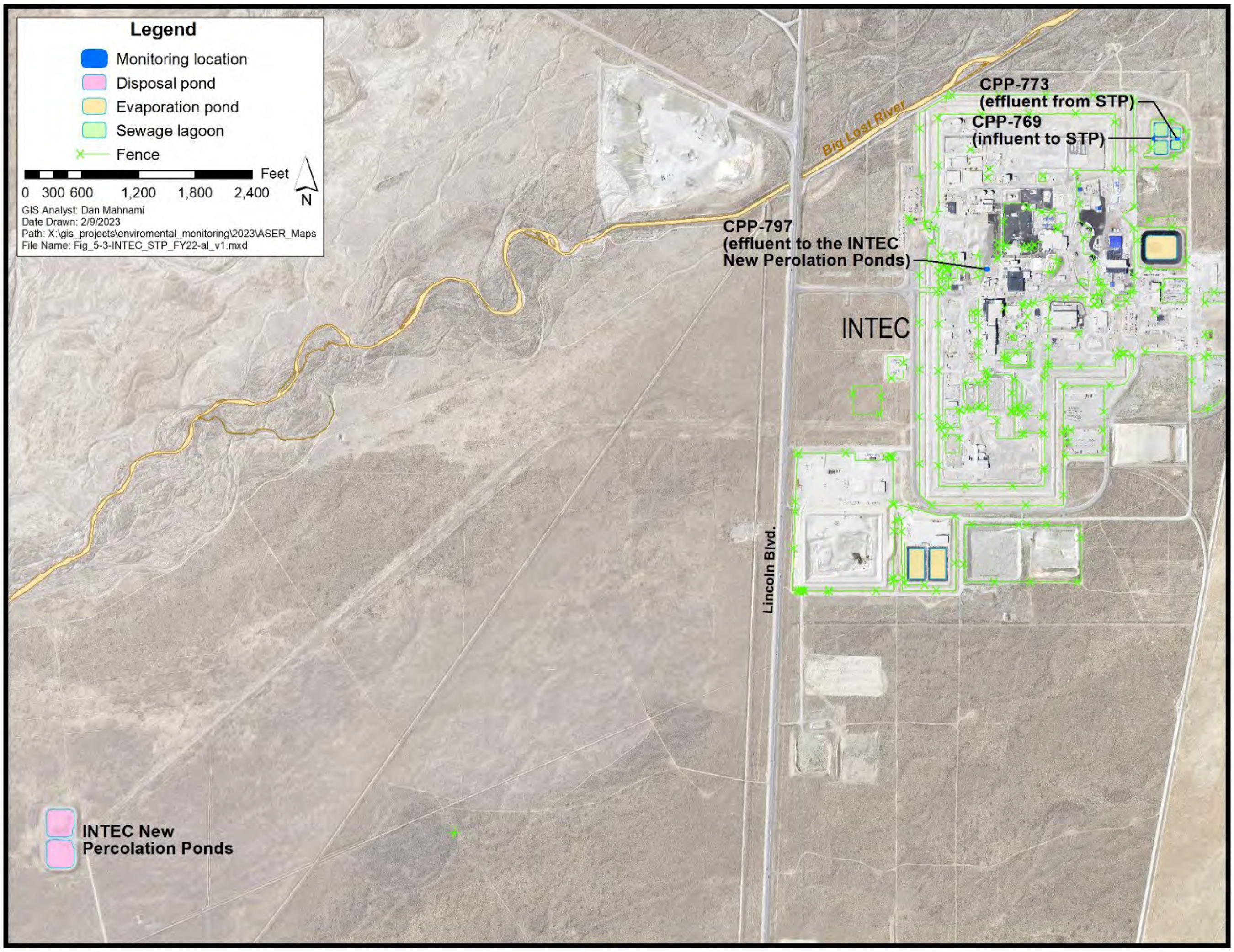

Figure 5-3. INTEC wastewater monitoring for reuse permit.

5.1.3 Materials and Fuels Complex Industrial Waste Pond

Description. The MFC Industrial Waste Pond (IWP) is an unlined basin that was first excavated in 1959 and has a design capacity of 1,078.84 ML (285 MG) at a maximum water depth of 3.96 m (13 ft) as identified in Figure 5-4. The industrial wastewater system that discharges to the IWP, referred to as the Industrial Wastewater Collection System (IWCS), consists of a combination of pipelines/branches, lift stations, flow meter, composite sampler, and associated components. Wastewater discharged to the IWCS consists of primarily noncontact cooling water, cooling tower drains, and air wash flows. Small volumes of MFC-768 Powerplant cooling water system blowdown, intermittent reverse osmosis blowdown, and floor drain and laboratory sink discharges are also sent to the IWCS. On occasion, with pre-approval, industrial wastewater from MFC facility process holdup tanks discharge to the pipeline. The IWP functions as a percolation basin for the infiltration of the nonhazardous industrial effluent, which is discharged to the pond via the IWCS.

The IWCS has two distinct sections: the IWCS Primary Line (PL) and IWCS Southwestern Branch Line (SBL). The IWCS PL begins near MFC-774, travels north to and beyond a lift station, then turns and travels west to the monitoring station, and eventually discharges to the pond. This section is referred to as the PL because it is the pipeline that collects wastewater from all sources, and on which the flow meter and composite sampler are located. The section referred to as the SBL collects wastewater from sources inside MFC-768 and discharges the wastewater to an underground pipe running northwest and then north into a lift station. This lift station pumps wastewater to the north and then northeast where it discharges into the PL upstream of the flow meter and composite sampler.

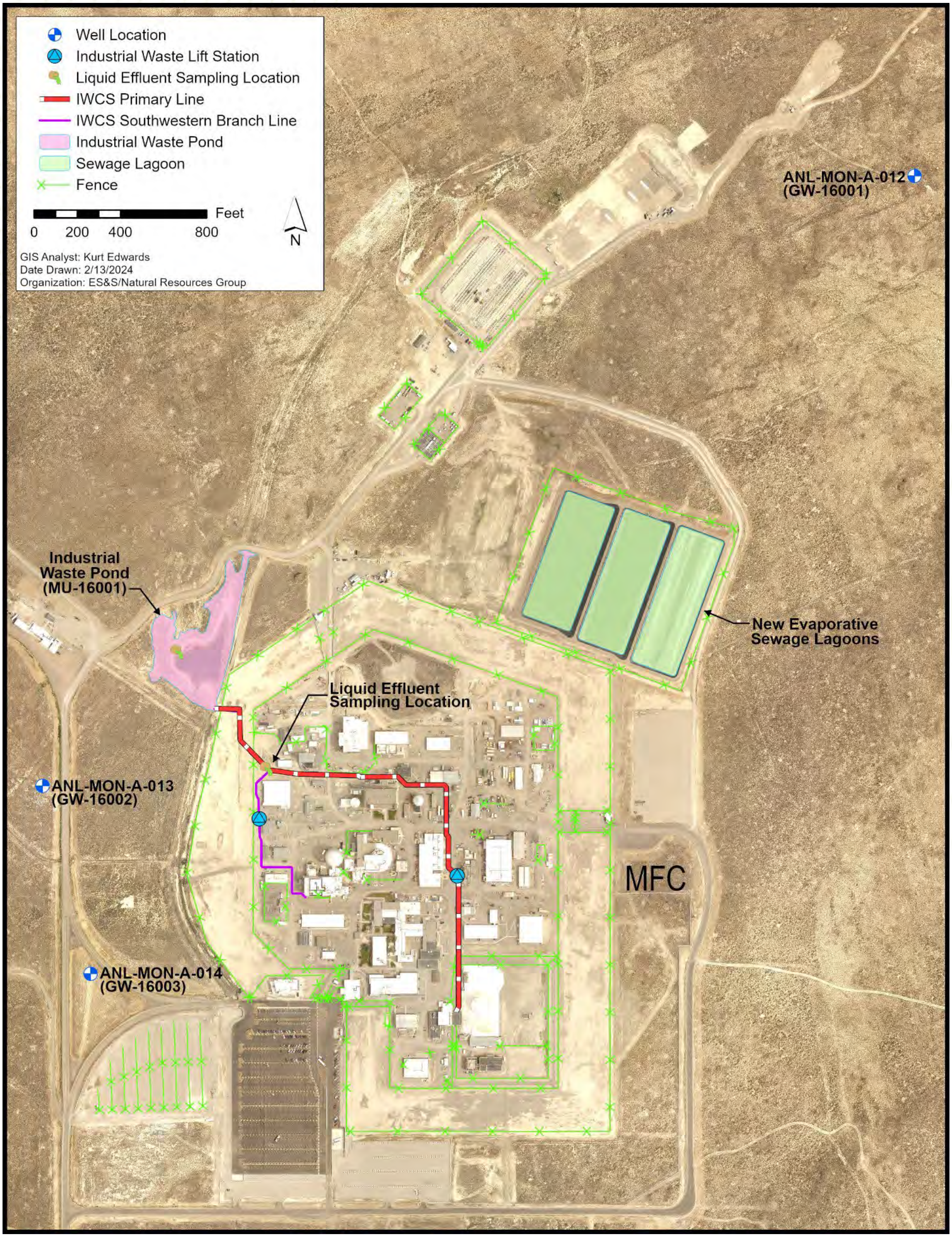

Figure 5-4. Wastewater and groundwater sampling locations at MFC.

Wastewater Monitoring Results for the Reuse Permit. Reuse Permit I-160-02 Modifications 4 and 5 require monthly sampling of effluent discharging from the IWCS into the IWP (DEQ 2022b, DEQ 2023b). The 2023 permit reporting year monitoring results are presented in the 2023 annual reuse report (INL 2024d), and the calendar year results are summarized in Table A-10. Based on the composition of the industrial effluent, the reuse permit does not require pre-treatment or specify maximum constituent loading limits or concentration limits. In 2023, concentrations of iron and manganese continued to be at or near the minimum detection levels of the laboratory instruments. Total dissolved solids ranged from 208 mg/L to 283 mg/L. The 2023 constituent concentrations continue to be within historical ranges.

The permit specifies an annual reporting year hydraulic loading limit of 17 MG/yr. As shown in Table A-11, the 2023 reporting year flow of 9.435 MG/yr was well below the permit limit.

Groundwater Monitoring Results for the Reuse Permit. The reuse permit requires groundwater monitoring twice per year, in April/May and September/October, at one upgradient well and two downgradient wells, as observed in Figure 5-4, to measure potential impacts from the pond. The analytical results are summarized in Table A-12. In 2023, none of the constituents exceeded their respective primary or secondary constituent standards, and the analyte concentrations in the downgradient wells remained consistent with the background levels in the upgradient well.

5.2 Liquid Effluent Surveillance Monitoring

The following sections discuss the results of liquid effluent surveillance monitoring performed at each wastewater reuse permitted facility.

5.2.1 Advanced Test Reactor Complex

The effluent to the CWP receives a combination of process water from various ATR Complex facilities. The CWP effluent is analyzed monthly for gross alpha, gross beta, gamma spectrometry, and tritium. Table A-13 lists wastewater effluent surveillance monitoring results for those constituents with at least one detected result. In 2023, gross alpha, gross beta, and radium-228 were the only constituents detected in the CWP effluent. Radium-228 was detected once at 0.755 (± 0.165) pCi/L and was well below the DOE DCS for ingested water of 73 pCi/L (DOE 2022).

Additionally, seven groundwater monitoring wells are sampled twice per year for radiological surveillance. The groundwater radionuclide surveillance monitoring results are summarized in Table A-14. All detected constituents, including tritium, gross alpha, and gross beta, were well below the Idaho groundwater primary constituent standards, IDAPA 58.01.11. Gross alpha and gross beta remain within historical ranges. Tritium continues to trend downward in the monitoring wells that have positive detections.

5.2.2 Idaho Nuclear Technology and Engineering Center

In addition to the permit-required monitoring summarized in Section 5.1.3, surveillance monitoring was conducted at CPP-797 (effluent to the INTEC New Percolation Ponds), and groundwater monitoring was conducted at the INTEC New Percolation Ponds. Table A-15 summarizes the results of radiological monitoring at CPP-797, while Table A-16 summarizes the results of radiological monitoring at groundwater Wells ICPP-MON-A-165, ICPP-MON-A-166, ICPP-MON-V-200, and ICPP-MON-V-212.

Twenty-four-hour flow proportional samples were collected from the CPP-797 wastewater effluent and composited daily into a monthly sample. Each collected monthly composite sample was analyzed for specific gamma-emitting radionuclides, gross alpha, gross beta, and total strontium activity. As shown in Table A-15, no total strontium activity was detected in any of the samples collected at CPP-797 in 2023. Gross alpha was detected in four samples, while gross beta was detected in all 12 samples collected in 2023.

Groundwater samples were collected from aquifer Wells ICPP-MON-A-165 and ICPP-MON-A-166 and perched water Wells ICPP-MON-V-200 and ICPP-MON-V-212 in May 2023 and September 2023 and were analyzed for gross alpha and gross beta. As shown in Table A-16, gross alpha was detected in three of the four monitoring wells in September 2023. Gross beta was detected in three of the four wells in May 2023 and all of the monitoring wells in September 2023. All detected constituents, including strontium-90 (^{90}Sr), tritium, gross alpha, and gross beta, were below the Idaho groundwater primary constituent standards, IDAPA 58.01.11.

5.2.3 Materials and Fuels Complex

The IWP is sampled three times per year and analyzed for gross alpha, gross beta, gamma spectrometry, and tritium, as shown in Figure 5-4. Annual samples are also collected and analyzed for select isotopes of americium, strontium, plutonium, and uranium. As summarized in Table A-17, the gross alpha, gross beta, and uranium isotopes that were detected in 2023 are all well below applicable DCS (DOE 2022) and remain within historical ranges.

Additionally, three ground water monitoring wells are sampled twice per year and analyzed for gross alpha, gross beta, alpha spectrometry, gamma spectrometry, and tritium. The 2023 groundwater surveillance monitoring results are summarized in Table A-18. Overall, the detected results were below the Idaho groundwater primary constituent standards, IDAPA 58.01.11, remain within historical ranges, and show no discernible impact from activities at MFC.

5.3 Surface Water Runoff Surveillance Water Sampling

Radionuclides could be transported outside the RWMC boundaries via surface water runoff. Surface water runs off the SDA only during periods of rapid snowmelt or heavy precipitation. At these times, water may be pumped out of the SDA retention basin into a drainage canal, which directs the flow outside RWMC. The canal also carries runoff from outside RWMC that has been diverted around the SDA.

Additionally, water sheet flows across asphalt surfaces and infiltrates around/under door seals at Waste Management Facility (WMF)-636 at AMWTP. The resulting surface water inflow accumulates in the WMF-636 Fire Water Catch Tanks (Tanks A, B, C, and D). If the level of surface water in the Fire Water Catch Tanks reaches a predetermined level, the water is pumped into aboveground holding tanks, where it can be sampled, prior to discharge into the drainage canal surrounding the SDA.

In compliance with DOE O 435.1, the ICP contractor collects surface water runoff samples at the RWMC SDA from the location shown in Figure 5-5. The WMF-636 Fire Water Catch Tanks are also shown in Figure 5-5. Surface water is collected to determine whether radionuclide concentrations exceed administrative control levels or if concentrations have increased significantly, as compared to historical data. A field blank is also collected for comparison. Samples from the WMF-636 Fire Water Catch Tanks were not collected during 2023 as periodic measurements of tank levels did not indicate pumping to be necessary.

One sample was collected from the SDA Lift Station in 2023. This sample was analyzed for a suite of radionuclides that includes ^{241}Am and ^{90}Sr, as well as plutonium and uranium isotopes. There were positive detections (three sigma [3σ]) of ^{241}Am, plutonium-238 (^{238}Pu), $^{239/240}$Pu, and ^{90}Sr in the samples taken in 2023. The maximum concentration detected for ^{241}Am was 2.35 (± 0.16) pCi/L, which is well below the 740 pCi/L DCS for ^{241}Am. The maximum concentration detected for ^{238}pu was 0.04 (± 0.01) pCi/L, which is well below the 430 pCi/L DCS. The maximum concentration detected for $^{239/240}$Pu was 0.32 (± 0.03) pCi/L, which is well below the applicable DCS (400 pCi/L). Finally, the maximum concentration detected for ^{90}Sr was 0.38 (± 0.17) pCi/L, which is also well below the applicable DCS (1,700 pCi/L). In addition to these nuclides, uranium isotopes were detected at levels consistent with historical results, which are below any applicable DCS.

Table 5-3 summarizes the specific alpha and beta results of human-made radionuclides. No human-made gamma-emitting radionuclides were detected. ICP temporarily ceased sample collection since the teardown of the Accelerated Retrieval Project (ARP) V facility removed electrical facilities to the SDA Lift Station. The ICP contractor is revising the process for sample collection and updating their sampling procedure to allow continued sampling at the SDA Lift Station considering the changes resulting from closure activities.

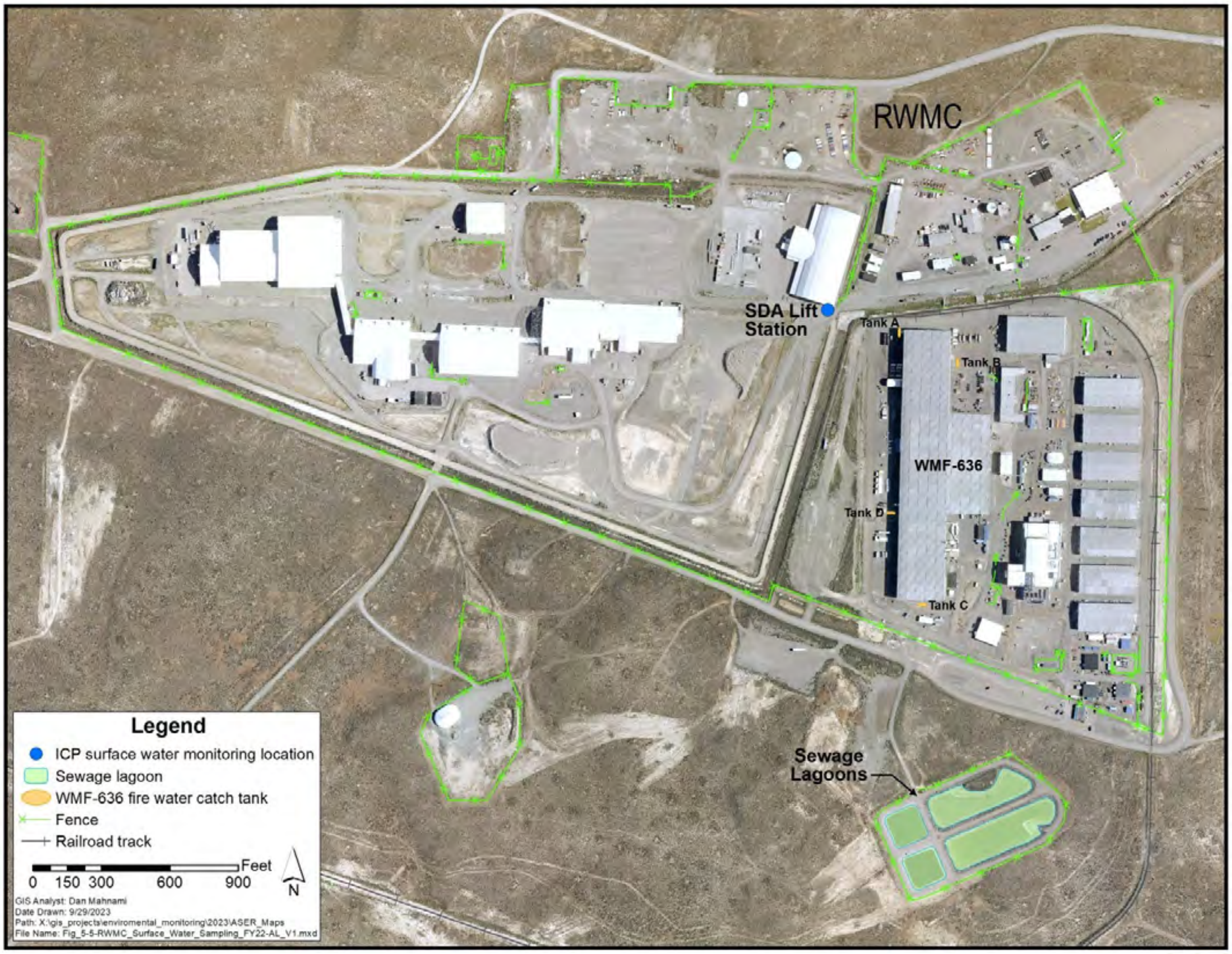

Figure 5-5. Surface water sampling location at the RWMC SDA.

Table 5-3. Radionuclides detected in surface water runoff at the RWMC SDA (2023).

LOCATION	PARAMETER	MAXIMUM CONCENTRATION[a] (pCi/L)	% DCS[b]
SDA Lift Station	Americium-241	2.36 ± 0.10	0.13
	Plutonium-238	0.04 ± 0.01	0.01
	Plutonium-239/240	0.32 ± 0.03	0.04
	Strontium-90	0.38 ± 0.17	0.04
	Uranium-234	0.53 ± 0.04	0.04
	Uranium-235	0.04 ± 0.01	0.00
	Uranium-238	0.44 ± 0.03	0.03

a. Result ±1s. Results shown are greater than 3σ.

b. See DOE-STD-1196-2021, Table A-6 (DOE 2022).

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Chapter 6: Environmental Monitoring Programs – Eastern Snake River Plain Aquifer Monitoring

CHAPTER 6

One potential pathway for exposure from contaminants released at the Idaho National Laboratory (INL) Site is through the groundwater pathway. Historic waste disposal practices have produced localized areas of chemical and radiochemical contamination beneath the INL Site in the eastern Snake River Plain Aquifer. These areas are regularly monitored by the U.S. Geological Survey (USGS), and reports are published showing the extent of contamination plumes. Results for most monitoring wells within the plumes show decreasing concentrations of tritium, strontium-90, and iodine-129 over the past 20 years. The decrease is probably the result of radioactive decay, discontinued disposal, dispersion, and dilution within the aquifer.

In 2023, the USGS sampled 25 groundwater monitoring wells at the INL Site for analysis of 61 purgeable (volatile) organic compounds. Nine purgeable organic compounds were detected in at least one well. Most of the detected concentrations were less than the maximum contaminant levels established by the U.S. Environmental Protection Agency (EPA) for public drinking water supplies. One exception was carbon tetrachloride, detected in the production well at the Radioactive Waste Management Complex (RWMC). This compound has shown a decreasing trend since 2005 and is removed from the water prior to human consumption. Trichloroethylene was detected above the maximum contaminant level (MCL) at a well near Test Area North (TAN) where there is a known groundwater plume containing this contaminant being treated.

Groundwater surveillance monitoring required in area-specific Records of Decision under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) was performed at Waste Area Groups (WAGs) 1–4, WAG 7, and WAG 10 in 2023.

In addition to the Advanced Test Reactor (ATR) Complex and the Materials and Fuels Complex (MFC), the INL contractor also monitors groundwater at the Remote-Handled Low-Level Waste Disposal (RHLLW) Facility for the surveillance of select radiological analytes. Groundwater samples were collected from three monitoring wells at the RHLLW Disposal Facility in 2023. The 2023 results show no discernible impacts to the aquifer from RHLLW operations.

There are 11 drinking water systems on the INL Site monitored by INL and Idaho Cleanup Project (ICP) contractors. All contaminant concentrations measured in drinking water systems in 2023 were below regulatory limits.

Drinking water and springs were sampled in the vicinity of the INL Site and analyzed for gross alpha and gross beta activity and tritium. Some locations were co-sampled with the Idaho Department of Environmental Quality (DEQ) INL Oversight Program. Results were consistent with historical measurements and do not indicate any impact from historical INL Site releases.

6. ENVIRONMENTAL MONITORING PROGRAMS – EASTERN SNAKE RIVER PLAIN AQUIFER

The eastern Snake River Plain Aquifer serves as the primary source of drinking water and crop irrigation in the upper Snake River Basin. This chapter presents the results of water monitoring conducted on and off the INL Site within the eastern Snake River Plain Aquifer hydrogeologic system. This includes the collection of water from the aquifer—including the drinking water wells—through downgradient springs along the Snake River where the aquifer discharges water, as observed in Figure 6-1, and an ephemeral stream (the Big Lost River), which flows through the INL Site and helps to recharge the aquifer. The purpose of this monitoring is to:

- Demonstrate the eastern Snake River Plain groundwater is protected from contamination from current INL Site activities
- Show areas of known underground contamination from past INL Site operations are monitored and trended
- Determine drinking water consumed by workers and visitors at the INL Site and by the public downgradient of the INL Site is safe
- Show the Big Lost River, which occasionally flows through the INL Site, is not contaminated by INL Site activities before entering the aquifer via channel loss and playas on the north end of the INL Site.

Analytical results are compared to applicable regulatory guidelines for compliance and informational purposes. These include the following:

- State of Idaho groundwater primary and secondary constituent standards (Ground Water Quality Rule, IDAPA 58.01.11)
- EPA health-based MCLs for drinking water (40 CFR 141)
- U.S. Department of Energy (DOE) Derived Concentration Standards for the ingestion of water (DOE 2022a).

6.1 Summary of Monitoring Programs

Three organizations monitor the eastern Snake River Plain Aquifer hydrogeologic system:

- The USGS INL Project Office performs groundwater monitoring, analyses, and scientific studies to improve the understanding of the hydrogeological conditions affecting the movement of groundwater and contaminants in the eastern Snake River Plain Aquifer underlying and adjacent to the INL Site. The USGS utilizes an extensive network of strategically placed monitoring wells on the INL Site, as shown in Figure 6-2, and at locations throughout the eastern Snake River Plain.

  Table 6-1 summarizes the USGS routine groundwater surveillance program. In 2023, USGS personnel collected and analyzed more than 1,200 samples for radionuclides and inorganic constituents, including trace elements, and another 25 samples for purgeable organic compounds. USGS INL Project Office personnel also published three reports, two software packages, and six data releases covering hydrogeologic conditions and monitoring at the INL Site. Links to these reports and products are presented in Section 6.10.

- The ICP contractor conducts groundwater monitoring at various WAGs delineated on the INL Site, which are identified in Figure 6-3, for compliance with the CERCLA. The ICP contractor also conducts drinking water monitoring at the Idaho Nuclear Technology and Engineering Center (INTEC), RWMC, and Naval Reactors Facility (NRF) Deactivation and Decommissioning project. In 2023, the ICP contractor also monitored groundwater at the TAN, ATR Complex, INTEC, Central Facilities Area (CFA), RWMC, and the INL Site-wide area, included in Operable Unit 10-08 (WAGs 1, 2, 3, 4, 7, and 10, respectively). Table 6-2 summarizes the routine monitoring for the ICP contractor drinking water program.
- The INL contractor monitors groundwater at MFC, the ATR Complex, and the RHLLW Disposal Facility. The INL contractor also monitors the drinking water at eight INL Site facilities: ATR Complex, CFA, the Critical Infrastructure Test Range Complex (CITRC), the Experimental Breeder Reactor-I (EBR-I), the Gun Range, the Main Gate, MFC, and TAN/Contained Test Facility (CTF). Table 6-3 summarizes the routine monitoring for the INL contractor drinking water program.
- The INL contractor collects drinking water samples from offsite locations and natural surface waters on and off the INL Site for surveillance purposes. This includes the Big Lost River, which occasionally flows through the INL Site, and springs along the Snake River that are downgradient from the INL Site. A summary of the program may be found in Table 6-4. In 2023, the INL contractor sampled and analyzed 50 surface and drinking water samples. Surface water samples were collected from six locations on the Big Lost River in 2023.

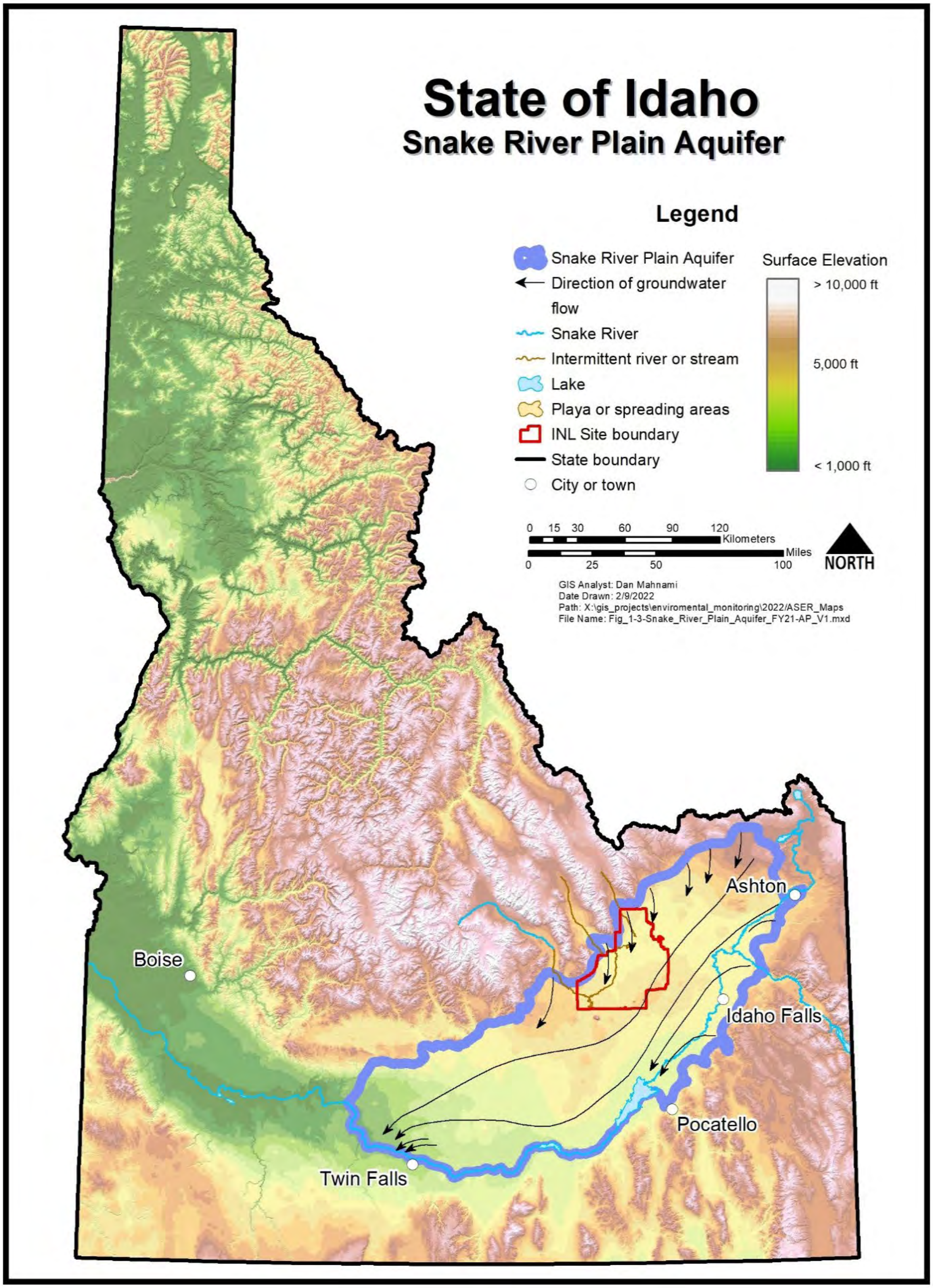

Figure 6-1. The eastern Snake River Plain Aquifer and direction of groundwater flow.

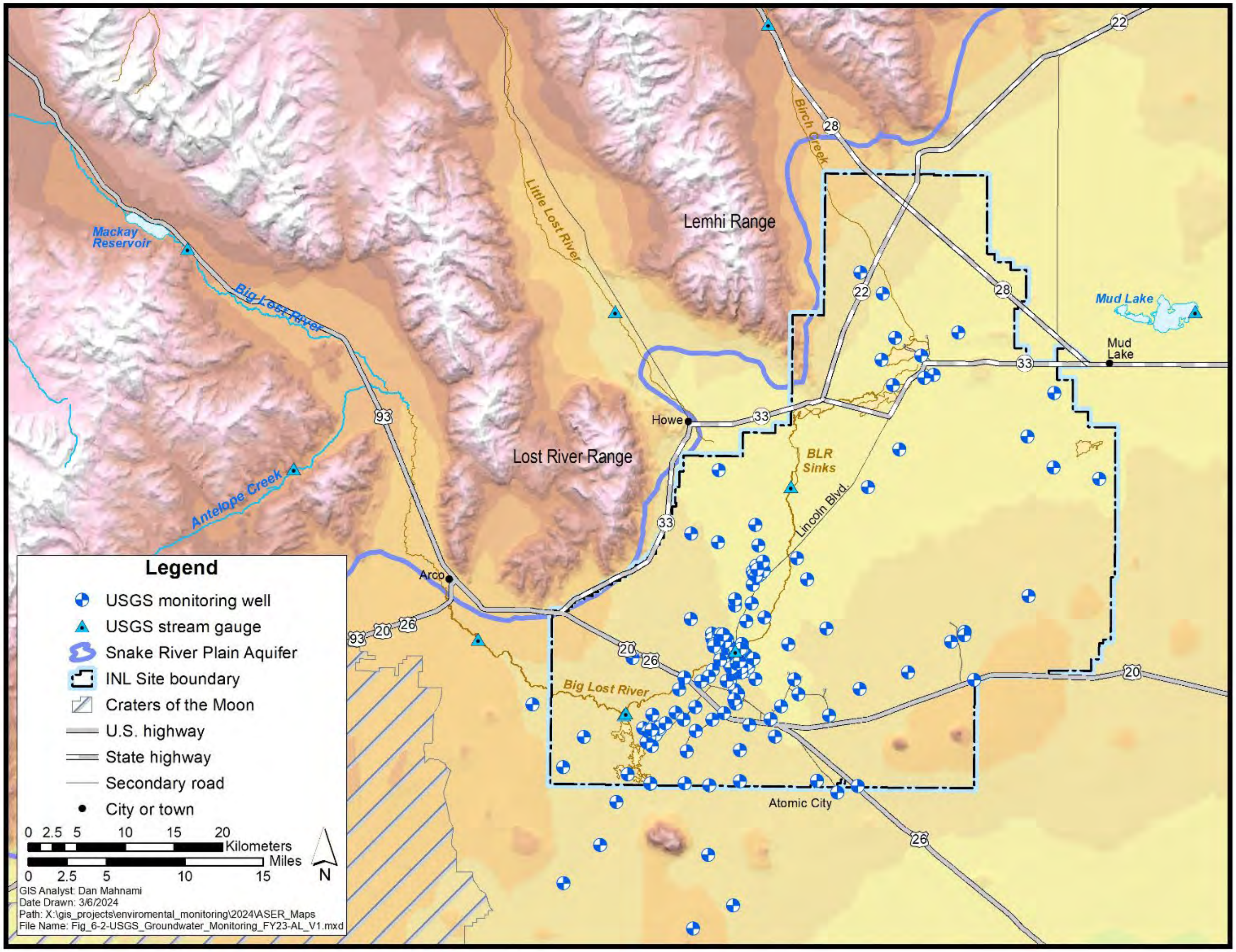

Figure 6-2. USGS groundwater monitoring locations on and off the INL Site.

Table 6-1. USGS monitoring program summary (2023).

CONSTITUENT	GROUNDWATER		SURFACE WATER		MINIMUM DETECTABLE CONCENTRATION OR ACTIVITY
	NUMBER OF SITES[a]	NUMBER OF SAMPLES	NUMBER OF SITES	NUMBER OF SAMPLES	
Gross alpha	57	69	1	1	8 pCi/L
Gross beta	57	69	1	1	3.5 pCi/L
Tritium	126	138	4	4	200 pCi/L
Gamma-ray spectroscopy	37	37	1	1	—[b]
Strontium-90	57	57	—[c]	—	2 pCi/L
Americium-241	8	8	—[c]	—	0.03 pCi/L
Plutonium isotopes	8	8	—[c]	—	0.02 pCi/L
Specific conductance	127	127	4	4	NA[d]
Sodium ion	123	144	—[c]	—	0.4 mg/L
Chloride ion	122	135	4	4	0.02 mg/L
Nitrates (as nitrogen)	106	116	—[c]	—	0.04 mg/L
Fluoride	5	5	—[c]	—	0.01 mg/L
Sulfate	113	134	—[c]	—	0.02 mg/L
Chromium (dissolved)	90	112	—[c]	—	1 µg/L
Purgeable organic compounds[e]	25	34	—[c]	—	Varies
Mercury	9	14	—[c]	—	0.005 µg/L
Trace elements	6	7	—[c]	—	Varies

a. Number of samples does not include 12 replicates and four blanks collected in 2023. The number of samples was different from the number of sites because one site for volatile organic compounds (VOCs) is sampled monthly, and three sites had pump problems or were dry, so they were not sampled. The number of sites does not include 24 zones from 10 wells sampled as part of the multi-level monitoring program.

b. Minimum detectable concentration for gamma spectroscopic analyses varies depending on radionuclide.

c. No surface water samples collected for this constituent.

d. NA = not applicable.

e. Each purgeable organic compound water sample is analyzed for 61 purgeable organic compounds.

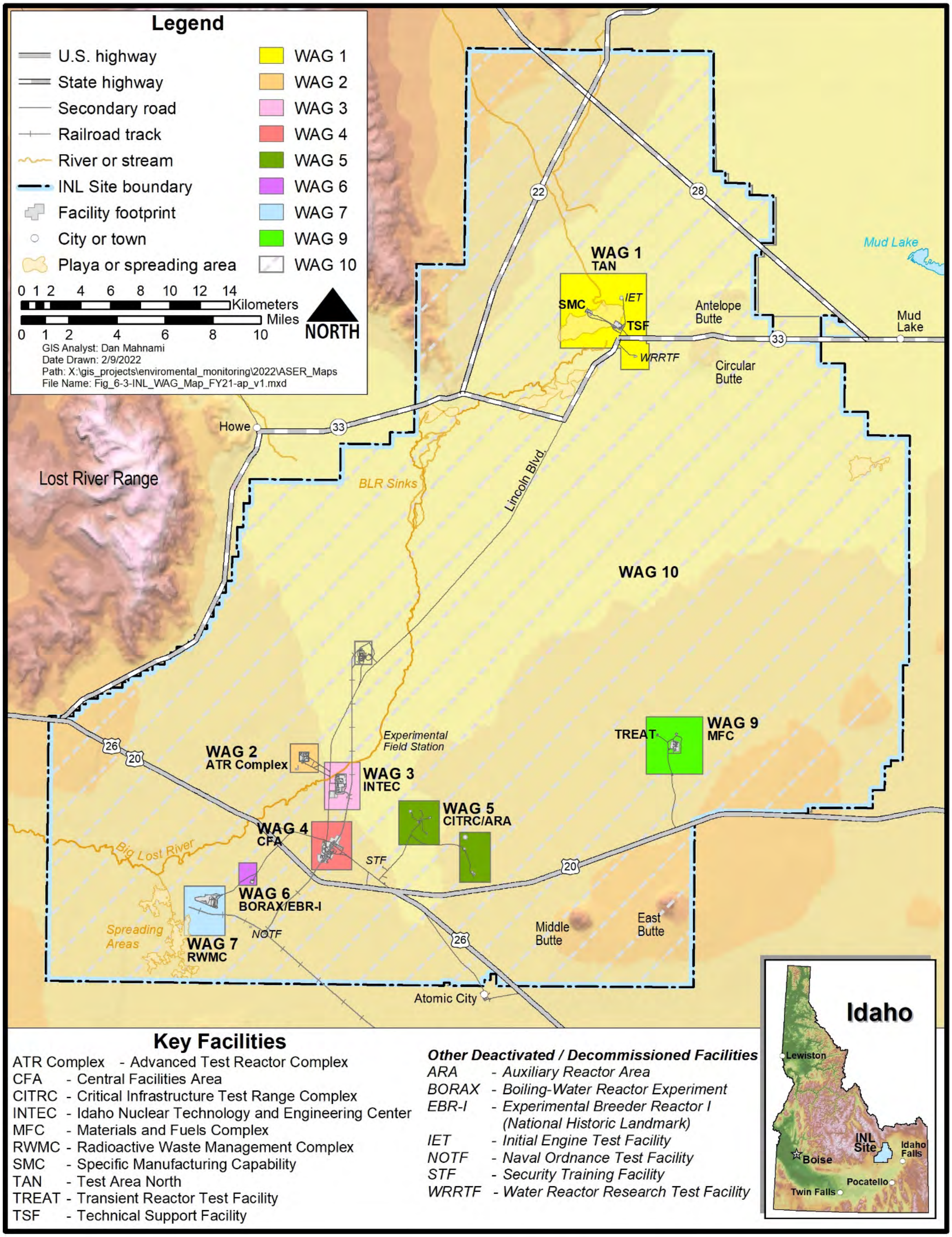

Figure 6-3. Map of the INL Site showing locations of facilities and corresponding WAGs.

Table 6-2. ICP contractor drinking water program summary (2023).

TYPE OF ANALYSIS	FREQUENCY (ONSITE)	MCL
Gross alpha	2 semiannually	15 pCi/L
Gross beta	2 semiannually	50 pCi/L screening level or 4mrem/yr
Haloacetic acids (HAA5)[a]	2 annually	0.06 mg/L
Total coliform[b]	6 to 8 monthly	See 40 CFR 141.63(d)
E. coli[b]	6 to 8 monthly	See 40 CFR 141.63(c)
Nitrate	2 annually	10 mg/L (as nitrogen)
Radium-226/-228	2 every 9 years	5 pCi/L
Strontium-90	2 annually	8 pCi/L
Total trihalomethanes	2 annually	0.08 mg/L
Tritium	2 annually	20,000 pCi/L
Uranium	2 every 9 years	30 µg/L
VOCs	2 annually	Varies

a. Haloacetic acids = sometimes referred to as HAA5, which includes the most common haloacetic acids found in drinking water. These consist of monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid.

b. Total coliform and *E. coli* are sampled monthly at the NRF Deactivation and Decommissioning Facility.

Table 6-3. INL contractor drinking water program summary (2023).

TYPE OF ANALYSIS	FREQUENCY (ONSITE)	MCL
Gross alpha[a]	10 to 12 semiannually	15 pCi/L
Gross beta[a]	10 to 12 semiannually	4 mrem/yr
Haloacetic acids[b]	4 annually	0.06 mg/L
Iodine-129[c]	1 semiannually	1 pCi/L
Lead/Copper[b]	35 triennially	0.015/1.3 mg/L
Nitrate[d]	10 annually	10 mg/L (as nitrogen)
Strontium-90[c]	3 annually	8 pCi/L
Total coliform and *E. coli*	12 to 14 monthly	See 40 CFR 141.63
Total trihalomethanes[b]	4 annually	0.08 mg/L
Tritium[a]	10 to 12 semiannually	20,000 pCi/L

a. Gross alpha, beta, and tritium are sampled at all INL water systems (i.e., ATR Complex, CFA, CITRC, EBR-1, Gun Range, Main Gate, MFC, and TAN/CTF).

b. Total trihalomethanes, haloacetic acids, and lead/copper are only sampled at ATR Complex, CFA, MFC, and TAN/CTF water systems.

c. Iodine-129 and ^{90}Sr are only sampled at the CFA water system.

d. Nitrate and bacteriological are sampled at all INL water distribution systems.

Table 6-4. INL contractor surface water and offsite drinking water summary (2023).

MEDIUM SAMPLED	TYPE OF ANALYSIS	LOCATIONS AND FREQUENCY		MINIMUM DETECTABLE CONCENTRATION
		ONSITE	OFFSITE	
Drinking Water[a]	Gross alpha	None	9-10 semiannually	3 pCi/L
	Gross beta	None	9-10 semiannually	2 pCi/L
	Tritium	None	9-10 semiannually	100 pCi/L
Surface Water[b,c]	Gross alpha	6, when available	3-4 semiannually	3 pCi/L
	Gross beta	6, when available	3-4 semiannually	2 pCi/L
	Tritium	6, when available	3-4 semiannually	100 pCi/L

a. Samples are co-located with the DEQ-INL Oversight Program at Shoshone and Minidoka water supplies. An upgradient sample is collected at Mud Lake Well #2. The number of samples includes a duplicate sample.

b. Onsite locations are the Big Lost River (when flowing) at the public rest stop on Highway 20/26, at two locations along Lincoln Boulevard, the Experimental Field Station, and the Big Lost River Sinks. A duplicate sample is also collected on the Big Lost River. Offsite samples are co-located with the DEQ-INL Oversight Program at Alpheus Spring, Clear Springs, and a fish hatchery at Hagerman. A duplicate sample is also collected at one location.

c. One sample is also collected offsite at Birch Creek as a control for the Big Lost River when it is flowing.

Details of the integrated approach used by the three organizations for aquifer, drinking water, and surface water compliance and surveillance monitoring programs may be found in the “Idaho National Laboratory Site Environmental Monitoring Plan” (DOE-ID 2021a) and “Idaho National Laboratory Groundwater Monitoring and Contingency Plan Update” (DOE-ID 2021b).

6.2 Hydrogeologic Data Management

Over time, hydrogeologic data at the INL Site have been collected by organizations, including USGS, current and past contractors, and other groups. The following data management systems are used:

- The Environmental Data Warehouse is the official long-term environmental data management and storage location for the ICP and INL programs. The Environmental Data Warehouse houses sampling and analytical data generated by site contractors and the USGS. It also stores comprehensive information pertaining to wells, including construction, location, completion zone, type, and status.
- The Hydrogeologic Data Repository houses geologic and hydrologic information compiled to support remedial investigation and feasibility study activities, Environmental Impact Statement preparation, site selection and characterization, and transport modeling in vadose and saturated zones. The information available includes (1) well construction and drill hole information, (2) maps, (3) historical data, (4) aquifer characteristics, (5) soil characterization, and (6) sediment property studies.
- The USGS Data Management Program involves putting all data in the National Water Information System, which is available online at https://waterdata.usgs.gov/id/nwis/nwis.

6.3 USGS Radiological Groundwater Monitoring at the INL Site

Historical waste disposal practices have produced localized areas of radiochemical contamination in the eastern Snake River Plain Aquifer beneath the INL Site.

Presently, strontium-90 (^{90}Sr) is the only radionuclide that continues to be detected by the ICP contractor and USGS above the primary constituent standard in some surveillance wells at TAN and between INTEC and CFA. Other radionuclides (e.g., gross alpha) have been detected above the primary constituent standard in wells monitored at individual WAGs.

Tritium – Because tritium is equivalent in chemical behavior to hydrogen—a key component of water—it has formed the largest plume of any of the radiochemical pollutants at the INL Site. The configuration and extent of the tritium contamination area, based on the most recent USGS data (2021), are shown in Figure 6-4 (Treinen et al. 2024). The area of contamination within the 500-pCi/L contour line decreased from about 103 km^2 (40 mi^2) in 1991 to about 52 km^2 (20 mi^2) in 1998 (Bartholomay et al. 2000). The area of elevated tritium concentrations near CFA likely represents water originating at INTEC some years earlier when larger amounts of tritium were disposed. This source is further supported by the fact that there are no known sources of tritium contamination in groundwater at CFA.

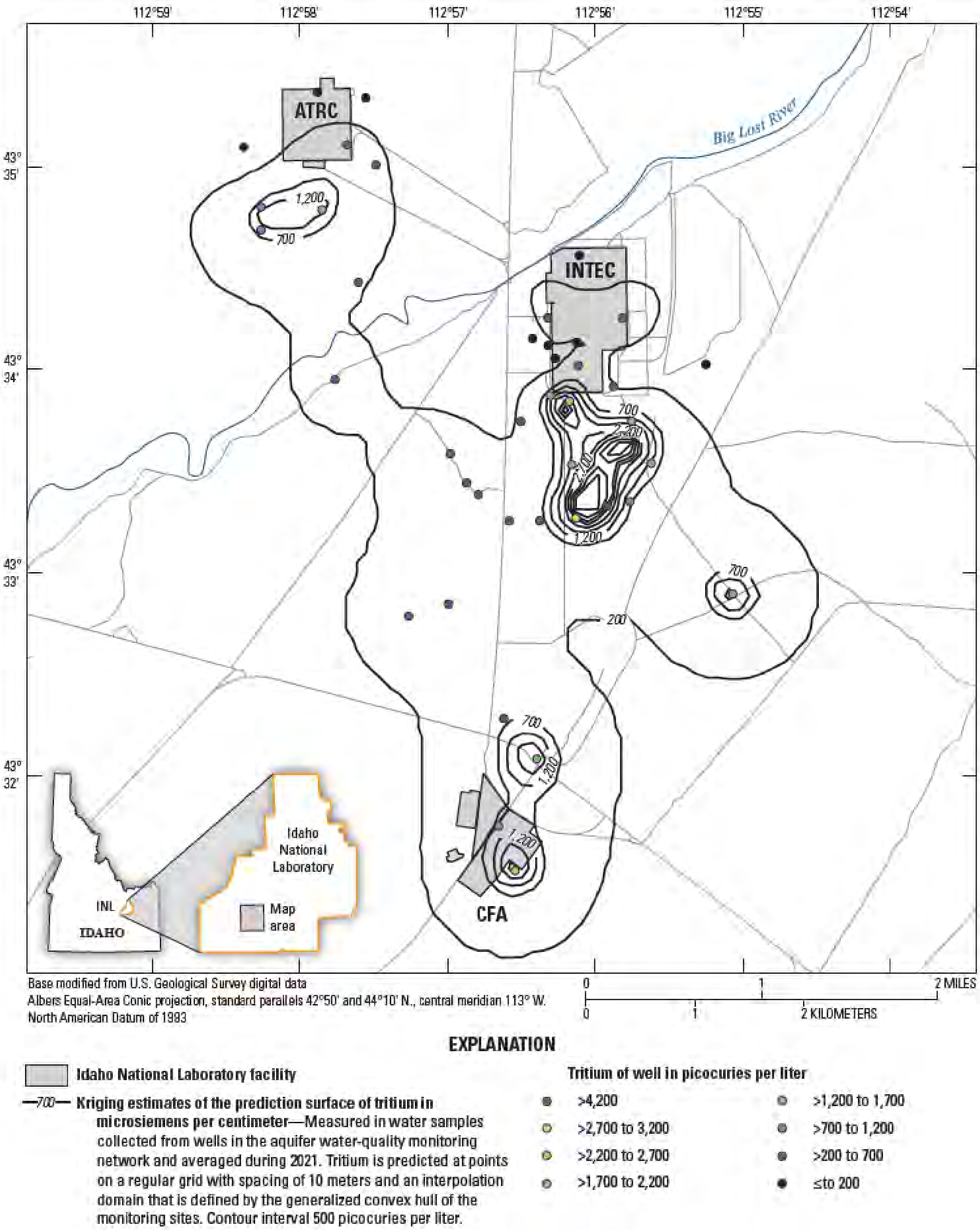

Figure 6-4. Distribution of tritium (pCi/L) in the eastern Snake River Plain Aquifer onsite in 2021 (from Treinen et al. 2024).

Two monitoring wells downgradient of the ATR Complex (USGS-065) and INTEC (USGS-114) have continually shown the highest tritium concentrations in the aquifer over the past 20 years, as shown in Figure 6-5. For this reason, these two wells are considered representative of maximum concentration trends in the rest of the aquifer. The concentration of tritium in USGS-065 near the ATR Complex increased from 400 ± 30 pCi/L in 2022 to 1110 ± 80 pCi/L in 2023; the tritium concentration in USGS-114, south of INTEC, decreased slightly from 3,970 ± 130 pCi/L in 2022 to 3,620 ± 130 pCi/L in 2023.

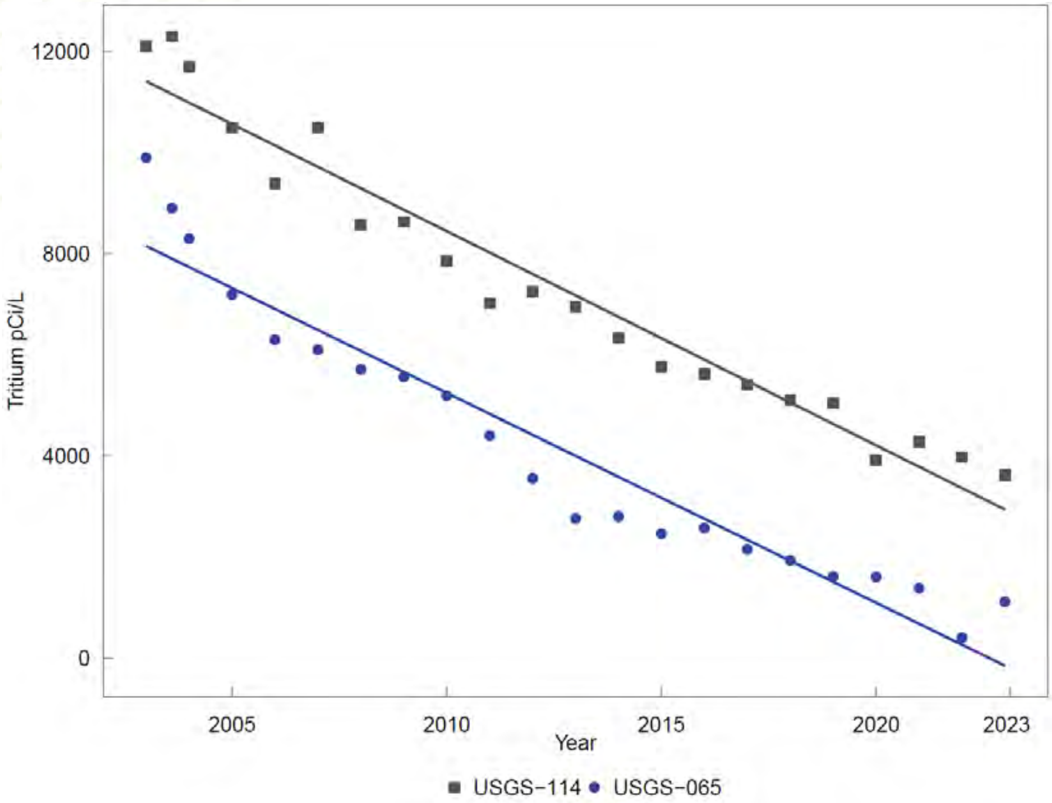

Figure 6-5. Long-term trend of tritium in Wells USGS-065 and USGS-114 (2003–2023).

The Idaho primary constituent standard for tritium (20,000 pCi/L) in groundwater is the same as the EPA MCL for tritium in drinking water. The values in Wells USGS-65 and USGS-114 dropped below this limit in 1997 due to radioactive decay (tritium has a half-life of 12.33 years), ceased tritium disposal, advective dispersion, and dilution within the aquifer. A 2015 report by the USGS (Davis et al. 2015) indicated that water quality trends for tritium in all but one well at the INL Site showed decreasing or no trends, and the well that showed the increasing trend changed to a decreasing trend after an analysis of the 2018 data (Bartholomay et al. 2020, Figure 15).

Strontium-90 – The configuration and extent of ^{90}Sr in groundwater, based on the latest published USGS data, are shown in Figure 6-6 (Treinen et al. 2024). The contamination originates at INTEC from the historical injection of wastewater. No ^{90}Sr was detected by USGS in the eastern Snake River Plain Aquifer near the ATR Complex during 2023. All ^{90}Sr at the ATR Complex was disposed to infiltration ponds in contrast to the direct injection that occurred at INTEC. At the ATR Complex, ^{90}Sr is retained in surficial sedimentary deposits, interbeds, and perched groundwater zones. The area of ^{90}Sr contamination from INTEC is approximately the same as it was in 1991.

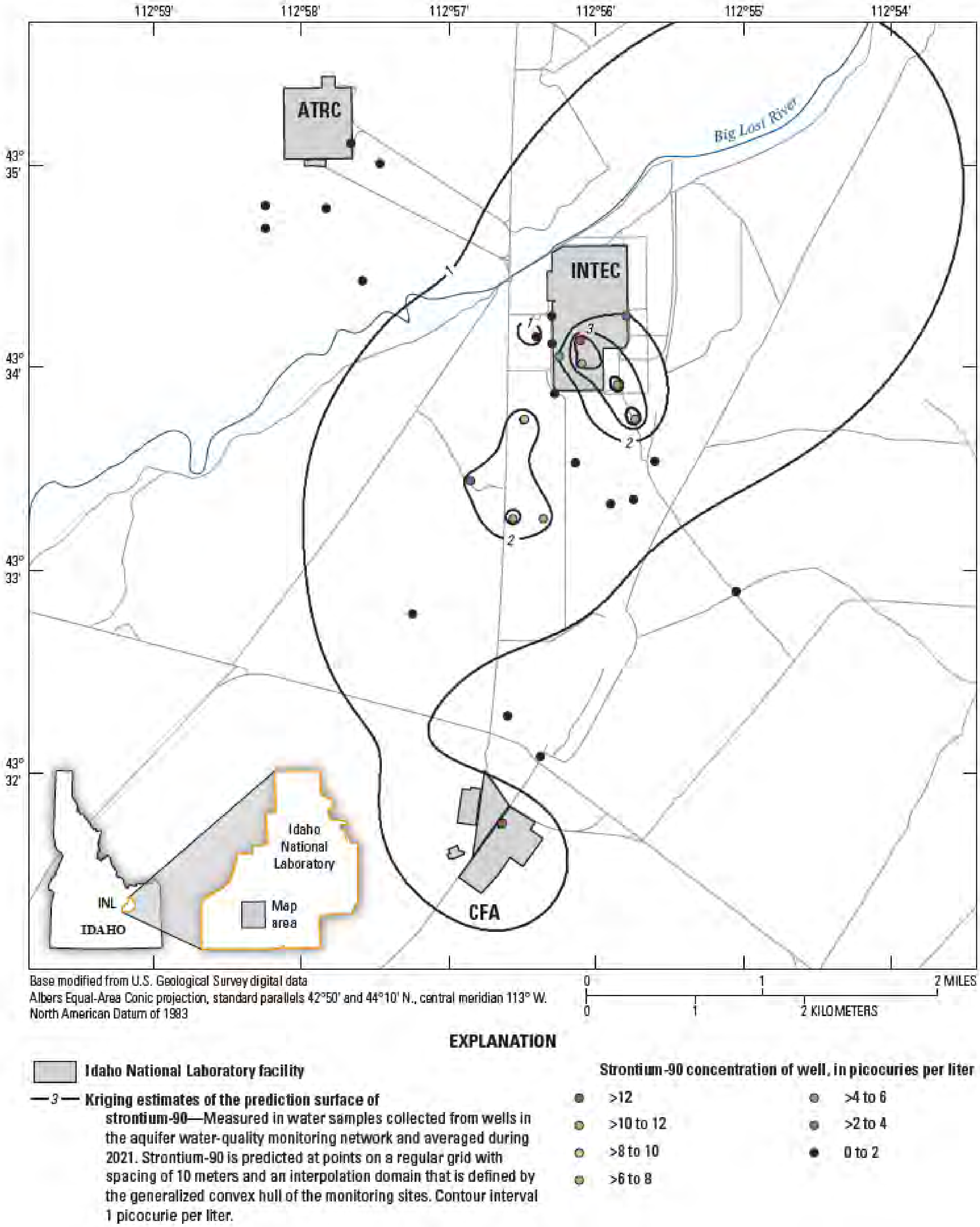

Figure 6-6. Distribution of ^{90}Sr (pCi/L) in the eastern Snake River Plain Aquifer onsite in 2021 (from Treinen et al. 2024).

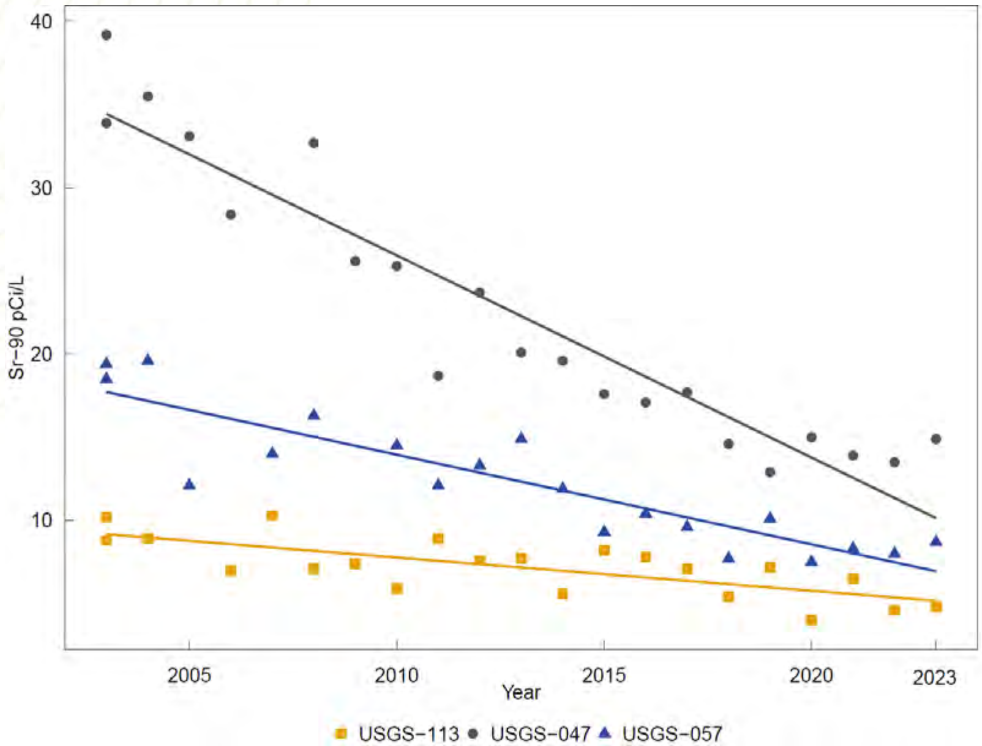

Figure 6-7. Long-term trend of ^{90}Sr in Wells USGS-047, USGS-057, and USGS-113 (2003–2023).

The ^{90}Sr trends over the past 20 years (i.e., 2003–2023) in Wells USGS-047, USGS-057, and USGS-113, all located at or downgradient from the INTEC facility, are shown in Figure 6-7. Concentrations in Well USGS-047 have varied throughout time but indicate a general decrease. Concentrations in Wells USGS-057 and USGS-113 also have generally decreased during this period. The variability of concentrations in some wells was thought to be due to, in part, a lack of recharge from the Big Lost River that would dilute the ^{90}Sr. Other reasons may include increased disposal of other chemicals into the INTEC percolation ponds, which may have changed the affinity of ^{90}Sr on soil and rock surfaces, causing it to become more mobile (Bartholomay et al. 2000). A 2015 report by the USGS (Davis et al. 2015) indicated that long-term water quality trends for ^{90}Sr in all but two perched water wells at the INL Site showed decreasing or no trends. A recent report by the USGS (Treinen and others, 2024) documented that these two perched wells near ATR Complex consistently have Sr-90 concentrations at or above the EPA established MCL of 8 pCi/L.

Summary of other USGS Radiological Groundwater Monitoring – USGS collects samples annually from select wells at the INL Site for gross alpha, gross beta, gamma spectroscopy analyses, and plutonium and americium isotopes. These values are shown in Table 6-1. Results for wells sampled in 2023 are available at https://waterdata.usgs.gov/id/nwis/ (U.S. Geological Survey 2024). Monitoring results for 2019–2021 are summarized in Treinen et al. (2024). During 2019–2021, concentrations of cesium-137, plutonium-239/240, and americium-241 were less than the reporting level (3 times the standard deviation [3*s*] provided by the laboratory) in all wells sampled. In 2019–2021, reportable concentrations (> 3*s*) of gross alpha radioactivity were observed in seven of the 49 wells and ranged from 6 ± 2 to 125 ± 7 pCi/L. Beta radioactivity equaled or exceeded the reporting level in all of the wells sampled, and concentrations ranged from 2.1 ± 0.7 to 716 ± 40 pCi/L (Treinen et al. 2024).

Periodically, the USGS has sampled for iodine-129 (^{129}I) in the eastern Snake River Plain Aquifer. Monitoring programs from 1977, 1981, 1986, 1990, 1991, 2003, 2007, 2011-2012, 2017-2018, and 2021-2022 were summarized in Mann et al. (1988), Mann and Beasley (1994), Bartholomay (2009, 2013), and Maimer and Bartholomay (2019). A publication summarizing results from the latest sampling campaign in 2021-2022 is currently in review. The USGS sampled for ^{129}I in wells at the INL Site in the fall of 2021 and collected additional samples in the spring of 2022. Average concentrations of 15 wells sampled in 1990–1991, 2003, 2007, 2011–2012, and 2017–2018 decreased from 1.15 pCi/L in 1990–1991 to 0.168 pCi/L in 2017–2018. The maximum concentration in 2017 was 0.877 ± 0.032 pCi/L in a monitoring well southeast of INTEC—the drinking water standard for ^{129}I is 1 pCi/L. The concentration in that same well in 2021 increased to 0.968 ± 0.023 pCi/L. In general, concentrations around INTEC showed slight decreases from samples collected in previous sample periods, and the decreases are attributed to discontinued disposal as well as dilution and dispersion in the aquifer. Select wells showed a slight increase in ^{129}I, which could be controlled by preferential flow from legacy contamination source locations southwest of INTEC. The configuration and extent of ^{129}I in groundwater, based on the 2017–2018 USGS data (most current published date), are shown in Figure 6-8 (Maimer and Bartholomay 2019).

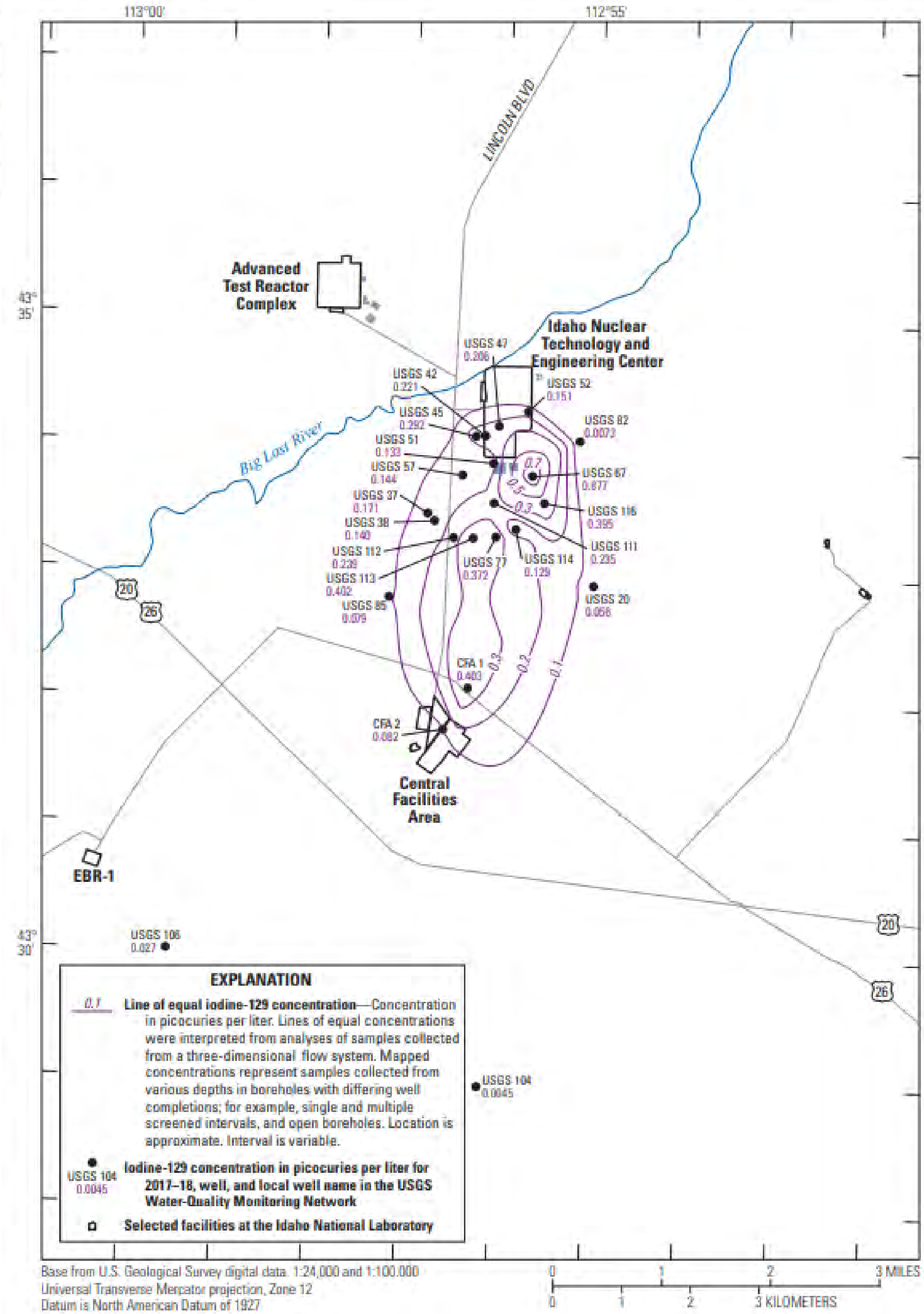

Figure 6-8. Distribution of ^{129}I in the eastern Snake River Plain Aquifer onsite in 2017–2018 (from Maimer and Bartholomay 2019).

6.4 USGS Non-radiological Groundwater Monitoring at the INL Site

USGS collects samples annually from select wells at the INL Site for chloride, sulfate, sodium, fluoride, nitrate, chromium, and other trace elements and purgeable organic compounds identified in Table 6-1. Treinen et al. (2024) provides a detailed discussion of results for samples collected during 2019–2021. Chromium had a concentration at the MCL of 100 µg/L in Well USGS-065 in 2009 (Fisher et al., 2021), but its concentration has since been below the MCL and was 80 µg/L in 2023. This well has shown a long-term decreasing chromium trend (Fisher et al. 2021, Appendix 7).

Concentrations of chloride, nitrate, sodium, and sulfate historically have been above background concentrations in many wells at the INL Site, but concentrations were below established MCLs or secondary MCLs in all wells during 2021 (Treinen et al. 2024).

VOCs are present in water from the eastern Snake River Plain Aquifer because of historical waste disposal practices at the INL Site. Products containing VOCs were used for degreasing, decontamination, and other activities at INL Site facilities. The USGS sampled purgeable (volatile) organic compounds in groundwater at the INL Site during 2023. Samples from 25 groundwater monitoring wells were collected and submitted to the USGS National Water Quality Laboratory in Lakewood, Colorado; the samples analyzed 61 purgeable organic compounds. USGS reports describe the methods used to collect the water samples and ensure sampling and analytical quality (Mann 1996; Bartholomay et al. 2003; Knobel et al. 2008; and Bartholomay et al. 2021). Nine purgeable organic compounds were detected above the laboratory reporting level of 0.2 or 0.1 µg/L in at least one well on the INL Site identified in Table 6-5.

Historically, concentrations of VOCs in water samples from several wells at and near the RWMC exceeded the reporting levels (Treinen et al., 2024). However, concentrations for all VOCs except tetrachloromethane (also known as carbon tetrachloride) and trichloroethene were less than the MCL for drinking water (40 CFR 141, Subpart G). The production well at the RWMC was monitored monthly for tetrachloromethane during 2023, and concentrations exceeded the MCL of 5 µg/L during 11 of the 12 months measured, as shown in Table 6-6.

Since 1998, concentrations have routinely exceeded the MCL for tetrachloromethane in drinking water (5 µg/L) at RWMC. (Note: VOCs are removed from production well water prior to human consumption—see Section 6.7.1.10.) Trend test results for tetrachloromethane concentrations in water from the RWMC production well indicated a statistically significant increase in concentrations has occurred from 1989 through 2021; however, Treinen et al. (2024) indicated that more recent data through 2021 showed no trend for the entire dataset and a decreasing trend for data collected since 2007. The more recent decreasing trend indicates that engineering practices designed to reduce VOC movement to the aquifer are having a positive effect.

Concentrations of tetrachloromethane from Wells USGS-87 and USGS-120, south of RWMC, have had an increasing trend since 1987, but concentrations have decreased through time at Well USGS-88 (Davis et al. 2015; Bartholomay et al. 2020; Fisher et al. 2021; Treinen et al. 2024).

Trichloroethylene (trichloroethene) (TCE) exceeded the MCL of 5 µg/L from one sample collected from GIN 2 at TAN, identified in Table 6-5. There is a known groundwater TCE plume being treated at TAN, as discussed in more detail in Section 6.5.1. The sample collected at RWMC also detected TCE above the MCL.

Table 6-5. Purgeable organic compounds in annual USGS groundwater well samples (2023).

CONSTITUENT	USGS-120	USGS-88	RWMC M3S	USGS-87	RWMC M7S	USGS-87	USGS-065	TAN-2312	GIN 2	TAN-2271
1,1,1-Trichloroethane (MCL = 200 µg/L)[a]	<0.1	<0.1	<0.1	0.121	<0.1	0.121	<0.1	0.223	<0.1	0.223
cis-1,2-Dichoroethene[b] (MCL = 70 µg/L)[a]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene (MCL = 700 µg/L)[a]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tetrachloroethene[b] (MCL = 5 µg/L)[a]	<0.1	<0.1	0.20	0.181	0.400	0.181	<0.1	4.51	3.21	<0.1
Tetrachloromethane (PCS = 2 µg/L)[c]	<0.2	<0.1	<0.2	3.49	<0.2	3.50	<0.2	<0.2	<0.2	<0.2
Trichloroethene[b] (MCL = 5 µg/L)[a]	0.20	0.50	1.06	0.919	2.30	0.919	<0.1	0.20	9.96	0.80
Trichloromethane (MCL = 5 µg/L)[a]	<0.1	<0.1	<0.1	0.338	<0.1	0.338	0.237	1.76	0.138	1.76
trans-1,2-Dichloroethene[b] (MCL = 100 µg/L)[a]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	59.83

a. MCL = maximum contaminant level from the EPA (40 CFR 141).

b. The International Union of Pure and Applied Chemistry name for ethylene is ethene. For example, trichloroethene is equivalent to trichloroethylene. This is the name reported in the USGS database. This nomenclature is used in this table in case the reader wants to look up the constituent in the USGS database.

c. PCS = primary constituent standard values from IDAPA 58.01.11.

Table 6-6. Purgeable organic compounds in monthly production well samples at the RWMC (2023).

CONSTITUENT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1,1,1-Trichloroethane (MCL = 200 µg/L)[a]	0.232	0.233	0.250	0.280	0.254	0.215	0.206	0.233	0.255	<0.1	<0.1	<0.1
Tetrachloroethene[b] (MCL = 5 µg/L)[a]	<0.1	0.319	0.359	0.419	0.380	0.311	0.295	0.351	0.353	0.300	0.400	0.400
Tetrachloromethane (MCL = 5 µg/L)[a]	<0.2	4.51	4.82	5.53	5.13	4.41	4.13	4.66	4.87	<0.2	<0.2	<0.2
Trichloroethene[b] (MCL = 5 µg/L)[a]	4.40	2.77	2.97	3.62	3.65	2.70	3.03	3.14	3.22	2.62	3.35	3.55
Trichloromethane (PCS = 2 µg/L)[c]	<0.1	1.76	1.82	1.97	1.72	1.55	1.32	1.43	1.37	<0.1	<0.1	<0.1

a. MCL = maximum contaminant level values from the EPA (40 CFR 141)

b. The International Union of Pure and Applied Chemistry name for ethylene is ethene. For example, trichloroethene is equivalent to trichloroethylene. This is the name reported in the USGS database. This nomenclature is used in this table in case the reader wants to look up the constituent in the USGS database.

c. PCS = primary constituent standard values from IDAPA 58.01.11.

6.5 Comprehensive Environmental Response, Compensation, and Liability Act Groundwater Monitoring During 2023

CERCLA activities at the INL Site are divided into WAGs that roughly correspond to the major facilities, with the addition of the INL Site-wide WAG 10. Locations of the various WAGs are shown in Figure 6-3. The following subsections provide an overview of the groundwater sampling results. More detailed discussions of CERCLA groundwater sampling can be found in the WAG-specific monitoring reports within the CERCLA Administrative Record at Administrative Record Information Repository (ARIR) Home – ARIR (idaho-environmental.com). WAG 8 is managed by the NRF and is not discussed in this report.

6.5.1 Summary of Waste Area Group 1 Groundwater Monitoring Results

Groundwater is monitored at WAG 1 (TAN) to evaluate the progress of the remedial action at TAN. The VOC groundwater plume at TAN has been divided into three zones based on the 1997 TCE concentrations with three different remedy components, which work together to remediate the entire VOC plume. The monitoring program and results are summarized by plume zone in the following paragraphs.

Hot Spot Zone (historical TCE concentrations exceeding 20,000 µg/L) – In-situ bioremediation (ISB) was used in the hot spot (near Well TSF-05) to create conditions favorable for naturally occurring anaerobic bacteria in the aquifer to break down chlorinated solvents (principally TCE). The hot spot concentration was defined using TCE data from 1997, which is identified in Figure 6-9, and is not reflective of current concentrations, as shown in Figure 6-10. With regulatory agency concurrence, an ISB rebound test began in July 2012 to determine whether the residual TCE source in the aquifer had been sufficiently treated. Currently, the ISB rebound test has been split into two components: (1) an ISB rebound test for the area near the former injection Well TSF-05, and (2) ISB activities to treat the TCE source affecting Well TAN-28.

In Fiscal Year (FY) 2023, data collected during the ISB rebound test for the area near the former injection Well TSF-05 indicated that anaerobic conditions created by ISB were still present in the hot spot area and that TCE concentrations were near or below MCLs in the wells near the former injection Well TSF-05, as shown in Figure 6-10. After background aquifer conditions are re-established, the effectiveness of the ISB part of the remedy will be evaluated (DOE-ID 2024a).

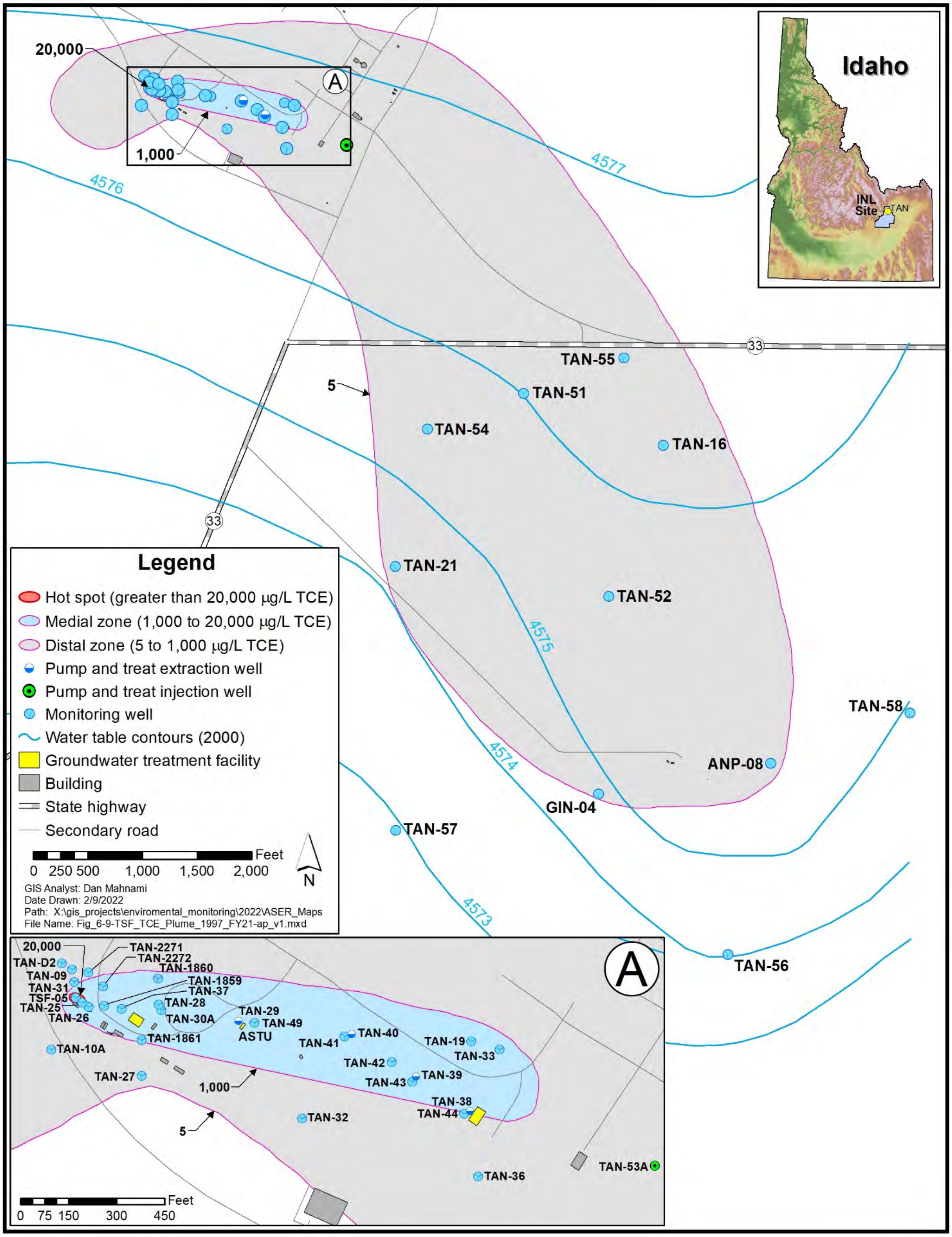

Figure 6-9. TCE plume at TAN in 1997.

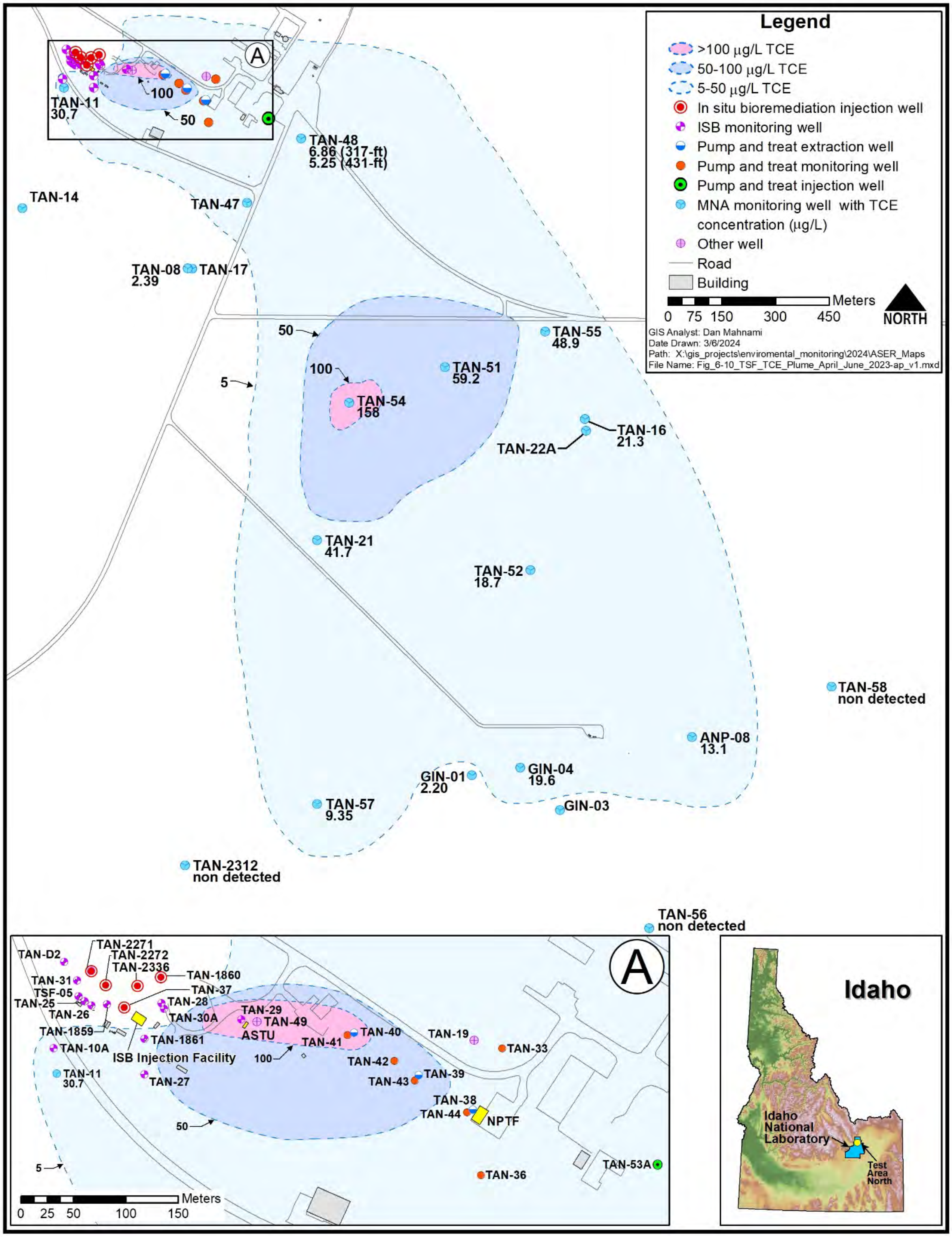

Figure 6-10. Distribution of TCE in the Snake River Plain Aquifer from April–June 2023.

To address the source of TCE in Well TAN-28, continued ISB injections have been made into TAN-2336. In FY 2023, injections into TAN-1860A were also resumed in order to increase the efficiency of the injection strategy. During FY 2023, a total of 17 totes of amendment (4,250 gal) were injected over the course of seven injection events. Six injections were performed into TAN-2336, with a total of 12 totes of amendment (3,000 gal) and three injections into TAN-1860A, with a total of five totes of amendment (1,250 gal; DOE-ID 2024a). Despite some variations, TCE concentrations have declined in TAN-28 because of the ISB injections, which were aimed at treating the TAN-28 TCE source. ISB injections will continue into these wells until it can be determined that the TAN-28 TCE source has been successfully treated and a transition to a rebound test for the TAN-28 TCE source can be made.

Medial Zone (historical TCE concentrations between 1,000 and 20,000 µg/L) – A pump and treat system has been used in the medial zone. The pump and treat system extracts contaminated groundwater, circulates the groundwater through air strippers to remove VOCs like TCE, and reinjects treated groundwater into the aquifer. The New Pump and Treat Facility generally operated Monday through Thursday in FY 2023, except for shutdowns due to maintenance. All 2023 New Pump and Treat Facility compliance samples were below the discharge limits. TCE concentrations used to define the medial zone (1,000–20,000 µg/L) are based on data collected in 1997, which is before remedial actions began shown in Figure 6-9, and do not reflect current concentrations, as identified in Figure 6-10. In FY 2023, none of the wells were above the concentration of 1,000 µg/L used historically to define the medial zone. The TCE concentrations in Wells TAN-33, TAN-36, and TAN-44 near the New Pump and Treat Facility are used as indicators of TCE concentrations migrating past the New Pump and Treat Facility extraction wells into the distal zone. In FY 2023, TCE concentrations for Wells TAN-33, TAN-36, and TAN-44 ranged from 23.8 to 39.6 µg/L (DOE-ID 2024a).

Distal Zone (historical TCE concentrations between 5 and 1,000 µg/L) – Monitored natural attenuation is the remedial action for the distal zone of the plume, as shown in Figure 6-9. Monitored natural attenuation is the sum of physical, chemical, and biological processes that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of groundwater contaminants. Institutional controls are in place to protect current and future users from health risks associated with groundwater contamination until concentrations decline through natural attenuation to below the MCL.

TCE data collected in FY 2023 from the distal zone wells indicate that all wells are consistent with the model predictions but additional data are needed to confirm the monitored natural attenuation part of the remedy will meet the remedial action objective of all wells below the MCL by 2095 (DOE-ID 2024a). The TCE data from the plume expansion wells suggest that plume expansion is currently within the limits allowed in the Record of Decision Amendment (DOE-ID 2001).

Radionuclide Monitoring – In addition to the VOC plume, ^{90}Sr, ^{137}Cs, tritium, and uranium-234 (^{234}U) are listed as contaminants of concern in the Record of Decision Amendment (DOE-ID 2001). Strontium-90 and ^{137}Cs are expected to naturally decline below their respective MCLs before 2095. However, wells in the source/ISB area currently show elevated ^{90}Sr and ^{137}Cs concentrations compared to levels prior to starting ISB. The elevated ^{90}Sr and ^{137}Cs concentrations are due to enhanced mobility created by elevated concentrations of competing cations (e.g., calcium, magnesium, sodium, potassium) for adsorption sites in the aquifer. The elevated cation concentrations are due to ISB activities to treat VOCs. As competing cation concentrations decline toward background conditions, ^{90}Sr and ^{137}Cs are trending lower. The radionuclide concentrations are expected to continue to decrease, and concentration trends will continue to be evaluated to determine whether the remedial action objective of declining below MCLs by 2095 will be met. Sampling will be conducted for ^{234}U after ISB conditions dissipate because ISB conditions suppress uranium concentrations (DOE-ID 2024a).

6.5.2 Summary of Waste Area Group 2 Groundwater Monitoring Results

Groundwater samples were collected from six aquifer wells to monitor WAG 2 in the ATR Complex during 2023. All of the wells shown in Figure 6-11 were sampled except for TRA-07, which could not be sampled due to a low water level within the well. Aquifer samples were analyzed for ^{90}Sr, gamma-emitting radionuclides (the target analyte is cobalt-60), tritium, and chromium (filtered) in accordance with the groundwater monitoring plan (DOE-ID 2016). The data for the October 2023 sampling event will be included in the FY 2024 Annual Report for WAG 2 (DOE-ID 2024b). The October 2023 sampling data are summarized in Table 6-7.

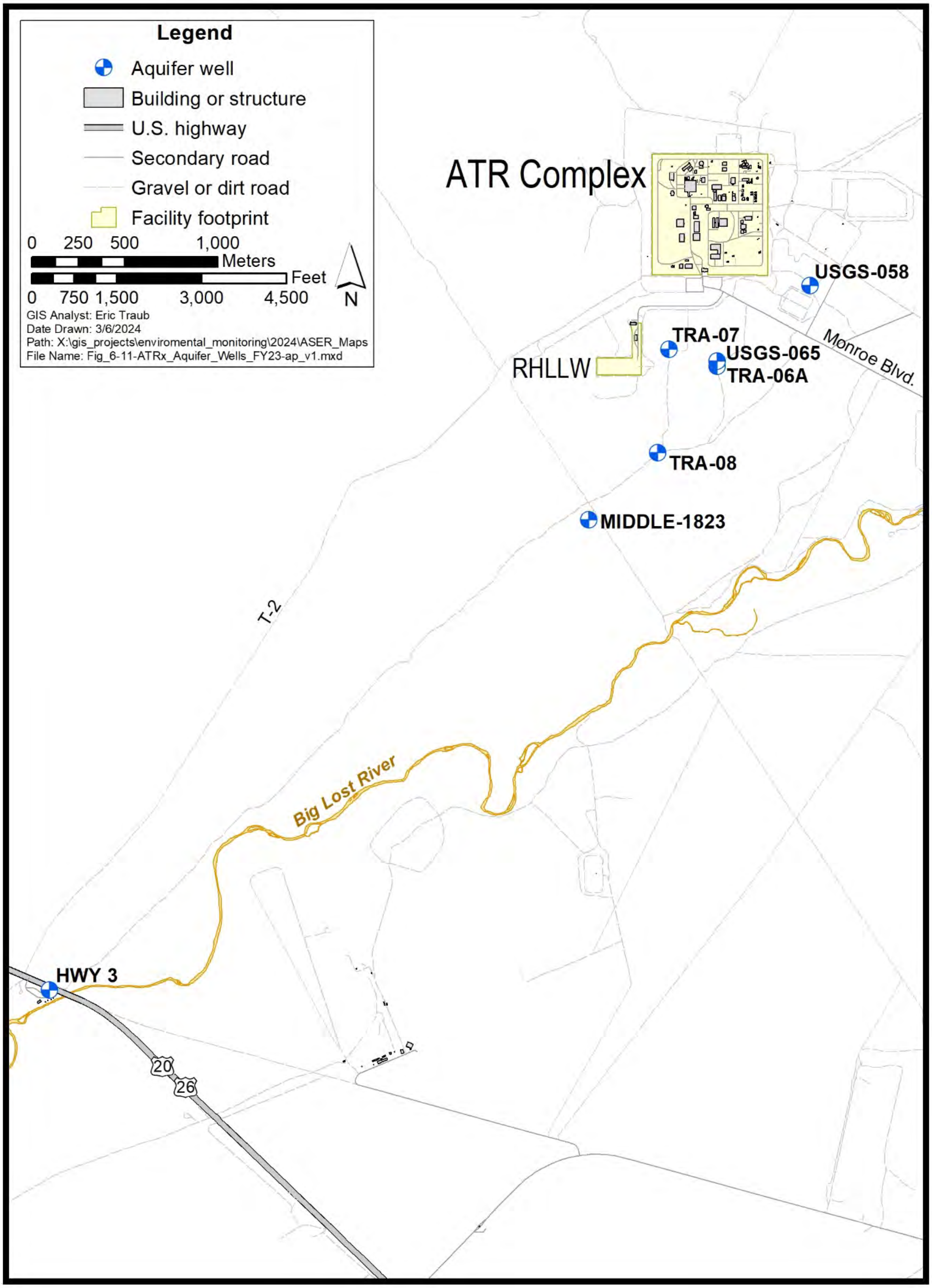

Figure 6-11. Locations of WAG 2 aquifer monitoring wells.

Table 6-7. WAG 2 aquifer groundwater quality summary (October 2023).

ANALYTE	MCL	BACKGROUND[a]	MAXIMUM	MINIMUM	NUMBER OF WELLS ABOVE MCL
Chromium (filtered) (µg/L)	100	4	86.3	2.09	0
Cobalt-60 (pCi/L)	100	0	ND[b]	ND	0
Strontium-90 (pCi/L)	8	0	ND	ND	0
Tritium (pCi/L)	20,000	34	770	ND	0

a. Background concentrations are for western tributary water for the eastern Snake River Plain Aquifer from Bartholomay and Hall (2016).

b. ND = not detected.

No analyte occurred above its MCL in the Snake River Plain Aquifer at WAG 2. The highest chromium concentration occurred in Well USGS-065 at 86.3 µg/L and was below the MCL of 100 µg/L. The second highest chromium concentration was in Well TRA-08 at 18.9 µg/L. The chromium concentrations in both wells have been mostly stable in recent years (DOE-ID 2024b).

Tritium was the only radionuclide analyte detected in the aquifer and was below the MCL of 20,000 pCi/L in all the sampled wells. The highest tritium concentration was 770 pCi/L in Well USGS-065 (DOE-ID 2024b).

Chromium and tritium concentrations in the aquifer have declined faster than predicted by the WAG 2 models used for the Operable Unit 2-12 Record of Decision and the revised modeling performed after the first five-year review (DOE-NE-ID 2005).

The October 2023 eastern Snake River Plain Aquifer water table map prepared for the vicinity of the ATR Complex was consistent with previous maps showing general groundwater flow direction to the southwest. Aquifer water levels in the vicinity of the ATR Complex declined by approximately 0.78 ft on average from October 2022 to October 2023 (DOE-ID 2024b).

6.5.3 Summary of Waste Area Group 3 Groundwater Monitoring Results

At INTEC, groundwater samples are collected from 17 Snake River Plain Aquifer monitoring wells during odd-numbered years and 14 wells during even-numbered years. During the reporting period, 16 of the 17 required wells were sampled. Well ICPP-2021-AQ was not sampled because the sample pump was not functional (Figure 6-12). Groundwater samples were analyzed for a suite of radionuclides and inorganic constituents, and the data are summarized in the 2023 Annual Report (DOE-ID 2024c). Table 6-8 summarizes the maximum concentrations observed, along with the number of MCL exceedances reported for each constituent.

Strontium-90 and Technetium-99 (^{99}Tc) exceeded their respective drinking water MCLs in one or more of the eastern Snake River Plain Aquifer monitoring wells at or near INTEC, with ^{90}Sr exceeding its MCL by the greatest margin. Strontium-90 concentrations remained above the MCL (8 pCi/L) at four of the well locations sampled. During 2023, the highest ^{90}Sr level in eastern Snake River Plain Aquifer groundwater was at monitoring Well USGS-047 (14.1 ± 1.31 pCi/L), located south (downgradient) of the former INTEC injection well. All well locations showed similar or slightly lower ^{90}Sr levels compared to those reported during the previous sampling events, except for Well USGS-048 (11.7 pCi/L), which remains elevated relative to 2015–2020 reported ^{90}Sr levels.

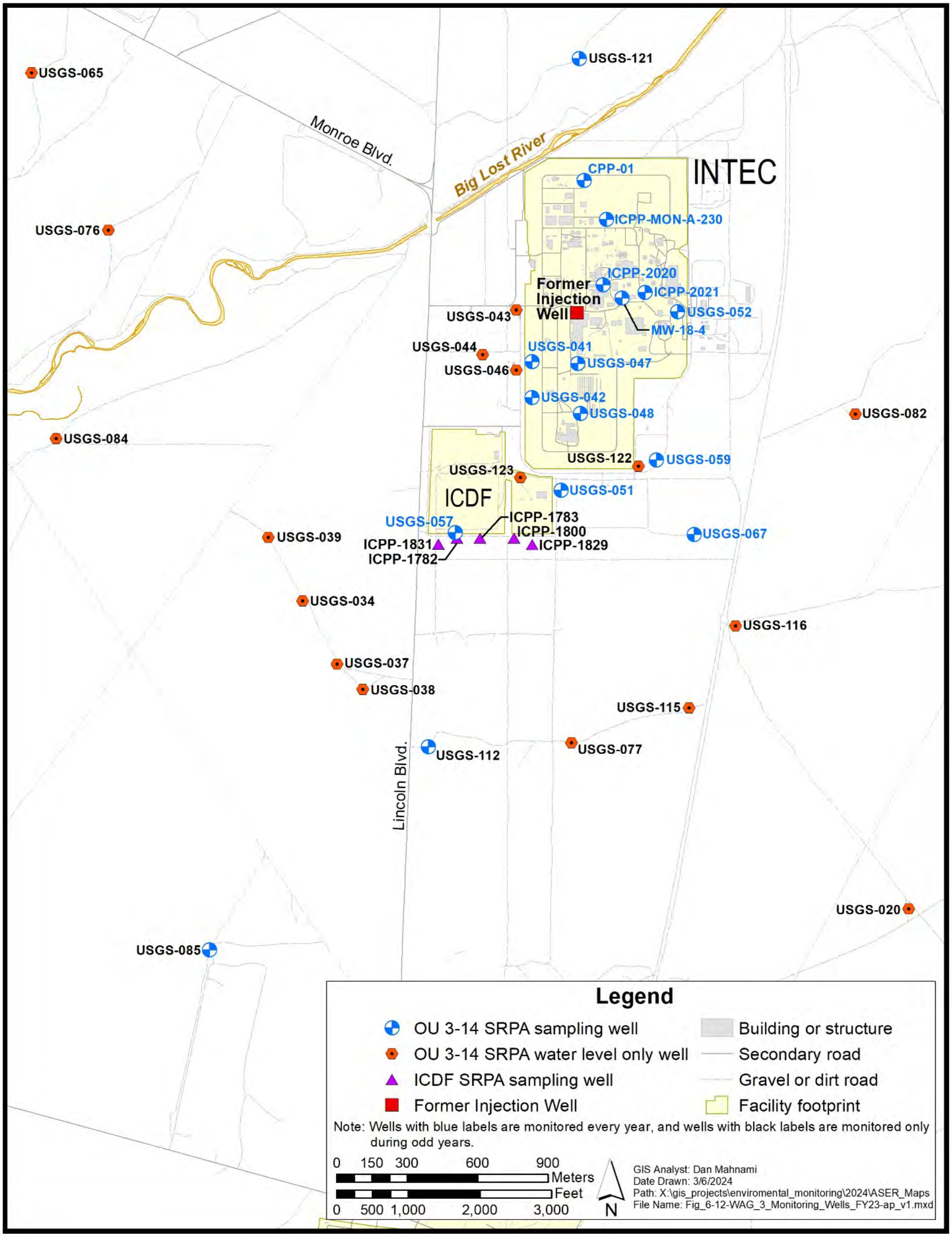

Figure 6-12. Locations of WAG 3 monitoring wells. *(Well names in blue are sampled every year; well names in black are sampled only during odd-numbered years.)*

Table 6-8. Summary of constituents detected in WAG 3 aquifer monitoring wells (FY 2023).

CONSTITUENT	EPA MCL[a]	UNITS	SNAKE RIVER PLAIN AQUIFER GROUNDWATER – APRIL 2023		
			MAXIMUM REPORTED VALUE	NUMBER OF RESULTS[a]	RESULTS > MCL[a]
Gross alpha	15	pCi/L	3.45 ± 1.1	18	0
Gross beta	NA[b]	pCi/L	687 ± 15.9 J	18	NA[c]
Cesium-137	200	pCi/L	ND[c]	18	0
Strontium-90	8	pCi/L	**14.1 ± 1.31**[d]	18	5
Technetium-99	900	pCi/L	**1,330 ± 77**	18	2
Iodine-129	1	pCi/L	0.609 ± 0.285 J	18	0
Tritium	20,000	pCi/L	2,240 ± 275	18	0
Plutonium-238	15	pCi/L	—[e]	—[e]	—[e]
Plutonium-239/240	15	pCi/L	—[e]	—[e]	—[e]
Uranium-233/234	NA MCL[f]	pCi/L	2.28 ± 0.344	18	NA
Uranium-235	NA MCL	pCi/L	0.191 ± 0.108	18	NA
Uranium-238	NA MCL	pCi/L	1.25 ± 0.244	18	NA
Bicarbonate	NA	mg/L	156	18	NA
Calcium	NA	mg/L	65.8	18	NA
Chloride	250	mg/L	161	18	0
Magnesium	NA	mg/L	24.4	18	NA
Nitrate/Nitrite (as N)	10	mg/L	8.17	18	0
Potassium	NA	mg/L	5.12	18	NA
Sodium	NA	mg/L	35	18	NA
Sulfate	250	mg/L	41.6	18	0
Total dissolved solids	500	mg/L	403	18	0

a. Include field duplicates.

b. NA = not applicable.

c. Data-qualifier flags:
ND = constituent not detected in sample.
J = estimated detection.

d. **Bold** values exceed MCL.

e. — = Gross alpha did not exceed 15 pCi/L; constituent not analyzed.

f. NA MCL = EPA MCL is reported in mass units (µg/L), and values listed are reported in pCi/L.

Technetium-99 was detected above the MCL (900 pCi/L) at nine monitoring wells. During 2023, the highest ^{99}Tc level in eastern Snake River Plain Aquifer groundwater was at Well ICPP-MON-A-230 (1,330 ± 77 pCi/L), located north of the INTEC Tank Farm. All wells sampled showed stable or declining trends from the previous reporting period.

Nitrate was detected in all wells sampled during this reporting period. No locations exceeded the nitrate concentration MCL (10 mg/L as N). Nitrate concentrations were similar or slightly lower than observed in previous years.

Tritium was detected at most of the wells sampled, but none of the groundwater samples exceeded the tritium MCL (20,000 pCi/L). The highest tritium concentrations in groundwater were reported at Well USGS-051, southeast of INTEC (2,240 ± 275 pCi/L). Tritium concentrations have declined at nearly all locations over the past few years.

During the reporting period, no plutonium isotope analyses were performed because the current monitoring plan identifies the contingency for plutonium analysis if gross alpha exceeds 15 pCi/L. Uranium-238 (^{238}U) was detected at all eastern Snake River Plain Aquifer well locations, with the highest concentration at Well ICPP-MON-A-230 (1.25 ± 0.244 pCi/L). Uranium-234 was also detected in all groundwater samples, with the greatest concentrations of 2.28 ± 0.344 pCi/L at Well ICPP-MON-A-230. Uranium-234 is the daughter product (from alpha decay) of the long-lived, naturally occurring ^{238}U. All uranium results for the other wells are consistent with background concentrations reported for Snake River Plain Aquifer groundwater. The ^{234}U/^{238}U ratio for all samples fell within the background range of 1.5 to 3.1 (Roback et al. 2001).

Uranium-235 (^{235}U) was not detected at any sample location. Uranium concentrations reported in pCi/L were converted to mass-basis concentrations (µg/L) for comparison to the total uranium MCL (30 µg/L). The highest total uranium concentration in the groundwater samples was 3.8 µg/L (Well ICPP-MON-A-230). Thus, uranium results for all Snake River Plain Aquifer wells were well below the total uranium MCL.

6.5.4 Summary of Waste Area Group 4 Groundwater Monitoring Results

The WAG 4 groundwater monitoring consists of two different components: (1) monitoring the CFA landfill and (2) monitoring of a nitrate plume south of CFA. The wells at the CFA landfills are monitored to determine potential impacts from the landfills, while the nitrate plume south of CFA is monitored to evaluate nitrate trends. Groundwater monitoring for the CFA landfills consisted of sampling seven wells for metals (filtered), VOCs, and anions (nitrate, chloride, and sulfate) and two wells for VOCs only, in accordance with the long-term monitoring plan (DOE-ID 2018). Four wells south of CFA were sampled for nitrate, sulfate, and chloride to monitor the CFA nitrate plume. The CFA landfill and nitrate plume monitoring well locations are shown on Figure 6-13.

Analytes detected in groundwater are compared to regulatory levels identified in Table 6-9. In 2023, no analytes exceeded an EPA MCL. The iron and lower threshold aluminum SMCLs were exceeded in one well and two wells exceeded a pH SMCL. The elevated iron and aluminum concentration was likely due to filter breakthrough resulting in higher-than-average metal concentrations. The elevated pH in the two wells was due to grout placed beneath the well screens during well construction. A complete list of the groundwater sampling results will be included in the FY 2023 Annual Report for WAG 4 (DOE-ID 2024d).

In the CFA nitrate plume monitoring wells south of CFA, one Well—CFA-MON-A-002—continued to exceed the nitrate groundwater MCL of 10 mg/L-N. The nitrate concentration within Well CFA-MON-A-002 decreased from 14.0 mg/L-N in 2022 to 12.5 mg/L-N in 2023, which is consistent with a declining trend that started in 2006. The nitrate concentration of 7.53 mg/L-N in Well CFA-MON-A-003 is below the MCL and shows a slight downtrend (DOE-ID 2024d).

Water level measurements taken in the CFA area decreased an average of 1.43 ft from August 2022 to August 2023. A water level contour map based on August 2023 water levels showed groundwater gradients and flow directions consistent with previous maps (DOE-ID 2024d).

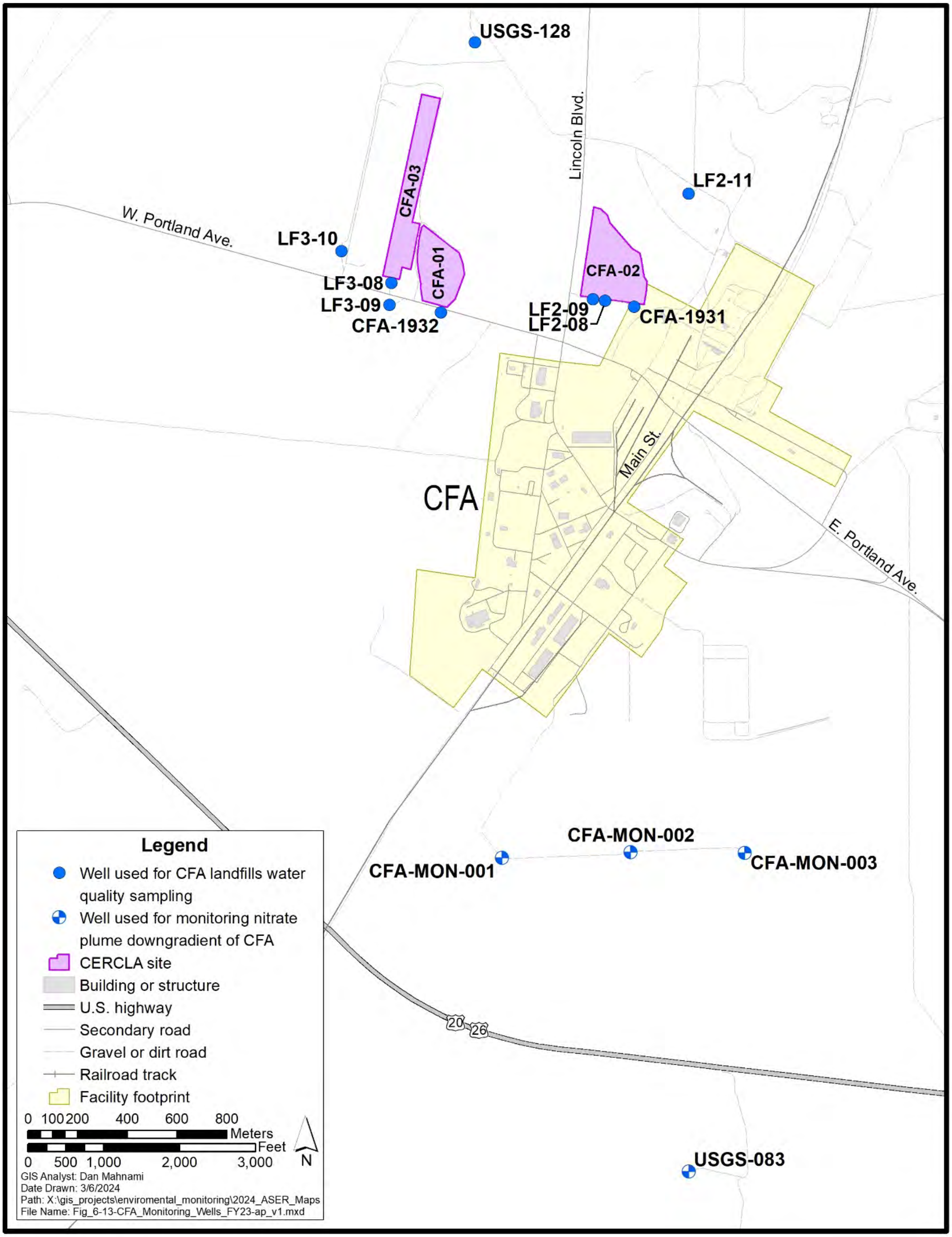

Figure 6-13. Locations of WAG 4/CFA monitoring wells.

Table 6-9. Comparison of CFA landfill and CFA nitrate plume groundwater sampling results to regulatory levels (August 2023).

COMPOUND	MCL OR SMCL	MAXIMUM DETECTED VALUE	NUMBER OF WELLS ABOVE MCL OR SMCL
CFA NITRATE PLUME WELLS			
Chloride (mg/L)	*250*[a]	75.0	0
Sulfate (mg/L)	*250*	32.9	0
Nitrate/nitrite (mg-N/L)	10	**12.5**[b]	1
CFA LANDFILL WELLS			
ANIONS			
Chloride (mg/L)	*250*	50.4	0
Sulfate (mg/L)	*250*	40.2	0
Nitrate/nitrite (mg-N/L)	10	2.15	0
COMMON CATIONS			
Calcium (µg/L)	None	53,600	NA[c]
Magnesium (µg/L)	None	16,000	NA
Potassium (µg/L)	None	6,000	NA
Sodium (µg/L)	None	26,400	NA
INORGANIC ANALYTES			
Antimony (µg/L)	6	ND[d]	0
Aluminum (µg/L)	*50–200*	**118**	0[e]
Arsenic (µg/L)	10	2.27	0
Barium (µg/L)	2,000	99.3	0
Beryllium (µg/L)	4	ND	0
Cadmium (µg/L)	5	ND	0
Chromium (µg/L)	100	38.5	0
Copper (µg/L)	*1,300*	3.10	0
Iron (µg/L)	*300*	**376**	1
Lead (µg/L)	15	ND	0
Manganese (µg/L)	50	43.4[f]	0
Mercury (µg/L)	2	ND	0
Nickel (µg/L)	None	80.5[f]	NA
Selenium (µg/L)	50	1.57	0
Silver (µg/L)	100	ND	0
Thallium (µg/L)	2	ND	0

Table 6-9. continued.

COMPOUND	MCL[a] OR SMCL[b]	MAXIMUM DETECTED VALUE	NUMBER OF WELLS ABOVE MCL OR SMCL
Vanadium (µg/L)	None	5.37	NA
Zinc (µg/L)	*5,000*	16.2[f]	0
DETECTED VOCS			
Acetone (µg/L)	None	7.18	0
Chloroform (µg/L)	80	0.90	0
Cyclohexane (µg/L)	None	0.60	0

a. Numbers in *italic* text are for the secondary MCL.
b. **Bold** values exceed an MCL or SMCL.
c. NA = not applicable.
d. ND = not detected.
e. Since the Aluminum value has only exceed the lower Aluminum SMCL threshold, it is not considered to be above the SMCL.
f. Results are from a resample that occurred in November 2023.

6.5.5 Summary of Waste Area Group 7 Groundwater Monitoring Results

Groundwater samples collected from nine monitoring wells near and downgradient of RWMC in May 2023 were analyzed for radionuclides, inorganic constituents, and VOCs. Of the 220 aquifer analytical results (excluding field and trip blanks), 19 met reportable criteria established in the "Field Sampling Plan for Operable Unit 7-13/14 Aquifer Monitoring" (DOE-ID 2021c). Table 6-10 summarizes the reportable contaminants of concern in 2023, and a discussion of those results follows. Figure 6-14 depicts the WAG 7 aquifer well monitoring network.

- *Carbon tetrachloride* – Carbon tetrachloride was reportable at eight monitoring locations in May 2023, one of which was detected above the MCL at Well M15S. The carbon tetrachloride concentrations decreased in most wells near and downgradient of the RWMC (except for USGS-120), as shown in Figures 6-15 and 6-16.

Table 6-10. Summary of WAG 7 aquifer analyses for May 2023 sampling.

ANALYTE	NUMBER OF WELLS SAMPLED	NUMBER OF SAMPLES ANALYZED[a]	NUMBER OF REPORTABLE DETECTIONS[a,b]	CONCENTRATION MAXIMUM[a]	LOCATION OF MAXIMUM CONCENTRATION	NUMBER OF DETECTIONS GREATER THAN MCL[c]	MCL[c]
Carbon tetrachloride	9	11	9	5.05 µg/L	M15S	1	5 µg/L
Trichloro-ethylene	9	11	6	3.96 µg/L	M15S	0	5 µg/L
Nitrate (as nitrogen)	9	11	3	2.22 mg/L	USGS-132:Port 22	0	10 mg/L
Carbon-14	9	11	1	19.7 ± 3.51 pCi/L	M3S	0	2000 pCi/L

a. Includes field duplicate samples collected for quality control purposes and samples collected from wells with multiple ports.
b. Results that exceeded reporting criteria as established in the Operable Unit 7-13/14 Field Sampling Plan (DOE-ID 2021c).
c. MCLs are from "National Primary Drinking Water Regulations" (40 CFR 141).

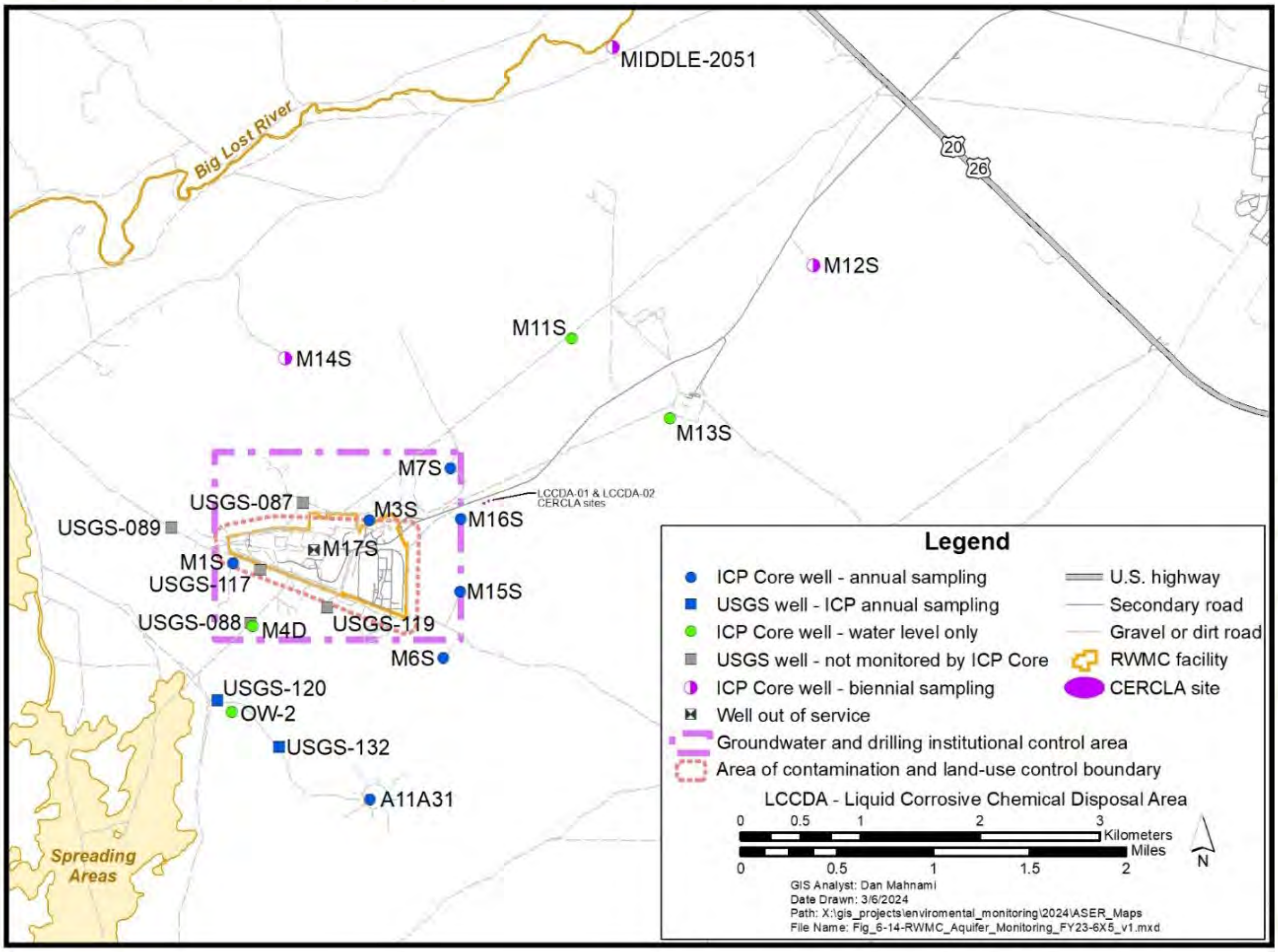

Figure 6-14. The WAG 7 aquifer well monitoring network at the RWMC (DOE-ID 2021c).

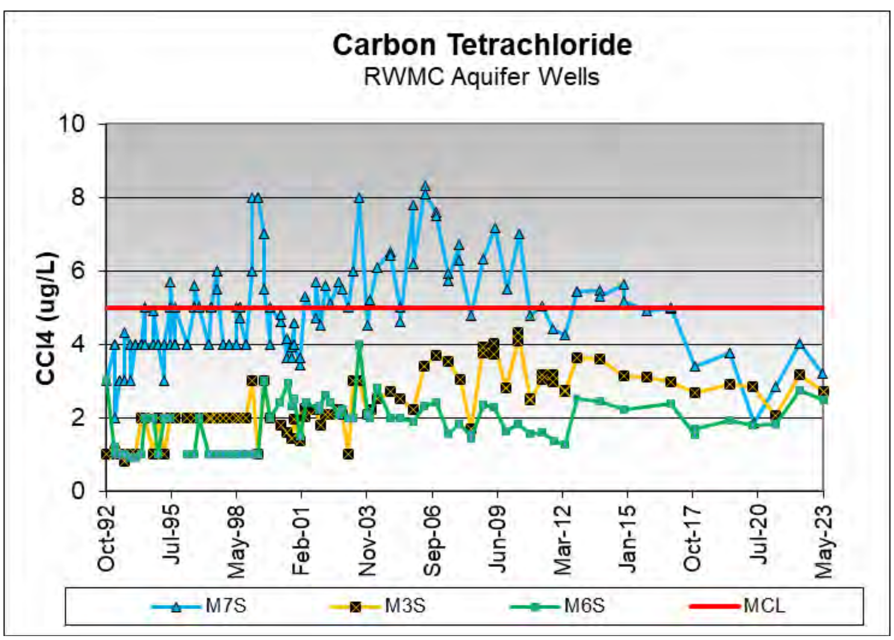

Figure 6-15. Carbon tetrachloride (CCL_4) concentration trends in RWMC aquifer Wells M7S, M3S, and M6S.

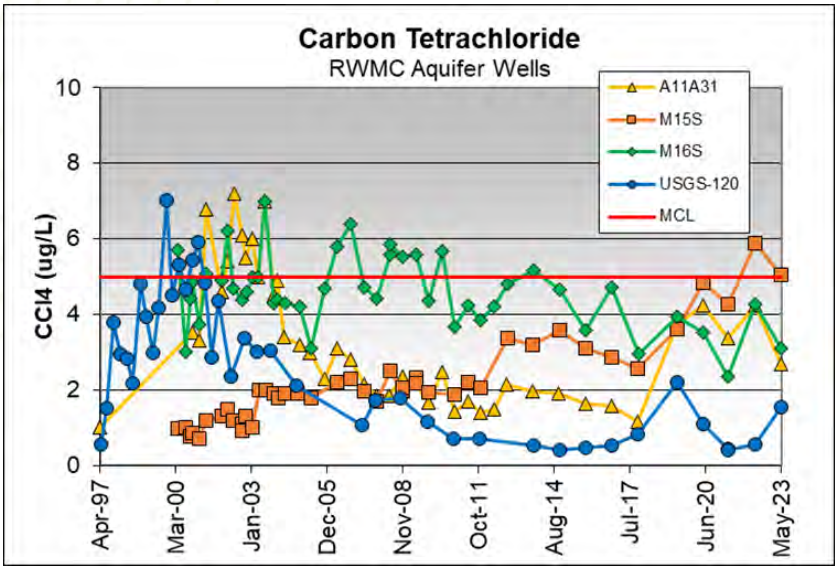

Figure 6-16. Carbon tetrachloride (CCL_4) concentration trends in RWMC aquifer Wells A11A31, M15S, M16S, and USGS-120.

- *Trichloroethylene* – In May 2023, the concentrations of reportable TCE remained steady in most wells near and downgradient of RWMC, except Well M15S, which increased, as shown in Figure 6-17. No TCE concentrations were detected above the MCL of 5 µg/L.
- *Nitrate (as Nitrogen)* – Nitrate (as nitrogen) was the only inorganic analyte detected above its reporting threshold (background concentration of 1.05 mg/L) in 2023, which was calculated based on maximum concentrations in upgradient background wells (DOE-ID 2021c). All detections were below the MCL of 10 mg/L.
- *Carbon-14* – Carbon 14 was the only reportable radiological analyte in May 2023. It was detected in one sample from Well M3S at 19.7 ± 3.51 pCi/L, which is considerably below its MCL of 2,000 pCi/L (40 CFR 141).

As in previous years, groundwater-level measurements in RWMC-area monitoring wells were taken prior to the sample collection for the May 2023 event. The groundwater-level contour map for the 2023 sampling indicates groundwater flow toward the south-southwest beneath the RWMC, as shown in Figure 6-18.

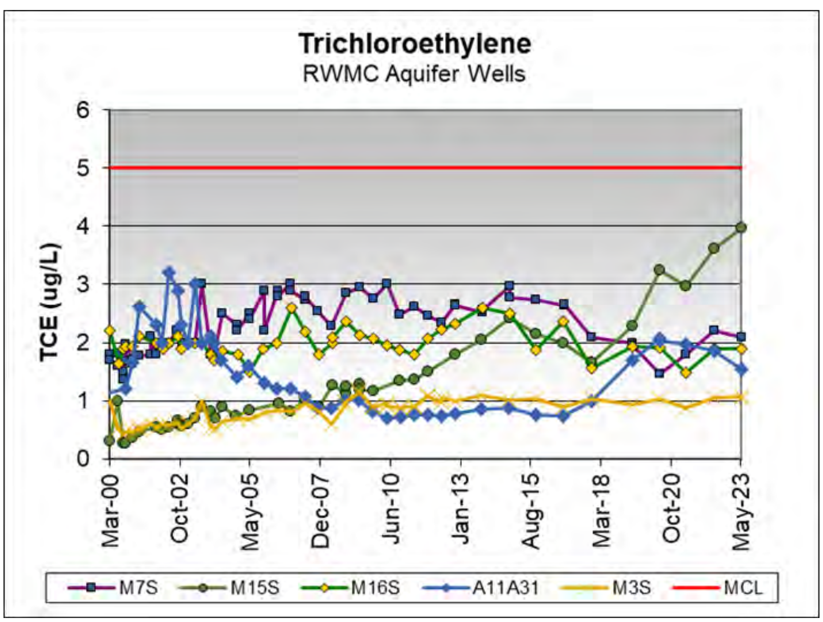

Figure 6-17. Concentration history of TCE in RWMC aquifer Wells M7S, M15S, M16S, A11A31, and M3S.

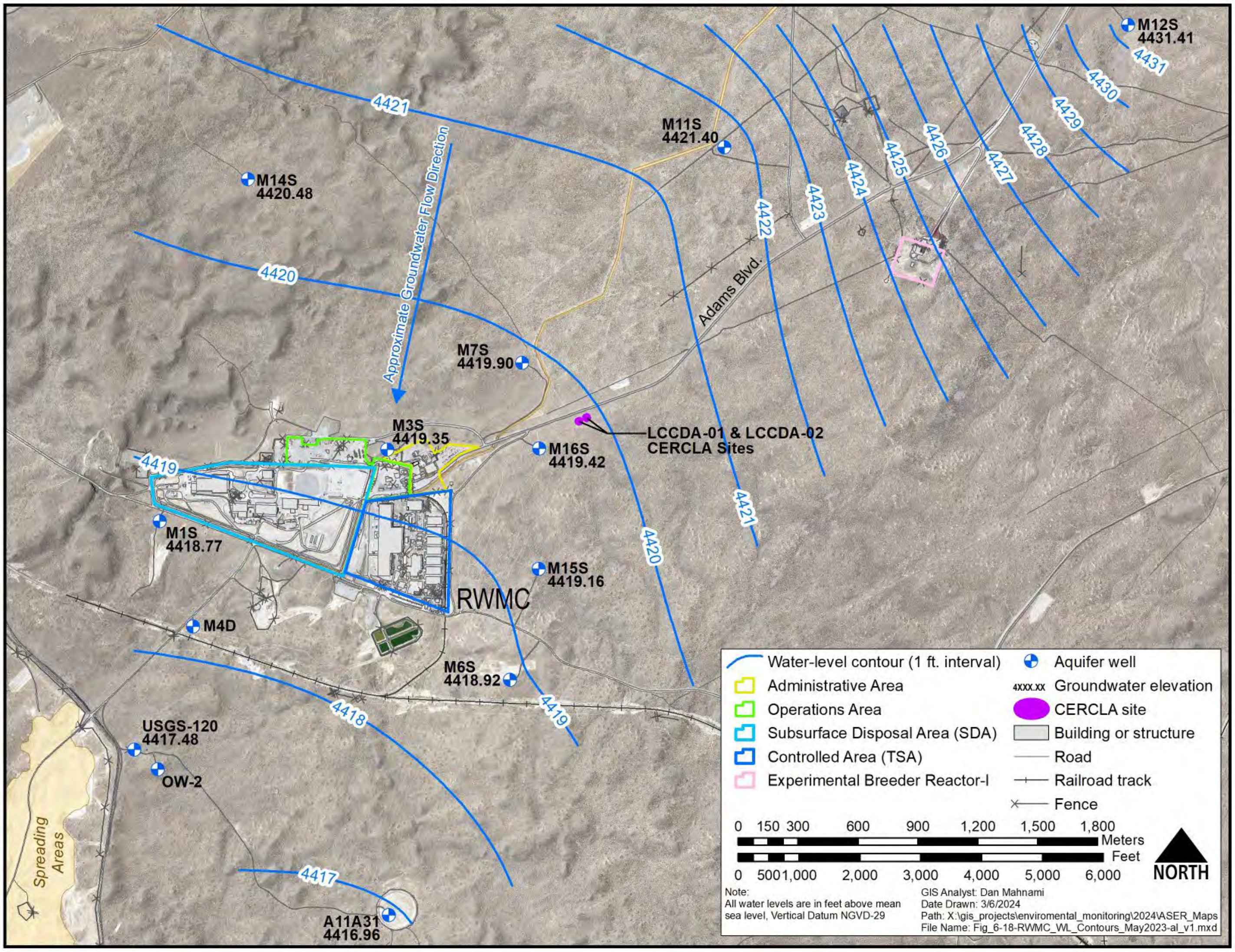

Figure 6-18. Groundwater-level contours in the aquifer near the RWMC based on 2023 measurements.

6.5.6 Summary of Waste Area Group 9 Groundwater Monitoring Results

Prior to 2023, five wells (four monitoring and one production) at the MFC were sampled twice per year by the INL contractor for selected radionuclides, metals, anions, cations, and other water quality parameters, as surveillance monitoring under the WAG 9 Record of Decision (Figure 6-19; ANL-W 1998).

Groundwater monitoring performed to meet the CERCLA requirements of the WAG 9 Record of Decision began in 1998 and was discontinued at the end of 2022. The "Operable Unit 9-04 Operations and Maintenance Report for Fiscal Years 2008–2014" (DOE-ID 2015) indicates the groundwater monitoring data:

- Demonstrate that concentrations of organic, inorganic, and radionuclide constituents have never exceeded groundwater or drinking water standards at WAG 9
- Show the remedies have achieved their expected outcomes
- Show no discernible impact from previous or current activities at MFC.

Termination of CERCLA semiannual groundwater monitoring in 2022 was formalized in the "Five-Year Review of CERCLA Response Actions at the Idaho National Laboratory Site – Fiscal Years 2015 – 2019" (DOE-ID 2021e).

While CERCLA-specific groundwater monitoring ended in 2022, groundwater monitoring for certain metals, inorganics, and radionuclides continued in 2023 at MFC monitoring Wells ANL-MON-A-012, ANL-MON-A-013, and ANL-MON-A-014 to meet the MFC reuse permit and DOE environmental surveillance monitoring requirements. The 2023 MFC groundwater monitoring results are discussed in Chapter 5 and presented in Appendix A.

6.5.7 Summary of Waste Area Group 10 Groundwater Monitoring Results

In accordance with the Operable Unit 10-08 monitoring plan (DOE-ID 2021d), groundwater samples are collected every two years at the locations shown on Figure 6-19. In 2023, seven wells and three intervals from two Westbay® wells were sampled. Groundwater samples from all wells were analyzed for chloride, nitrate/nitrite as nitrogen, gross alpha, and gross beta. Sulfate and VOCs were collected from a subset of Operable Unit 10-08 monitoring wells. None of the noted analytes exceeded EPA MCLs or SMCLs (Table 6-11; DOE-ID 2024e).

Table 6-11. WAG 10 aquifer groundwater quality summary (June 2023).

ANALYTE	MCL or SMCL	MAXIMUM	MINIMUM	NUMBER OF WELLS ABOVE MCL
ANIONS				
Chloride (mg/L)	*250*[a]	20.3	11.4	0
Sulfate (mg/L)	*250*	25.6	4.11	0
Nitrate/nitrite (mg-N/L)	10	2.76	0.109	0
RADIONUCLIDES				
Gross alpha (pCi/L)	15	3.93	ND[b]	0
Gross beta (pCi/L)	4 mrem/yr[c]	5.56	ND	0
DETECTED VOCS				
Cyclohexane	NA[d]	0.86	ND	0

a. Numbers in *italic* text are for the SMCL.

b. ND = not detected.

c. The Ground Water Quality Rule, IDAPA 58.01.11, specifies a PCS for combined beta/photon emitters of 4 millirems/year effective dose equivalent. Speciation of the individual radionuclides present would be necessary to determine the equivalent PCS in units of pCi/L. For comparison purposes, the EPA also specifies a MCL of 4 mrem/yr for public drinking water systems and uses a screening level of 50 pCi/L. Public drinking water samples with gross beta activity greater than 50 pCi/L must be analyzed to identify the major radionuclides present.

d. NA = not applicable.

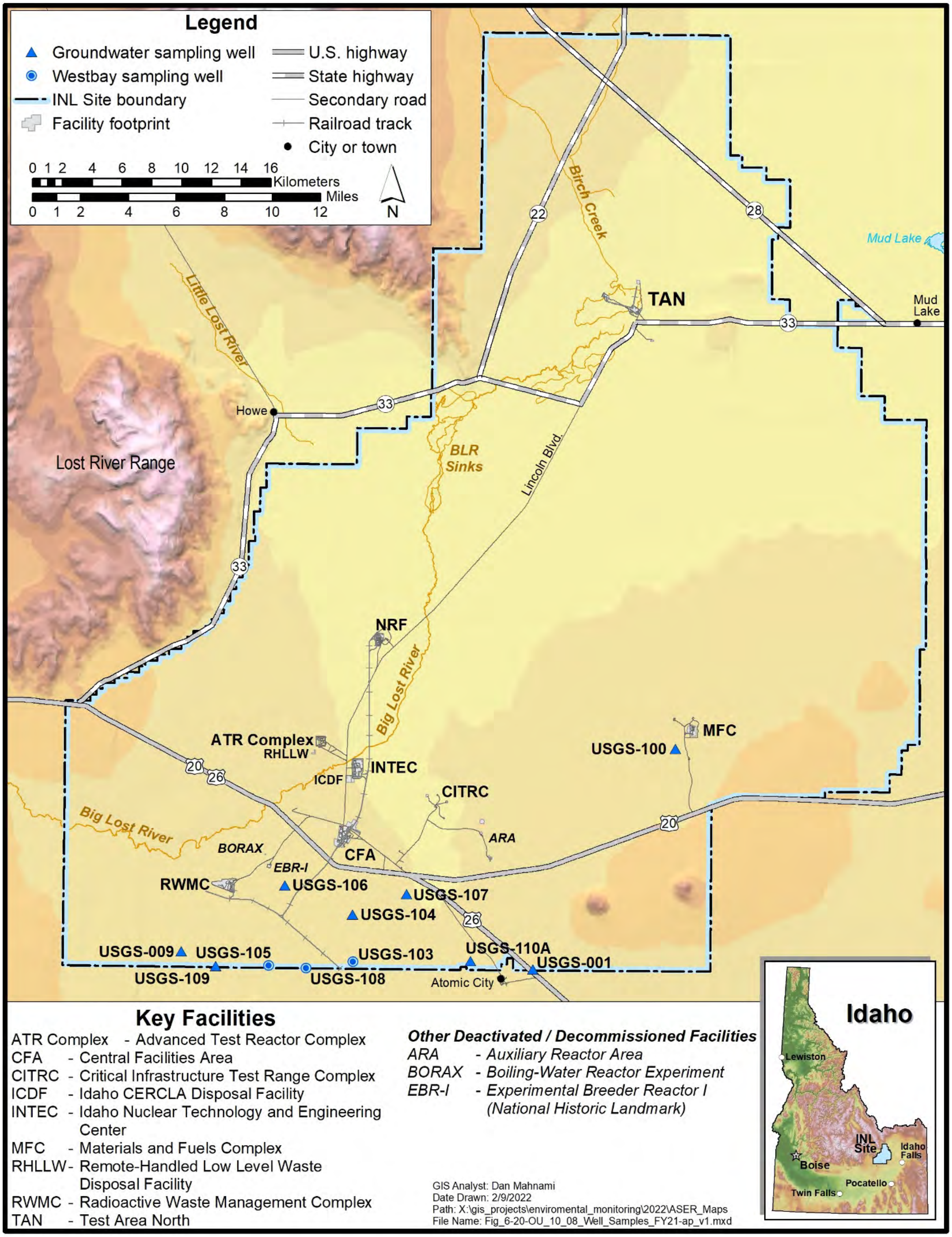

Figure 6-19. Well locations sampled for Operable Unit 10-08.

6.6 Remote-Handled Low-Level Waste Disposal Facility

The INL contractor monitors groundwater at the RHLLW Disposal Facility to demonstrate compliance with DOE O 435.1, “Radioactive Waste Management,” and IDAPA 58.01.11, “Ground Water Quality Rule.” Samples were collected from three monitoring wells in 2023 and analyzed for gross alpha, gross beta, carbon-14 (^{14}C), ^{129}I, ^{99}Tc, and tritium in accordance with PLN-5501, “Monitoring Plan for the INL RHLLW Disposal Facility,” as shown in Figure 6-20. Results for analytes with positive detections are summarized in Table 6-12. Tritium and gross beta were detected in all three wells, while gross alpha was positively detected in two of the three wells. Carbon-14, ^{129}I, and ^{99}Tc were not detected in any samples. Results for gross alpha, gross beta, ^{14}C, ^{129}I, and ^{99}Tc are consistent with concentrations in the aquifer established prior to facility completion (INL 2017) with no observable trends. Tritium in all three wells continue to gradually decline over time. The 2023 results show no discernible impacts to the aquifer from RHLLW Disposal Facility operations.

While not required for compliance at the RHLLW Disposal Facility, facility performance is monitored by collecting and analyzing soil-pore water samples, where sufficient water is present, from vadose-zone lysimeters installed in native materials adjacent to and below the base of the vault arrays. For establishment of the baseline, soil-pore water samples were analyzed for the same indicator and target analytes as the aquifer compliance samples (e.g., gross alpha, gross beta, tritium, ^{14}C, ^{129}I, and ^{99}Tc). The baseline monitoring results are documented in INL (2023). Beginning in 2024, soil-pore water sample results will be collected from select lysimeters adjacent to each vault array and analyzed for gross alpha, gross beta, and tritium. The soil-pore water results will be compared to the baseline measurements and used as early indicators of facility performance.

Table 6-12. Radioactivity detected in surveillance groundwater samples collected at the RHLLW Facility (2023).

WELL:	USGS-136		USGS-140		USGS-141		PCS/SCS[a]
SAMPLE DATE:	05/15/2023	09/18/2023	05/16/2023	09/25/2023	05/16/2023	09/25/2023	
RADIONUCLIDES[b]							
Gross alpha (pCi/L)	1.3 ± 0.325 [ND][c,d]	0.887 ± 0.344	ND	ND	ND	1.31 ± 0.369	15 pCi/L
Gross beta (pCi/L)	1.77 ± 0.171 [1.54 ± 0.19]	1.18 ± 0.227	2.15 ± 0.294	1.47 ± 0.267	1.69 ± 0.244	1.03 ± 0.179	4 mrem/yr[e]
Tritium (pCi/L)	583 ± 140 [714 ± 151]	748 ± 136	835 ± 159	485 ± 115	683 ± 147	561 ± 122	20,000 pCi/L

a. PCS = primary constituent standard, SCS = secondary constituent standard, as specified in the Idaho Ground Water Quality Rule, IDAPA 58.01.11.

b. Result ± 1σ. Only analytes with at least one statistically positive result greater than 3σ uncertainty are shown. Samples were analyzed for gross alpha, gross beta, carbon-14, iodine-129, technecium-99, and tritium.

c. ND = not detected.

d. Duplicate sample results are shown in brackets.

e. The Ground Water Quality Rule, IDAPA 58.01.11, specifies a PCS for combined beta/photon emitters of 4 millirems/yr effective dose equivalent. Speciation of the individual radionuclides present would be necessary to determine the equivalent PCS in units of pCi/L. For comparison purposes only, the EPA also specifies MCL of 4 mrem/yr for public drinking water systems and uses a screening level of 50 pCi/L. Public drinking water samples with gross beta activity greater than 50 pCi/L must be analyzed to identify the major radionuclides present.

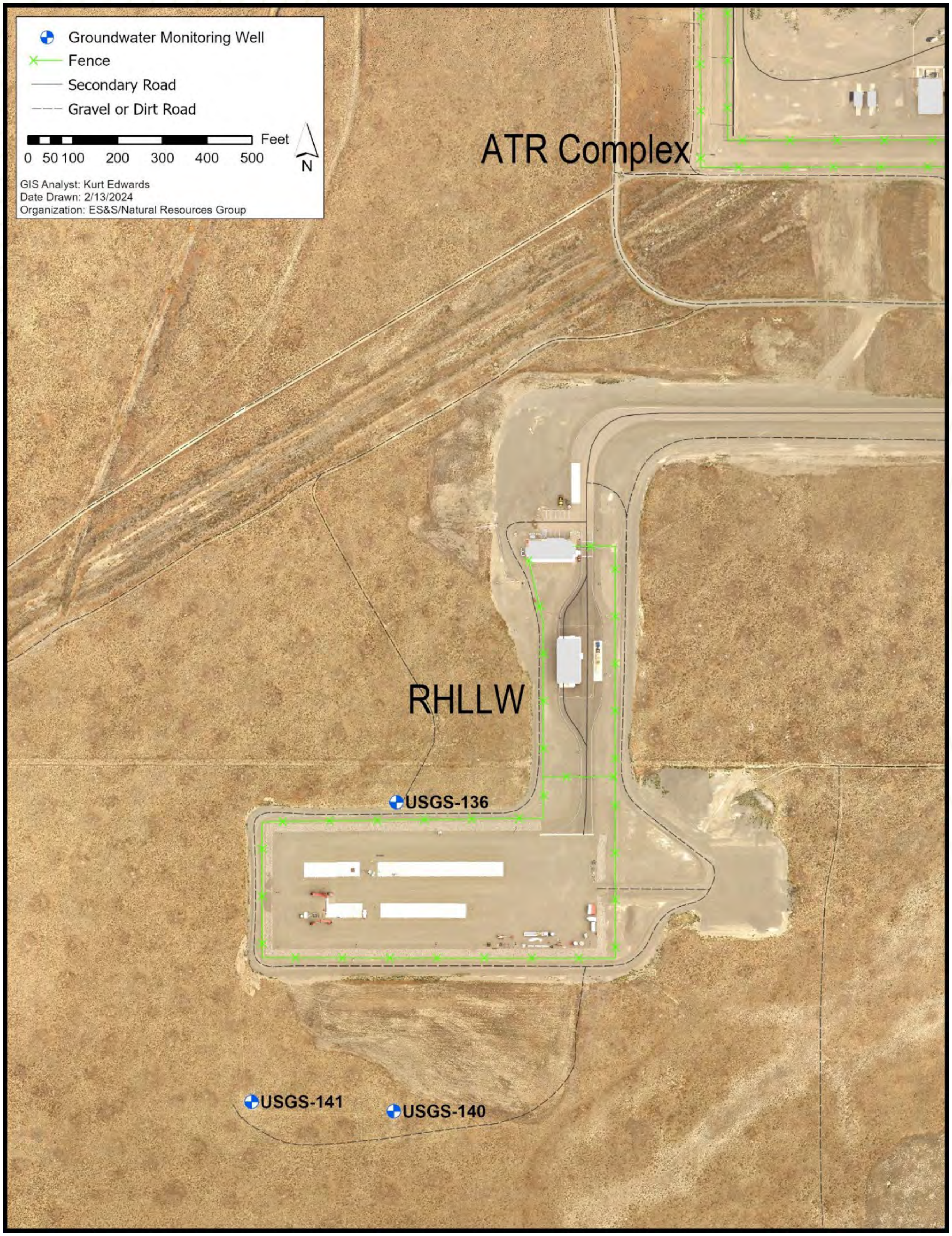

Figure 6-20. Groundwater monitoring locations for the RHLLW Facility.

6.7 Onsite Drinking Water Sampling

The INL Site contractors monitor drinking water to demonstrate that it is safe for consumption and that it meets federal and state regulations. Drinking water parameters are regulated by the state of Idaho under authority of the Safe Drinking Water Act (40 CFR 141, 142). Parameters are sampled according to a 9-year monitoring cycle, which identifies the frequency and the specific classes of contaminates to monitor at each drinking water source (https://www2.deq.idaho.gov/water/monitoringschedulereport). Parameters with primary MCLs must be monitored at least once every three years. Parameters with SMCLs are monitored every three years based on a recommendation by the EPA (40 CFR 143). Many parameters require more frequent sampling during an initial period to establish a baseline, and subsequent monitoring frequency is determined from the baseline results.

The INL Site has 11 drinking water systems that are monitored by the INL Site contractors. The INL contractor monitors eight of these drinking water systems, while the ICP contractor monitors three. The NRF also monitors a drinking water system. The results are not included in this annual report but are addressed in the "Naval Reactors Facility Environmental Monitoring Report for Calendar Year 2023" (FMP 2024). According to the "Idaho Rules for Public Drinking Water Systems" (IDAPA 58.01.08), INL Site drinking water systems are classified as either non-transient or transient, non-community water systems. The four INL contractor transient, non-community water systems are located at the CITRC, EBR-I, Gun Range, and Main Gate. The four remaining INL contractor water systems are classified as non-transient, non-community water systems and are located at the ATR Complex, CFA, MFC, and TAN/CTF. Two of the ICP contractor systems, INTEC and RWMC, are classified as non-transient, non-community, while the NRF Deactivation and Decommissioning (D&D) Facility is classified as transient, non-community.

As required by the state of Idaho, INL and the ICP drinking water programs use EPA-approved (or equivalent) analytical methods to analyze drinking water in compliance with current editions of IDAPA 58.01.08 and 40 CFR Parts 141–143. State regulations also require that analytical laboratories be certified by the state or by another state whose certification is recognized by Idaho. Idaho DEQ oversees the certification program and maintains a list of approved laboratories.

The INL Site contractors monitor certain parameters more frequently than required by regulation because of low volume usage on weekends. For example, bacterial analyses are conducted monthly rather than quarterly at all eight INL contractor drinking water systems and at the three ICP contractor drinking water systems during months of operation. Because of known groundwater plumes near one ICP contractor drinking water well, additional sampling is conducted for carbon tetrachloride at RWMC.

The INL contractor enforces measures to shield the water supply from contamination threats as outlined in IDAPA 58.01.08 and the Idaho Plumbing code. A key protective strategy involves the stringent prevention of cross-connections between potable drinking water systems, industrial, and fire-suppression water systems. This is achieved through the implementation of cross-connection control, which entails fitting protective devices such as double-check valves and reduced pressure zone valves at the point where a facility's plumbing meets the public water main. It is compulsory for facilities that handle hazardous materials, which might inadvertently contaminate the potable water system under conditions of low water pressure, to install these cross-connection control devices.

During 2023, 309 cross-connection control devices were inspected for all INL facilities, including primary devices installed at interfaces to the potable water main and secondary control devices at the point of use. If a problem with a cross-connection device was encountered during testing, the device was repaired and re-tested to ensure proper function.

6.7.1 INL Site Drinking Water Monitoring Results

During 2023, the INL contractor collected 120 routine/compliance samples from the eight INL-operated drinking water systems. Semiannual sampling was conducted at all eight water systems for gross alpha, beta, and tritium. CFA was also sampled for ^{129}I and ^{90}Sr due to its location downgradient of the plume around INTEC. Table 6-13 lists results of routine/compliance and radiological surveillance monitoring. In addition to routine samples, the INL contractor collected 210 surveillance bacteriological, radiological, and per- and polyfluoroalkyl substances (PFAS) samples and 48 quality control samples in the form of blanks.

The ICP contractor collected 25 routine/compliance samples and five quality control samples from the ICP drinking water systems. ICP also collected 54 surveillance bacteriological, lead and copper, PFAS, synthetic organic compounds, and VOCs samples. Two gross alpha/beta samples were collected semiannually from both ICP drinking water systems

(INTEC and RWMC). One tritium sample was also collected from each drinking water system, as shown in Table 6-13. Samples for lead and copper were collected from INTEC and RWMC.

All INL Site water systems were sampled for nitrates and all values measured less than the MCL of 10 mg/L. The highest nitrate values were 2.94 mg/L at CFA. Samples for total trihalomethanes and haloacetic acids were collected at the ATR Complex, CFA, INTEC, MFC, RWMC, and TAN/CTF, as seen in Table 6-13. Samples for lead and copper were collected from the ATR Complex, CFA, MFC, and TAN/CTF.

All INL Site drinking water systems were well below the regulatory limits for drinking water or there were no detections. Since all water systems are categorized as PWS, their data are listed on the Idaho DEQ's PWS Switchboard (www.deq.idaho.gov).

The EPA is actively researching and beginning to establish regulations for a class of very widely used and dispersed man-made-chemicals called PFAS, which are considered to be an emerging contaminant of concern and have been used in industry and consumer products worldwide since the 1950s in non-stick cookware, water-repellent clothing, stain resistant fabrics and carpets, some cosmetics, some firefighting foams, and products that resist grease, water, and oil. Many of the common PFAS have been phased out of production. These chemicals do not degrade in the environment. During production and use, PFAS can migrate into the soil, water, and air. Because of their widespread use and their persistence in the environment, PFAS are found in the blood of people and animals all over the world and are present at low levels in a variety of food products and the environment. Some PFAS can build up in people and animals with repeated exposure over time. Research involving humans suggests that high levels of certain PFAS may lead to numerous health impacts. A common pathway for humans to be potentially impacted by PFAS is through drinking contaminated water.

In February 2023, DOE published the "Guide for Investigating Historical and Current Uses of Per- and Polyfluoroalkyl Substances at Department of Energy Sites" (DOE 2023). This guide outlines a framework for DOE programs investigating historic or current PFAS uses at DOE-owned or -operated entities nationwide. INL Site contractors will continue to monitor PFAS based on the "DOE PFAS Strategic Roadmap: DOE Commitments to Action 2022–2025" (DOE 2022b), the INL PFAS Implementation Plan (Chunn 2023), and the ICP PFAS Implementation Plan (SPR-190). In 2023, the INL Site contractors hired subcontractors to conduct a Preliminary Assessment on past uses of PFAS at INL, in accordance with the DOE Roadmap. This work is ongoing.

In March 2023, the EPA proposed MCLs for six PFAS contaminants in drinking water. In addition to the MCL's, the EPA also proposed health-based, non-enforceable Maximum Contaminant Level Goals (MCLGs). MCLGs are the maximum level of a contaminant in drinking water where there are no known or anticipated negative health effects allowing for a margin of safety. The proposed contaminants and MCLGs and MCLs are listed in Table 6-14.

Table 6-13. Summary of INL Site drinking water results (2023).

CONSTITUENT (units)	MCL	ATR COMPLEX PWS[a] 6120020	CFA PWS 6120008	CITRC PWS 6120019	EBR-I PWS 6120009	GUN RANGE PWS 6120025	INTEC PWS 6120012	MAIN GATE PWS 6120015	MFC PWS 6060036	NRF D&D PWS 6120031	RWMC PWS 6120018	TAN CTF PWS 6120013
RADIOLOGICAL SURVEILLANCE MONITORING												
Gross Alpha[b] (pCi/L)	15	ND[c]-2.43	ND-5.71	ND-1.66	ND-1.56	ND-1.62	ND	ND-1.65	ND-5.03	NA[d]	ND-3.10	ND-2.00
Gross Beta[b] (pCi/L)	50 screening	ND-2.53	4.58-9.16	3.69-3.72	ND-3.26	3.14-9.2	ND-7.02	3.05-3.61	2.58-7.86	NA	3.19-3.27	2.67-3.76
Tritium[b] (pCi/L)	20,000	ND	1,980-2,030	ND	ND	ND	ND	ND	ND	NA	ND	ND
Iodine-129 (pCi/L)	1	NA	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90[b] (pCi/L)	8	NA	ND	NA	NA	NA	ND	NA	NA	NA	ND-3.10	NA
COMPLIANCE MONITORING												
Copper[e] (mg/L)	1.3	0.052	0.19	NA	NA	NA	0.24	NA	0.077	NA	0.18	0.245
Lead[e] (ug/L)	15	2.30	3.90	NA	NA	NA	0.0011	NA	1.10	NA	0.005	1.385
Nitrate[b] (mg/L)	10	ND	2.94	ND	ND	ND	0.564	ND	2.23-2.25	NA	0.954	ND
Total trihalomethanes[b] (ppb)	80	ND	4.40	NA	NA	NA	5.24	NA	3.21	0.500/ 6.60[b]	3.47	4.94
Total coliform	See 40 CFR 141.63	Absent	Absent	Absent	Absent	Absent	Absent	6 Absent 3 Present	Absent	Absent	Absent	Absent
E. coli	See 40 CFR 141.63	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Haloacetic acids (ppb)	60	ND	ND	NA	NA	NA	ND	NA	ND	NA	ND	ND

a. PWS = public water system.
b. Range of results (minimum – maximum) presented.
c. ND = not detected.
d. NA = not applicable based on water system classification or not analyzed.
e. 90[th] percentile level.

Table 6-14. *EPA proposed PFAS MCLGs and MCLs.*

CHEMICAL	MCLG	MCL
Perfluorooctanoic acid (PFOA)	0	4.0 ppt
Perfluorooctanesulfonic acid (PFOS)	0	4.0 ppt
Perfluorononanoic acid (PFNA) Perfluorohexanesulfonic acid (PFHxS) Perfluorobutanesulfonic acid (PFBS) Hexafluoropropylene Oxide (HFPO-DA) (commonly referred to as GenX Chemicals)	1 (unitless) Hazard Index for a combination of two or more	1 (unitless) Hazard Index for a combination of two or more

The Hazard Index is a tool used to evaluate potential health risks from exposure to chemical mixtures.

In 2023, the INL contractor sampled all operating potable water wells and entry points to the distribution system for PFAS. In 2023, the ICP contractor collected PFAS samples from two drinking water wells at INTEC and one well at RWMC. CFA was the only sample location with any detections of PFOA and PFOS, which are the two primary constituents of concern. CFA had detections of PFBS, and both CFA and TAN CTF had detections of PFHxS. All sample results at INL are below the proposed MCLs for PFAS.

Advanced Test Reactor Complex, PWS 6120020

There are over 500 employees assigned to the ATR Complex. The water system has a continuous chlorination system to disinfect the water on a voluntary basis as an added protection. A new potable well was completed for the ATR Complex in September 2019. This gives the ATR Complex two drinking water wells. Since both are approximately 600 feet deep and less than 100 feet apart, they are designated as a wellfield. Compliance samples are collected from the wellfield at TRA-696 for most constituents. Other compliance samples are collected from the distribution system as required by the regulations. In 2023, all compliance samples were below the MCL, which includes the quarterly bacteriological (i.e., total coliform and *E. coli*) samples. These wells can pump over 200 gpm. Water is also supplied to the RHLLW Disposal Facility, which is outside the fence of the ATR Complex.

Central Facilities Area, PWS 6120008

The CFA water system has two wells that serve over 500 people daily. The two wells are 639 and 681 feet deep, and they pump over 600 gpm. The water system is continuously disinfected on a voluntary basis as an added protection. Compliance samples are collected from the manifold at CFA-1603 for most constituents. Other compliance samples are collected from the distribution system as required by the regulations. In 2023, all constituents sampled were below the MCL, which includes the quarterly bacteriological samples (i.e., total coliform and *E. coli*).

Critical Infrastructure Test Range Complex Facility, PWS 6120019

At present, there are no permanent employees at CITRC. The water system has a continuous chlorination system to disinfect the water. CITRC #1 well is located at PBF-602, is 653 feet deep and can pump 400 gpm. CITRC #2 well is located at PBF-614. The well is 1,217 feet deep and can pump 800 gpm. Compliance samples are collected from the manifold, located at PBF-638. In 2023, all compliance samples were below the MCL, which includes the quarterly bacteriological samples (i.e., total coliform and *E. coli*).

Experimental Breeder Reactor-I, PWS 6120009

EBR-I has a public water system that is open to the public from Memorial Day to Labor Day with scheduled tours throughout the year. There are no personnel stationed at this facility. The well is 1,075 feet deep. EBR-I is one of three water systems at INL that does not automatically disinfect. The water system and well were constructed in 1949. In 2023, all compliance samples, including the quarterly bacteriological samples (i.e., total coliform and *E. coli*), were below the MCL.

Gun Range Facility, PWS 6120025

There is one employee permanently stationed at the Gun Range Facility. The Gun Range system is one of three water systems at INL that does not automatically disinfect. The well is located at B21-607 and was completed in January 1990. The well is 626 feet deep. The well pumps 20 gpm. Compliance samples are collected from the B21-607 well for most constituents. Bacteriological (i.e., total coliform and *E. coli*) compliance samples are collected from the distribution system as required by the regulations. In 2023, all sampled constituents were below the MCL, which includes the quarterly bacteriological samples.

Idaho Nuclear Technology and Engineering Center, PWS 6120012

Drinking water for the INTEC is supplied by two wells, CPP-04 and ICPP-POT-A-012, located north of the facility. A disinfectant residual (e.g., chlorine) is maintained throughout the distribution system. In 2023, drinking water samples were collected from the point of entry to the distribution system (CPP-614) and from various buildings throughout the distribution system.

Six compliance samples were collected from various buildings throughout the distribution system at INTEC and were analyzed for contaminants identified by the state of Idaho per the monitoring frequency. Sample results for these compliance samples are summarized in Table 6-13. All detected contaminants were below the MCL concentrations.

Main Gate Badging Facility, PWS 6120015

There are three employees permanently stationed at the Main Gate Badging Facility. The Main Gate system is one of three water systems at INL that does not automatically disinfect. The well is located at B27-605 and was completed in January 1985. The well is 644 feet deep. The well pumps 20 gpm. Compliance samples are collected from the B27-605 well for most constituents. Bacteriological (i.e., total coliform and *E. coli*) compliance samples are collected from the distribution system as required by the regulations. In 2023, the Main Gate system had multiple detections of total coliform in the water following replacement of the pump. Chlorination, pH adjustment, and flushing of the system successfully removed the bacteria. The INL contractor submitted a Level 1 Assessment to DEQ outlining the actions taken. Despite these detections, all of the sampled constituents were below the MCL, including the quarterly bacteriological samples.

Materials and Fuels Complex, PWS 6060036

There are 1,200 employees located at MFC. The water system has a continuous chlorination system to disinfect the water on a voluntary basis as an added protection. Well #1 is located at MFC-754 and Well #2 at MFC-756. Well #1 was completed in 1958 and is 747 feet deep. Well #2 was completed in 1959 and is 755 feet deep. Most compliance samples are collected from both wells. Other compliance samples, such as lead/copper, total trihalomethanes/haloacetic acids, and bacteria (i.e., total coliform and *E. coli*), are collected from the distribution system as required by the regulations. In 2023, all sampled constituents were below the MCL, which includes the two monthly bacteriological samples.

Naval Reactors Facility Deactivation and Decommissioning Facility, PWS 6120031

The NRF D&D Facility is made up of two comfort stations and two shower trailers that serve approximately 50 people. These trailers each have their own individual storage tanks. The source water is transported from the Idaho Falls public water system and dispersed to each individual storage tank.

Four compliance samples (total coliform and *E. coli*) were collected from each location and analyzed for contaminants identified by the state of Idaho per the monitoring frequency. Sample results for these compliance samples are summarized in Table 6-13. All detected contaminants were below the MCL concentrations.

Radioactive Waste Management Complex, PWS 6120018

The RWMC production well is located in Building WMF-603 and is the source of drinking water for RWMC. A disinfectant residual (e.g., chlorine) is maintained throughout the distribution system. Historically, carbon tetrachloride, total xylenes, and other VOCs had been detected in samples collected at the WMF-603 production well and at the point of entry to the distribution system (WMF-603). In July 2007, a packed tower air stripping treatment system was placed into operation to remove the VOCs from the groundwater prior to human consumption.

In 2023, drinking water samples were collected from the point of entry to the distribution system (WMF-603) and from various buildings throughout the distribution system.

Six compliance samples were collected from various buildings throughout the distribution system at RWMC and analyzed for the contaminants identified by the state of Idaho per the monitoring schedule. Sample results for these compliance samples are summarized in Table 6-13. All detected contaminants were below the MCL concentrations.

Test Area North/Contained Test Facility, PWS 6120013

There are more than 300 employees located at TAN/CTF. The water system has a continuous chlorination system to disinfect the water on a voluntary basis for added protection. TAN/CTF #1 Well is located at TAN-632 and was constructed in November 1957. The well is 339 feet deep. The well can pump 1,000 gpm. TAN/CTF #2 Well is located at TAN-639 and was completed in April 1958. The well is 462 feet deep and can pump 1,000 gpm. Compliance samples are collected from the manifold at TAN-1612 for most constituents. Other compliance samples are collected from the distribution system as required by the regulations. In 2023, all sampled constituents, including the quarterly bacteriological (i.e., total coliform and *E. coli*) samples, were below the MCL.

6.8 Offsite Drinking Water Sampling

The public/drinking water source, in southeastern Idaho, is primarily derived from groundwater. Surveillance monitoring of offsite drinking-water systems due to the potential for contaminant migration beyond the INL Site boundary are conducted by the INL contractor. Samples are collected from municipal water sources that have been through a water treatment facility or a well used for drinking water. Samples collected offsite are included as drinking-water samples but are not used for compliance with drinking-water regulations. Instead, media results are used to assess groundwater quality.

As part of the offsite surveillance monitoring program, drinking water samples were collected off the INL Site for radiological analyses in 2023. Two downgradient locations of the INL Site, Shoshone and Minidoka, and one upgradient location, Mud Lake, were co-sampled with the state of Idaho DEQ-INL Oversight Program (DEQ-IOP) in May and November 2023. Samples were also collected at Atomic City, Craters of the Moon, Howe, Idaho Falls, and the public rest area at Highway 20/26. The samples were analyzed for gross alpha and gross beta activities and for tritium. To improve the readability of this chapter, INL contractor offsite drinking water data tables are included when surveillance monitoring results exceed three sigma (3σ). All sample media results for 2023 are provided in quarterly surveillance reports (INL 2024a, INL 2024b, INL 2024c, and INL 2024d). The offsite drinking water detection results are shown in Table 6-15. DEQ-IOP results are reported quarterly and annually and can be accessed at www.deq.idaho.gov/inl-oversight.

Gross alpha activity was detected statistically (above 3σ) in 4 of 17 samples collected in 2023. The results are below the screening level of 15 pCi/L for gross alpha activity, with a maximum of 2.97 ± 0.93 pCi/L, as measured at Howe in November.

Gross beta activity was detected statistically in all but two drinking water samples collected during 2023. Gross beta activity was not detected in the bottled water sample (control) collected in May. The results are below the screening level of 50 pCi/L for gross beta activity, with a maximum of 5.45 ± 0.54 pCi/L, measured at Minidoka in May. If gross beta activity exceeds 50 pCi/L, an analysis of the sample must be performed to identify the major radionuclides present (40 CFR 141). Gross beta activity has been measured at these levels historically in offsite drinking water samples. For example, the maximum level reported since 2013 in past Annual Site Environmental Reports was 8.8 ± 1.0 pCi/L at Atomic City in fall of 2021.

The maximum tritium result measured was 176 ± 33 pCi/L, measured in a sample collected from bottled water (control) collected in May. The result was within historical measurements and well below the EPA MCL of 20,000 pCi/L. The maximum tritium level was lower than the maximum measured since 2013 (209 ± 25 pCi/L) at Minidoka in spring 2018.

Table 6-15. Gross alpha, gross beta, and tritium concentrations detected in offsite drinking water samples collected by the INL contractor in 2023.

LOCATION	SAMPLE RESULTS (PCI/L)[a]	
GROSS ALPHA[b]		
	SPRING	**FALL**
Howe	ND[c]	2.97 ± 0.93
Minidoka	ND	2.83 ± 0.90
Rest Area (Highway 20/26)	1.32 ± 0.37	ND
Shoshone	1.73 ± 0.49	ND
GROSS BETA[d]		
	SPRING	**FALL**
Atomic City	3.99 ± 0.45	3.78 ± 0.56
Craters of the Moon	1.84 ± 0.43	—[e]
Howe	ND	2.48 ± 0.47
Idaho Falls	3.51 ± 0.50	3.12 ± 0.58
Minidoka	4.24 ± 0.49	4.37 ± 0.58
Minidoka (duplicate)	5.45 ± 0.54	—[f]
Mud Lake (Well #2)	3.96 ± 0.41	5.24 ± 0.56
Rest Area (Highway 20/26)	2.54 ± 0.44	3.22 ± 0.49
Shoshone	3.46 ± 0.46	2.34 ± 0.51
TRITIUM[g]		
Control (bottled water)	176 ± 33	—[h]
Howe	109 ± 32	ND

a. Results ≥ 3σ are considered to be statistically positive.
b. EPA MCL = 15 pCi/L.
c. ND = non detect.
d. The MCL for gross beta activity is not established. However, the EPA drinking water standard of 4 mrem/yr for public drinking water systems is applied and a screening level of 50 pCi/L is used. Samples with gross beta activity greater than 50 pCi/L must be analyzed to identify the major radionuclides present.
e. Unable to collect a sample from Craters of the Moon during 4th quarter. No water access due to the visitor center closure until January 26, 2024.
f. A control sample of bottled water was not obtained for November 2023.

6.9 Surface Water Sampling

Two main sources of water could potentially be affected from activities on the INL Site: (1) the Eastern Snake River Plain Aquifer, and (2) the Big Lost River. The Eastern Snake River Plain Aquifer is a primary source of regional drinking water and supplies irrigation water to regional agricultural and aquaculture economy.

The Big Lost River is an intermittent, ephemeral body of water that flows only during periods of high spring runoff and when the Mackay dam, which impounds the river upstream of the INL Site, releases water. The river flows through the INL Site and enters a depression where the water flows into the ground, called the Big Lost River Sinks. The river then mixes with other water in the eastern Snake River Plain Aquifer and emerges about 100 miles (160 km) away at Thousand Springs near Hagerman and at other springs downstream of Twin Falls.

Normally the riverbed is dry because of upstream irrigation and rapid infiltration into desert soil and underlying basalt. In 2023 the Big Lost River had enough flow that onsite surface water samples were collected during the months of June and July. Offsite surface water samples are collected semiannually at locations downgradient of the INL Site: Alpheus Springs near Twin Falls, Clear Springs near Buhl, and a trout farm near Hagerman. These locations were co-sampled with DEQ-IOP in May and November 2023.

To improve the readability of this chapter, INL contractor offsite surface water data tables are included when surveillance monitoring results exceed three sigma (3σ). All sample media results for 2023 are provided in quarterly surveillance reports (INL 2024a, INL 2024b, INL 2024c, and INL 2024d). Surface water detection results are shown in Table 6-16.

Table 6-16. Gross beta and tritium concentrations detected in surface water samples collected by the INL contractor in 2023.

LOCATION	SAMPLE RESULTS (PCI/L)[a]	
GROSS BETA[b]		
	SPRING	**FALL**
Alpheus Springs-Twin Falls	7.97 ± 0.61	6.78 ± 0.74
Clear Springs-Buhl	4.44 ± 0.54	6.25 ± 0.62
Clear Springs-Buhl (duplicate)	—[c]	3.71 ± 0.63
JW Bill Jones Jr. Trout Farm-Hagerman	4.7 ± 0.48	2.3 ± 0.45
TRITIUM[d]		
	SPRING	**FALL**
Alpheus Springs-Twin Falls	110.00 ± 32.20	ND[e]
Clear Springs-Buhl	143.00 ± 32.50	ND

a. Result ± 1σ. Results ≥ 3σ are considered to be statistically positive.
b. The MCL for gross beta activity is not established. However, the EPA drinking water standard of 4 mrem/yr for public drinking water systems is applied and a screening level of 50 pCi/L is used. Samples with gross beta activity greater than 50 pCi/L must be analyzed to identify the major radionuclides present.
c. A duplicate was not collected for May 2023.
d. EPA MCL = 20,000 pCi/L.
e. ND = not detected.

Gross alpha activity was not detected in any of the surface water samples collected in 2023.

Gross beta activity was detected in all surface water samples. The highest results were measured in the Alpheus Springs samples (7.97 ± 0.61 pCi/L) collected in May and (6.78 ± 0.74 pCi/L) in November. The maximum result measured since 2013 was 10.6 ± 0.56 pCi/L at Alpheus Springs in 2014.

Tritium was detected in two of the seven surface water samples collected in 2023. The highest results were measured in the Clear Springs sample collected in May (143 ± 33 pCi/L) and in the Alpheus Springs sample collected (110 ± 32 pCi/L) in May. Concentrations were similar to those found in the drinking water samples and in other liquid media, such as precipitation throughout the year.

The onsite surface water samples were analyzed for gross alpha, gross beta, gamma-emitting radionuclides, and tritium. Results are compared with EPA MCLs since there are no federal or state standards for surface water. None of the results exceeded these limits. Tritium was not detected in any Big Lost River samples collected in 2023. Gross alpha and gross beta detections are shown in Table 6-17. No human-made gamma-emitting radionuclides were detected.

Table 6-17. Gross alpha and gross beta detections in surface water samples collected along the Big Lost River by the INL contractor in 2023.

LOCATION	SAMPLE RESULTS (PCI/L)[a]	
GROSS ALPHA[a]		
	JUNE	**JULY**
Birch Creek	1.73 ± 0.55	1.58 ± 0.37
Experimental Field Station	2.60 ± 0.53	ND[b]
INTEC	3.23 ± 0.51	ND
NRF	5.74 ± 0.60	ND
Rest Area	3.32 ± 0.50	1.48 ± 0.36
Sinks	1.93 ± 0.63	ND
GROSS BETA[c]		
	JUNE	**JULY**
Birch Creek	2.21 ± 0.33	1.86 ± 0.27
Experimental Field Station	4.91 ± 0.45	1.82 ± 0.27
INTEC	5.62 ± 0.44	1.71 ± 0.34
NRF	6.03 ± 0.38	1.07 ± 0.22
Rest Area	4.45 ± 0.32	1.91 ± 0.28
Sinks	3.75 ± 0.38	2.25 ± 0.37

a. EPA MCL = 15 pCi/L
b. ND = not detected
c. EPL MCL = 4 mrem/yr (50 pCi/L)

6.10 USGS 2023 Publication Abstracts

In 1949, the USGS was asked to characterize water resources prior to the building of nuclear-reactor testing facilities at the INL Site. Since that time, USGS hydrologists and geologists have been studying the hydrology and geology of the eastern Snake River Plain and the eastern Snake River Plain Aquifer.

At the INL Site and in the surrounding area, the USGS INL Project Office:

- Monitors and maintains a network of existing wells
- Drills new research and monitoring wells, providing information about subsurface water, rock, and sediment
- Performs geophysical and video logging of new and existing wells
- Maintains the Lithologic Core Storage Library.

Data gathered from these activities are used to create and refine hydrologic and geologic models of the aquifer, to track contaminant plumes in the aquifer, and to improve understanding of the complex relationships between the rocks, sediments, and water that compose the aquifer. The USGS INL Project Office publishes reports about their studies, available through the bibliography website*, inlpubs*: https://rconnect.usgs.gov/INLPO/inlpubs-main/articles/inlpo-pubs.html. Three reports, Twining and others (2023), Rattray (2023), and Rattray and Paces (2023), two software packages (Fisher 2023a and 2023b), and six data releases, Trcka and Twining (2023a, 2023b, 2023c, 2023d), and Dorn and Twining (2023a and 2023b) were published by the USGS INL Project Office in 2023. These studies and the publication information associated with each study are presented below:

- Twining, B. V., K. C. Treinen, and A. R. Trcka, 2023, "Completion summary for Borehole TAN-2336 at Test Area North, Idaho National Laboratory, Idaho," U.S. Geological Survey Scientific Investigations Report 2023–5020, U.S. Geological Survey, Idaho Falls, ID. 33 p. plus appendixes, https://doi.org/10.3133/sir20235020.
- Rattray, G. W., 2023, "Determining three-dimensional hydrologic processes in the eastern Snake River Plain aquifer using geochemical mass-balance modeling, Idaho National Laboratory, eastern Idaho, with contributions by Treinen, K. C.," U.S. Geological Survey Professional Paper 1837–C (DOE/ID-22258), U.S. Geological Survey, Idaho Falls, ID. 133 p., https://doi.org/10.3133/pp1837C.
- Rattray, G. W., and J. B. Paces, 2023, "Evaluation of hydrologic processes in the eastern Snake River Plain aquifer using uranium and strontium isotopes, Idaho National Laboratory, eastern Idaho, with contributions by Treinen, K. C.," U.S. Geological Survey Professional Paper 1837–D (DOE/ID-22259), U.S. Geological Survey, Idaho Falls, ID. 65 p., https://doi.org/10.3133/pp1837D.
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INL Archaeologists investigate a collapsed historic structure.

Chapter 7: Environmental Surveillance Monitoring Programs – Agricultural Products, Wildlife, Soil, and Direct Radiation

CHAPTER 7

Radionuclides released by Idaho National Laboratory (INL) Site operations and activities have the potential to be assimilated by agricultural products and game animals, which can then be consumed by humans. These media are thus sampled and analyzed for human-made radionuclides because of the potential transfer of radionuclides to people through food chains. Iodine-131 and strontium-90 were not detected in any milk samples collected in 2023. Cesium-137 was detected in a milk sample collected in Monteview; however, a review of the result and uncertainty suggest the result is a false positive. Cesium-137 was not detected in any other milk sample collected in 2023. Human-made radionuclides were not detected in any of the other agricultural products (e.g., lettuce, grain, potatoes, alfalfa) collected in 2023.

No human-made radionuclides were detected in road-killed animal samples collected in 2023. Four human-made radionuclides (e.g., cesium-137, cobalt-60, strontium-90, zinc-65) were detected in some tissue samples of waterfowl collected on ponds in the vicinity of the Advanced Test Reactor Complex at the INL Site. The source of these radionuclides was most likely the radioactive wastewater evaporation pond, which can be accessed by waterfowl, but not the public.

Direct radiation measurements made at boundary and offsite locations were consistent with background levels. The average annual dose equivalent from external exposure was estimated from dosimeter measurements to be 114 mrem off the INL Site. The total background dose from natural sources to an average individual living in southeast Idaho was estimated to be approximately 376 mrem per year.

Direct radiation measurements taken in the vicinity of waste storage and soil contamination areas near INL Site facilities were consistent with previous measurements. Direct radiation measurements using a radiometric scanner system at the Radioactive Waste Management Complex and the Idaho Comprehensive Environmental Response, Compensation, and Liability Act Disposal Facility were historically near background levels.

7. ENVIRONMENTAL SURVEILLANCE MONITORING PROGRAMS – AGRICULTURAL PRODUCTS, WILDLIFE, SOIL, AND DIRECT RADIATION

This chapter summarizes the results of environmental surveillance monitoring of agricultural products, wildlife, soil, and direct radiation on and around the INL Site during 2023, as shown in Table 7-1. Details of these programs may be found in the "Idaho National Laboratory Site Environmental Monitoring Plan" (DOE-ID 2021). INL Site contractors monitor soil, vegetation, biota, and direct radiation on and off the INL Site to comply with applicable DOE orders and other requirements, as shown in Table 7-1. INL Site has the potential to release contaminants in the environment which may be present in agricultural products, biota, soil, and direct radiation. To improve the readability of this chapter, INL contractor data tables are included when surveillance monitoring results exceed three sigma (3σ) and/or background upper threshold limits. All sample media results for 2023 are provided in quarterly surveillance reports (INL 2024a, INL 2024b, INL 2024c, and INL 2024d).

Table 7-1. Environmental surveillance monitoring of agricultural products, biota, soil, and direct radiation on and around the INL Site.

AREA/FACILITY[a]	MEDIA				
	AGRICULTURAL PRODUCTS	BIOTA	ECOLOGICAL	SOIL	DIRECT RADIATION
INL CONTRACTOR					
INL Site/Regional	•	•	•	•	•
ICP CONTRACTOR					
ICDF[b]	—[d]	—	—	—	•
RWMC[c]	—	—	—	—	•

a. INL Site = Idaho National Laboratory Site facility areas and areas between facilities.
b. ICDF = Idaho Comprehensive Environmental Response, Compensation, and Liability Act Disposal Facility.
c. RWMC = Radioactive Waste Management Complex.
d. — = media not sampled.

7.1 Agricultural Products and Biota Sampling

Agricultural products and game animals are sampled by the INL contractor because of the potential transfer of radionuclides to people through food chains, as was shown in Chapter 4, Figure 4-1. Sampling of agricultural foodstuffs is performed on and around the INL Site to meet the following requirements and criteria for environmental surveillance of DOE facilities:

- DOE O 458.1, "Radiation Protection of the Public and the Environment"
- "DOE Handbook Environmental Radiological Effluent Monitoring and Environmental Surveillance" (DOE 2015)
- Stakeholder inputs and values.

Figure 7-1 shows the locations where agricultural products were collected in 2023.

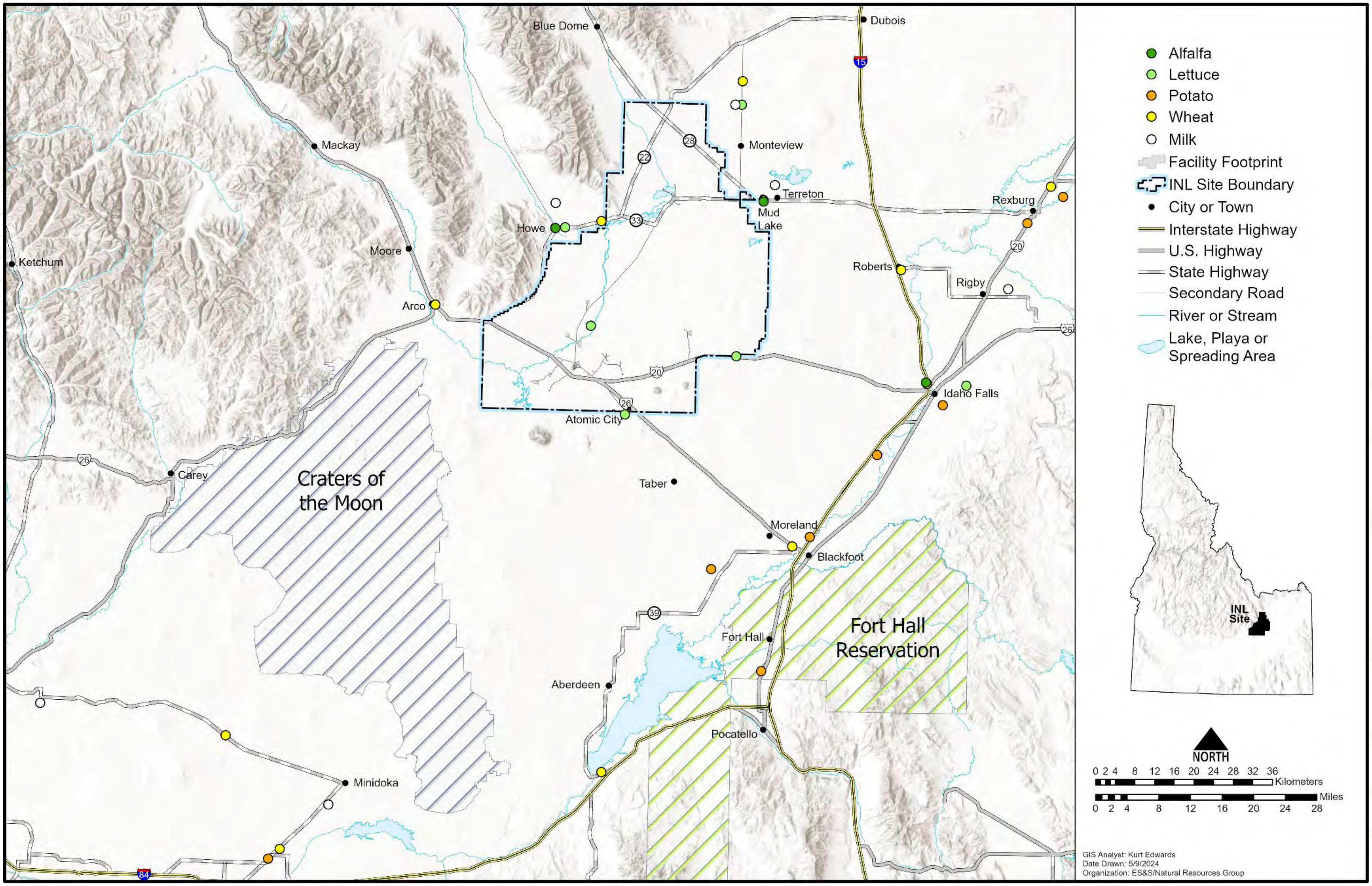

Figure 7-1. Locations of agricultural product samples collected (2023).

7.2 Sampling Design for Agricultural Products

Agricultural products could become contaminated by radionuclides released from INL Site facilities, which are transported offsite by wind and deposited in soil and on plant surfaces. This is important, since approximately 45% of the land surrounding the INL Site is used for agriculture (DOE-ID 1995). Additionally, many residents maintain home gardens that could be impacted by INL Site releases. Animals could also eat contaminated crops and soil and in turn transfer radionuclides to humans through the consumption of meat and milk.

Agricultural product sampling began in the vicinity of the INL Site in the 1960s with milk and wheat as part of the routine environmental surveillance monitoring program. Currently, the program focuses on milk, leafy green vegetables, alfalfa, potatoes, and grains.

As specified in the "DOE Handbook Environmental Radiological Effluent Monitoring and Environmental Surveillance" (DOE 2015), representative samples of the pathway-significant agricultural products grown within 16 km (10 miles) of the INL Site should be collected and analyzed for radionuclides potentially present from INL Site operations. These samples should be collected in at least two locations: (1) the place of expected maximum radionuclide concentrations, and (2) a "background" location unlikely to be affected by radionuclides released from the INL Site.

Sample design was primarily guided by wind direction and frequencies and farming practices. Air dispersion modeling, using CALPUFF and INL Site meteorological data measured from 2006 through 2008, was performed to develop data quality objectives for radiological air surveillance monitoring for the INL Site using the methodology documented in Rood and Sondrup (2014). The same methodology was used to discern deposition patterns. The dispersion and deposition patterns resulting from these sources reflect wind patterns typical of the INL Site. Prevailing winds at most INL Site locations are from the southwest during daytime hours. During evening hours, the winds will sometimes shift direction and blow from the north or northeast but at a lower velocity. Model results show the location of maximum offsite deposition is located between the southwest INL Site boundary and the Big Southern Butte. Because there are no agricultural activities in this region, sampling is focused on other agricultural areas west and northeast of the INL Site. In addition, the sampling design considers locations of interest to the public, as well as those of historical interest, which is why some samples are collected at extended distances from the INL Site.

7.2.1 Methods

Fresh produce and milk are purchased from local farmers when available. In addition, lettuce is grown by the INL contractor in areas that have no commercial or private producers.

7.2.2 Milk Results

Cow milk, and in certain localities, goat milk, is widely consumed by all age groups. Therefore, milk is frequently one of the most important foods contributing to the radiation dose to people if dairy animals are pastured near a nuclear site (INL 2023).

Milk is sampled to monitor the pathway from potentially contaminated, regionally grown feed to cows, then to milk, which is then ingested by humans. During 2023, the INL contractor collected 179 milk samples (including duplicates and controls) at various locations off the INL Site (Figure 7-1) and purchased milk commercially produced outside the state of Idaho (the control). The number and location of the dairies can vary from year to year as farmers enter and leave the business. Milk samples were collected weekly from dairies in Rigby and Terreton, Idaho, and monthly at other locations around the INL Site.

All milk samples were analyzed for gamma-emitting radionuclides, including iodine-131 (^{131}I) and cesium-137 (^{137}Cs). During the second and fourth quarters, samples were analyzed for strontium-90 (^{90}Sr) and tritium.

Iodine is an essential nutrient and is readily assimilated by cows or goats that eat plants containing the element. Iodine-131 is of particular interest because it is produced by nuclear reactors or weapons, is readily detected, and, along with ^{134}Cs and ^{137}Cs, can dominate the ingestion dose regionally after a severe nuclear event, such as the Chernobyl accident (Kirchner 1994) in Ukraine or the 2011 accident at Fukushima in Japan. The ingestion pathway of milk is the main route of internal ^{131}I exposure for people. Iodine-131 has a short half-life (eight days) and, therefore, does not persist in the environment. Past releases from experimental reactors at the INL Site and fallout from atmospheric nuclear weapons tests and Chernobyl are no longer present. None was detected in air samples collected at or beyond the INL Site boundary (see Chapter 4). Iodine-131 was not detected in any milk sample collected during 2023.

Cesium-137 is chemically analogous to potassium in the environment and behaves similarly by accumulating in many types of tissue, most notably in muscle tissue. It has a half-life of about 30 years and tends to persist in soil. If in a soluble form, it can readily enter the food chain through plants. It is widely distributed throughout the world from historic nuclear weapons detonations, which occurred between 1945 and 1980, and has been detected in all environmental media at the INL Site. Potential sources of ^{137}Cs include releases from INL Site facilities and resuspension of previously contaminated soil particles. A sample collected in Monteview on April 18, 2023, resulted in a detect of ^{137}Cs (4.70 ± 1.35 pCi/L). A review of the ^{137}Cs result and uncertainty suggest the data could be a false positive. The DCS for ^{137}Cs in milk is 27,000 pCi/L. Cesium-137 was not detected in any other milk sample collected in 2023.

Strontium-90 is an important radionuclide because it behaves like calcium and can deposit in bones. Strontium-90, like ^{137}Cs, is produced in high yields either from nuclear reactors or from detonations of nuclear weapons. It has a half-life of about 29 years and can persist in the environment. Strontium tends to form compounds that are more soluble than ^{137}Cs and is therefore comparatively mobile in ecosystems. Strontium-90 was not detected in any milk sample collected during 2023. These levels were consistent with levels reported by the U.S. Environmental Protection Agency (EPA) as resulting from worldwide fallout deposited on soil and taken up by cows through the ingestion of grass. The results from EPA Region 10, which includes Idaho, for a limited dataset of seven samples collected from 2007 through 2016, ranged from 0 to 0.54 pCi/L (EPA 2017). The maximum concentration detected in the past 10 years was 2.37 ± 0.29 pCi/L, measured at Fort Hall in November 2013.

DOE has established Derived Concentration Standards (DCS) (DOE 2022) for radionuclides in air, water, and milk. A DCS is the concentration of a radionuclide in air, water, or milk that would result in a dose of 100 mrem from ingestion, inhalation, or immersion in a gaseous cloud for one year. The DCS for ^{90}Sr in milk is 5,800 pCi/L. Therefore, the maximum observed value in milk samples (0.55 ± 0.13 pCi/L) is approximately 0.009% of the DCS for milk.

Tritium, with a half-life of about 12 years, is an important radionuclide because it is a radioactive form of hydrogen, which combines with oxygen to form tritiated water. The environmental behavior of tritiated water is like that of water and can be present in surface water, precipitation, and atmospheric moisture. Tritium is formed by natural processes, as well as by reactor operation and nuclear weapons testing. Tritium enters the food chain through surface water that people and animals drink and from plants that contain water. Tritium was detected in the milk control sample purchased from a producer in Colorado. Concentrations varied from -51.30 ± 21.20 pCi/L in a sample from Howe in November 2023 to 111.00 ± 33.70 pCi/L in the milk control sample collected in May 2023. A negative result indicates the measurement was less than the laboratory background measurement. These concentrations are similar to those of previous years and are consistent with those found in atmospheric moisture and precipitation samples. The DCS for tritium in milk is 12,000,000 pCi/L.

7.2.3 Lettuce Results

Lettuce was sampled because radionuclides in air can be deposited on soil and plants, which can then be ingested by people, as shown previously in Figure 4-1. The uptake of radionuclides by plants may occur through root uptake from soil and from deposited material absorbed into leaves. For most radionuclides, uptake by foliage is the dominant process for the contamination of plants (Amaral et al. 1994). For this reason, green, leafy vegetables, such as lettuce, have higher concentration ratios of radionuclides to soil than other kinds of plants. The INL contractor collects lettuce samples every year from areas on and adjacent to the INL Site, as observed in Figure 7-1. The number and locations of gardens have changed from year to year, depending on whether vegetables were available. Home gardens have been replaced with portable lettuce

Figure 7-2. Portable lettuce planter.

planters, as shown in Figure 7-2, because the availability of lettuce from home gardens was unreliable at some key locations.

In addition, planters can be placed, and the lettuce collected at areas previously unavailable to the public such as on the INL Site and near air samplers. The planters can allow radionuclides deposited from the air to accumulate on the soil and plant surfaces throughout the growth cycle. The planters are placed in the spring, filled with soil and potting mix, sown with lettuce seed, and self-watered through a reservoir.

Five lettuce samples were collected from portable planters at Atomic City, the Experimental Field Station, the Federal Aviation Administration Tower, Howe, and Monteview. In 2023, soil from the vicinity of the sampling locations was used in the planters. This soil was amended with potting soil as a gardener in the region would typically do when they grow their lettuce. In addition to the portable samplers, a sample was obtained from a farm in Idaho Falls, Idaho, and a control sample was purchased at the grocery store from an out-of-state location (Washington).

The samples were analyzed for ^{90}Sr and gamma-emitting radionuclides. Strontium-90 was not detected in the lettuce samples collected during 2023. Strontium-90 is present in the environment as a residual of fallout from above-ground nuclear weapons testing, which occurred between 1945 and 1980. No other human-made radionuclides were detected in any of the lettuce samples. Although ^{137}Cs from nuclear weapons testing fallout is measurable in soils, the ability of vegetation, such as lettuce, to incorporate cesium from soil in plant tissue is much lower than for strontium (Fuhrmann et al. 2003; Ng, Colsher, and Thompson 1982; Schulz 1965). In addition, the availability of ^{137}Cs to plants depends highly on soil properties, such as clay content or alkalinity, which can act to bind the radionuclide (Schulz 1965). Soils in southeast Idaho tend to be moderately to highly alkaline.

7.2.4 Grain Results

The DOE Handbook (DOE 2015) generally recommends representative milk and vegetation (fruits, grains, and vegetables) be included in an agriculture product monitoring program.

Grain (including wheat and barley) is sampled because it is a staple crop in the region. In 2023, the INL contractor collected grain samples at 11 locations from areas surrounding the INL Site (Figure 7-1); an additional duplicate sample was collected from Blackfoot. A control sample was purchased from outside the state of Idaho. The locations were selected because they are typically farmed for grain and are encompassed by the air surveillance monitoring network. Exact locations may change as growers rotate their crops. No human-made radionuclides were found in any samples. Agricultural products, such as fruits and grains, are naturally lower in radionuclides than green, leafy vegetables (Pinder et al. 1990).

7.2.5 Potato Results

Potatoes are collected because they are one of the main crops grown in the region and are of special interest to the public. Because potatoes are not exposed to airborne contaminants, they are not typically considered a key part of the ingestion pathway. Potatoes were collected by the INL contractor at eight locations in the INL Site vicinity (Figure 7-1), and a duplicate sample was collected from Shelley. A control sample was purchased from outside the state of Idaho. None of the potato samples (including the duplicate) collected during 2023 contained a detectable concentration of any human-made radionuclides. Potatoes, like grain, are generally less efficient at removing radioactive elements from soil than leafy vegetables, such as lettuce.

7.2.6 Alfalfa Results

In addition to analyzing milk, the INL contractor began collecting data in 2010 on alfalfa consumed by milk cows. Samples of alfalfa were collected from locations in the cities of Blackfoot, Howe, Idaho Falls, and Mud Lake. Mud Lake is an agricultural area with a high potential for offsite contamination via the air pathway, as shown in Figure 8-6. (Note: The highest offsite air concentration used for estimating human doses was located southeast of the INL Site's east entrance; however, there is limited agriculture near that location.) No ^{90}Sr or gamma-emitting radionuclides were detected in the alfalfa samples collected during 2023.

7.2.7 Big Game Animals Results

Since big game have historically been documented to uptake some level of radioactive contaminants, opportunistic sampling of road-killed game animals is important to ascertain the potential impacts of these contaminants on the animals, as well as the humans potentially consuming them (INL 2022a).

Muscle, liver, and thyroid samples were collected, under a scientific collection permit, from five big game animals. In addition, only a muscle sample was able to be collected from a sixth big game animal. The muscle and liver samples were analyzed for ^{137}Cs because it is an analog of potassium and is readily incorporated into muscle and organ tissues. Thyroids are analyzed for ^{131}I because the isotope accumulates selectively in the thyroid gland of many animals when ingested, making them an ideal bio-indicator of atmospheric releases.

Iodine-131 was not detected in the thyroid samples. No ^{137}Cs or other human-made, gamma-emitting radionuclides were found in any of the muscle or liver samples.

7.2.8 Waterfowl Results

Waterfowl are collected each year at ponds on the INL Site and at a location offsite under an Idaho Department of Fish and Game and an U.S. Fish and Wildlife scientific collection permits. In 2023, three waterfowl were collected from wastewater ponds located at the Advanced Test Reactor (ATR) Complex, two control waterfowl were collected from the South Fork of the Snake River, and one control was collected from Swan Valley. Waterfowl samples were analyzed for gamma-emitting radionuclides (^{90}Sr) and actinides (^{241}Am, ^{238}Pu, $^{239/240}$Pu). These radionuclides were selected because they have historically been measured in liquid effluents from some INL Site facilities. Each sample was divided into the following three subsamples: (1) edible tissue (e.g., muscle, gizzard, heart, liver); (2) external portion (e.g., feathers, feet, head); and (3) all remaining tissue.

Four human-made radionuclides were detected in edible, exterior, and remainder subsamples from the ducks collected at the ATR Complex ponds. The radionuclides were ^{137}Cs, ^{60}Co, ^{90}Sr, and ^{65}Zn. A Green-winged Teal collected from the sewage lagoons at ATR Complex had four of these radionuclides in edible tissue as identified in Table 7-2. One of the radionuclides (^{137}Cs) was also detected in edible tissue of a Mallard collected from the South Fork of the Snake River.

Table 7-2. Radionuclide concentrations detected in waterfowl collected in 2023.

RADIONUCLIDES DETECTED IN WATERFOWL TISSUE (pCi/kg)				
LOCATION	SPECIES	PORTION	RADIONUCLIDE	CONCENTRATION
ATR Complex	Green-winged Teal	Edible	Cesium-137	1,650 ± 77
			Cobalt-60	370 ± 30
			Strontium-90	161 ± 32
			Zinc-65	820 ± 73
South Fork of the Snake River	Mallard	Edible	Cesium-137	13 ± 4

Because more human-made radionuclides were found in ducks from the ATR Complex than other locations and at higher levels, it is assumed that the evaporation pond associated with this facility is the source of these radionuclides. The ducks were not taken directly from the two-celled Hypalon-lined radioactive wastewater evaporation pond, but rather from an adjacent sewage lagoon. However, it is likely the ducks also spent time at the evaporation pond. Concentrations of radionuclides detected in waterfowl collected at the ATR Complex were higher than those collected in 2022. All results were within historical measurements observed during the past ten years (2013-2022). The ^{137}Cs detected in the control duck is most likely from fallout from past weapons testing. The hypothetical dose to a hunter who eats a contaminated duck from the ATR Complex ponds is presented in Chapter 8, Section 8.3.1.

7.3 Soil Sampling

The "DOE Handbook – Environmental Radiological Effluent Monitoring and Environmental Surveillance" (DOE 2015) states that soil sampling and analysis should be used to evaluate the long-term accumulation trends and to estimate environmental radionuclide inventories. It notes that soil provides an integrating medium that can account for contaminants released to the atmosphere either directly in gaseous effluents or indirectly from resuspension of onsite contamination or through liquid effluents released to a stream that is subsequently used for irrigation. However, while soil sampling is a useful approach for determining the accumulation of initially airborne radionuclides that have been deposited on the ground, such sampling generally serves a supplementary role in environmental surveillance monitoring programs (Gallegos 1995; Hardy and Krey 1971; EML 1997). In addition, soil sampling is of questionable value in attempting to estimate small increments of deposition over a period of a few years or less because of the large uncertainties in sampling and the inherent variability in soil and because it is not recommended as a routine method of environmental surveillance monitoring except in pre-operational surveys (EML 1997).

The INL contractor currently completes soil sampling on a five-year rotation at the INL Site to evaluate long-term accumulation trends and to estimate environmental radionuclide inventories. The next soil sampling event is scheduled for 2027. Data from previous years of soil sampling and analysis on the INL Site show slowly declining concentrations of short-lived radionuclides of human origin (e.g., ^{137}Cs), with no evidence of detectable concentrations depositing onto surface soil from ongoing INL Site releases, as discussed in INL (2017).

7.4 Direct Radiation

Environmental direct radiation measures exposure of the public and non-involved workers within INL Site boundaries and surrounding areas. Dosimeters are placed around INL facilities, along the INL Site perimeter, and in areas within a 50-mile radius of the INL Site boundaries.

7.4.1 Sampling Design

An array of optically stimulated luminescent dosimeters (OSLDs) are distributed throughout the Eastern Snake River Plain and on the INL Site to measure for environmental radiation. In addition, neutron dose surveillance monitoring is conducted around INL facilities and buildings where neutron radiation may be present. Offsite and boundary dosimeter locations are shown in Figure 7-3. The sampling periods for 2023 were from November 2022 to April 2023 and May 2023 to October 2023.

Dosimeters on the INL Site are placed at facility perimeters, concentrated in areas likely to detect the highest gamma radiation readings. Other dosimeters on the INL Site are located near radioactive materials storage areas and along roads.

7.4.2 Methods

Environmental OSLDs are placed in the field for six months. After the six-month period, the OSLDs are collected and returned to the supplier for analysis. Transit control dosimeters are shipped with the field dosimeters to measure any dose received during shipment.

Background radiation levels are highly variable; therefore, historical information establishes localized regional trends to identify variances. It is anticipated that 5% of the measurements will exceed the background dose. If a single measurement is greater than the background dose, it does not necessarily mean that there is an unusually high amount of radiation in the area. When a measurement exceeds the background dose, the measurement is compared to other values in the area and to historical data to determine if the results may require further action as described in "Data Quality Objectives Supporting the Environmental Direct Radiation Monitoring Program for the Idaho National Laboratory" (INL 2022b). The method for computing the background value as the upper tolerance limit (UTL) is described in EPA (2009) and EPA (2016). The ProUCL Version 5.1 software (EPA 2016) has been used to compute UTLs, given all available data in the area since 2012.

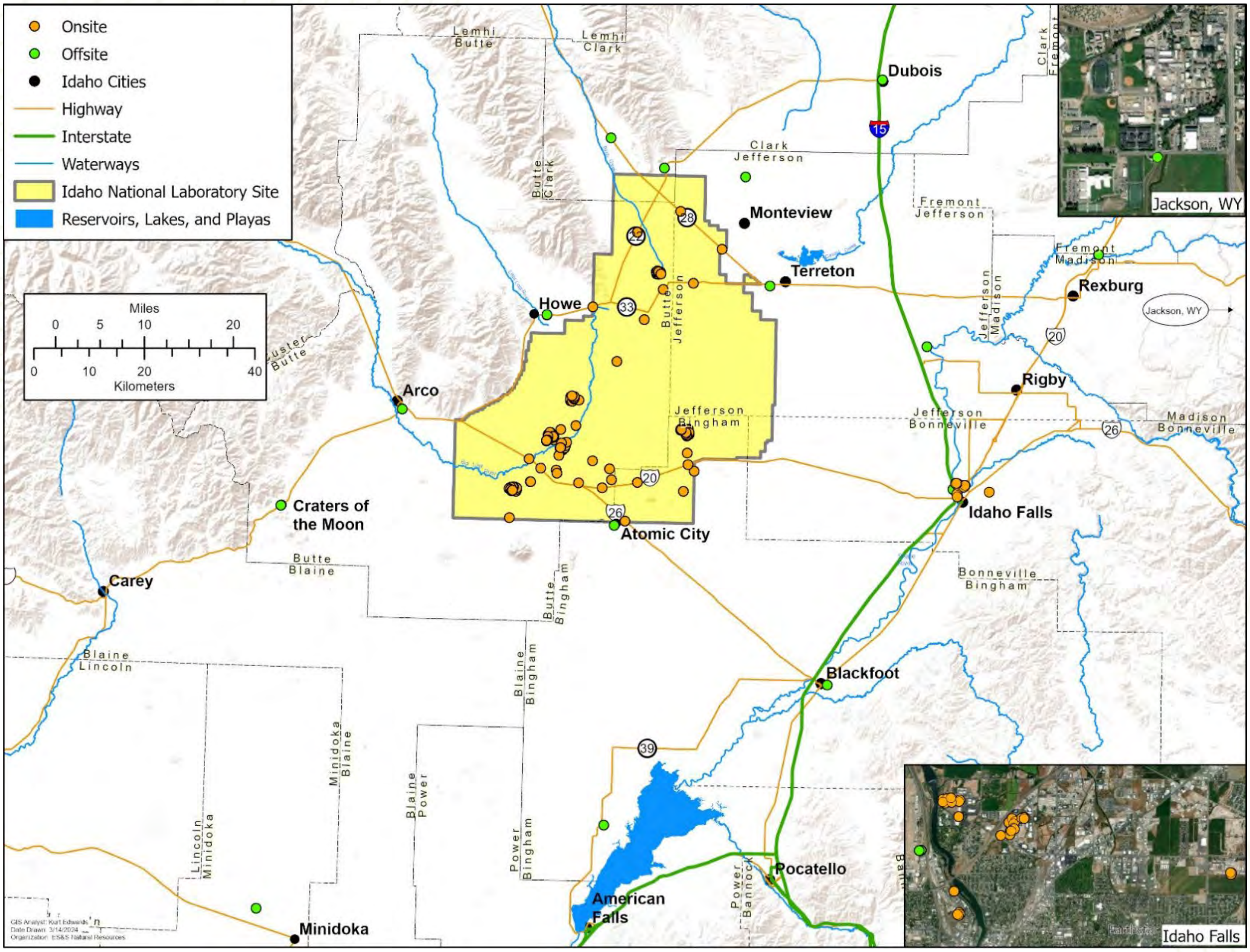

Figure 7-3. INL contractor OSLD locations (2023).

7.4.3 Direct Radiation Results

The 2023 direct radiation results collected by the INL contractor at boundary, offsite, and onsite locations are provided in Appendix B. The building number for the Lindsay Building changed from IF-652A to IF-695. During sample collection in May 2023, dosimeters were missing from the Idaho Nuclear Technology and Engineering Center (ICPP O-14) and the Lindsay Building (IF-652A O-3). Similarly, dosimeters were not found at Materials and Fuels Complex (ANL O-15) and the Portable Isotopic Neutron Spectroscopy Laboratory (IF-675S O-34) when sample collection was performed in November 2023. Results are reported in gross units of ambient dose equivalent (mrem). The 2023 reported values for field locations were primarily below the historic six-month UTL. Table 7-3 lists locations that exceeded their specific six-month UTL. As anticipated, 2% exceeded the UTL for 2023 (Section 7.4.2). The results listed in Table 7-3, showed similarity when compared to historical data suggesting no further action was required.

Table 7-3. Dosimetry locations above the six-month background UTL (2023).

LOCATION	NOV. 2022 – APRIL 2023 SAMPLE RESULT (mrem)	MAY 2023 – OCT. 2023 SAMPLE RESULT (mrem)	BACKGROUND LEVEL UTL[a] (mrem)
ANL O-23	—[b]	88.6 ± 4.4	87.5
ANL O-26	—	89.1 ± 4.5	87.5
ICPP O-15[c]	177.6 ± 8.3	165.3 ± 8.3	146.9
IF-603W O-4	—	62.3 ± 3.1	61.8
TRA O-10[c]	130.7 ± 6.5	139.2 ± 7.0	121.0
TRA O-11[c]	—	123.4 ± 6.2	121.0

a. The UTL is the value such that 95% of all the doses in the area are less than that value with 95% confidence. It is anticipated that 5% of the doses should exceed the UTL.
b. — = Sample did not exceed the UTL for the collection period.
c. Elevated levels expected due to the work being performed in the area.

Neutron dose surveillance monitoring is conducted around buildings in Idaho Falls where sources may emit or generate neutron radiation. These buildings include IF-675, the Portable Isotopic Neutron Spectroscopy Laboratory; IF-695 (formerly IF-652A), the Lindsay Building; IF-670, the Bonneville County Technology Center; and IF-638, the INL Research Center Physics Laboratory. Additional neutron dosimeters are placed at the INL Research Center along the south perimeter fence and at the background location Idaho Falls O-10. Onsite locations with neutron badges include the Transient Reactor Test Facility and the Remote-Handled Low-Level Waste Facility. Neutron dosimeters were missing from the Lindsay Building (IF-652A O-3) during May 2023 sample collection, and at the Portable Isotopic Neutron Spectroscopy Laboratory (IF-675S O-34) and the Transient Reactor Test Facility (TREAT O-4) for November 2023 sample collection. All neutron dosimeters collected in 2023 were reported as "M," which denotes the dose equivalents are below the minimum measurable quantity of 10 mrem. The background level for neutron dose is zero, and the current dosimeters have a detection limit of 10 mrem. Any neutron dose measured is considered present due to sources inside the building. The INL contractor follows the recommendations of the manufacturer to prevent environmental damage to the neutron dosimetry by wrapping each in aluminum foil. To keep the foil intact, the dosimeter is inserted into an ultraviolet protective cloth pouch when deployed.

Table 7-4 summarizes the calculated effective dose a hypothetical individual would receive on the Snake River Plain from various natural background radiation sources (e.g., cosmic, terrestrial). This table includes the latest recommendations of the National Council of Radiation Protection and Measurements (NCRP) in Ionizing Radiation Exposure of the Population of the United States (NCRP 2009).

The terrestrial natural background radiation exposure estimate is based on concentrations of naturally occurring radionuclides found in soil samples collected from 1976–1993, as summarized by Jessmore, Lopez, and Haney (1994). Concentrations of naturally occurring radionuclides in the soil do not change significantly over this relatively short period. Data indicate the average concentrations of ^{238}U, ^{232}Th, and ^{40}K were 1.5, 1.3, and 19 pCi/g, respectively. The calculated external dose equivalents received by a member of the public from ^{238}U plus decay products, ^{232}Th plus decay products, and ^{40}K based on the above-average area soil concentrations were 21, 28, and 27 mrem/yr, respectively, for a total of 76 mrem/yr (Mitchell et al. 1997). Because snow cover can reduce the effective dose that Idaho residents receive from soil, a correction factor must be made each year to the estimated 76 mrem/yr. In 2023, this resulted in a reduction in the effective dose from soil to a value of 62 mrem/yr.

The cosmic component varies primarily with increasing altitude. Using Figure 3.4 in NCRP Report No. 160 (NCRP 2009), it was estimated that the annual cosmic radiation dose near the INL Site is approximately 57 mrem. Cosmic radiation may vary slightly because of solar cycle fluctuations and other factors.

Table 7-4. Calculated effective dose from natural background sources (2023).

SOURCE OF RADIATION DOSE	TOTAL AVERAGE ANNUAL DOSE	
	CALCULATED (mrem)	MEASURED[a] (mrem)
EXTERNAL IRRADIATION		
Terrestrial	62[b]	NA[c]
Cosmic	57[d]	NA
Subtotal	**119**	**114**
INTERNAL IRRADIATION (PRIMARILY INGESTION)[e]		
Potassium-40	15	NM[f]
Thorium-232 and uranium-238	13	NM
Others (carbon-14 and rubidium-87)	1	NM
INTERNAL IRRADIATION (PRIMARILY INHALATION)[d]		
Radon-222 (radon) and its short-lived decay products	212	NM
Radon-220 (thoron) and its short-lived decay products	16	NM
TOTAL	**376**	

a. Calculated from the average annual external exposure at all offsite locations measured using OSLDs.
b. Estimated using concentrations of naturally occurring radionuclide concentrations in soils in the Snake River Plain.
c. NA indicates terrestrial and cosmic radiation parameters were not measured individually but were measured collectively using dosimeters located offsite and at the boundary of the INL Site.
d. Estimated from Figure 3.4 of NCRP Report No. 160.
e. Values reported for the average American adult in Table 3.14 of NCRP Report No. 160.
f. NM = not measured.

Based on this information, the sum of the terrestrial and cosmic components of external radiation dose to a person residing on the Snake River Plain in 2023 was estimated to be 119 mrem/yr. This is similar to the 114 mrem/yr measured at offsite locations using OSLD data. Measured values are typically within normal variability of the calculated background doses. Therefore, it is unlikely that INL Site operations contributed to background radiation levels at offsite locations in 2023.

The component of background dose that varies the most is inhaled radionuclides. According to the NCRP, the major contributor of effective dose received by a member of the public from ^{238}U plus decay products is short-lived decay products of radon (NCRP 2009). The amount of radon in buildings and groundwater depends, in part, upon the natural radionuclide content of soil and rock in the area. The amount of radon also varies among buildings of a given geographic area depending on the materials each contains, the amount of ventilation and air movement, and other factors. The United States average of 212 mrem/yr was used in Table 7-4 for this component of the total background dose. The NCRP also reports that the average dose received from thoron, a decay product of ^{232}Th, is 16 mrem.

People also receive an internal dose from ingestion of ^{40}K and other naturally occurring radionuclides in environmental media. The average ingestion dose to an adult living in the U.S. was reported in the NCRP Report No. 160 to be 29 mrem/yr (NCRP 2009).

With all these contributions, the total background dose to an average individual living in southeast Idaho was estimated to be approximately 376 mrem/yr, as identified in Table 7-4. This value was used to calculate background radiation dose to the population living within 50 miles of INL Site facilities (Table 8-5).

7.5 Waste Management Surveillance Sampling

For compliance with DOE O 435.1, "Radioactive Waste Management," vegetation and soil were at the Radioactive Waste Management Complex (RWMC), and direct surface radiation is measured at the RWMC and the Idaho Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Disposal Facility (ICDF). Soil sampling was conducted at the Subsurface Disposal Area (SDA) at the RWMC from 1994 to 2017. Soil surveillance monitoring was discontinued based on several factors including the limited availability of undisturbed soils and sufficient historical data being collected previously to satisfy the characterization objectives.

7.5.1 Vegetation Sampling at the Radioactive Waste Management Complex

At the RWMC, vegetation was historically collected from four major areas and a control location approximately seven miles south of the SDA at the base of Big Southern Butte. Russian thistle was collected in even-numbered years. Crested wheatgrass and rabbitbrush were collected in odd-numbered years. In 2018, the ICP contractor decided, using guidance from DOE-HDBK-1216-2015 (DOE 2015), to discontinue further biota sampling activities. This decision was based on an evaluation of biota sample data trends, which concluded that vegetation is not considered a major mode of radionuclide transport through the environment surrounding the SDA at RWMC.

7.5.2 Surface Radiation Survey at the Radioactive Waste Management Complex and the Idaho CERCLA Disposal Facility

Surface radiation surveys are performed to characterize gamma radiation levels near the ground surface at waste management facilities. Comparing the data from these surveys year to year helps to determine whether radiological trends exist in specific areas. This type of survey is conducted at the SDA at RWMC and at the ICDF to complement air sampling. The SDA contains legacy waste, of which some is in the process of being removed for repackaging and shipment to an offsite disposal facility. The ICDF consists of a landfill and evaporation ponds, which serve as the consolidation points for CERCLA-generated waste within the INL Site boundaries.

Surface Radiation mapping did not occur in 2023 because of issues stemming from attrition of technical staff but will occur in 2024, twice at the SDA to characterize potential changes resulting from closure activities at those facilities. An automated annual reminder has been put into place to ensure completion of subsequent drive over surveys. Historically, the average background values were around 4,000 counts per second at RWMC with most readings being at or near background. At ICDF, background values were around 3,000 counts per second with most readings being at or near background.

7.6 References

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Northwest indian paintbrush

Chapter 8: Dose to the Public and Biota

CHAPTER 8

Airborne emissions from Idaho National Laboratory (INL) Site operations were used to determine potential radiological dose to members of the public using the Clean Air Act Assessment Package-1988 personal computer (CAP88-PC) program. The annual dose to the maximally exposed individual in 2023, as determined using CAP88-PC, was 0.029 mrem (0.29 µSv), which was well below the applicable standard of 10 mrem (100 µSv) per year. A maximum potential dose from ingestion of game animals was also estimated using the highest radionuclide concentrations in the edible tissue of waterfowl collected at Advanced Test Reactor (ATR) ponds in 2023. The maximum potential dose to an individual who consumes waterfowl was calculated to be 0.026 mrem (0.26 µSv). It was determined there is no dose associated with the consumption of big game animals. Therefore, the total dose (from air emissions and ingestion of the waterfowl) to the maximally exposed individual (MEI) during 2023 was estimated to be 0.055 mrem (0.55 µSv). This dose is also well below the public dose limit of 100 mrem (1 mSv) established by the U.S. Department of Energy (DOE) for a member of the public.

The maximum potential population dose to the approximately 353,789 people residing within an 80 km (50 mi) radius of any INL Site facility was also evaluated. The population dose was calculated using reported releases, an air dispersion model known as the HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) used by the National Oceanic and Atmospheric Administration (NOAA) Special Operations and Research Division, and a dose calculation model. For 2023, the estimated potential population dose was 0.031 person-rem (0.00031 person-Sv). This is approximately 0.00002 percent of the expected dose from exposure to natural background radiation of 133,025 person-rem (1,330 person-Sv).

The potential doses to aquatic and terrestrial biota from contaminated soil and water were evaluated using a graded approach. Initially, the potential doses were screened using maximum concentrations of radionuclides detected in soil and effluents at the INL Site. Results of the screening calculations indicate that contaminants released from INL Site activities do not have an adverse impact on plants or animal populations. Additionally, maximum concentrations of radionuclides measured in waterfowl accessing INL Site ponds and in bats, which were collected at or near INL facilities, were used to estimate internal doses to the waterfowl and bats. The estimated dose to waterfowl was calculated to be 0.00036 rad/d (0.0036 mGy/d), whereas the estimated dose to bats was 0.0014 rad/d (0.014 mGy/d). These calculations indicate the potential doses to waterfowl and bats do not exceed the DOE limits of 0.1 rad/d (1 mGy/d).

8. DOSE TO THE PUBLIC AND BIOTA

DOE O 458.1, "Radiation Protection of the Public and the Environment," contains requirements for protecting the public and the environment against undue risk from radiation associated with radiological activities conducted under DOE control. In addition to requiring environmental monitoring to ensure compliance with the order, DOE O 458.1 establishes a public dose limit. DOE sites must perform dose evaluations using mathematical models that represent various environmental pathways to demonstrate compliance with the public dose limit and to assess collective (population) doses. In the interest of protecting the environment against ionizing radiation, DOE also developed technical standard DOE-STD-1153-2019, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (DOE 2019). The standard provides a graded approach for evaluating radiation doses to aquatic and terrestrial biota.

Title 40 CFR Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities," establishes federal radiation dose limits for the maximally exposed member of the public from all airborne emissions and pathways. It requires that doses to members of the public from airborne releases are calculated using U.S. Environmental Protection Agency (EPA)-approved sampling procedures, computer models, or other methods procedures.

This chapter describes the estimated potential dose to members of the public and biota from operations at the INL Site, based on 2023 environmental monitoring measurements or calculated emissions.

8.1 Possible Exposure Pathways to the Public

Air, soil, groundwater, agricultural products, and biota are routinely sampled to document the amount of radioactivity in these media and to determine if radioactive materials have been transported off the INL Site. The air pathway is the primary way people living beyond the INL Site boundary could be exposed to releases from INL Site operations, as shown in Figure 4-1.

Airborne radioactive materials are carried from the source and dispersed by winds. The concentrations from routine releases are too small to measure at locations around the INL Site, so atmospheric dispersion models were used to estimate the downwind concentration of air pollutants and the potential doses from these projected offsite concentrations. Conservative doses were also calculated from the ingestion of meat from wild game animals that access the INL Site. Ingestion doses were calculated from the concentrations of radionuclides measured in game animals killed by vehicles on INL Site roads and waterfowl harvested from INL Site wastewater ponds that had detectable levels of human-made radionuclides. External exposure to radiation in the environment—primarily from naturally-occurring radionuclides—was measured directly using optically-stimulated luminescence dosimeters.

Water pathways were not considered major contributors to dose, because no surface water flows off the INL Site and radionuclides associated with INL Site releases have not been measured in public drinking water wells.

8.2 Dose to the Public from INL Site Air Emissions

The potential doses from INL Site air emissions were estimated using the amounts reported to be released or could be released by the facilities. The 2023 INL National Emission Standards for Hazardous Air Pollutants (NESHAP) evaluation (DOE-ID 2024) reported potential radionuclide releases from 73 source locations at the INL Site. However, many of the sources resulted in doses that were insignificant, and many sources are located relatively close together, such that the sampling network response from a release would be the same for all nearby sources. Therefore, insignificant sources were not explicitly modeled, and some sources were consolidated with nearby sources. Emissions from five large operating stacks were modeled explicitly and included the Advanced Test Reactor (ATR) main stack (TRA-770), the Materials Test Reactor (MTR) stack (TRA-710), the Idaho Nuclear Technology and Engineering Center (INTEC) main stack (CPP-708), the Fuel Conditioning Facility stack (MFC-764), and the Transient Reactor Test Facility (TREAT) stack (MFC-720). All other releases within a facility were assigned as near ground-level releases from a single location within the facility. These other releases include other non-fugitive releases from stacks, ducts, and vents, and also include fugitive releases from ponds, soil, or other sources. Figure 8-1 shows the location of all sources modeled in the dose assessment.

The radionuclides and source terms used in the dose calculations were presented previously in Table 4-2 of Chapter 4 and are summarized again in Table 8-1. Noble gases comprised the largest emission quantity but only contributed slightly to the dose. Radionuclides in the form of noble gases tend to have short half-lives and are not typically incorporated into the food supply. Radionuclides that contributed most to the overall estimated dose to the maximally exposed individual (MEI) were uranium-238 (^{238}U), uranium-234 (^{234}U), chlorine-36 (^{36}Cl), tritium (^{3}H), cesium-137 (^{137}Cs), and strontium-90 (^{90}Sr). These radionuclides are a very small fraction of the total amount of radionuclides reported.

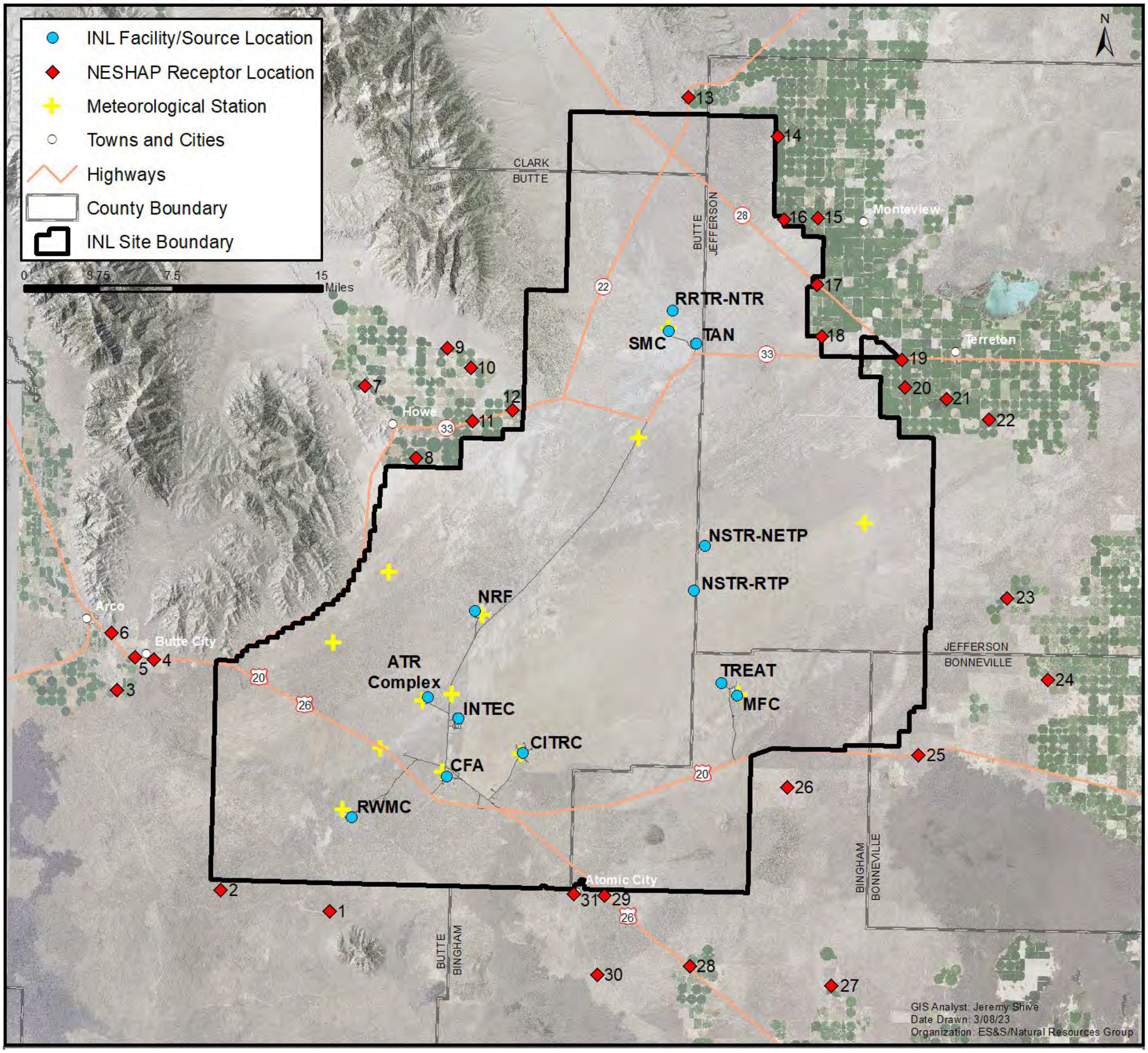

Figure 8-1. INL Site major facility airborne source locations. *TRA-770, TRA-710, CPP-708, MFC-720 (TREAT), and MFC-764 were modeled as stack releases. TRA-770 and TRA-710 are located at the ATR Complex, CPP-708 is located at INTEC, MFC-720 and MFC-764 are located at MFC. The remaining sources were modeled as ground-level releases. Newer facilities, including the National Security Test Range–Radiological Training Pad (NSTR-RTP), and National Security Test Range–New Explosive Test Pad (NSTR-NETP), reported no releases in calendar year 2023; therefore, they were not included in this analysis. Thirty-one specific receptor locations are also shown, including the MEI (location 26), modeled by Clean Air Act Assessment Package-1988 personal computer (CAP88-PC).*

Table 8-1. Summary of radionuclide composition of INL Site airborne effluents (2023).

TOTAL CURIES[a] RELEASED											
FACILITY[b]	TRITIUM	NOBLE GASES[c] (*T1/2* > 40 DAYS)	NOBLE GASES[d] (*T1/2* < 40 DAYS)	FISSION AND ACTIVATION PRODUCTS[e] (*T1/2* < 3 HOURS)	FISSION AND ACTIVATION PRODUCTS[f] (*T1/2* > 3 HOURS)	TOTAL RADIOIODINE[g]	TOTAL RADIOSTRONTIUM[h]	TOTAL URANIUM[i]	PLUTONIUM[j]	OTHER ACTINIDES[k]	OTHER[l]
ATR Complex	5.29E+02	1.48E-19	2.36E+03	3.75E-01	1.38E-02	5.29E-06	2.82E-02	2.29E-09	8.46E-06	2.49E-05	3.40E-10
CFA	3.62E-01	1.02E-04	3.15E-01	4.00E-03	2.36E-05	3.79E-01	3.62E-10	4.17E-10	1.52E-11	4.29E-11	3.62E-15
CITRC	2.20E-01	0.00E+00	0.00E+00	4.60E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INTEC	1.87E-01	1.09E+00	0.00E+00	3.68E-08	2.81E-03	1.43E-04	3.00E-04	4.84E-07	1.05E-05	1.30E-05	0.00E+00
MFC	2.17E+02	1.54E-01	1.66E+02	1.15E+01	1.57E-02	2.90E-06	6.96E-03	2.25E-01	6.36E-06	1.42E-05	0.00E+00
NRF	1.10E-02	4.20E-03	0.00E+00	0.00E+00	2.10E-01	1.42E-05	5.60E-05	0.00E+00	2.70E-06	0.00E+00	0.00E+00
RRTR	0.00E+00	3.50E-06	8.91E-11	5.24E-11	6.46E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RWMC	4.29E+01	0.00E+00	0.00E+00	0.00E+00	2.22E-02	0.00E+00	2.00E-08	9.27E-09	3.27E-05	5.49E-05	0.00E+00
TAN	1.45E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.01E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SMC	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-12	0.00E+00	0.00E+00	0.00E+00
Total	7.90E+02	1.25E+00	2.53E+03	1.19E+01	6.73E+00	3.80E-01	3.56E-02	2.25E-01	6.07E-05	1.07E-04	3.40E-10

a. One curie (Ci) = 3.7 × 10^{10} becquerels (Bq).

b. ATR Complex = Advanced Test Reactor Complex; CFA = Central Facilities Area; CITRC = Critical Infrastructure Test Range Complex; INTEC = Idaho Nuclear Technology and Engineering Center; MFC = Materials and Fuels Complex; NRF = Naval Reactors Facility; RRTR-NTR = Radiological Response Training Range-Northern Test Range; RWMC = Radioactive Waste Management Complex (including the Advanced Mixed Waste Treatment Project [AMWTP]); TAN = Test Area North; and SMC = Specific Manufacturing Capability.

c. Noble gases ($T_{1/2}$ > 40 days) released in 2023 = ^{39}Ar, ^{42}Ar, ^{81}Kr, and ^{85}Kr (^{39}Ar, ^{42}Ar, and ^{81}Kr release is negligible).

d. Noble gases ($T_{1/2}$ < 40 days) released in 2023 = ^{41}Ar, ^{79}Kr, ^{83m}Kr, ^{85m}Kr, ^{87}Kr, ^{88}Kr, ^{89}Kr, ^{90}Kr, ^{92}Kr, ^{220}Rn, ^{131m}Xe, ^{133}Xe, ^{133m}Xe, ^{135}Xe, ^{135m}Xe, ^{137}Xe, and ^{138}Xe.

e. Fission products and activation products ($T_{1/2}$ < 3 hours) released in 2021 = ^{106}Ag, ^{109m}Ag, ^{110}Ag, ^{111m}Ag, ^{94}Au, ^{196m}Au, ^{137m}Ba, ^{139}Ba, ^{141}Ba, ^{80}Br, ^{83}Br, ^{84}Br, ^{117}Cd, ^{118}Cd ^{60m}Co, ^{134m}Cs, ^{135m}Cs, ^{138}Cs, ^{139}Cs, ^{140}Cs, ^{66}Cu, ^{165}Dy, ^{167m}Er, ^{158}Eu, ^{68}Ga, ^{75}Ge, ^{78}Ge, ^{117}In, ^{117m}In, ^{118}In, ^{142}La, ^{56}Mn, ^{97}Nb, ^{149}Nd, ^{65}Ni, ^{111}Pd, ^{150}Pm, ^{144}Pr, ^{144m}Pr, ^{88}Rb, ^{89}Rb, ^{90}Rb, ^{103m}Rh, ^{104}Rh, ^{106}Rh, ^{106m}Rh, ^{126m}Sb, ^{128m}Sb, ^{130}Sb, ^{77m}Se, ^{81}Se, ^{81m}Se, ^{123m}Sn, ^{127}Sn, ^{128}Sn, ^{129}Te, ^{131}Te, ^{133}Te, ^{133m}Te, ^{134}Te, ^{89m}Y, ^{91m}Y, and ^{69}Zn.

f. Fission products and activation products ($T_{1/2}$ > 3 hours) released in 2023 = ^{108m}Ag, ^{110m}Ag, ^{111}Ag, ^{112}Ag, ^{113}Ag, ^{76}As, ^{77}As, ^{78}As, ^{195}Au, ^{196}Au, ^{198}Au, ^{133}Ba, ^{135m}Ba, ^{140}Ba, ^{10}Be, ^{207}Bi, ^{210}Bi, ^{210m}Bi, ^{80m}Br, ^{82}Br, ^{14}C, ^{45}Ca, ^{109}Cd, ^{113m}Cd, ^{115}Cd, ^{115m}Cd, ^{117m}Cd, ^{139}Ce, ^{141}Ce, ^{143}Ce, ^{144}Ce, ^{36}Cl, ^{57}Co, ^{58}Co, ^{60}Co, ^{51}Cr, ^{132}Cs, ^{134}Cs, ^{135}Cs, ^{136}Cs, ^{137}Cs, ^{64}Cu, ^{67}Cu, ^{166}Dy, ^{169}Er, ^{171}Er, ^{172}Er, ^{152}Eu, ^{152m}Eu, ^{154}Eu, ^{155}Eu, ^{156}Eu, ^{157}Eu, ^{55}Fe, ^{59}Fe, ^{60}Fe, ^{72}Ga, ^{73}Ga, ^{159}Gd, ^{68}Ge, ^{71}Ge, ^{77}Ge, ^{175}Hf, ^{178m}Hf, ^{179m}Hf, ^{181}Hf, ^{182}Hf, ^{203}Hg, ^{166}Ho, ^{167}Ho, ^{115m}In, ^{192}Ir, ^{193m}Ir, ^{194}Ir, ^{40}K, ^{42}K, ^{140}La, ^{141}La, ^{52}Mn, ^{53}Mn, ^{54}Mn, ^{93}Mo, ^{99}Mo, ^{22}Na, ^{24}Na, ^{92m}Nb, ^{93m}Nb, ^{94}Nb, ^{95}Nb, ^{95m}Nb, ^{96}Nb, ^{147}Nd, ^{57}Ni, ^{59}Ni, ^{63}Ni, ^{66}Ni, ^{185}Os, ^{191}Os, ^{32}P, ^{33}P, ^{205}Pb, ^{210}Pb, ^{107}Pd, ^{109}Pd, ^{112}Pd, ^{147}Pm, ^{148}Pm, ^{148m}Pm, ^{149}Pm, ^{151}Pm, ^{210}Po, ^{142}Pr, ^{143}Pr, ^{145}Pr, ^{195m}Pt, ^{84}Rb, ^{86}Rb, ^{87}Rb, ^{184}Re, ^{184m}Re, ^{186}Re, ^{186m}Re, ^{187}Re, ^{188}Re, ^{105}Rh, ^{103}Ru, ^{105}Ru, ^{106}Ru, ^{122}Sb, ^{124}Sb, ^{125}Sb, ^{126}Sb, ^{127}Sb, ^{128}Sb, ^{129}Sb, ^{46}Sc, ^{48}Sc, ^{79}Se, ^{32}Si, ^{151}Sm, ^{153}Sm, ^{156}Sm, ^{113}Sn, ^{117m}Sn, ^{119m}Sn, ^{121}Sn, ^{121m}Sn, ^{123}Sn, ^{125}Sn, ^{126}Sn, ^{179}Ta, ^{182}Ta, ^{183}Ta, ^{160}Tb, ^{161}Tb, ^{99}Tc, ^{99m}Tc, ^{123m}Te, ^{125m}Te, ^{127}Te, ^{127m}Te, ^{129m}Te, ^{131m}Te, ^{132}Te, ^{204}Tl, ^{171}Tm, ^{49}V, ^{181}W, ^{185}W, ^{187}W, ^{188}W, ^{88}Y, ^{90}Y, ^{90m}Y, ^{91}Y, ^{92}Y, ^{93}Y, ^{65}Zn, ^{69m}Zn, ^{71m}Zn, ^{72}Zn, ^{93}Zr, ^{95}Zr, and ^{97}Zr.

g. Radioiodine released in 2023 = ^{125}I, ^{126}I, ^{128}I, ^{129}I, ^{130}I, ^{131}I, ^{132}I, ^{132m}I, ^{133}I, ^{134}I, and ^{135}I.

h. Radiostrontium released in 2023 = ^{80}Sr, ^{85}Sr, ^{87m}Sr, ^{89}Sr, ^{90}Sr, ^{91}Sr, and ^{92}Sr.

i. Uranium isotopes released in 2023 = ^{232}U, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{237}U, and ^{238}U.

j. Plutonium isotopes released in 2023 = ^{236}Pu, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, and ^{244}Pu.

k. Other actinides released in 2023 = ^{225}Ac, ^{227}Ac, ^{241}Am, ^{242}Am, ^{243}Am, ^{252}Cf, ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{237}Np, ^{239}Np, ^{231}Pa, ^{233}Pa, ^{234}Pa, ^{234m}Pa, ^{229}Th, ^{230}Th, ^{231}Th, ^{232}Th, and ^{234}Th.

l. Other = radioisotopes of elements that are not noble gases, activation or fission products, radioiodine, radiostrontium, or actinides released in 2023. These are typically heavy elements that are decay chain members of actinides. They include ^{214}Bi, ^{214}Pb, and ^{226}Ra.

The following two kinds of dose estimates were made using the release data:

- ***The effective dose to the hypothetical MEI, as defined by the NESHAP regulations.*** The CAP88-PC model Version 4.1 (EPA 2020) was used to predict the maximum concentration and dose at offsite receptor locations. The receptor location with the highest estimated dose is the MEI location.
- ***The collective effective dose (population dose) for the population within 80 km (50 mi) of any INL Site facility.*** For this calculation, the HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model (Stein et al. 2015) was used to model atmospheric transport, dispersion, and deposition of radionuclides released to the air from the INL Site. The population dose was estimated using the Dose Multi-Media (DOSEMM) model (Rood 2019) using dispersion and deposition factors calculated by HYSPLIT to comply with DOE O 458.1.

The dose estimates considered the air immersion dose from gamma-emitting radionuclides, internal dose from inhalation of airborne radionuclides, internal dose from ingestion of radionuclides in plants and animals, and external dose from gamma-emitting radionuclides deposited on soil, as previously shown in Figure 4-1. The CAP88-PC computer model uses dose and risk tables developed by the EPA. Population dose calculations were made using: (1) DOE effective dose coefficients for inhaled radionuclides (DOE 2022), (2) EPA dose conversion factors for ingested radionuclides (EPA 2002), and (3) EPA dose conversion factors for external exposure to radionuclides in the air and deposited on the ground surface (EPA 2002).

8.2.1 Maximally Exposed Individual Dose

The EPA NESHAP regulation requires demonstration that radionuclides other than radon released to the air from any DOE nuclear facility do not result in a dose to the public of greater than 10 mrem/yr (0.1 mSv/yr) (40 CFR 61, Subpart H). EPA requires the use of an approved computer model, such as CAP88-PC, to demonstrate compliance with 40 CFR 61, Subpart H. CAP88-PC uses a modified Gaussian plume model to estimate the average dispersion of radionuclides released from up to six sources. It uses average annual wind files based on data collected at multiple locations on the INL Site by the National Oceanic and Atmospheric Administration (NOAA).

In calendar year 2023, NESHAP receptor locations were revised to ensure the currently selected locations are still occupied by the public and to capture new residences, schools, or offices that were constructed since the last receptor location evaluation. Receptor locations were last updated in 1995 when 62 locations were identified during a helicopter fly-over inspection of the INL Site boundary (Ritter 1997). This updated analysis employed high-resolution aerial imagery to identify suitable receptor locations quickly and easily. The use of aerial imagery instead of in-person helicopter surveys ensures this process can be completed at a reasonably frequent interval and for minimum cost. Additionally, a defensible strategy for identifying receptor locations was established to eliminate selecting redundant receptor locations. The analysis resulted in a total of 31 NESHAP receptor locations. The calendar year 2023 MEI remains at the same location as in previous years; however, it is now identified as Receptor 26 instead of Receptor 54. References to the MEI prior to 2019 (Receptor 1) continue to be referred to as Receptor 1 in the new arrangement (INL 2023).

The dose to the MEI from INL Site airborne releases of radionuclides was calculated to demonstrate compliance with NESHAP and is published in the *National Emissions Standards for Hazardous Air Pollutants – Calendar Year 2023 INL Report for Radionuclides* (DOE-ID 2024). To identify the MEI, the doses at 31 offsite locations, as shown in Figure 8-1, were calculated and then screened for the maximum potential dose to an individual who might live at one of these locations. The highest potential dose location was determined to be location 26, a farmhouse and cattle operation located 3.1 km south of Highway 20 and 3 km from the INL Site's east entrance. This is the same MEI location as in the previous year, but it is different from the MEI location prior to 2019, which was identified as location 1 (i.e., Frenchmans Cabin). Location 1 is located 2.3 km south of the INL boundary, just south of RWMC. An effective annual dose of 0.029 mrem (0.29 μSv) was calculated for a hypothetical person living at location 26 during 2023. The 2023 dose at the former MEI (location 1) was 0.0021 mrem/yr and it was the fourth highest receptor location in terms of dose.

Figure 8-2 compares the MEI doses calculated for years 2014–2023. All the doses are well below the whole-body dose limit of 10 mrem/yr (0.1 mSv/yr) for airborne releases of radionuclides established by 40 CFR 61, Subpart H. The highest dose estimated during the past ten years was in 2021.

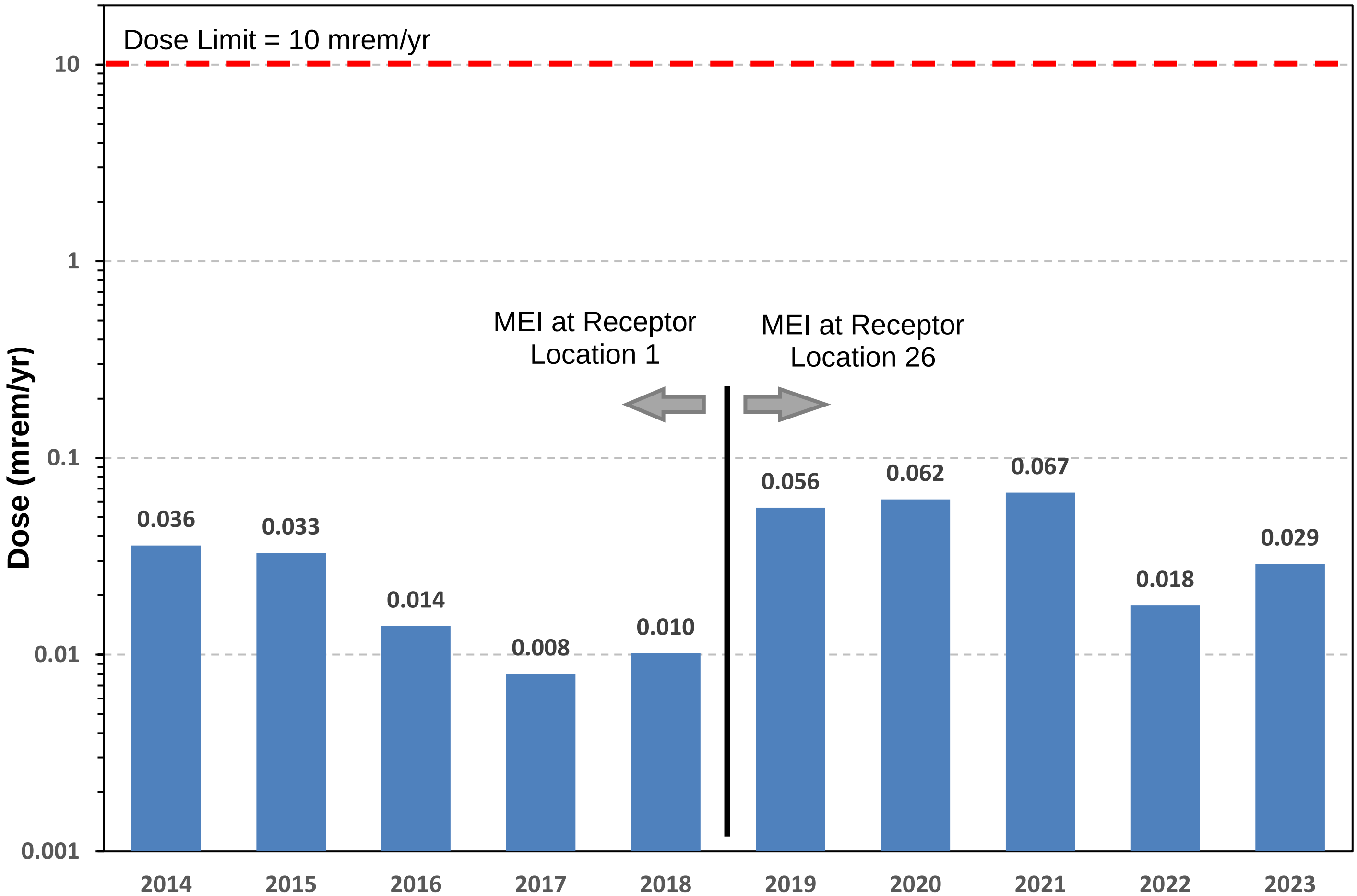

Figure 8-2. MEI dose from INL Site airborne releases estimated for 2014–2023. *See Figure 8-1 for INL Site receptor locations.*

Although noble gases were the radionuclides that were released in the largest quantities in 2023, they accounted for less than 2% of the cumulative MEI dose from all pathways largely because of their relatively short half-lives and because they only affect the immersion dose (i.e., they are excluded from the food supply). For example, about 61.2% of the total INL activity released was argon-41 (^{41}Ar), as shown in Table 4-2 of Chapter 4, yet ^{41}Ar accounted for less than 2% of the estimated MEI dose. In contrast, radionuclides typically associated with airborne particulates, such as ^{238}U, ^{234}U, ^{36}Cl, ^{137}Cs, and ^{90}Sr, comprised only a small fraction (e.g., less than 0.0081%) of the total amount of radionuclides reported to be released in Table 4-2 of Chapter 4, yet the radionuclides resulted in approximately 83.1% of the estimated MEI dose, as shown in Figure 8-3. Uranium-234 and ^{238}U are isotopes of natural uranium with half-lives of 245,500 years and 4.5 billion years, respectively. During decay, both isotopes emit alpha particles that are less penetrating than other forms of radiation, and ^{238}U emits a weak gamma ray. As long as it remains outside the body, uranium poses a small health hazard, mostly from gamma-rays. If inhaled or ingested, the radioactivity poses increased risks of cancer due to alpha particle emissions. Chlorine-36 also has a very long half-life that decays by emitting a relatively low-energy beta particle and a small amount of gamma radiation that poses a hazard only if ingested. Cesium-137 has a half-life of about 30.05 years and releases beta particles when decaying. Strontium-90 has a half-life of 28.8 years and decays into Yttrium-90, releasing beta particles in the process.

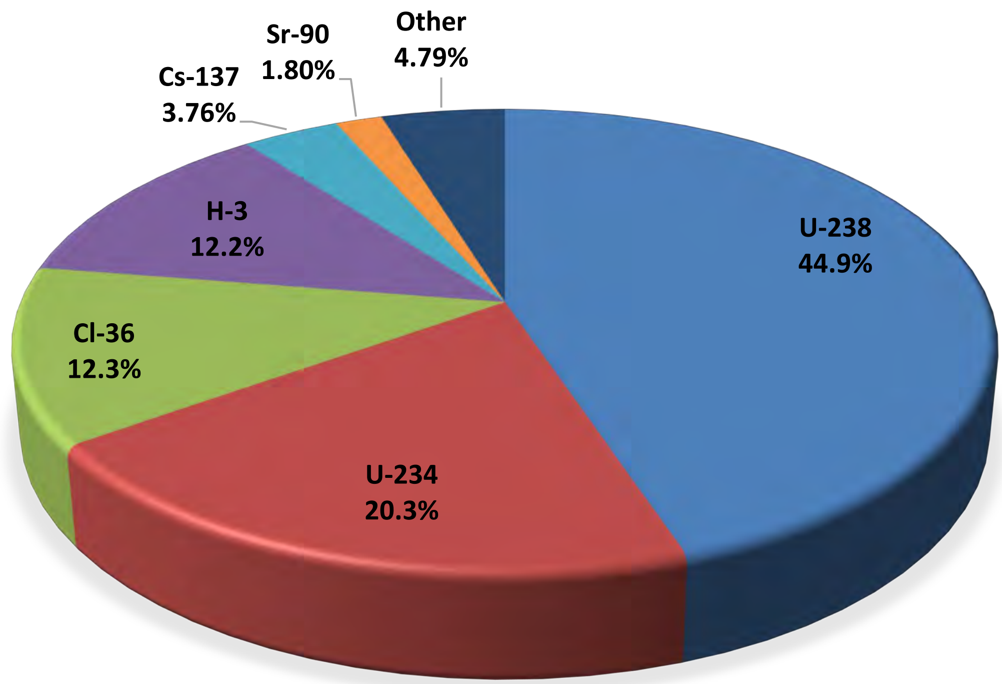

Figure 8-3. Radionuclides contributing to the MEI dose from INL Site airborne effluents as calculated using the CAP88-PC Model (2023).

Primary sources of the major radionuclides used to estimate the dose to the MEI, as indicated in Figure 8-3, were identified during the preparation of the annual NESHAP report (DOE-ID 2024) as follows:

- ^{238}U and ^{234}U account for 44.9% and 20.3% of the MEI dose, respectively; the majority of which came from the Advanced Fuels Facility (MFC-784) at MFC.
- The second largest dose contribution was from ^{36}Cl (12.3%), most of which originated at the Electron Microscopy Laboratory (MFC-774) at MFC.
- Tritium accounts for 12.2% of the MEI dose with 80% coming from the MFC-774, 13.4% coming from the Beryllium blocks buried at the RWMC Subsurface Disposal Area, 4.9% from TRA-770, 1.2% from TRA-715, and the rest from other sources.
- ^{137}Cs and ^{90}Sr contributed 3.8% and 1.8%, respectively. The remaining 4.79% came from other radionuclides.

The largest contribution by facility to the MEI dose overwhelmingly came from MFC at 94.0%, followed by the ATR Complex at 3.33%, and RWMC at 1.79%%, as shown in Figure 8-4. This is expected for location 26 given its proximity to MFC. Additionally, primary wind directions at the INL Site are from the southwest and northeast; thus, emissions from Test Area North (TAN), the Naval Reactors Facility (NRF), INTEC, the ATR Complex, and RWMC are off axis from a receptor near MFC.

The dose to the MEI is higher than in 2022 at 0.029 mrem/year, but is still far below the regulatory standard of 10 mrem/yr (0.1 mSv/yr) (40 CFR 61, Subpart H).

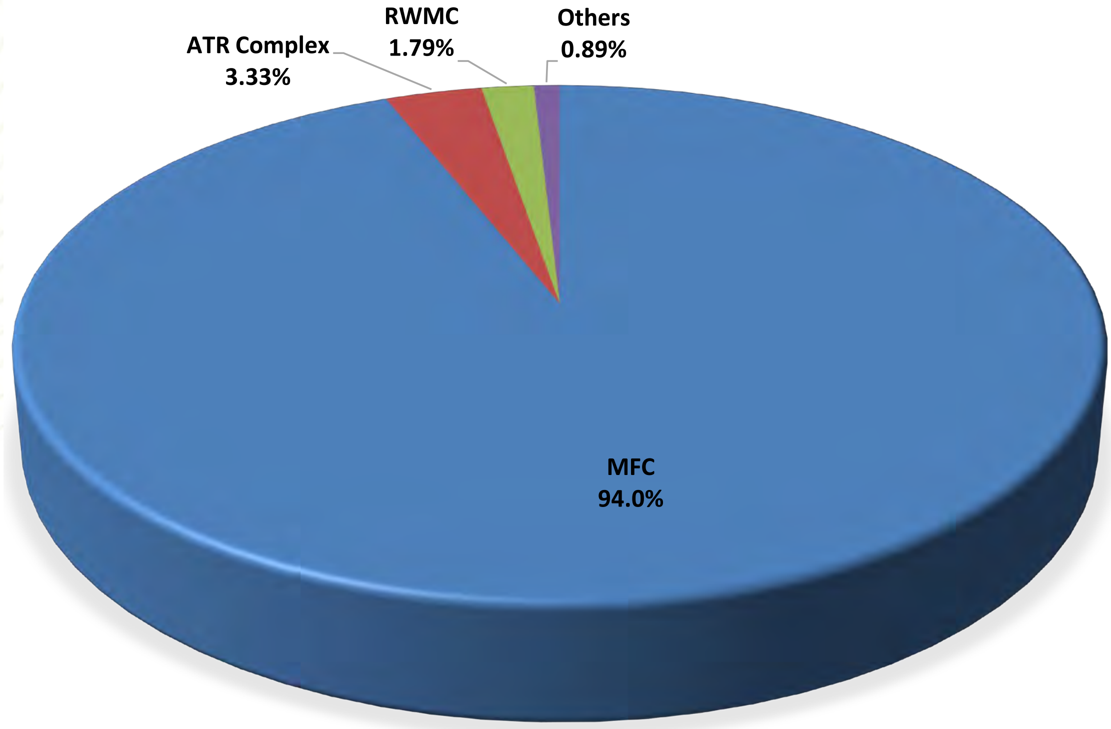

Figure 8-4. Percent contributions, by facility, to MEI dose from the INL Site airborne effluents as calculated using the CAP88-PC Model (2023).

8.2.2 Eighty Kilometer (50 Mile) Population Dose

The total effective population dose from airborne releases was calculated using air dispersion modeling performed by the NOAA Air Resources Laboratory Special Operations and Research Division using their HYSPLIT model (Stein et al. 2015; Draxler et al. 2013), and the DOSEMM v 190926 (Rood 2019) dose assessment model. The HYSPLIT model and its capabilities are described on the NOAA Air Resources Laboratory website (see https://www.arl.noaa.gov/hysplit/).

The objective of these calculations was to provide a grid of total effective dose across a model domain that encompasses an 80-km (50-mi) radius from any INL Site source, as observed in Figure 8-5. In addition to INL Site sources, releases from Idaho Falls facilities located at the INL Research Center (IRC) within Idaho Falls city limits were also included. These data were then used with geographical information system software to compute population dose.

The radionuclide source term for facilities that contributed significantly to the annual dose were the same as those used by the CAP88-PC (EPA 2020) modeling performed for the annual NESHAP report (DOE-ID 2024). These sources and radionuclides were included in the HYSPLIT/DOSEMM modeling. Radionuclides and facilities that yielded greater than 0.005% of the total dose at the location of the INL Site MEI were selected to be modeled, as observed in Table 8-2 and Table 8-3. For Idaho Falls facilities, radionuclides that result in a dose greater than 0.1% of the total dose at the MEI in Idaho Falls were included. The radionuclide source term used for the Idaho Falls facilities modeling is shown in Table 8-4.

During 2023, the NOAA Air Resources Laboratory Special Operations and Research Division continuously gathered data at 34 meteorological stations on and around the INL Site (see *Meteorological Monitoring*, a supplement to this Annual Site Environmental Report). The transport and dispersion of contaminants by winds and deposition onto the ground was projected by the HYSPLIT model using hourly averaged observations from the meteorological stations throughout 2023 together with regional topography. The model predicted dispersion and deposition resulting from releases at each facility from one of 17,877 grid points projected on and around the INL Site. The Cartesian grid was designed to encompass the region within 80 km (50 mi) of INL Site facilities, as shown in Figure 8-5. In addition, 27 boundary receptor locations, representing actual residences around the INL Site, were included in the modeling. These 27 receptor locations are a subset of the 62 receptor locations used for the NESHAP evaluation.

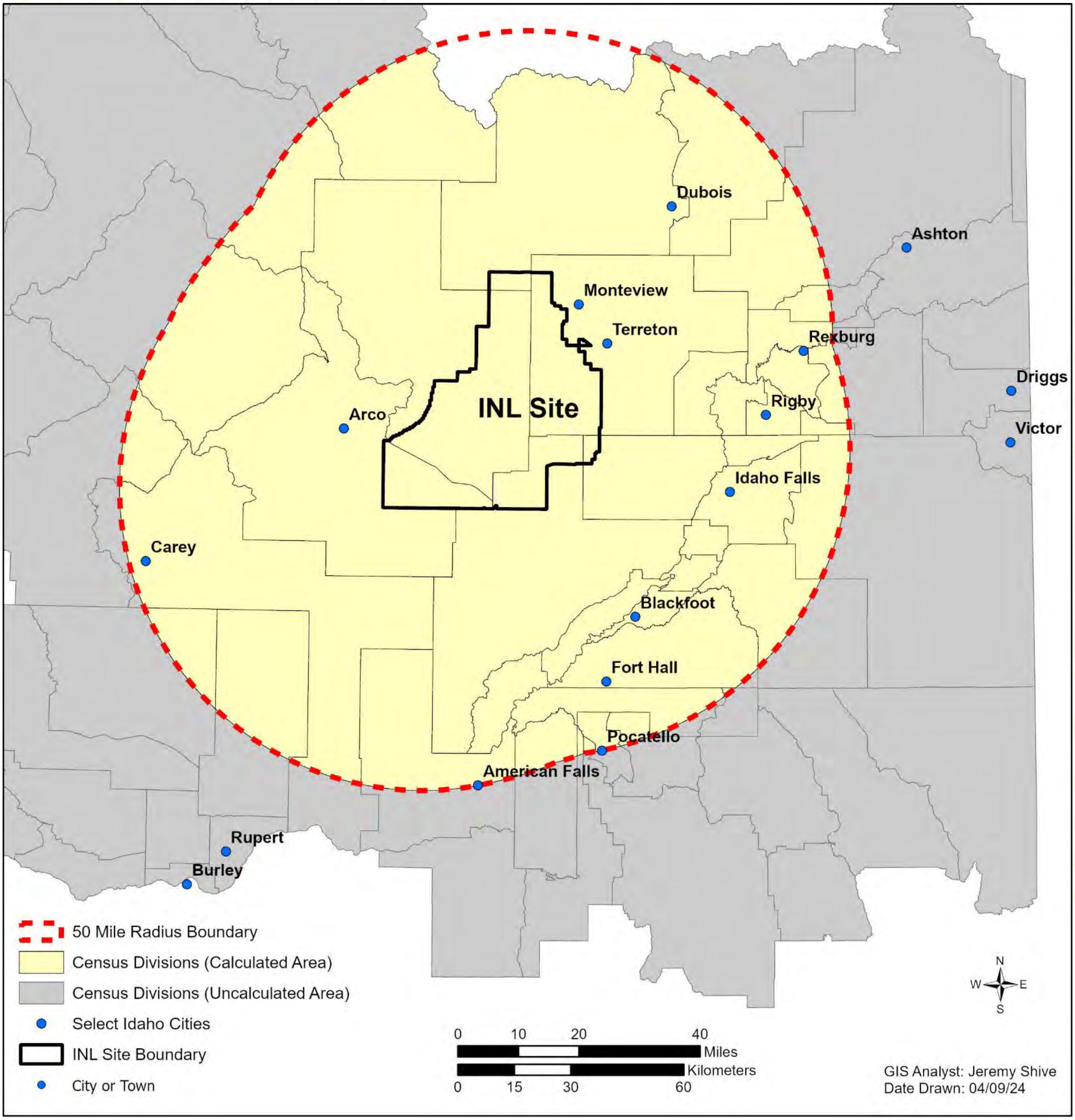

Figure 8-5. Region within 80 km (50 miles) of INL Site facilities. Census divisions used in the 50-mile population dose calculation are shown.

Table 8-2. Particulate radionuclide source term (Ci yr^{-1}) for radionuclide-facility combinations that contributed greater than 0.005% of the total dose for INL Site facilities at the MEI location (2023).

RADIONCULIDE	ATRC[a]	ATRC-ATR[a]	ATRC-MTR[a]	CFA[a]	CITRC[a]	INTEC[a]	INTEC-MS[a]	MFC[a]	MFC -MS[a]	MFC-TREAT[a]	NRF[a]	RRTR[a]	RWMC[a]	SMC[a]	TAN[a]	TOTAL (Ci yr^{-1})[b]
Americium-241	2.18E-05	NS	—	NS	—	1.30E-05	NS	NS	—	—	—	—	5.49E-05	—	—	9.01E-05
Barium-82	—[d]	—	—	NS	—	—	—	NS	—	—	—	6.29E+00	—	—	—	6.29E+00
Chlorine-36	—	—	—	NS	—	NS	—	7.17E-03	—	—	—	NS	—	—	—	7.17E-03
Cobalt-60	5.90E-03	NS	NS	NS	—	NS	—	—	—	—	—	—	NS	—	—	5.90E-03
Cesium-134	NS	—	NS	NS	—	—	—	8.59E-04	—	—	—	—	—	—	—	8.60E-04
Cesium-137	5.23E-03	NS	NS	NS	—	3.78E-04	NS	7.64E-03	—	NS	NS	—	NS	—	—	1.34E-02
Neptunium-237	NS	—	—	—	—	NS	—	1.42E-05	—	—	—	—	—	—	—	1.42E-05
Plutonium-239	NS	—	—	—	—	NS	NS	4.95E-06	NS	NS	NS	—	2.57E-05	—	—	4.68E-05
Plutonium-240	NS	—	—	—	—	NS	NS	NS	—	—	—	—	5.89E-06	—	—	1.07E-05
Plutonium-242	NS	—	—	—	—	NS	—	1.26E-06	—	—	—	—	—	—	—	1.26E-06
Strontium-90	2.82E-02	—	—	—	—	3.00E-04	NS	1.22E-03	NS	NS	NS	—	NS	—	NS	2.98E-02
Uranium-234	NS	—	NS	—	—	NS	—	7.66E-02	—	—	—	—	—	NS	—	7.66E-02
Uranium-235	NS	—	NS	—	—	NS	—	3.49E-03	—	NS	—	—	NS	NS	—	3.49E-03
Uranium-238	NS	—	NS	—	—	NS	—	1.45E-01	—	NS	—	—	NS	NS	—	1.45E-01

a. ATRC = Advanced Test Reactor Complex, ATRC-ATR = Advanced Test Reactor Complex-Advanced Test Reactor, ATRC-MTR = Advanced Test Reactor Complex-Material Test Reactor, CFA = Central Facilities Area, CITRC = Critical Infrastructure Test Range Complex, INTEC = Idaho Nuclear Technology and Engineering Center, INTEC-MS = Idaho Nuclear Technology and Engineering Center-Main Stack, MFC = Materials and Fuels Complex, MFC-MS = Materials and Fuels Complex-Main Stack, MFC-TREAT = Materials and Fuels Complex-Transient Reactor Test Facility, NRF = Naval Reactors Facility, RRTR = Radiological Response Test Range, RWMC = Radioactive Waste Management Complex (including Advanced Mixed Waste Treatment Project), SMC = Specific Manufacturing Capability, TAN = Test Area North (including Technical Support Facility).

b. Total curies reported in this column may not match the sum of the numeric values shown in the row as values reported as NS are included in this sum.

c. NS = not significant. The radionuclide contribution was estimated to be < 0.005% of the total MEI dose from that facility.

d. A long dash signifies no emissions reported in 2023.

Table 8-3. Noble gases, iodine, tritium and carbon-14 source term (Ci yr^{-1}) for radionuclide-facility combinations that contributed greater than 0.005% of the total dose for INL Site facilities at the MEI location (2023).

RADIONUCLIDE	ATRC[a]	ATRC-ATR[a]	ATRC-MTR[a]	CFA[a]	CITRC[a]	INTEC[a]	INTEC-MS[a]	MFC[a]	MFC-TREAT[a]	NRF[a]	RRTR[a]	RWMC[a]	SMC[a]	TAN[a]	TOTAL (Ci yr^{-1})[b]
Argon-41	NS	1.97E+03	—	NS	—	—	—	—	7.46E+01	—	NS	—	—	—	2.04E+03
Carbon-14	NS	—	NS	NS	—	NS	—	—	—	2.10E-01	—	2.22E-02	—	—	2.35E-01
Tritium	1.76E+01	5.05E+02	6.50E+00	3.62E-01	NS	NS	NS	2.17E+02	—	NS	—	4.29E+01	—	NS	7.90E+02
Iodine-129	NS	—	—	NS	—	1.39E-04	NS	—	—	NS	—	—	—	—	1.52E-04
Iodine-131	NS	NS	—	1.41E-02	—	—	—	NS	—	NS	—	—	—	—	1.41E-02
Krypton-85m	NS	NS	—	NS	—	—	—	—	9.21E+00	—	—	—	—	—	1.13E+01
Krypton-87	NS	NS	—	NS	—	—	—	—	9.65E+00	—	NS	—	—	—	1.65E+01
Krypton-88	NS	NS	—	NS	—	—	—	—	8.77E+00	—	—	—	—	—	1.26E+01
Krypton-89	—[d]	—	—	—	—	—	—	—	3.16E+01	—	—	—	—	—	3.16E+01
Xenon-133	NS	3.44E+02	—	NS	—	—	—	NS	NS	—	—	—	—	—	3.44E+02
Xenon-135	NS	NS	—	NS	—	—	—	—	2.41E+00	—	—	—	—	—	2.09E+01
Xenon-138	NS	NS	—	—	—	—	—	—	1.49E+01	—	—	—	—	—	3.16E+01

a. ATRC = Advanced Test Reactor Complex, ATRC-ATR = Advanced Test Reactor Complex-Advanced Test Reactor, ATRC-MTR = Advanced Test Reactor Complex-Material Test Reactor, CFA = Central Facilities Area, CITRC = Critical Infrastructure Test Range Complex, INTEC = Idaho Nuclear Technology and Engineering Center, INTEC-MS = Idaho Nuclear Technology and Engineering Center-Main Stack, MFC = Materials and Fuels Complex, MFC-MS = Materials and Fuels Complex-Main Stack, MFC-TREAT = Materials and Fuels Complex-Transient Reactor Test Facility, NRF = Naval Reactors Facility, RRTR = Radiological Response Test Range, RWMC = Radioactive Waste Management Complex (including Advanced Mixed Waste Treatment Project), SMC = Specific Manufacturing Capability, TAN = Test Area North (including Technical Support Facility). MFC-MS is not included in this table as it had no emissions of noble gases, iodine, tritium, or carbon-14 reported in 2023.

b. Total curies reported in this column may not match the sum of the numeric values shown in the row as values reported as NS are included in this sum.

c. NS = not significant. The radionuclide contribution was estimated to be < 0.005% of the total MEI dose from that facility.

d. A long dash signifies no emissions reported in 2023.

Table 8-4. Radionuclide source term (Ci yr^{-1}) for radionuclides that contributed greater than 0.1% of the total dose for INL in-town facilities (2023).

RADIONUCLIDE	IF-603[a]	IF-611[a]	IF-683[a]	ANNUAL RELEASE (Ci yr^{-1})
Actinium-227	—[b]	—	5.06E-09	5.06E-09
Americium-241	—	—	1.04E-07	1.04E-07
Americium-243	—	—	2.09E-09	2.09E-09
Barium-133	8.17E-11	—	3.15E-07	3.15E-07
Cobalt-60	4.98E-13	—	3.51E-08	3.51E-08
Cesium-134	3.12E-07	—	1.26E-08	3.25E-07
Cesium-137	2.67E-08	—	7.38E-08	1.00E-07
Europium-152	2.03E-17	—	4.04E-08	4.04E-08
Europium-154	1.11E-12	—	1.60E-07	1.60E-07
Iodine-125	—	—	7.22E-08	7.22E-08
Iodine-131	—	—	2.12E-07	2.12E-07
Lead-210	—	—	4.26E-08	4.26E-08
Neptunium-237	—	—	6.48E-09	6.48E-09
Plutonium-238	—	—	7.71E-08	7.71E-08
Plutonium-239	—	—	1.32E-07	1.32E-07
Protactinium-231	—	—	1.15E-09	1.15E-09
Radium-226	—	—	7.52E-08	7.52E-08
Sodium-22	—	—	7.01E-08	7.01E-08
Strontium-90	—	—	6.71E-08	6.71E-08
Tritium	—	—	1.35E-04	1.35E-04
Uranium-232	—	—	3.12E-08	3.12E-08
Uranium-233	—	—	1.64E-07	1.64E-07
Xenon-133	—	4.50E-01	—	4.50E-01

a. IF-603 = INL Research Complex Laboratory, IF-611 = National Security Laboratory, and IF-683 = Radiological and Environmental Sciences Laboratory.
b. A long dash signifies no emissions reported in 2023.

Outputs from the NOAA HYSPLIT model were radionuclide air concentrations and deposition amounts for a unit release (1 Ci/s) for each significant INL Site source calculated at 17,877 grid nodes across the model domain. These values were converted to dispersion and deposition factors for use in DOSEMM (Rood 2019).

The dispersion factor, often referred to as the X/Q value (concentration divided by source), was calculated by dividing the concentration in the air (Ci/m^3) by the unit release rate (1 Ci/s) resulting in dispersion factor units of s/m^3. The deposition factor was calculated by dividing the total deposition (Ci/m^2) by the release time (seconds), then dividing that total by the unit release rate (1 Ci/s) to yield deposition factors in units in 1/m^2. Dispersion and deposition factors were calculated for each month of the year and were read into DOSEMM along with the annual radionuclide release rates from each source. Although annual release quantities were provided, monthly release quantities could have been used if available to account for seasonal variations in atmospheric dispersion.

Using DOSEMM, the actual estimated radionuclide emission rate (Ci/s) for each radionuclide and each facility was multiplied by the air dispersion and deposition factors that were calculated by HYSPLIT to yield an air concentration

(Ci/m³) and deposition (Ci/m²) at each of the grid points over the time of interest (in this case, one year). The products were then used to calculate the effective dose (mrem) via inhalation, ingestion, and external exposure pathways at each grid point and at each boundary receptor location using the methodology described in Rood (2019).

Figure 8-6 displays the summation of the doses calculated from the modeling of all releases from the facilities (including INL in-town facilities) as isopleths, ranging in value from 0.0008 to 0.8 mrem (0.008 to 8 µSv). The highest dose to an INL Site boundary receptor was estimated to be 0.00601 mrem (0.0601 µSv) at a farmhouse and cattle operation (e.g., Receptor 26, which is the same receptor location in Figure 8-1). The farmhouse and cattle operation are also the MEI location used for the NESHAP dose assessment in 2023, which reported an estimated dose of 0.029 mrem (0.29 µSv) to the MEI (see Section 8.2.1). The lower dose of the HYSPLIT/DOSEMM model are attributed to the generally lower HYSPLIT dispersion factors when compared to those from CAP88-PC and the one-year buildup time in soil in DOSEMM for external exposure compared to 100-year buildup time in CAP88-PC (Rood 2024). The HYSPLIT dispersion factors reflect differences in plume trajectory, turbulent diffusion, terrain complexities, plume depletion, and sector averaging between the HYSPLIT and CAP88-PC models.

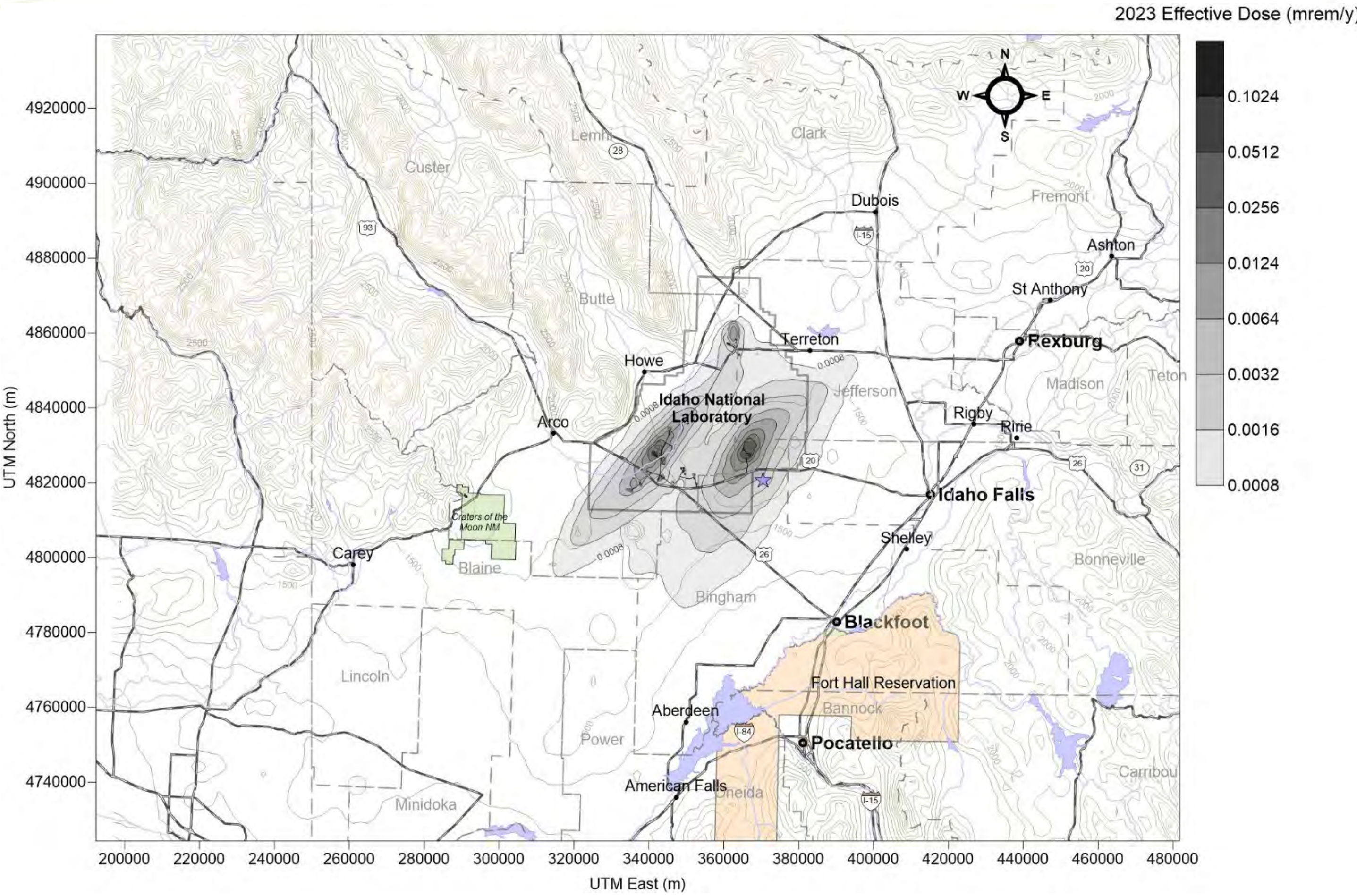

Figure 8-6. Effective dose (mrem) isopleth map with boundary receptor locations displayed (2024). *The maximum receptor dose is projected at a farmhouse and cattle operation as depicted as a blue star east of the INL east entrance. This is the same location as Receptor 26 in Figure 8-1.*

To calculate the 80 km (50 mi) population dose, the number of people living in each census division was first estimated with data from the 2020 census and extrapolated to 2023. The extrapolation of the population for each census division was performed by calculating the change in the population during the last ten-year period between censuses (i.e., 2010–2020), then the result was divided by ten to yield the rate of change per year. The rate of change per year was adjusted for the 2023 time period and applied to the 2020 population to estimate the number of people living in each census division. The next step involved the use of the geographic information system. The grid and dose values from DOSEMM were imported into the geographic information system. The doses within each census division were averaged and multiplied by the population within each of the divisions or division portions within the 80 km (50 mi) area defined in Figure 8-5. These doses were then summed over all census divisions to obtain the 80 km (50 mi) population dose. The estimated potential population dose was 0.031 person-rem (0.00031 person-Sv) to a population of approximately 353,789. When compared with the approximate population dose of 133,025 person-rem (e.g., 1,330 person-Sv) estimated to be received from natural background radiation, as observed in Table 8-5, this represents an increase of about 0.00002 percent.

The estimated population dose for 2023 is greater than that calculated for 2022 (0.019 person-rem), primarily due to increased emissions from ATR, as core internal change out (CIC) was completed and reactor operations resumed.

Table 8-5. Contribution to estimated annual dose from INL Site facilities by pathway (2023).

PATHWAY	ANNUAL DOSE TO MEI		PERCENT OF DOE 100 mrem/yr LIMIT[a]	ESTIMATED POPULATION DOSE		POPULATION WITHIN 80 km	ESTIMATED BACKGROUND RADIATION POPULATION DOSE (PERSON-rem)[b]
	(mrem)	(μSv)		(PERSON-rem)	(PERSON-Sv)		
Air	0.029	0.29	0.029	0.031	0.00031	353,789	133,025
Waterfowl	0.026	0.26	0.026	NA[c]	NA	NA	NA
Big Game Animals	0.000	0.00	NA	NA	NA	NA	NA
TOTAL, ALL PATHWAYS	**0.055**	**0.55**	**0.055**	**0.031**	**0.00031**	**NA**	**NA**

a. The DOE public dose limit from all sources of ionizing radiation and exposure pathways that could contribute significantly to the total dose is 100 mrem/yr (1 mSv/yr) total effective dose equivalent. It does not include dose from background radiation.

b. The individual background dose was estimated to be 376 mrem or 0.376 rem in 2023, as shown previously in Table 7-5. The background population dose is calculated by multiplying the individual background dose by the population within 80 km (50 mi) of the INL Site.

c. NA = Not applicable.

8.3 Dose to the Public from Ingestion of Wild Game from the INL Site

The potential dose that an individual may receive from occasionally ingesting meat from game animals continues to be studied at the INL Site. These studies estimate the potential dose to individuals who may eat waterfowl that may briefly reside at wastewater disposal ponds at the ATR Complex and game animals that may reside on or migrate through the INL Site.

8.3.1 Waterfowl

The maximum potential dose of 0.026 mrem (0.26 μSv) calculated for an individual consuming contaminated waterfowl based on 2023 sample results showed an increase from the dose estimated for 2022 (0.0009 mrem [0.009 μSv]). The 2023 dose estimate is below the maximum potential dose from the past 10 years (0.49 mrem [4.9 μSv]) and the 0.89 mrem (8.9 μSv) dose estimated from the most contaminated ducks taken from the evaporation ponds between 1993 and 1998 (Warren et al. 2001). As in the past, the 2023 samples were not collected directly from the warm wastewater evaporation ponds at the ATR Complex but from sewage lagoons adjacent to them. The dose calculation assumes the waterfowl resided at all the ponds while in the area.

8.3.2 Big Game Animals

A study on the INL Site from 1972–1976 conservatively estimated the potential whole-body dose that could be received from an individual eating the entire muscle (27,000 g [952 oz]) and liver mass (500 g [17.6 oz]) of an antelope with the highest levels of radioactivity found in these animals. This dose was 2.7 mrem (27 µSv) (Markham et al. 1982). Game animals collected at the INL Site during the past few years have generally shown much lower concentrations of radionuclides. In 2023, none of the game samples collected (e.g., four elk and one mule deer) had a detectable concentration of ^{137}Cs or other human-made radionuclides. Therefore, no dose from human-made radionuclides would be associated with the consumption of these animals.

The contribution of game animal consumption to the population dose is calculated because only a limited percentage of the population hunts game, few animals killed have spent time on the INL Site, and most of the animals that migrate from the INL Site would have reduced concentrations of radionuclides in their tissues by the time they were harvested (Halford, Markham, and White 1983). The total population dose contribution from these pathways would realistically be less than the sum of the population doses from the inhalation of air, submersion in air, ingestion of vegetables, and deposition on soil.

8.4 Dose to the Public from Drinking Groundwater from the INL Site

Tritium has previously been detected in three U.S. Geological Survey wells located on the INL Site along the southern boundary (Mann and Cecil 1990; Bartholomay, Hopkins, and Maimer 2015; Twining et al. 2021). These wells, located in an uninhabited area, have shown a historical downward trend in tritium detections. The maximum concentration from all the wells on the INL Site (3,620 ± 130 pCi/L) in 2023 is considerably less than the maximum contaminant level established by EPA for drinking water (20,000 pCi/L). An individual drinking water from a well with the maximum concentration would hypothetically receive a dose of 0.173 mrem (0.00173 mSv) in one year. Because these wells are not used for drinking water, this is an unrealistic scenario, and the groundwater ingestion pathway is not included in the total dose estimate to the MEI.

8.5 Dose to the Public from Direct Radiation Exposure along INL Site Borders

The direct radiation exposure pathway from gamma radiation to the public is monitored annually using optically-stimulated luminescent dosimeters, as previously shown in Figure 7-3.

In 2023, the external radiation dose (116 mrem) measured along the INL Site boundary was statistically equivalent to the calculated background radiation dose (119 mrem) and, therefore, does not represent a dose resulting from INL Site operations.

8.6 Dose to the Public from All Pathways

DOE O 458.1 establishes a radiation dose limit to a member of the general public from all possible pathways as a result of DOE facility operations. This limit is 100 mrem/yr (1 mSv/yr) above the dose from background radiation and includes the air transport, ingestion, and direct exposure pathways, as indicated in Figure 8-7. For 2023, the only probable pathways from INL Site activities to a realistic MEI include the air transport pathway and ingestion of game animals.

The hypothetical individual, assumed to live at a farmhouse and cattle operation located 3.1 km south of Highway 20 and 3 km from INL Site's east entrance, as presented previously in Figure 8-1 and Figure 8-6, would receive a calculated dose from INL Site airborne releases reported for 2023 (see Section 8.2.1) and from consuming a duck contaminated by the ATR Complex wastewater ponds (see Section 8.3.1). No dose was calculated from eating big game animals in 2023 (see Section 8.3.2).

The dose estimate for an offsite MEI is presented in Table 8-5. The total all pathways dose was conservatively estimated to be 0.055 mrem (0.55 µSv) for 2023. This represents about 0.01 percent of the annual dose expected to be received from background radiation (376 mrem [3.8 mSv], as shown in Table 7-5) and is well below the 100 mrem/yr (1 mSv/yr) public dose limit above the background radiation dose established by DOE. As discussed in the Helpful Information section of this report, the 100 mrem/yr limit is far below the exposure levels expected to result in acute health effects.

The dose received by the entire population within 80 km (50 mi) of INL Site facilities was calculated to be 0.031 person-rem (0.00031 person-Sv), as identified in Table 8-5. This is approximately 0.00002 percent of the dose (133,025 person-rem, [1,330 person-Sv], Table 8-5) expected from exposure to natural background radiation in the region.

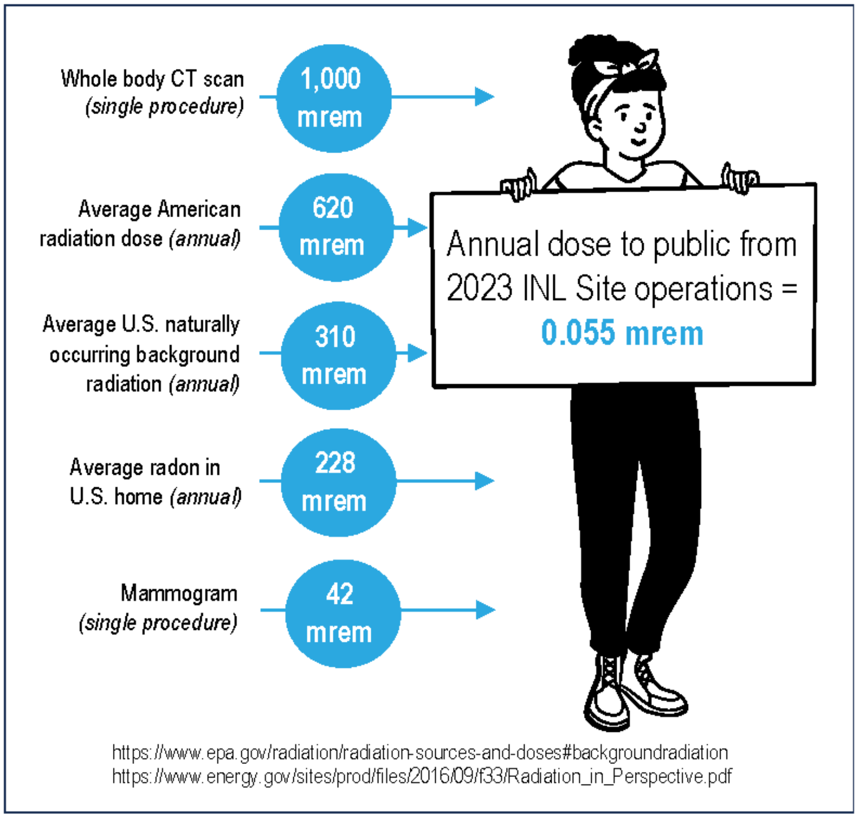

Figure 8-7. Radiation doses associated with some common sources.

8.7 Dose to the Public from Operations on the INL Research and Education Campus

Facilities in Idaho Falls that reported potential radionuclide emissions for inclusion in the 2023 NESHAP report include the IRC Laboratory (IF-603), DOE Radiological and Environmental Sciences Laboratory (IF-683), and the National Security Laboratory (IF-611). These facilities are located contiguously at IRC, which is part of the Research and Education Campus on the north side of the city of Idaho Falls. Though programs and operations at IRC are affiliated with INL, IRC is located within the city limits of Idaho Falls and is not contiguous with the INL Site. The nearest boundary of the INL Site is about 35 km (22 mi) west of Idaho Falls. For this reason, the 2023 INL NESHAP evaluation (DOE-ID 2024) includes a dose calculation to a member of the public that is separate from the INL Site MEI. (Note: The Research and Education Campus source term was, however, included in the population dose calculation reported in Section 8.2.2.) The IRC MEI for calendar year 2023 is approximately 147 meters south-southeast of IF-683. The effective dose equivalent to the MEI was conservatively calculated, using CAP88-PC, to be 0.0048 mrem/yr (0.048 µSv/yr), which is less than 0.1 percent of the 10-mrem/yr federal standard.

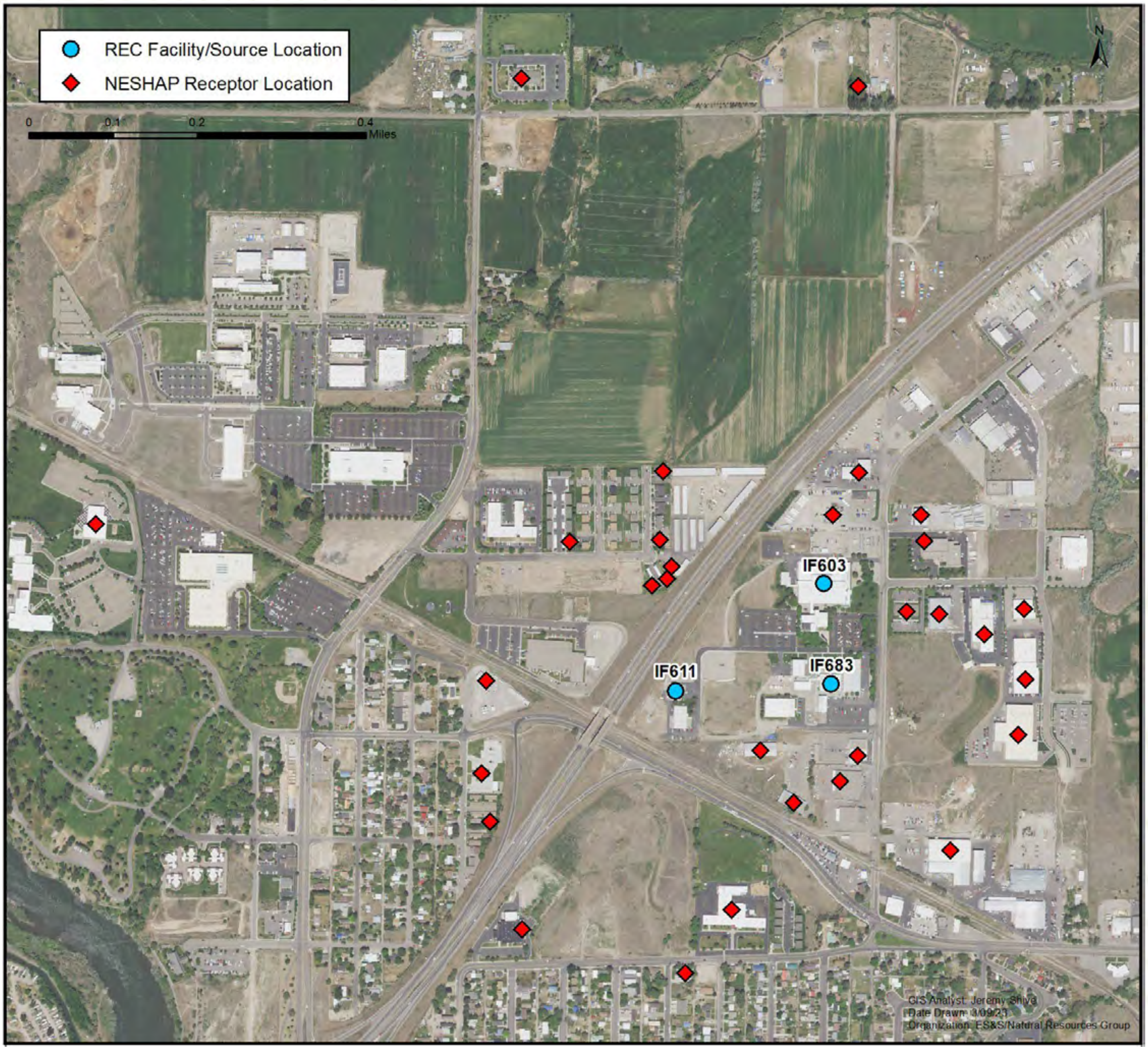

Figure 8-8. INL Research and Education Campus sources (IF-611, IF-603, and IF-683) and receptor locations used in the 2023 NESHAP report.

8.8 Dose to Biota

8.8.1 Introduction

The impact of environmental radioactivity at the INL Site on nonhuman biota was assessed using "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (DOE 2019) and the associated software, RESRAD-Biota 1.8 (DOE 2019). The graded approach includes a screening method and three more detailed levels of analysis for demonstrating compliance with standards for the protection of biota. The threshold of protection is assumed at the following absorbed doses: 1 rad/d (10 mGy/d) for aquatic animals, 0.1 rad/d (1 mGy/d) for riparian and terrestrial animals, and 1 rad/d (10 mGy/d) for terrestrial plants.

The first step in the graded approach uses conservative default assumptions and maximum values for all currently available data. This general screening level (Level 1 in RESRAD-Biota) provides generic limiting concentrations of radionuclides in environmental media, termed "Biota Concentration Guides." Each biota concentration guide is the environmental concentration of a given radionuclide in soil or water that, under the assumptions of the model, would result in a dose rate of less than 1 rad/d (10 mGy/d) to aquatic animals or terrestrial plants or of 0.1 rad/d (1 mGy/d) to riparian or terrestrial animals. If the sum of the measured maximum environmental concentrations divided by the biota concentration guides (i.e., the combined sum of fractions) is less than one, no negative impact to plant or animal populations is expected. Doses are not calculated unless the screening process indicates a more detailed analysis is necessary. Failure at this initial screening step does not necessarily imply harm to organism populations. Instead, it is an indication that more realistic model assumptions may be necessary.

If the screening process indicates the need for a more site-specific analysis, an analysis is performed using site-representative parameters (e.g., distribution coefficients, bioconcentration factors) instead of the more conservative default parameters. This is Level 2 in RESRAD-Biota.

The next step in the graded approach methodology involves a site-specific analysis employing a kinetic modeling tool provided in RESRAD-Biota (Level 3). Multiple parameters that represent contributions to the organism internal dose (e.g., body mass, consumption rate of food/soil, inhalation rate, lifespan, biological elimination rates) can be modified to represent site- and organism-specific characteristics. The kinetic model employs equations relating body mass to internal dose parameters. At Level 3, bioaccumulation (the process by which biota concentrate contaminants from the surrounding environment) can be modeled to estimate the dose to a plant or animal. Alternatively, concentrations of radionuclides measured in the tissue of an organism can be input into RESRAD-Biota to estimate the dose to the organism.

The final step in the graded approach involves an actual site-specific biota dose assessment. This would include a problem formulation, analysis, and risk characterization protocol similar to that recommended by the EPA (1998). RESRAD-Biota cannot perform these calculations.

8.8.2 Terrestrial Evaluation

The division of the INL Site into evaluation areas based on potential soil contamination and habitat types is of particular importance for the terrestrial evaluation portion of the 2023 biota dose assessment. For the INL Site, it is appropriate to consider specific areas that have been historically contaminated above background levels. Most of these areas have been monitored for radionuclides in soil since the early 1970s (Jessmore, Lopez, and Haney 1994). In some of these areas, structures have been removed and areas cleaned to a prescribed, safe contamination level, but the soil may still have residual, measurable concentrations of radionuclides. These areas are associated with the facilities shown in Figure 1-4 and include the following:

- Auxiliary Reactor Area
- ATR Complex
- Critical Infrastructure Test Range Complex
- INTEC
- Large Grid, a 24-mile radius around INTEC
- MFC
- NRF
- RWMC
- TAN.

For the initial terrestrial evaluation, the most recently measured maximum concentrations of radionuclides in INL Site soil were used, as discussed in Table 8-7. The table includes laboratory analyses of soil samples collected in 2005, 2006, 2012, 2015, and 2022 (soil samples were not collected on the INL Site in 2016, 2018, 2019, 2020, 2021, or 2023).

Using the maximum radionuclide concentrations for all locations in Table 8-7, a screening level analysis was made of the potential terrestrial biota dose. The soil concentrations are conservative because background concentrations were not subtracted. The analysis also assumed that animals have access to water in facility effluents and ponds. The maximum radionuclide concentrations reported in ponds at the INL Site were for the MFC Industrial Waste Pond presented in Table A-17. The results for $^{233/234}U$ and ^{238}U in Table A-17 in Appendix A (i.e., 0.88 pCi/L and 0.388 pCi/L, respectively) were used to represent surface water concentrations. When $^{233/234}U$ was reported, it was assumed that the radionuclide present was ^{233}U since doses due to ingestion and inhalation are more conservative for ^{233}U than for ^{234}U (EPA 2002).

The combined sum of fractions was less than one for both terrestrial animals (0.21) and plants (0.002) and passed the general screening test, as indicated in Table 8-8. Based on the results of the graded approach, there is no evidence that INL Site-related radioactivity in soil is harming terrestrial plant or animal populations.

Bat carcasses have been collected on the INL Site since the summer of 2015 under an Idaho Department of Fish and Game scientific collection permit to assess the effects exposure to INL Site radionuclides may have on the health of bat populations, as required by the INL Site Bat Protection Plan (DOE-ID 2018). Bat carcasses that are discovered in facility buildings or outside in areas near facilities, may be sent to a qualified laboratory to assess the presence of radionuclides. The analysis results can be used to calculate the potential dose bats receive. Bats are typically desiccated when received and generally weigh a few grams each. The samples collected in 2023 were analyzed for gamma-emitting radionuclides (^{60}Co and ^{137}Cs), for specific alpha-emitting radionuclides (plutonium isotopes and ^{241}Am), and for a beta-emitting radionuclide (^{90}Sr).

In 2023, bat carcasses were divided and composited by the following areas: ATR Complex, Central Facilities Area, Materials and Fuels Complex, Naval Reactors Facility, Radioactive Waste Management Complex, and Test Area North.

The bat analysis results are summarized in Table 8-6. The following radionuclides were detected in at least one sample during 2023: ^{241}Am, ^{137}Cs, ^{60}Co, $^{239/240}Pu$, and ^{90}Sr.

Table 8-6. Radionuclide concentrations detected in bats collected in 2023.

BAT TISSUE CONCENTRATIONS (pCi/g)			
RADIONUCLIDE	MINIMUM[a]	MAXIMUM[b]	NUMBER OF DETECTIONS[c]
Americium-241	0.017 ± 0.005	0.017 ± 0.005	1
Cesium-137	0.354 ± 0.097	2.98 ± 0.24	3
Cobalt-60	1.38 ± 0.15	17.40 ± 1.09	2
Plutonium-239/240	0.024 ± 0.007	0.024 ± 0.007	1
Strontium-90	0.853 ± 0.097	14.80 ± 1.36	3

a. Minimum detected concentration.
b. Maximum detected concentration.
c. Out of six composites analyzed.

Concentrations of radionuclides in tissue were input into the RESRAD-Biota computer model at the Level 3 step to calculate the internal dose to bats. The results of the dose evaluation to bats using radionuclide concentrations measured in their tissue, water, and soil are shown in Table 8-9. The maximum dose received by bats at the INL Site was estimated to be 0.0014 rad/d (0.014 mGy/d) in 2023. The calculated doses are well below the threshold of 0.1 rad/d (1 mGy/d). Based on these results, members of the bat population at the INL Site receive an absorbed dose that is within the DOE standard established for the protection of terrestrial animals.

8.8.3 Aquatic Evaluation

Maximum radionuclide concentrations reported in Table A-17 of Appendix A (results for the MFC Industrial Waste Pond) were also used for aquatic evaluation. The results shown in Table 8-10 indicate that INL Site-related radioactivity in ponds and liquid effluents is not harming aquatic biota. The combined sum of fractions was less than one for both aquatic animals (0.006) and riparian animals (0.002).

Tissue data from waterfowl collected on the ATR Complex wastewater ponds in 2023 were also available, as shown previously in Table 7-2 of Chapter 7. Concentrations of radionuclides in tissue can be input into the RESRAD-Biota code at the Level 3 step to calculate the internal dose to biota. To confirm that doses to waterfowl from exposure to radionuclides in the vicinity of the ATR Complex are not harmful, a Level 3 analysis was performed using the maximum tissue concentrations from Table 7-2. The waterfowl were assumed in the model to be riparian animals, accessing both aquatic and terrestrial environments in the area. External dose was calculated using the maximum radionuclide concentrations measured in soils around the ATR Complex and uranium concentrations in water. The concentrations of uranium in sediment were estimated by the RESRAD-Biota code from the concentrations in water.

Results of the dose evaluation to waterfowl using radionuclide concentrations measured in tissue are shown in Table 8-11. The estimated dose to waterfowl was calculated by RESRAD-Biota to be 0.00036 rad/d (0.0036 mGy/d). This dose is significantly less than the standard of 0.1 rad/d (1 mGy/d). Based on these results, there is no evidence that water held in ponds at the INL Site is harming aquatic biota.

Table 8-7. Concentrations of radionuclides in INL Site soils, by area.

LOCATION[a]	RADIONUCLIDE	DETECTED CONCENTRATION (pCi/g)[b]	
		MINIMUM	MAXIMUM
ARA/CITRC	Cesium-134	4.0E-02	6.0E-02
	Cesium-137	1.3E-01	3.0
	Strontium-90	2.1E-01	3.7E-01
	Plutonium-238	—[c]	3.9E-03
	Plutonium-239/240	1.3E-02	1.8E-02
	Americium-241	5.5E-03	8.5E-03
ATR Complex	Cesium-137	2.0E-1	6.1E-01
	Strontium-90	—	5.8E-02
	Plutonium-238	5.9E-03	4.3E-02
	Plutonium-239/240	1.7E-02	2.2E-02
EFS	Cesium-137	1.7E-01	6.2E-01
	Strontium-90	—	2.1E-01
	Plutonium-239/240	—	1.9E-02
INTEC	Cesium-134	—	8.0E-02
	Cesium-137	3.0E-02	3.5
	Strontium-90	4.9E-01	7.1E-01
	Plutonium-238	2.5E-02	4.3E-02
	Plutonium-239/240	1.1E-02	2.9E-02
	Americium-241	6.1E-03	8.1E-03
MFC	Cesium-134	4.0E-02	6.0E-02
	Cesium-137	1.3E-01	4.9E-01

Table 8-7. continued

LOCATION[a]	RADIONUCLIDE	DETECTED CONCENTRATION (pCi/g)[b]	
		MINIMUM	MAXIMUM
	Cobalt-60	—	5.0E-02
	Plutonium-239/240	1.5E-02	2.9E-02
	Americium-241	4.3E-03	1.2E-02
NRF	Cesium-134	—	6.0E-02
	Cesium-137	—	3.3E-01
	Plutonium-239/240	5.7E-03	1.6E-02
	Americium-241	4.3E-03	9.7E-03
Rest Area	Cesium-137	2.3E-01	3.3E-01
	Strontium-90	—	1.1E-01
	Plutonium-239/240	—	2.0E-02
	Americium-241	—	1.3E-02
RWMC	Cesium-137	8.0E-02	6.2E-01
	Strontium-90	5.6E-02	2.3E-01
	Plutonium 238	9.9E-03	2.4E-02
	Cesium-134	—	6.0E-02
	Plutonium-239/240	1.6E-02	1.6E+00
	Americium-241	1.4E-02	1.2E+00
TAN/SMC	Cesium-134	4.0E-02	6.0E-02
	Cesium-137	1.1E-01	3.1
	Plutonium-239/240	1.3E-02	1.7E-02
	Americium-241	3.2E-03	5.7E-03
All	Cesium-134	4.0E-02	8.0E-02
	Cesium-137	3.0E-02	3.5E+00
	Cobalt-60	—	5.0E-02
	Strontium-90	5.6E-02	7.1E-01
	Plutonium-238	5.9E-03	4.3E-02
	Plutonium-239/240	5.7E-03	1.6E+00
	Americium-241[d]	3.2E-03	1.2E+00

a. ATR Complex = Advanced Test Reactor Complex, ARA/CITRC = Auxiliary Reactor Area/Critical Infrastructure Test Range Complex, EFS = Experimental Field Station, MFC = Materials and Fuels Complex, INTEC = Idaho Nuclear Technology and Engineering Center, RWMC = Radioactive Waste Management Complex, TAN/SMC = Test Area North/Specific Manufacturing Capability. See Figure 1-6.

b. Legend:

a.	Results measured in 2013–2014 using in situ gamma spectroscopy.
b.	Results measured by laboratory analyses of soil samples collected in 2005.
c.	Results measured by laboratory analyses of soil samples collected in 2006.
d.	Results measured by laboratory analyses of soil samples collected in 2012.
e.	Results measured by laboratory analyses of soil samples collected in 2015.
f.	Results measured by laboratory analyses of soil samples collected in 2022.

c. — indicates that only one measurement was taken and is reported as the maximum result.

d. The data were the results of laboratory analysis for Americium-241 in soil samples.

Table 8-8. RESRAD-Biota assessment (screening level) of terrestrial ecosystems on the INL Site (2023).

TERRESTRIAL ANIMAL						
	WATER			SOIL		
NUCLIDE	CONCENTRATION (pCi/l)	BCG[a] (pCi/l)	RATIO	CONCENTRATION (pCi/g)	BCG (pCi/g)	RATIO
Americium-241	—	2.02E+05	—	1.2	3.89E+03	3.08E-04
Cobalt-60	—	1.19E+06	—	0.05	6.92E+02	7.23E-05
Cesium-134	—	3.26E+05	—	0.08	1.13E+01	7.97E-03
Cesium-137	—	5.99E+05	—	3.5	2.08E+01	1.69E-01
Plutonium-238	—	1.89E+05	—	0.043	5.27E+03	8.16E-06
Plutonium-239	—	2.00E+05	—	1.6	6.11E+03	2.62E-04
Strontium-90	—	5.45E+04	—	0.71	2.25E+01	3.16E-02
Uranium-233	0.88	4.01E+05	2.20E-06	—	4.83E+03	—
Uranium-238	0.39	4.06E+05	9.56E-07	—	1.58E+03	—
SUMMED	**—**	**—**	**3.15E-06**	**—**	**—**	**2.08E-01**
TERRESTRIAL PLANT						
	WATER			SOIL		
NUCLIDE	CONCENTRATION (pCi/l)	BCG (pCi/l)	RATIO	CONCENTRATION (pCi/g)	BCG (pCi/g)	RATIO
Americium-241	—	7.04E+08	—	1.2	2.15E+04	5.57E-05
Cobalt-60	—	1.49E+07	—	0.05	6.13E+03	8.16E-06
Cesium-134	—	2.28E+07	—	0.08	1.09E+03	7.36E-05
Cesium-137	—	4.93E+07	—	3.5	2.21E+03	1.59E-03
Plutonium-238	—	3.95E+09	—	0.043	1.75E+04	2.46E-06
Plutonium-239	—	7.04E+09	—	1.6	1.27E+04	1.26E-04
Strontium-90	—	3.52E+07	—	0.71	3.58E+03	1.98E-04
Uranium-233	0.88	1.06E+10	8.30E-11	—	5.23E+04	—
Uranium-238	0.39	4.28E+07	9.06E-09	—	1.57E+04	—
SUMMED	**—**	**—**	**9.14E-09**	**—**	**—**	**2.05E-03**

a. BCG = Biota Concentration Guide. Each radionuclide-specific BCG represents the limiting radionuclide concentration in an environmental medium, which would not result in recommended dose standards for biota to be exceeded.

Table 8-9. RESRAD-Biota assessment (level 3 analysis) of terrestrial ecosystems on the INL Site using measured bat tissue data (2023).

BAT DOSE (rad/d)					
NUCLIDE	WATER	SOIL	SEDIMENT	TISSUE[a]	SUMMED
Americium-241	—	1.42E-06	—	9.47E-05	9.61E-05
Cobalt-60	—	6.21E-06	—	1.52E-04	1.59E-04
Cesium-134	—	9.30E-05	—	8.69E-05	9.30E-05
Cesium-137	—	9.91E-05	—	3.92E-05	1.38E-04
Plutonium-238	—	7.99E-07	—	7.98E-07	7.99E-07
Plutonium-239/240	—	1.90E-08	—	1.28E-04	1.28E-04
Strontium-90	—	4.27E-06	—	7.65E-04	7.69E-04
Uranium-233/234	2.19E-07	—	—	2.19E-07	2.19E-07
Uranium-238	8.61E-08	—	—	8.49E-08	8.61E-08
TOTAL	**3.05E-07**	**2.05E-04**	**—**	**1.27E-03**	**1.38E-03[b]**

a. Calculated using maximum concentrations measured in bat tissues.
b. DOE biota dose rate criteria for terrestrial animals is 0.1 rad/day.

Table 8-10. RESRAD-Biota assessment (screening level) of aquatic ecosystems on the INL Site (2023).

AQUATIC ANIMAL						
	WATER			SEDIMENT		
NUCLIDE	CONCENTRATION (pCi/l)	BCG[a] (pCi/l)	RATIO	CONCENTRATION (pCi/g)	BCG (pCi/g)	RATIO
Uranium-233	0.88	2.00E+02	4.41E-03	0.044	1.06E+07	4.15E-09
Uranium-238	0.388	2.23E+02	1.74E-03	0.0194	4.28E+04	4.53E-07
Summed	**—**	**—**	**6.14E-03**	**—**	**—**	**4.57E-07**
RIPARIAN ANIMAL						
	WATER			SEDIMENT		
NUCLIDE	CONCENTRATION (pCi/l)	BCG (pCi/l)	RATIO	CONCENTRATION (pCi/g)	BCG (pCi/g)	RATIO
Uranium-233	0.88	6.76E+02	1.30E-03	0.044	5.28E+03	8.34E-06
Uranium-238	0.388	7.56E+02	5.13E-04	0.0194	2.49E+03	7.80E-06
SUMMED	**—**	**—**	**1.81E-03**	**—**	**—**	**1.61E-05**

a. BCG = Biota Concentration Guide. Each radionuclide-specific BCG represents the limiting radionuclide concentration in an environmental medium which would not result in recommended dose standards for biota to be exceeded.

Table 8-11. RESRAD-Biota assessment (level 3 analysis) of aquatic ecosystems on the INL Site using measured waterfowl tissue data (2023).

WATERFOWL DOSE (rad/d)					
NUCLIDE	WATER[a]	SOIL[b]	SEDIMENT	TISSUE[c]	SUMMED
Americium-241	—	8.45E-07	—	—	8.45E-07
Cobalt-60	—	4.97E-06	—	2.22E-05	2.71E-05
Cesium-134	—	4.78E-06	—	—	4.78E-06
Cesium-137	—	7.58E-05	—	3.27E-05	1.08E-04
Plutonium-238	—	1.76E-10	—	—	1.76E-10
Plutonium-239	—	3.27E-09	—	—	3.27E-09
Strontium-90	—	5.14E-07	—	3.18E-05	3.23E-05
Uranium-233	1.30E-04	NA	8.28E-07	1.31E-04	1.31E-04
Uranium-238	5.04E-05	NA	3.36E-07	5.07E-05	5.08E-05
Zinc-65	—	—	—	7.90E-06	7.90E-06
TOTAL	**1.80E-04**	**8.69E-05**	**1.16E-06**	**2.76E-04**	**3.63E-04[d]**

a. Only uranium isotopes were measured in the Material and Fuels Complex Industrial Waste Pond. Hence, doses were not calculated for other radionuclides in water and sediment.

b. External doses to waterfowl were calculated using soil concentrations. Maximum concentrations of radionuclides measured in soil at the INL Site were used (Table 8-8). Note: NA = uranium isotopes were not analyzed in soil.

c. Internal doses to waterfowl were calculated using maximum concentrations in edible tissue shown in Table 7-2. Note: NA=uranium isotopes were not analyzed for in tissue samples.

d. DOE biota dose rate criteria for riparian animals is 0.1 rad/day.

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Lupin spreading areas

Chapter 9: Natural and Cultural Resources Conservation and Monitoring

CHAPTER 9

Natural resource information is used to demonstrate compliance with applicable rules and regulations and to ensure that the Idaho National Laboratory (INL) Site mission and goals can be achieved with few-to-no impacts to natural resources. There are four key areas of emphasis: (1) conservation planning, (2) special status species, (3) natural resource monitoring and research, and (4) land stewardship.

For species of elevated concern or with extensive populations and key habitats on the INL Site, DOE-ID has developed conservation plans to protect species and the valuable ecosystems they inhabit. These efforts include: (1) the Candidate Conservation Agreement (CCA) for Greater Sage-grouse (*Centrocercus urophasianus*) on the INL Site, (2) the INL Site Bat Protection Plan, (3) the Sagebrush Steppe Ecosystem Reserve, (4) the Migratory Bird Conservation Plan and Avian Protection Planning documents, and (5) the implementation of the U.S. Department of Energy (DOE) Conservation Action Plan. The U.S. Department of Energy's Idaho Operations Office (DOE-ID) also addresses conservation concerns by continually evaluating the regulatory rankings, abundance, and distribution of special status plant and animal species.

Natural resource monitoring and research has been conducted for more than 70 years on the INL Site, with some studies dating back to the 1950s. The focus of this work is to better understand the INL Site's ecosystem and biota and to determine the impact on these species' populations from activities conducted at the INL Site. Natural resource monitoring activities include: (1) breeding bird surveys, (2) midwinter raptor survey, (3) long-term vegetation transects, and (4) vegetation mapping. Additionally, the INL Site was designated as a National Environmental Research Park (NERP) in 1975 and serves as an outdoor laboratory for environmental scientists to study Idaho's native plants and wildlife in an intact and relatively undisturbed ecosystem. Ongoing NERP activities include: (1) addressing ecohydrology in sagebrush steppe, (2) evaluating beta diversity within the context of fire severity, (3) identifying high-quality foodscapes critical to sage-grouse, and (4) validating pygmy rabbit habitat distribution models.

Land stewardship involves managing ecosystems on the INL Site through planning, assessment, restoration, and rehabilitation activities. Areas where DOE-ID is actively employing land stewardship activities include: (1) wildland fire protection planning, management, and recovery; (2) restoration and revegetation; (3) weed management; and (4) ecological support for the National Environmental Policy Act (NEPA).

The INL Cultural Resource Management Office (CRMO) coordinates cultural resource-related activities at the INL Site and implements the 2023 Programmatic Agreement (2023 PA) (DOE-ID 2023) and INL Cultural Resource Management Plan (CRMP) (DOE-ID 2016) with oversight by DOE-ID's Cultural Resource Coordinator. Cultural resource identification and evaluation studies in calendar year 2023 included: (1) archaeological field surveys, (2) cultural resource monitoring and site record updates related to INL Site project activities and research, (3) comprehensive evaluations of pre-1980 built environment resources, and (4) meaningful collaboration with members of the Shoshone-Bannock Tribes and public stakeholders.

9. NATURAL RESOURCES CONSERVATION AND MONITORING

The INL Site is in the Upper Snake River Plain, near the southern extent of the Beaverhead Mountains and the Lemhi and Lost River Ranges. It is host to a variety of wildlife species including, but not limited to, large ungulates, such as elk (*Cervus canadensis*) and pronghorn (*Antilocapra americana*); ten species of bats, commonplace being the western small-footed myotis (*Myotis ciliolabrum*); and sagebrush obligates, such as the sagebrush lizard (*Sceloporus graciosus*) and the Greater Sage-grouse. Herpetofauna, such as the Great Basin rattlesnake (*Crotalus oreganus lutosus*) and the Great Basin spadefoot (*Spea intermontana*), use locally appropriate habitats, as do over 100 species of birds (e.g., raptor, waterfowl, passerine, upland game species). The natural vegetation of the INL Site consists of an overstory of shrubs and an understory of grasses and forbs, or wildflowers. Big sagebrush (*Artemisia tridentata*) and green rabbitbrush (*Chrysothamnus viscidiflorus*) are the most common shrubs, while perennial grasses, such as needle and thread (*Hesperostipa comata*), Sandberg bluegrass (*Poa secunda*), and thickspike wheatgrass (*Elymus lanceolatus*), are generally the most abundant understory species. A diversity of flowering herbaceous forbs occurs in most plant communities, especially under favorable precipitation conditions.

The primary ecosystem of the INL Site is characterized as sagebrush steppe. Approximately 94% of the land on the INL Site is undeveloped (DOE-ID and USFWS 2014), with approximately 60% open to livestock grazing. Over the past two decades, wildland fire has affected natural resources across a substantial portion of the INL Site. Because of threats like these, the sagebrush ecosystem is considered one of the most imperiled ecosystems in the United States (Noss et al. 1995), and these ecosystems are being lost at an alarming rate. In fact, by the early 2000s, only about 56% of their historic range was occupied (Knick et al. 2003; Schroeder et al. 2004). Consequently, natural resources on the INL Site are a high conservation priority for the survival of species that are dependent upon sagebrush steppe (Smith et al. 2023), some of which may be at the risk of local extirpation or even regional loss (Davies et al. 2011). As such, effective natural resource monitoring and land stewardship are imperative to executing the INL Site's mission with minimal impacts to the local flora and fauna.

Natural resources conservation, monitoring, and land stewardship activities on the INL Site can be organized in four categories: (1) planning and implementing conservation efforts for high-priority natural resources; (2) frequently evaluating the regulatory rankings, distribution, and populations for special status species; (3) ongoing monitoring and research to provide baseline and trend data for specific taxa and broader ecological communities; and (4) conducting land stewardship activities to minimize impacts to natural resources and restore ecological condition, where appropriate. Natural resource data collected on vegetation and key wildlife species provide DOE-ID with an understanding of how species use the INL Site and context for analyzing trends. These data are often used in NEPA analyses and enable DOE-ID to make informed decisions for project planning and to maintain up-to-date information on potentially sensitive species on the INL Site. The data are also summarized and reported to support DOE-ID's compliance with environmental regulations, agreements, policies, and Executive Orders (EOs). Finally, conservation management, wildland fire recovery, and vegetation management plans are developed and maintained to provide land management guidance for a variety of land stewardship concerns.

9.1 Conservation Planning

9.1.1 Conservation Action Plan, Ecological Connectivity, and Nature-Based Solutions

EO 14008 (2021), "Tackling the Climate Crisis at Home and Abroad," establishes the need for the United States to increase the speed and scale of necessary actions to mitigate the effects of the climate crisis. This EO states, "The United States will also move quickly to build resilience, both at home and abroad, against the impacts of climate change that are already manifest and will continue to intensify according to current trajectories." Additionally, it requires federal agencies to identify strategies that will encourage broad participation in the goal of conserving 30% of the Nation's lands and waters by 2030.

To address EO 14008 and its requirements, the "Conserving and Restoring America the Beautiful" report was developed by federal resource agencies and the Council on Environmental Quality. The report outlines seven focus areas for early action, and DOE developed a Conservation Action Plan to summarize ongoing and planned conservation projects within each of those focus areas that are broadly applicable across DOE lands. The focus areas that are specifically addressed at each DOE site are related to the complexity and sensitivity of the mission at that site. The following are long-term and ongoing projects that are conducted on the INL Site to address some of these focus areas:

- ***Support Tribal Led Conservation and Restoration Priorities*** – The lands now designated as the INL Site are included in the ancestral homelands of the Shoshone and Bannock people. Archaeological sites on the INL Site and far beyond are held by the Shoshone-Bannock Tribes as evincing their cultural heritage and a reflection of their ancestors. Landmarks, such as the Middle Butte, define home and territory, figure in oral histories that tell how the world came to be the way it is, and provide a living link between contemporary Shoshone and Bannock people and their ancestral homelands. This landscape is part of the tribe's past subsistence and settlement, seasonal grounds for hunting (e.g., bison), plant gathering, travel and trade routes, tool sources (i.e., obsidian), and features many areas that are of great importance or are sacred to them. As a signatory to the "Memorandum of Understanding Regarding Interagency Coordination and Collaboration for the Protection of Indigenous Sacred Sites Among the U.S. Department of the Interior, U.S. Department of Agriculture, U.S. Department of Transportation, U.S. Department of Energy, U.S. Environmental Protection Agency, White House Council on Environmental Quality, Advisory Council on Historic Preservation, and Tennessee Valley Authority," DOE-ID works to provide access to and protection of such sites.

  DOE-ID's long-term relationship with the Shoshone-Bannock Tribes is documented in an Agreement in Principle that formalizes tribal involvement in DOE-ID planning and implementation of environmental restoration, long-term stewardship, cultural resources protections, waste management operations, and nuclear energy programs. For example, the tribes, DOE-ID, the INL contractor, and Bureau of Land Management (BLM) staff are collaborating on restoration efforts at the Birch Creek site to stabilize soils and vegetation in the area. In 2022, soil samples were collected and analyzed so that nutrient deficiencies could be addressed prior to planting. During the spring of 2023, nutrient supplements were applied to the soil surface. The site was hydroseeded with locally appropriate grasses and planted with sagebrush and juniper seedlings during the fall of the same year. In addition, almost 75,000 sagebrush seedlings were planted in the vicinity of the Middle Butte Cave during the fall of 2023 (Section 9.4.2).

- ***Expand Collaborative Conservation of Fish and Wildlife Habitats and Corridors*** – The Idaho Department of Fish and Game (IDFG) has identified sagebrush steppe as one of the most important ecosystems for wildlife in Idaho (IDFG 2023) and the INL Site remains one of the best remaining examples of an intact sagebrush steppe ecosystem in the region. DOE-ID is working to restore these important habitats where they have been impacted by wildland fires or other disturbances by planting sagebrush seedlings (Section 9.4.2), reducing invasive species and noxious weeds (Section 9.4.3), and implementing conservation plans for key species, such as sage-grouse (Section 9.1.2) and bats (Section 9.1.3). DOE-ID has also set aside 29,945 ha (74,000 ac) of sagebrush steppe habitat as an ecosystem reserve (Section 9.1.4). In many cases, these conservation efforts are undertaken in collaboration with federal and state stakeholders, such as the United States Fish and Wildlife Service (USFWS), BLM, IDFG, and the Idaho State Office of Species Conservation.

  Over the past two years, DOE-ID and the INL contractor have been partnering with agency stakeholders to restore important sage-grouse habitat across jurisdictional boundaries using Bipartisan Infrastructure Law (BIL) funds. These restoration efforts will help reestablish ecological integrity and habitat connectivity where it has been impacted by wildfire. Specific restoration treatments include using herbicide to control cheatgrass in the limited areas where it has become abundant and planting sagebrush where it has been slow to recover naturally (Section 9.4.2). In addition to these ongoing efforts, several new conservation opportunities were identified in the Climate Vulnerability and Resilience Planning for INL (see Other Actions Supportive of the America the Beautiful Campaign in this section below).

- ***Increase Access for Outdoor Recreation Opportunities*** – The INL is a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Site. Public access to the INL Site is restricted under the CERCLA program, which establishes a remedial action object to prevent any inadvertent contact with potential unexploded ordnance by members of the public. Currently limited access is allowed for public recreational hunters in designated portions of the INL under the CERCLA program due to crop depredation on surrounding agricultural lands by elk and antelope using the INL Site as refuge. The designated hunting zones are located along the northern and western boundaries of the INL Site adjacent to agricultural lands. Access to the INL Site is administered by the IDFG under an agreement with DOE-ID that establishes specific restrictions for hunting onsite. A valid hunting license and an IDFG-issued INL Site hunting permit are required to access these areas."

- ***Incentivize and Reward Voluntary Conservation Efforts of Fishers, Ranchers, Farmers, and Forest Owners*** – Livestock grazing permits for cattle and sheep are administered by BLM on eight allotments that overlap the INL Site boundary, resulting in approximately 60% of the INL Site that is open to ranching operations. DOE-ID and the INL contractor collaborate with BLM and allotment permittees by attending allotment reviews, providing vegetation monitoring data, reviewing Environmental Assessments (EAs) for activities that may impact the INL Site, and sharing resources for fire recovery of sagebrush ecosystems and sagebrush habitat restoration. These parties also cooperate to ensure that conservation measures, such as ensuring that fences are wildlife-compatible and water troughs are located to minimize impacts to vegetation, are implemented and yield the desired outcome. In many cases, these conservation measures have the potential to reduce impacts from livestock operations on natural resources and increase efficiencies for permittees.
- ***Other Actions Supportive of the America the Beautiful Campaign*** – Along with the Conservation Action Plan (DOE 2021a), DOE also developed the Climate Adaptation and Resilience Plan (CARP; DOE 2021b) in response to EO 14008. The CARP provides a framework for developing a Vulnerability Assessment and Resilience Plan for each DOE site. The INL Vulnerability Assessment and Resilience Plan, or "Climate Vulnerability Assessment and Resilience Planning for Idaho National Laboratory" (Ischay and Nate 2022), identifies programmatic and technological solutions to increase resilience to climate change across INL Site facilities (see Chapter 3), and it also includes opportunities to increase climate resilience across the natural landscape through inventory, monitoring, and implementing resource management plans. Finally, DOE-ID and the INL contractor are participating in DOE's Sustainable Climate-Ready Sites program, which is a voluntary recognition program designed to foster excellence in sustainability, climate resilience, and natural resource protection. This program supports implementation of the Conservation Action Plan and the CARP.

In addition to EO 14008 (2021), DOE-ID and the INL contractor are addressing several other federal strategies for improving the health of the ecosystem and enhancing climate resilience of the sagebrush steppe native to the INL Site. These strategies include direction and guidance for developing nature-based solutions, outlined in EO 14072 (2022); Council of Environmental Quality Guidance on Ecological Connectivity and Wildlife Corridors (2023), and aspects of DOE Order 436.1A (2023), Departmental Sustainability, that pertain to land and natural resource management. Many facets of the INL's current Natural Resources Program support these conservation-based strategies; however, more recent initiatives include the development of a comprehensive wildland fire recovery framework (Section 9.4.1) and enhancing habitat connectivity through cooperative restoration efforts (Section 9.4.2). Because DOE has identified their NERPs as important venues for facilitating research partnerships to enhance ecosystem services and develop innovative nature-based solutions, the INL contractor continues to improve NERP processes and pursue opportunities for collaborative ecological research (Section 9.3.5).

9.1.2 Candidate Conservation Agreement for Greater Sage-grouse

Populations of greater sage-grouse (hereafter, sage-grouse) have declined in recent decades (Coates et al. 2022), and the species range-wide distribution across western North America has been reduced to nearly half of its historical distribution (Schroeder et al. 2004, Connelly et al. 2011a). Healthy stands of sagebrush (*Artemisia* spp.) are necessary for sage-grouse to survive throughout the year; however, young sage-grouse also require a diverse understory of native forbs and grasses during the summer months. Sagebrush habitats that consist of a diversity of vegetation provide protection from predators and supply high-protein insects necessary for rapidly growing chicks (Connelly et al. 2011b). Sagebrush habitats have been greatly altered during the past 150 years and are currently at risk from a variety of pressures (Connelly et al. 2004; Davies et al. 2011; Knick et al. 2011). Because of sage-grouse reliance on broad expanses of sagebrush, there is concern about the trajectory of sage-grouse populations.

When sage-grouse were petitioned for listing under the Endangered Species Act of 1973 (ESA), DOE-ID recognized the need to reduce the potential for impact to existing and future mission activities. In 2014, DOE-ID entered into a CCA with the USFWS to identify threats to the species and their habitat and develop conservation measures and objectives to avoid or minimize threats to sage-grouse. This voluntary agreement established a Sage-Grouse Conservation Area (SGCA; Figure 9-1), and DOE-ID committed to deprioritize the SGCA when planning infrastructure development and to establish mechanisms for reducing human disturbance of breeding and nesting sage-grouse (DOE-ID and USFWS 2014).

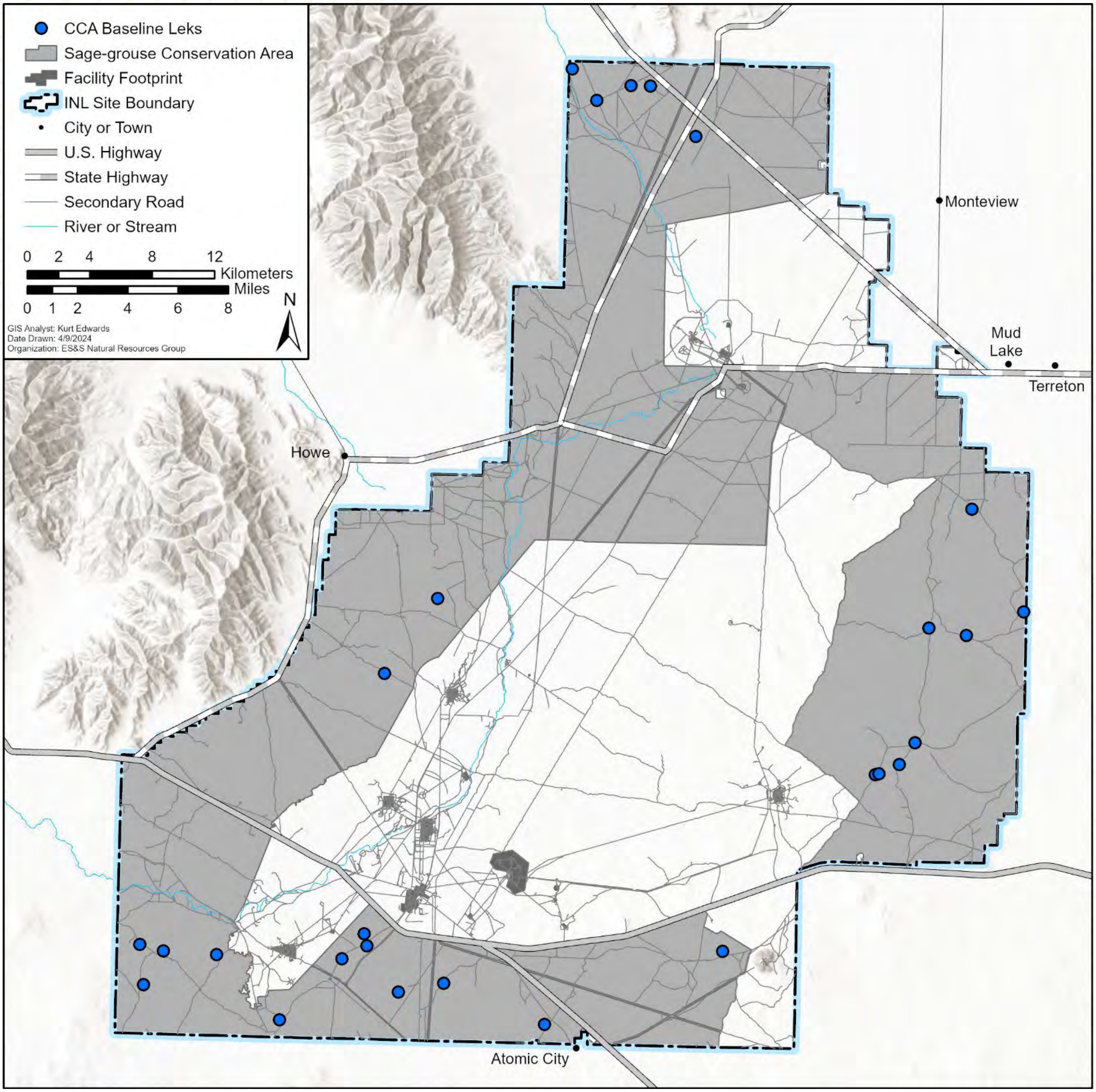

Figure 9-1. Area defined by the CCA for Greater Sage-grouse onsite as a SGCA and location of baseline leks used for determining the population trigger.

To evaluate sage-grouse population declines with respect to their natural range of variation, the CCA established population and habitat triggers. The baseline value for the sage-grouse population trigger for the INL Site equals the number of males counted in 2011 during peak male attendance on 27 active leks within the SGCA (i.e., 316 males). The population trigger will be tripped if the three-year running average of males on those 27 baseline leks decreases ≥ 20% (i.e., ≤ 253 males). The baseline value of the original habitat trigger was equivalent to the amount of area within the SGCA that was characterized as sagebrush-dominated habitat at the beginning of 2013. After a CCA stakeholder meeting in February 2022, it was agreed upon that the sagebrush habitat trigger baseline would be updated using the most recent vegetation map (Shive et al. 2019). The updated baseline value for sagebrush habitat is 72,300 ha (178,656 ac) and the habitat trigger will trip if there is a reduction of ≥ 20% (14,460 ha [35,731 ac]) of sagebrush habitat within the SGCA. Total sagebrush habitat area and distribution are monitored using aerial imagery and a geographic information system (GIS). If a trigger is tripped, an automatic response by both DOE and USFWS would be initiated, as described in the CCA (DOE-ID and USFWS 2014).

The INL contractor biologists monitor sage-grouse populations, sagebrush habitats, and activities that are considered threats to sage-grouse survival on the INL Site. For details about the most recent annual results, refer to Implementing the Candidate Conservation Agreement for Greater Sage-Grouse on the Idaho National Laboratory Site 2023 Full Report (INL 2024a).

Population and Habitat Status

Each spring, biologists monitor sage-grouse that have congregated on leks for breeding purposes. Baseline and all other active leks are monitored multiple times from March 20 until peak male attendance has been determined and recorded. Inactive leks are also surveyed every five years to determine whether the lek status has changed. During 2023, the peak male attendance on baseline leks was 304—a 23.6% increase of males observed in 2022. The three-year (2021–2023) running average of peak male attendance on baseline leks increased 11.2% to 259 males, exceeding the population trigger threshold of 253 males. This was the first year since 2018 that the three-year average has increased, returning the running average above the population threshold, which effectively reset the population trigger that had tripped in 2022. Furthermore, male sage-grouse attendance on lek routes monitored by IDFG increased 8% when compared to 2022 (Kemner 2023) with the INL contractor observing a lek route attendance increase of 13.5% during the same period (INL 2024b).

Two monitoring tasks are designed to identify vegetation changes across the landscape and assist in maintaining an accurate record of the condition and distribution of the sagebrush habitat within the SGCA to facilitate annual evaluation of the habitat trigger: (1) sagebrush habitat condition, and (2) sagebrush habitat amount and distribution. Monitoring sagebrush condition provides data used to track annual changes in sagebrush habitat on the INL Site. Data collected to support this task may also be used to document gains in habitat as non-sagebrush map polygons transition back into sagebrush classes or to document losses when compositional changes occur within sagebrush polygons that may require a change in the assigned map class. This task is also designed to track losses to sagebrush habitat following events that alter vegetation communities, such as wildland fires and land development. As updates are made to map classes (e.g., vegetation polygon boundaries), the total area of mapped sagebrush habitat is compared to the baseline value established for the habitat trigger to determine the status with respect to the habitat threshold.

Together, these two monitoring tasks provide the basis for maintaining an accurate map and estimate of the condition and quantity of sagebrush habitat on the INL Site. The condition of sagebrush habitat remained high in 2023. Sagebrush cover was near the upper range of its historical range of variability. Herbaceous cover exceeded its range of variability, and the abundance of non-natives was generally low. The total area of sagebrush habitat in the SGCA on the INL Site remained unchanged from 2022 to 2023, with 71,358.8 ha (176,331.4 ac). To date, a total loss of sagebrush habitat in the SGCA of approximately 1.3% has been reported.

Threats and Associated Conservation Measures

The CCA identifies and rates eight threats that potentially impact sage-grouse and their habitats on the INL Site, including wildland fire, grazing, infrastructure development, and raven predation. Conservation measures have been assigned to each threat and consist of actions aimed toward mitigating impacts to the sage-grouse and its habitat by INL Site activities. This is accomplished through the avoidance and minimization of threats by using best management practices (BMPs) such as setting seasonal and time-of-day restrictions. DOE-ID also recognizes that sagebrush-dominated communities outside of the SGCA serve as important habitats for sage-grouse, so BMPs that guide infrastructure development and other land use decisions were developed and applied to the entire INL Site.

9.1.3 Bat Protection Plan

Over the past several decades, newly identified threats to bat populations (e.g., white-nose syndrome and large-scale commercial wind energy development) have caused widespread mortality events in bats and resulted in precipitous declines of numerous common bat species and elevated conservation concern for bats across the United States, including additional listings under the ESA. Bats represent over 30% of mammal species described for the INL Site. Large undisturbed areas of shrub-steppe habitat, basalt outcrops, lava caves, juniper uplands, and ponds and landscape trees at industrial facilities provide complex and abundant foraging and roosting habitat for a variety of resident and transient bat species. Since the early 1980s, the INL Site has supported bat research either through program funding or through outside-funded projects managed under the NERP. These efforts have promoted general bat conservation and provided critical conservation data to DOE-ID decision-makers and state and federal resource agencies. The result of numerous publications, reports, conservation assessments, and theses has been the recognition of the INL Site and surrounding desert as crucial bat habitat.

In 2011, DOE-ID and the Naval Reactors Laboratory Field Office/Idaho Branch Office decided to increase the attention they give to bat resources and initiate the development of a comprehensive INL Site-wide bat protection and monitoring program. In 2018, the INL Site Bat Protection Plan was finalized (DOE-ID 2018), which provides a framework for eliminating mission impacts associated with protected bat species, monitoring the status of bat populations, providing current data for environmental analyses, and engaging resource agency stakeholders such as the USFWS, BLM, and IDFG on bat issues. The Idaho National Laboratory Site Bat Protection Plan Annual Report 2023 provides the most current INL Site bat data (INL 2023).

During 2023, work performed under the INL Site Bat Protection Program scope included the following activities: there were 2,665,618 total files collected from acoustic monitoring stations; five caves were monitored year-round, four additional caves were monitored during the winter (November–April) months, two additional caves were monitored during the summer (May–October) months, two locations around the Middle Butte were also monitored during the summer (May–October) months, and eight facilities were monitored during the summer (May–October) months. Of the total number of files, 813,261 files (105,472 identifiable as bat files) were from facilities, while the remaining 1,852,357 files (141,579 identifiable as bat files) were from caves. Ongoing monitoring efforts show consistent patterns in seasonal bat distribution. The summer resident bat community consists predominantly of western small-footed myotis, Townsend's big-eared bat (*Corynorhinus townsendii*), big brown bat (*Eptesicus fuscus*), and western long-eared myotis (*Myotis evotis*) with some little brown myotis (*Myotis lucifugus*) and silver-haired bat (*Lasionycteris noctivagans*) detected at moderate levels at a few locations. Low levels of summer activity of hoary bat (*Lasiurus cinereus*) were detected at many monitoring locations. Western small-footed myotis was the most detected bat species at all surveyed features (facilities and caves). Little brown myotis are more commonly detected at facilities than at cave sites. Tree bats (hoary bats and silver-haired bats) were detected more frequently at facilities than caves. The results of the passive monitoring program are providing critical information regarding bat distribution, ecology, and conservation on the INL Site. The INL Site also participated in the North American Bat Monitoring program, facilitated by the United States Geological Survey (USGS) in 2023, collecting acoustic data in two priority grid cells as part of a nationwide sampling framework. These data were provided to IDFG.

In addition to acoustical bat monitoring at the INL Site, several other activities were performed to address bat conservation. To support surveillance for white-nose syndrome (a disease impacting hibernating bats), humidity/temperature dataloggers were checked and reset in eight monitored hibernacula during the summer of 2023. Two live bats were found in areas of facilities that were disrupting work and were relocated to safe areas. There was one other bat that was not interfering with work activities and left to disperse on its own. Thirty bat carcasses were recovered from facilities and submitted for radiological testing. Additionally, multiple public events were held at the Idaho Falls Zoo, Harriman State Park, and Museum of Idaho.

9.1.4 Sagebrush Steppe Ecosystem Reserve

On July 19, 2004, DOE-ID signed a Finding of No Significant Impact for an EA and Management Plan that outlined a framework to collaboratively manage the Idaho National Engineering and Environmental Laboratory (INEEL) Sagebrush Steppe Ecosystem Reserve (SSER) with the BLM, USFWS, and IDFG. The SSER includes 29,945 ha (74,000 ac) of high desert land in the north central portion of the INL Site. In the 1999 Proclamation establishing the SSER, then

Secretary of Energy Bill Richardson recognized that the "Reserve is a valuable ecological resource unique to the Intermountain West and contains lands that have had little human contact for over 50 years. The sagebrush steppe ecosystem across its entire range was listed as a critically endangered ecosystem by the National Biological Service in 1995, having experienced greater than a 98% decline since European Settlement." Because the SSER represents a unique ecological resource, "conservation management of the area is intended to maintain the current plant community and provide the opportunity for study of an undisturbed sagebrush steppe ecosystem." The Proclamation also specified that traditional rangeland uses will be allowed to continue under the SSER management designation and that Public Land Orders, which withdrew INL lands, would supersede SSER management objectives if the land was needed to support INL's nuclear energy research mission (DOE-ID 2004).

Specific actions to guide the SSER management according to its mission and management goals were provided in the INEEL Sagebrush Steppe Ecosystem Reserve Final Management Plan (DOE-ID 2004). The primary actions included in the preferred alternative for managing the SSER were as follows: (1) establishment of a Reserve Management Committee, (2) reduction in road access and use, (3) implementation of an integrated weed management plan, (4) limitation of restoration actions to locally collected plant materials, (5) no changes in livestock class or increase in stocking levels, (6) no construction of wells for livestock watering purposes, (7) minimization of anthropogenic structures for raptor perching, and (8) responding to wildland fire suppression and post-fire restoration in a manner that is consistent with INL's Wildland Fire EA.

Implementation of the SSER Management Plan and associated actions were contingent on funding allocations from the cooperating agencies because those agencies recognized that innovative funding sources would likely be required for timely implementation. To date, the cooperating agencies have been unable to identify funding resources sufficient to establish the SSER managing committee and fully implement the SSER Management Plan. As such, DOE-ID is currently evaluating actions to improve the management of the SSER. However, DOE-ID and the INL contractor continue to consider the mission and goals of the SSER Management Plan in their planning processes and land management decisions on the INL Site. When federal actions are proposed by DOE-ID on or including portions of the SSER, the restrictions on travel, infrastructure development, and other activities described in the SSER Management Plan are documented and applied to any proposed actions through the INL NEPA process.

9.1.5 Migratory Bird Conservation and Avian Protection Planning

Most activities at the INL Site are conducted within fenced, industrial complexes that are up to several hundred acres in size. General actions from day-to-day operations that may affect migratory birds include mowing vegetated areas for wildland fire protection, maintenance of utilities and infrastructure, and moving equipment such as trailers and nuclear fuel casks. It is not unusual to encounter a variety of animals, including migratory birds, while conducting these activities. As directed in EO 13186 (2001) and outlined in a 2013 Memorandum of Understanding between the DOE and USFWS (Federal Register 2013), DOE-ID has developed a Migratory Bird Conservation Plan (DOE-ID 2022) that provides a framework for protecting and conserving migratory birds and their habitat in accordance with the Migratory Bird Treaty Act of 1918 and the Bald and Golden Eagle Protection Act of 1940 while accomplishing critical DOE-ID and Naval Reactors Laboratory Field Office/Idaho Branch Office missions.

DOE-ID maintains a Special Purpose Permit issued by USFWS that allows for the destruction or relocation of a pre-determined number of migratory bird nests, when permit conditions are met. Additionally, a Scientific Collection Permit issued by IDFG allows for the retrieval or harvest of certain migratory birds with the intent of using them for scientific and monitoring purposes. All practicable minimization and avoidance efforts identified in the Migratory Bird Conservation Plan are to be implemented before parties exercise their ability to take migratory birds under these permits. The conservation plan identifies measures that are designed to eliminate or minimize impacts on migratory birds and to protect their habitat. These measures include the protection of native vegetation, avoiding disturbing nesting birds, reducing the potential for conflicts with INL missions, and enhancing native habitat as practical. Conservation measures are identified through the NEPA process, which assesses the potential impacts on migratory birds during the implementation of a project or activity. The plan also identifies BMPs that are implemented across the INL Site. These BMPs include routine surveys of structures, equipment, and vegetated areas conducted during nesting season (i.e., April 1 to October 1) to ensure project activities do not disturb or otherwise interfere with active nests. If an active nest with eggs or chicks is discovered, all work that could result in the abandonment or destruction of the nest is suspended and the appropriate environmental personnel are contacted for assistance and guidance. Until a determination is made whether to remove the nest, actions are conducted to ensure the nest is not abandoned due to work activities.

In 2019, DOE-ID established a Migratory Bird/Wildlife Conservation Working Group to provide a forum for discussing, resolving, and collaborating on all activities related to migratory bird and other wildlife matters arising on the INL Site. The primary task of this group is to promote the conservation of migratory birds, share ideas to minimize the impact of nesting birds to operations, and ensure compliance with permit requirements. Accomplishments to date include the development of online Migratory Bird Awareness Training for environmental staff, facility maintenance, operations, and program managers; mitigation actions, such as incorporating critical equipment inspections into daily operations orders to identify nesting activities; use of window dressings to reduce mortality from window collisions; and effectively exchanging information regarding the use of relocating bird eggs or young to licensed rehabilitators are used as options in lieu of unavoidable destruction and take situations.

The INL contractor has developed an Avian Protection Plan and Bird Management Policy (MCP-3367 2016) in accordance with Avian Power Line Interaction Committee requirements (Avian Power Line Interaction Committee 2006). This plan includes documenting, tracking, and correcting conditions that resulted in a migratory bird's death. When birds are electrocuted, power poles are either retrofitted or modified with avian protection devices during the next scheduled power outage. These efforts help to reduce future electrocutions. Avian interactions are also considered when siting new power line locations and when replacing existing power poles to reduce risks to migratory birds through proactive and innovative resolutions.

On July 14, 2022, an unauthorized removal of swallow nests occurred at a bus stop at the Central Facilities Area (CFA) that resulted in the take of seven nests with viable eggs and 10 hatchlings.

Additional corrective actions taken in 2023 related to the incident included:

- A nest inspection form was developed for use at all mission centers. This form allows personnel to identify areas where nesting birds may impact mission or personnel, areas where deterrents may be installed, locations where nests have been located, and whether eggs were present within the nests.
- Signage was developed and provided to mission centers that alerts employees to the presence of an active nest and identifies the appropriate point of contact for any activities that may need to occur within the area.
- A Corrective Action Review Board meeting was held where the corrective actions taken related to this event were evaluated and subsequently approved.

On May 2, 2023, INL personnel located two dead great horned owls (*Bubo virginianus*) near a tree used for nesting at CFA. Staff from the Natural Resource Group (NRG) were notified and made the determination to submit the owls to IDFG for necropsies to determine case of death. Initial observations by IDFG wildlife health personnel were consistent with the exposure to anticoagulants with subsequent toxicology analyses indicating secondary poisoning of the owls from rodenticide.

Corrective actions taken in 2023 related to this incident included:

- The INL temporarily suspended the use of rodenticides
- The INL began reviewing all pesticides for potential impacts to wildlife
- The INL initiated an improvement agenda to help ensure events similar to this do not occur in the future.

On July 26, 2023, the Naval Reactors Facility reported the unauthorized destruction of seven active barn swallow (*Hirundo rustica*) nests at the facility. This event is currently under evaluation.

In 2023, a total of 211 birds, 10 nests, and 15 eggs were salvaged near INL facilities. Information collected about the location of these birds is used to inform the placement of visual deterrents that may reduce bird collisions with infrastructure. One great horned owl was found dead along the powerlines. The power poles will either be retrofitted or modified with avian protection devices during the next scheduled power outage. An additional three migratory species (waterfowl) were collected for radionuclide analysis; details of this effort can be found in Section 7.2.8 of this report.

9.2 Special Status Species

9.2.1 Wildlife

The INL Site provides breeding and foraging habitat for a variety of species, including 28 species of birds and 11 species of mammals, one reptile, and one amphibian species that are of elevated conservation concern by state or federal agencies. Several of these species are sagebrush obligates, while others use habitats that are very localized on the INL Site, such as juniper woodlands or surface water features. Many of these species are detected or monitored during annual survey efforts, including the midwinter raptor counts, sage-grouse lek counts, breeding bird surveys, and bat acoustical monitoring.

Federally Listed Wildlife Species

Several species currently listed according to the ESA have been documented in the state of Idaho, including the North American wolverine (*Gulo gulo luscus*) and the Canada lynx (*Lynx canadensis*); however, due to habitat requirements of these and other listed species, they are not likely to occur on the INL Site. Several species that have either been proposed for listing under the ESA or have been recovered and delisted occur seasonally or are considered residents of the INL Site. The bald eagle (*Haliaeetus leucocephalus*), delisted in 2007, is commonly seen during the winter months on or near the INL Site. Species associated with sagebrush habitats, such as the pygmy rabbit (*Brachylagus idahoensis*) and the sage-grouse, have been proposed for listing under the ESA in recent years. In 2015, the USFWS deemed the listing of sage-grouse unwarranted because “the primary threats to sage-grouse have been ameliorated by conservation efforts implemented by federal, state, and private landowners” (Federal Register 2015). On March 6, 2023, the USFWS received a petition to list the pygmy rabbit under the ESA, however, a final determination as to the status of this species has yet to be made.

While no wildlife species currently listed under the ESA are known to occur on the INL Site, there are at least 27 wildlife species of conservation concern identified by the BLM as special status species (Type 2) that have been documented on the INL Site (see Table 9-1). A BLM ranking of Type 2 indicates that a species is a candidate, was delisted within the past five years, is an experimental population, or has a proposed critical habitat by the USFWS (BLM 2008). Some of these species would also be considered sensitive if they were assigned a global or state conservation status ranking of three or less by NatureServe (2023). Of these BLM Type 2 species, some of the most common at the INL Site include the sage thrasher (*Oreoscoptes montanus*), the loggerhead shrike (*Lanius ludovicianus*), the ferruginous hawk (*Buteo regalis*), and the sage-grouse. Currently, DOE-ID and the USFWS are signatories on a CCA for the sage-grouse and sage-grouse habitat; details of this agreement are discussed in Section 9.1.2.

State Sensitive Wildlife Species

At least 36 wildlife species identified in the Statewide Wildlife Action Plan (IDFG 2024a) by the IDFG as Species of Greatest Conservation Need (SGCN) or Species of Greatest Information Need have been documented on the INL Site (see Table 9-1). These include occasional sightings of species, such as the American white pelican (*Pelecanus erythrorhynchos*) and the ring-billed gull (*Larus delawarensis*), to more commonly observed species, such as the sage-grouse and the burrowing owl (*Athene cunicularia*). As with BLM special status species, many SGCN species are detected or monitored during annual survey efforts at the INL Site; additional details of these survey efforts are discussed in Sections 9.3.1 and 9.3.2.

Table 9-1. Special status animal taxa documented to occur on the INL Site.

COMMON NAME	SCIENTIFIC NAME	GLOBAL RANK†	STATE RANK†	BLM RANK‡	IDFG RANK	USESA STATUS	SEASONAL OCCURRENCE
American white pelican	*Pelecanus erythrorhynchos*	G4	S3B	—	I	Species of Concern	Migrant
bald eagle	*Haliaeetus leucocephalus*	G5	S5	Type 2	—	Delisted / Recovery	Migrant, Winter
big brown bat	*Eptesicus fuscus*	G5	S3	Type 2	I	Species of Concern	Year-round
black-throated sparrow	*Amphispiza bilineata*	G5	S2B	Type 2	—	Species of Concern	Migrant, Summer
Brewer's sparrow	*Spizella breweri*	G5	S3B	Type 2	C	Species of Concern	Migrant, Breeding
bobolink	*Dolichonyx oryzivorus*	G5	S2B	—	C	—	Summer
burrowing owl	*Athene cunicularia*	G4	S2B	Type 2	C	Species of Concern	Migrant, Breeding
California gull	*Larus californicus*	G5	S2B, S5N	—	C	—	Migrant
California myotis	*Myotis californicus*	G5	S3	Type 2	—	Species of Concern	Unknown
Clark's nutcracker	*Nucifraga columbiana*	G5	S3	—	C	Species of Concern	Year-round
cinnamon teal	*Spatula cyanoptera*	G5	S3B	—	C	—	Migrant
common nighthawk	*Chordeiles minor*	G5	S3B	—	C	Species of Concern	Migrant, Breeding
desert horned lizard	*Phrynosoma platyrhinos*	G5	S3	—	I	—	Year-round
eared grebe	*Podiceps nigricollis*	G5	S3B, S3N	—	C	—	Migrant
evening grosbeak	*Coccothraustes vespertinus*	G5	S4	—	I	—	Year-round
ferruginous hawk	*Buteo regalis*	G4	S3B	Type 2	C	Resolved	Migrant, Breeding
flammulated owl	*Psiloscops flammeolus*	G4	S3B	Type 2	—	—	Migrant
Franklin's gull	*Leucophaeus pipixcan*	G5	S2B	—	C	Species of Concern	Migrant
fringed myotis	*Myotis thysanodes*	G4	S3	Type 2	—	Species of Concern	Summer
golden eagle	*Aquila chrysaetos*	G5	S3	Type 2	C	Species of Concern	Migrant, Summer, Winter
grasshopper sparrow	*Ammodramus savannarum*	G5	S3B	Type 2	C	Species of Concern	Migrant, Breeding
Great Basin spadefoot	*Spea intermontana*	G5	S3	—	I	—	Year-round, Breeding
greater sage-grouse	*Centrocercus urophasianus*	G3, G4	S2	Type 2	C	Resolved	Year-round, Breeding
green-tailed towhee	*Pipilo chlorurus*	G5	S4B	Type 2	—	Species of Concern	Summer
hoary bat	*Lasiurus cinereus*	G3, G4	S3	Type 2	C	—	Summer, Migratory
little brown myotis	*Myotis lucifugus*	G3	S3	Type 2	C	Petitioned for Listing	Summer
loggerhead shrike	*Lanius ludovicianus*	G4	S3	Type 2	C	Species of Concern	Migrant, Breeding
long-billed curlew	*Numenius americanus*	G5	S2B	Type 2	C	Resolved	Migrant, Breeding
long-legged myotis	*Myotis volans*	G4, G5	S3	Type 2	I	Species of Concern	Summer

Table 9-1. continued.

COMMON NAME	SCIENTIFIC NAME	GLOBAL RANK†	STATE RANK†	BLM RANK‡	IDFG RANK	USESA STATUS	SEASONAL OCCURRENCE
northern pintail	*Anas acuta*	G5	S3B, S3N	—	C	—	Migrant
pronghorn	*Antilocapra americana*	G5	S3	—	C	—	Resident
pygmy rabbit	*Brachylagus idahoensis*	G4	S3	Type 2	C	Petitioned for Listing	Resident
ring-billed gull	*Larus delawarensis*	G5	S3B, S5N	—	C	Species of Concern	Migrant
sage thrasher	*Oreoscoptes montanus*	G4	S3B	Type 2	C	Species of Concern	Migrant, Breeding
sagebrush sparrow	*Artemisiospiza nevadensis*	G5	S2B	Type 2	C	—	Migrant, Breeding
short-eared owl	*Asio flammeus*	G5	S3	Type 2	C	Species of Concern	Year-round, Breeding
silver-haired bat	*Lasionycteris noctivagans*	G3,G4	S3	Type 2	C	Species of Concern	Summer, Migratory
Townsend's big-eared bat	*Corynorhinus townsendii*	G4	S3	Type 2	C	—	Winter
western grebe	*Aechmophorus occidentalis*	G5	S2B	—	C	Species of Concern	Migrant, Summer, Winter
western long-eared myotis	*Myotis evotis*	G5	S3	Type 2	—	—	Year-round
western small-footed myotis	*Myotis ciliolabrum*	G5	S3	Type 2	C	—	Migratory
white-faced ibis	*Plegadis chihi*	G5	S2B	—	C	Species of Concern	Migrant, Summer
Yuma myotis	*Myotis yumanensis*	G5	S3	Type 2	C	—	Year-round

†See NatureServe for a description of rankings (NatureServe 2024)

‡See BLM Manual 6840 – Special Status Species Management for a description of rankings (BLM 2008)

*See IDFG SWAP for a description of rankings (IDFG 2024a)

— = Not applicable

9.2.2 Plants

During the establishment of the INL Site research facilities in the 1950s, the flora and fauna were required to be monitored by the Atomic Energy Commission (Singlevich et al. 1951). Plant specimen collections were made during field surveys and the Plants of the INL herbarium was founded. The herbarium contributes to the knowledge of species historically present across the INL Site. When the ESA was enacted, a list of proposed plant species for conservation protection was developed for the state of Idaho, but botanical professionals indicated there were state-specific data gaps (Henderson et al. 1977). On the INL Site, a concerted effort to survey rare and sensitive plant species was undertaken in the early 1980s, and another similar effort was completed during the early 1990s to fill data gaps and to inform both state and federal assessments (Cholewa and Henderson 1984; Anderson et al. 1996). The INL contractor continues to conduct botanical surveys for special status plant species to support state and federal conservation efforts, to provide information for the NEPA assessment, and to facilitate mission critical activities in a manner that minimizes impacts to sensitive species (Atwood 1969; Cholewa and Henderson 1984; Anderson et al. 1996; Forman 2015).

There are currently 28 special status plant species that have been documented to occur on the INL Site. Many of those species are rare and occur very infrequently within their optimal habitats. Others may have slightly larger population sizes but are restricted by unique habitat requirements. A few special status plants have a widespread distribution across the INL Site.

Federally Listed Plant Species

The state of Idaho is host to five federally listed plant species under the ESA. None of the federally listed species are known to occur on the INL Site. Population occurrences of Ute ladies'-tresses (*Spiranthes diluvialis*) and whitebark pine (*Pinus albicaulis*) have been documented within proximity to the INL Site, but these species require specific habitats, which are negligible or nonexistent within the cold desert steppe site. Although appropriate slickspot peppergrass (*Lepidium papilliferum*) habitat is available on the INL Site, the only known populations do not occur on the INL Site and are located hundreds of miles to the west. There are eight plant species with BLM rankings that are known to occur on the INL Site. Most of these species have very limited distribution and are restricted to areas with unique soils, topography, and associated plant communities.

State Sensitive Plant Species

In addition to those species that receive federal regulatory support, State agencies also maintain a list of sensitive species. The list is a tool for agencies to prioritize conservation efforts and to promote a unified conservation approach statewide, which can be used proactively to avoid potential ESA listings. The Idaho Natural Heritage Program (IDFG 2024b) and the Idaho Native Plant Society established this list of state sensitive species for Idaho in the 1980s at the Idaho Rare Plant Conference (e.g., INPS 2024). Since then, Idaho Rare Plant Working Groups were established, and members currently use the National NatureServe Network framework to assemble species accounts (Faber-Langendoen et al. 2012). The conference provides a collaborative platform for experts from different federal, state, academic, and private organizations to present and evaluate species accounts to determine their conservation status. The state of Idaho manages the associated spatial data within the Idaho Fish and Wildlife Information Systems program and disseminates species' specific information to make species account evaluations available to support special status plant species conservation and assist in assessments of potential environmental impacts for project activities. Additionally, the special status plant list is made publicly available after each list revision by the Idaho Native Plant Society. Species are assigned a global (Global Rank) and subnational ranking (State Rank) to indicate the level of conservation concern. Flora denoted with either a vulnerable rank (G3 or S3), imperiled rank (G2 or S3), or a critically imperiled (G1 or S1) are considered as special status plant species. There have been 28 special status species documented on the INL Site within its diverse composition of sagebrush steppe habitats (see Table 9-2).

Table 9-2. Special status plant taxa documented to occur on the INL Site.

COMMON NAME	SCIENTIFIC NAME	GLOBAL RANK†	STATE RANK†	BLM RANK‡	IDFG RANK*	USESA STATUS	ABUNDANCE
white sand verbena	*Abronia mellifera*	G4	S1	—	—		Rare
Swallen's mountain-ricegrass	*Achnatherum swallenii*	G3	S3	—	—	—	Rare
Webber's needlegrass	*Achnatherum webberi*	G4	S3	—	—	—	Rare
Lemhi milkvetch	*Astragalus aquilonius*	G3	S3	Type 2	—	—	Rare
painted milkvetch	*Astragalus ceramicus* var. *apus*	G4T3	S3	—	—	Resolved	Widespread
plains milkvetch	*Astragalus gilviflorus*	G5	S2	Type 4	—	—	Rare
wingfruit suncup	*Camissonia pterosperma*	G4	S2	Type 4	—	—	Localized
hairy suncup	*Camissonia pubens*	G3	SNR	—	—	—	Rare
Coville's Indian paintbrush	*Castilleja covilleana*	G3	SNR	—	—	—	Rare
smooth goosefoot	*Chenopodium subglabrum*	G3	—	—	—	—	Rare
rosy pussypaws	*Cistanthe rosea*	G5	S2	—	—	—	Rare
desert dodder	*Cuscuta denticulata*	G4G5	S1	—	—	—	Rare
Hooker's buckwheat	*Eriogonum hookeri*	G5	S1	Type 2	—	—	Localized
imperfect buckwheat	*Eriogonum mancum*	G4	S2	—	—	—	Localized
nakedstem gymnosteris	*Gymnosteris nudicaulis*	G4	S3	—	—	—	Localized
fineleaf hymenopappus	*Hymenopappus filifolius* var. *idahoensis*	G5T3	S3	—	—	Resolved	Localized
manybranched ipomopsis	*Ipomopsis polycladon*	G4	S2	Type 3	—	—	Localized
King bladderpod	*Lesquerella kingii*	G5	S3	—	—	—	Rare
Middle Butte bladderpod	*Lesquerella obdeltata*	G2	S2	Type 4	—	—	Rare
sand wildrye	*Leymus flavescens*	G3	SNR	—	—	—	Localized
Torrey's desert dandelion	*Malacothrix torreyi*	G4	S2	—	—	—	Rare
shortflower monkeyflower	*Mimulus breviflorus*	G4	S2	—	—	—	Rare
narrowleaf oxytheca	*Oxytheca dendroidea*	G4	S3	—	—	—	Rare
mountain ball cactus	*Pediocactus simpsonii*	G5?	S3	Type 4	—	—	Localized
hoary phacelia	*Phacelia incana*	G3	SNR	—	—	—	Rare
hidden phacelia	*Phacelia inconspicua*	G2	S1S2	Type 2	—	Species of Concern	Rare

Table 9-2. continued.

COMMON NAME	SCIENTIFIC NAME	GLOBAL RANK†	STATE RANK†	BLM RANK‡	IDFG RANK*	USESA STATUS	ABUNDANCE
silver chickensage	*Sphaeromeria argentea*	G3	SNR	—	—	—	Localized
green princesplume	*Stanleya viridiflora*	G4	S3	—	—	—	Widespread

†See NatureServe for a description of rankings (NatureServe 2024)

‡See BLM Manual 6840 – Special Status Species Management for a description of rankings (BLM 2008)

*See IDFG SWAP for a description of rankings (IDFG 2024a)

— = Not applicable

9.3 Natural Resource Monitoring and Research

9.3.1 Breeding Bird Surveys

The North American Breeding Bird Survey (BBS) was developed by the USFWS and the Canadian Wildlife Service to document trends in bird populations. Pilot surveys began in 1965 and immediately expanded to cover the United States east of the Mississippi and Canada, and by 1968 included all of North America (Sauer and Link 2011). The BBS program in North America is managed by the USGS and currently consists of over 5,100 routes, with approximately 2,500 of these being sampled each year (Sauer and Link 2011).

BBS data provide long-term species abundance and distribution trends for more than 420 species of birds across a broad geographic extent. These data have been used to estimate population changes for hundreds of bird species, and they are the primary source for regional conservation programs and modeling efforts for birds. The BBS provides a wealth of information about population trends of birds in North America and is the foundation for broad conservation assessments extending beyond local jurisdictional boundaries (Sauer and Link 2011).

Five official USGS BBS routes (i.e., remote routes) are on the INL Site and have been surveyed nearly each year since 1985 (except 1992 and 1993). In 1985, DOE-ID also established eight additional routes around INL Site facilities to monitor birds near human activity centers (i.e., facility routes; see Figure 9-2). These routes are also surveyed annually using the same techniques and methods as those indicated by USGS. Surveys are conducted from late May until early July and are scheduled to be conducted as close to the same day each year. All birds seen and heard during the survey are recorded regardless of breeding status (e.g., flyovers). BBS data can directly benefit INL Site managers by providing information on local breeding bird populations, which may be useful as they consider new activities and comply with the NEPA assessment process.

A total of 5,269 birds and 66 species were documented during the 2023 surveys. Total observations were 14.1% higher than the 37-year mean of 4,617 birds (1985–1991 and 1994–2023). The total number of species recorded was also higher than the 37-year mean of 56 species.

Nine species observed during the 2023 BBS are considered by the IDFG as SGCN, which includes the sage thrasher (n=341), Franklin's gull (*Leucophaeus pipixcan*, n=138), sagebrush sparrow (*Artemisiospiza nevadensis*, n=136), common nighthawk (*Chordeiles minor*, n=89), ferruginous hawk (n=45), grasshopper sparrow (*Ammodramus savannarum*, n=22), short-eared owl (*Asio flammeus*, n=11), long-billed curlew (*Numenius americanus*, n=7), and burrowing owl (n=4). When Franklin's gulls are observed, they are often in large flocks foraging on the INL Site, and it is unlikely they are nesting.

The five most abundant birds across all routes were horned lark (*Eremophila alpestris*, n=2,320), western meadowlark (*Sturnella neglecta*, n=680), Brewer's sparrow (*Spizella breweri*, n=356), sage thrasher (n=341), and the common raven (*Corvus corax*, n=270). These five species were observed on every route (INL 2024b).

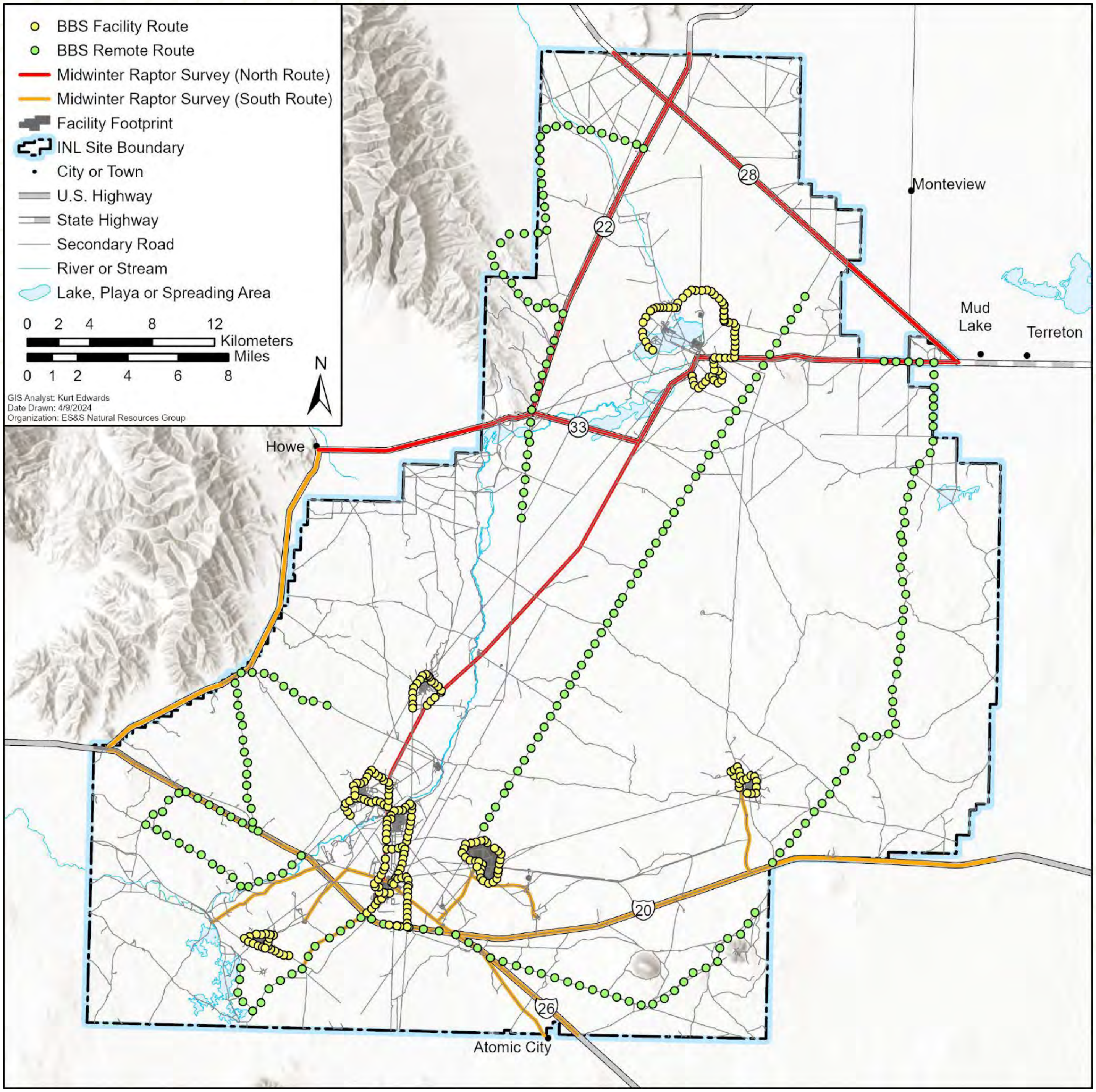

Figure 9-2. Remote and facility BBS routes and north and south midwinter raptor survey routes on the INL Site.

9.3.2 Midwinter Raptor Survey

Midwinter eagle surveys were initiated during 1979 by the USGS to develop a population index of wintering bald eagles in the lower 48 states, determine bald eagle distribution, and identify previously unrecognized areas of important wintering habitat. In 1983, two midwinter eagle survey routes were established on the INL Site, one that encompasses the northern portion of the INL Site and one that encompasses the southern portion (see Figure 9-2). Initially, the counts focused on eagle populations; however, biologists recognized the importance of collecting data on raptor abundance during this survey and started recording all raptors, including owls, hawks, and falcons in 1985. In 1992, the list of recorded species expanded to include corvids and shrikes.

In early January of each year, biologists survey the two established routes to detect any target species perched, hovering, or soaring. The number of individuals per species is counted for each of the target species detected. A total of 284 birds representing seven species were observed during the 2023 midwinter raptor surveys. One hawk that was not positively identified during the survey was omitted from the final count. Common ravens and rough-legged hawks are typically the most observed species during this survey and made up 68% and 21% of the observations in 2023, respectively. Two roads on the south route were inaccessible and not surveyed.

9.3.3 Long-term Vegetation Transects

The long-term vegetation (LTV) transects and associated permanent plots were established on what is now the INL Site in 1950 for the purposes of assessing impacts of nuclear energy research and production on the surrounding ecosystems (Singlevich et al. 1951). Initial sampling efforts focused on potential fallout from nuclear reactors and the effects of radionuclides on the flora and fauna of the Upper Snake River Plain. After several years of sampling, however, the concentrations and any related effects of radionuclides on the sagebrush steppe ecosystem of the INL Site were determined to be negligible (Harniss 1968). Because the LTV plots were widely distributed across two transects that bisect the INL Site, as shown in Figure 9-3, and vegetation abundance data had been collected periodically since their establishment, the LTV plots' utility as a basis for monitoring vegetation trends in terms of species composition, abundance, and distribution was eventually recognized. Regular vegetation data collection has continued on the LTV plots—occurring about once every five years. Eighty-nine LTV plots are still accessible, and most have been sampled consistently between 1950–2022, making the resulting dataset one of the oldest, largest, and most comprehensive for sagebrush steppe ecosystems in North America.

As the mission of the INL Site has grown and changed over the past 70 years, so too has the purpose and utility of the LTV project. Although the LTV project was initiated to address energy development at the INL Site, it is unique in its capacity to allow investigators to observe long-term vegetation change and the potential impacts of that change at the INL Site and across the region. Abiotic and biotic conditions (e.g., conditions created by the physical environment and by other living organisms) have been characterized by rapid change over the past few decades. These changes include shifts in land cover, land use, and weather patterns. Several wildland fires have removed sagebrush from a large portion of the Upper Snake River Plain over the past few decades; approximately 99,000 ha (250,000 ac) have burned on the INL Site since 1994. Soil disturbance associated with fighting wildland fires and disturbance associated with general increases in the use of remote backcountry areas are notable at INL and throughout the Intermountain West. Concurrently, many of the hottest and driest years during the 70-year INL Site weather record occurred during the past decade. All these factors contribute to increasing stress on native plant communities and potentially set the stage for a period of dramatic change in vegetation across the region. The LTV project is documenting this change and may provide some context for understanding resistance and resilience in the local sagebrush steppe.

Data were collected across the 89 active LTV plots for the fourteenth time between June and August of 2022. Plots were sampled for cover and density by species according to methodologies developed in 1950, with supplemental sampling protocols added in 1985 (see Forman and Hafla [2018] for details of the project sample design). The 2022 data will be integrated into the larger LTV dataset, and summary results will be presented in a technical report scheduled to be released in 2024. Notable changes between the 2011 and 2016 sample periods (the most recent sample periods for which data have been published) include decreases in shrub cover and particularly big sagebrush, increases in native grass cover, and declines in the densities of introduced annual grasses and forbs. In terms of long-term trends, big sagebrush cover was at its lowest point in the 66-year history of the dataset, and native, perennial grasses were near the upper end of their historical range of variability. Introduced annuals, primarily cheatgrass (*Bromus tectorum*), exhibited fluctuations with greater magnitudes of change from one sample period to the next over the past two decades when compared with earlier sample periods.

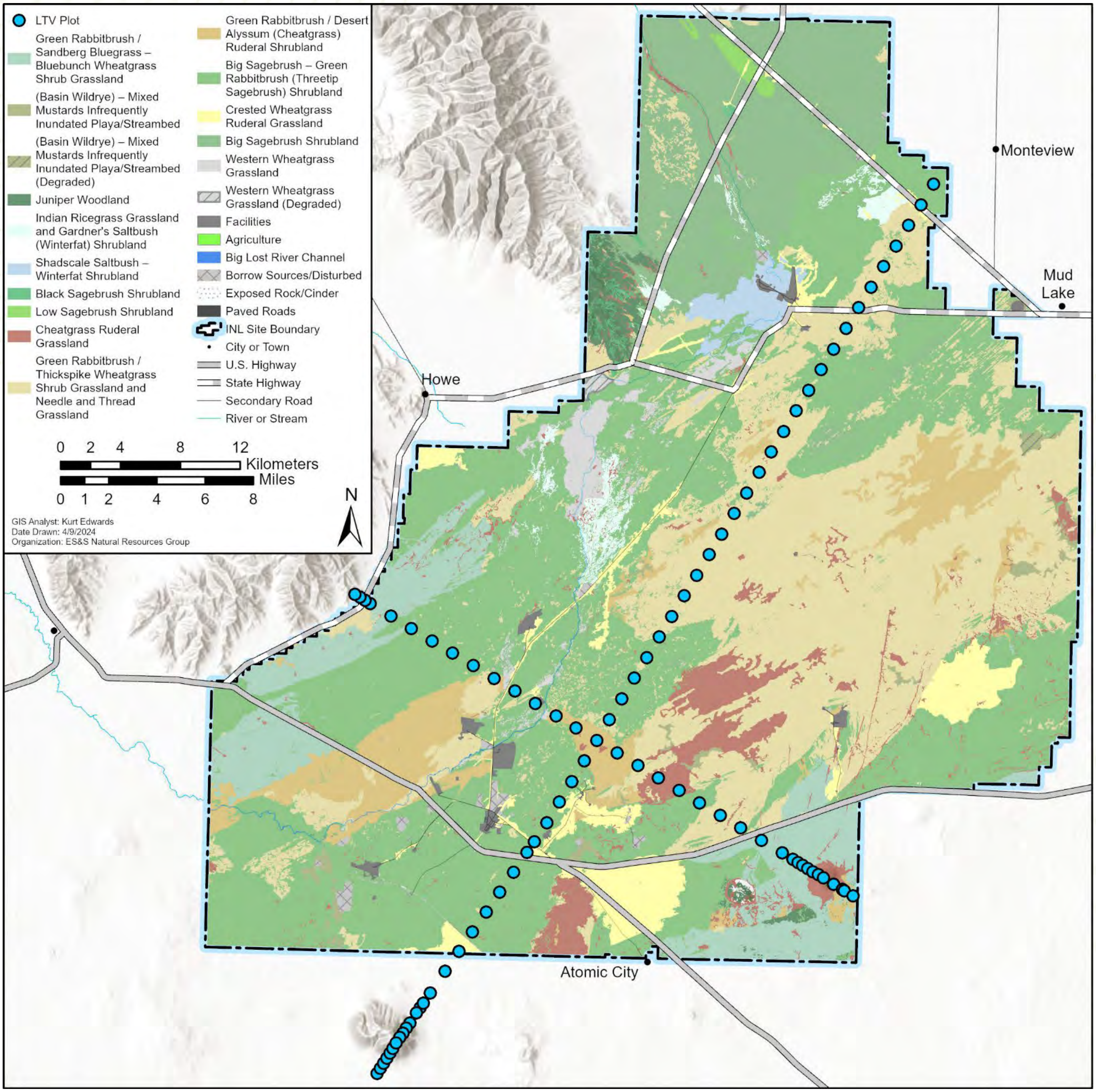

Figure 9-3. Locations for the LTV plots established on the INL Site in 1950 and sampled regularly over the past 70 years shown with the INL Site vegetation community classification map published in 2019.

9.3.4 Vegetation Map

A comprehensive update to the 2011 vegetation map (Shive et al. 2011) was initiated in 2017 and involved three steps: (1) a plant community classification to define vegetation classes, (2) manual map delineations of those classes, and (3) an accuracy assessment of the completed map. A total of 16 unique vegetation classes resulted from the plant community classification, in which 12 represented natural vegetation classes and four were ruderal classes (e.g., classes dominated by non-native species; Shive et al. 2019). Within the native classes, there was one woodland class, six shrubland classes, two shrub grasslands, and three grasslands. Within the ruderal classes, there was one shrubland, two grasslands, and a class characterized by mixed weedy forbs that tend to dominate areas with a specific hydrologic regime, namely playas.

Some plant community classes were combined prior to the map accuracy assessment because those classes were known to be difficult to map with imagery. This resulted in 13 map classes that were evaluated through an independent map accuracy assessment. Overall map accuracy across all classes was 77.3% with a Kappa value of 0.75. These results indicate the new vegetation map is not only the highest spatial resolution (i.e., 1:6,000), but also the most accurate map ever produced for the INL Site (see Figure 9-3). The vegetation map continues to be an integral dataset to support a variety of natural resources work on the INL Site. For more information about vegetation classification and mapping results see Shive et al. 2019.

After the new vegetation map was published in 2019, the Sheep Fire burned 40,403 ha (99,839 ac) across the interior region of the INL Site later that year. Four more fires burned in 2020 that met the criteria for post-fire ecological recovery planning and affected 1,561 ha (8,494 ac). The fires in 2019–2020 burned about 18% of the Site, and those regions of the map are now outdated and no longer representative of current ground conditions. Rather than conducting new statistical classifications and delineating new class boundaries across the entire Site, the defined vegetation classes will remain the same and only new map class boundaries will be updated within the 2019–2020 burned areas.

The new map class boundaries will be manually delineated in a GIS using National Agricultural Imagery Program (NAIP) high-resolution multispectral imagery as the basemap data source. NAIP imagery was scheduled for acquisition in Idaho during the summer of 2023 and will be used to delineate new map class boundaries. The 2023 Idaho NAIP imagery will not be disseminated to the public until 2024 and mapping will commence when the imagery is available. Once new boundaries are mapped, those areas will need to be validated for accuracy so the map user can consider any limitations and determine whether the data are appropriate for an anticipated use. The imagery is representative of ground conditions during the summer of 2023, which corresponds to when ground validation data were collected allowing for a direct comparison of mapping results to field data.

The total number of ground validation plots collected to quantify the original 2019 vegetation map was 453. Considering the need to update 18% of the map due to wildland fire, that percentage was used to calculate the number of ground validation plots to be sampled. This resulted in 81.5 plots and was rounded up to 85 total plots. A couple iterations were run to select random points across the sampling area. The three smallest fires (e.g., Telegraph, Howe Peak, Lost River Fires) had one or no points selected within their footprint using the first random selection process, and the remainder of points all fell within the much larger Sheep Fire footprint. Plot locations needed to be representative across all fires, so an additional five plot locations were assigned to each smaller fire using the same random selection process. These 15 plots combined with the 85 plots resulted in a total of 100 plots selected for sampling in summer 2023.

Plot size was kept consistent with the data collected to conduct the original accuracy assessment of the 2019 vegetation map. Validation plots were circular with a 28 m (91.9 ft) radius encompassing 0.25 ha (0.62 ac). At each validation plot, the location coordinates were collected, the vegetation class present was recorded using a dichotomous key developed for the 2019 vegetation map validation (Shive et al. 2019), indication of whether the dichotomous key worked well characterizing the vegetation class present at the plot was noted, and a second vegetation class call was entered if the key did not characterize the plot well. Four representative landscape photos were also taken in the cardinal directions from each plot center point.

Ground validation plot data collection began on July 10 and concluded on July 31, 2023. All 100 plots were visited and sampled across the burned areas from 2019–2020. The field data were internally reviewed for accuracy and any plot that keyed to a class that seemed questionable was investigated further to determine whether the class designation was correct. Once the 2023 Idaho NAIP imagery becomes available, it will be imported to a GIS where manual delineations will be digitized to spatially define the vegetation class boundaries. The ground validation plot data from 2023 will be used to conduct a formal accuracy assessment of the newly mapped areas, and the corresponding accuracy assessment results and project report will be presented in 2024.

9.3.5 National Environmental Research Park

The INL Site was designated as a NERP in 1975 through a NERP Charter, the Energy Reorganization Act, and the Non-nuclear Energy Research and Development Act. The Idaho NERP and NERPs at other DOE sites are outdoor laboratories that provide opportunities for environmental studies on protected lands that act as buffers around DOE facilities. The objective of the NERP system is to facilitate research and education, particularly to demonstrate the compatibility of energy technology development and a quality environment. INL's NERP designation has allowed the INL Site to host environmental scientists to study Idaho's native plants and wildlife in an intact and relatively undisturbed ecosystem (see Figure 9-4). The Idaho NERP provides exceptional opportunities for research because of its established facilities, a security buffer that protects research areas, extensive historical data, and partnerships with universities. In 2023, the INL contractor facilitated university-led research on four ecological research projects through the NERP: (1) addressing ecohydrology in sagebrush steppe, (2) evaluating beta diversity within the context of fire severity, (3) identifying high-quality foodscapes critical to greater sage-grouse, and (4) validating pygmy rabbit habitat distribution models.

Figure 9-4. A diverse plant community recovering from wildfire, an adult pygmy rabbit, a NERP research partner sampling sagebrush to understand local habitat nutritional characteristics.

The INL Site and other landscapes with sagebrush steppe vegetation are experiencing a simultaneous change in climate and plant community composition that is impacting habitat for wildlife, wildfire risks, and ecosystem services such as forage. Determining the separate and combined/interactive effects of climate and vegetation change is important for assessing future changes on the landscape and for hydrologic processes. Since the early 2000s, investigators have used an existing INL ecohydrology research facility, the former Protective Cap/Biobarrier Experiment, to study vegetation change with respect to precipitation regime, vegetation type, and soil depth. The focus of the current research is to compare the impacts of grass invasion and shifts in timing of precipitation to the function of the whole ecosystem, including biogeochemistry, carbon storage, and other attributes that relate to resistance and resilience in a changing environment. The experiment site was burned in its entirety by the 2019 Sheep Fire, which created an exceptional opportunity to test the underlying basis for the theory on resistance to exotic annual-grass invasion (cheatgrass) and resilience of sagebrush steppe. The long-term treatments conveniently create a gradient of pre-fire climate differences, and the cessation of treatment application has induced large differences in simulated drought conditions on the experiment. Researchers continue to sample the differences in cheatgrass among the treatments along with the corresponding soil nutrients and water. The research team includes Dr. Matthew Germino from the USGS Forest and Rangeland Ecosystem Science Center and Dr. Toby Maxwell and Dr. Marie-Anne DeGraff from Boise State University; their research continues to use a facility that has been in operation since 1994. They will continue to collect data for at least the next few years.

In 2017, vegetation abundance data were collected from over three hundred plots across the INL Site to support an update to the INL Site vegetation map. These plots were used to classify plant communities into mappable units and were therefore distributed across a range of representative vegetation types. The plant communities sampled during this survey effort included intact sagebrush steppe and recovering post-fire assemblages from areas that burned at various times and intensities prior to data collection. In 2022, an effort to revisit these data and summarize them for publication in the peer-reviewed literature was initiated. The purpose is two-fold. The first objective of this research effort is to document and describe the methodologies used to develop the INL Site plant community classification. The second objective is to evaluate changes to beta diversity in the context of fire severity across the INL Site. The principal investigator for this project is Dr. Ken Aho from Idaho State University, and his work to complete analyses and develop manuscripts related to this study is ongoing.

The Idaho NERP is collaborating in a multiagency research project focused on identifying high-quality foodscapes critical to sage-grouse habitat conservation across the sagebrush steppe ecosystem. The project has been conducted for several years and spans across multiple western states. The research team aims to identify the chemical phenotype (or chemotype) of sagebrush species linked with high-sage-grouse forage fidelity to identify which habitats are crucial dietary hotspots for sage-grouse that should be prioritized for conservation and where seed collection should occur for local restoration of plants that are palatable to local sage-grouse populations. Field research is conducted during the winter and spring months to identify the seasonal changes in chemotypes of sagebrush consumed by sage-grouse. Browsed vegetation and excreta of sage-grouse are collected and used to determine diet quality using Near-Infrared Spectroscopy and analytical chemistry of plants, diet composition using DNA barcoding of feces, digestibility of food using a particle size analysis of feces, and detoxification capacity by analyzing renal metabolites in uric acid. Overall, the project is focused on supporting preventative management actions, protecting functional biodiversity and palatable sagebrush, and improving the availability of locally adapted seed sources most appropriate in habitat restoration projects that aim to promote health populations of sage-grouse. The principal investigator is Boise State University researcher, Dr. Jennifer Forbey, and her work is anticipated to continue at the INL Site.

Pygmy rabbits are a sagebrush specialist, endemic to the western United States, and are considered threatened by habitat alteration, habitat loss, climate change, and disease (Rachlow et al. 2021; Crowell et al. 2023). Formalized pygmy rabbit surveys were last conducted on the INL Site in 2009; however, the current distribution and habitat usage of the pygmy rabbit on the INL Site is relatively unknown. With the proposed listing of the species under the ESA in 2023, current data regarding pygmy rabbit occurrence on the INL Site is invaluable. University of Idaho researchers have developed statewide pygmy rabbit habitat distribution models and validating those models in the field provides an opportunity to collect some INL Site-specific occurrence data and to understand the utility of occupancy models locally. Over two winter seasons (2023–2024 and 2024–2025), the University of Idaho is conducting pygmy rabbit surveys at approximately 800 sites statewide and the INL contractor is supporting a subset of those surveys on the INL Site. Pygmy rabbit occupancy rates and dynamics will be estimated using detection/non-detection surveys based on burrow and fecal pellet observations and the subsequent DNA confirmation of species presence. By refining existing pygmy rabbit habitat modeling methodologies, this study will allow for the estimation of potential pygmy rabbit habitat in Idaho that is currently occupied, the ability to model trends in occupancy over the last 20 years (i.e., extinction/colonization rates), and assess if fine-scale climate and weather variables predict occupancy, extinction, or colonization rates. These data on species occupancy and trends can inform land management plans and conservation actions for pygmy rabbits both on and off the INL Site. The research team for this project includes Dr. Janet Rachlow, professor in the Department of Fish and Wildlife Sciences at University of Idaho; Dr. Leona Svancara, researcher at USGS and University of Idaho; and Fiona McKibben, doctoral student at University of Idaho.

9.4 Land Stewardship

9.4.1 Wildland Fire Protection Planning, Management, and Recovery

The INL Fire Department provides wildland fire suppression services on the rangeland within the INL Site boundary, as well as a five-mile buffer outside of the INL Site boundary. The INL Fire Department employs pre-incident strategies, such as the identification of special hazards, mitigation procedures, and mapping necessary to facilitate response to fires. DOE-ID maintains mutual aid agreements with regional agencies, including the BLM, to assist in response to high-challenge wildland fires. Additionally, the INL contractor implements PLN-14401 (INL 2015), “Idaho National Laboratory Wildland Fire Management Plan,” which incorporates essential elements of various federal and state fire management standards, policies, and agreements. A balanced fire management approach has been adopted to ensure the protection of improved laboratory assets in a manner that minimizes effects on natural, cultural, and biological resources. The INL contractor has established a Wildland Fire Management Committee (WFMC) to review seasonal fuel management activities and the potential impact of all fires greater than 40.5 ha (100 ac).

A primary responsibility of the WFMC is to determine whether a post-fire recovery plan is warranted for a given fire. Once an ecological resources post-fire recovery plan is requested, the INL NRG completes an ecological resource assessment to evaluate the resources potentially impacted by a wildland fire and drafts a recovery plan for treatment prioritization and implementation by the WFMC. After the 2019 Sheep Fire, WFMC members expressed an interest in a recovery plan where implementation is phased over five years and is flexible, in that actions can be implemented individually depending on specific resource concerns and funding availability. The resulting plan was organized into four natural resource recovery objectives: (1) soil stabilization for erosion, (2) cheatgrass and noxious weed control, (3) native herbaceous recovery, and (4) sagebrush habitat restoration. Multiple treatment options were provided in the plan for improving post-fire recovery. Because the structure and organization of the plan, as well as the options of prioritizing treatment actions, were useful to the WFMC, subsequent post-fire ecological recovery plans continue to use this framework. There is one active post-fire recovery plan for four wildfires that burned in 2020, and one fire recovery plan for the 2019 Sheep Fire that recently sunset.

In 2020, the WFMC requested an ecological assessment and fire recovery plan for four fires ranging in size from 11 ha (27 ac) to 678 ha (1,675 ac): the Howe Peak Fire, the Telegraph Fire, the Cinder Butte Fire, and the Lost River Fire. Under approved emergency stabilization actions listed in the existing Wildland Fire EA (DOE 2003), the INL contractor completed several activities during the fall of 2020, including recontouring containment lines on the fires where they were used, reseeding containment lines with native grass seed, and spraying noxious weeds, especially in disturbed soils on and around containment lines. Upon completion and review of the ecological resource recovery plan (Forman et al. 2021), additional recovery actions were prioritized by INL’s WFMC, including: (1) monitoring temporary fire suppression access roads for natural recovery, (2) installing signs, (3) replanting those access roads, if necessary, and (4) ongoing noxious weed inventory and treatment across all four fires. Additionally, sagebrush restoration was recommended on the Telegraph Fire because it would improve habitat value in proximity to an active sage-grouse lek, and it would improve habitat connectivity across the burned area. A total of 41,300 sagebrush seedlings were planted in the Telegraph Fire footprint in October 2022.

The Sheep Fire burned more than 40,000 ha (98,842 ac) of land on the INL Site in July 2019. Under the direction of the WFMC, several restoration efforts outlined in the Sheep Fire Ecological Resources Post-Fire Recovery Plan (Forman et al. 2020) were completed. Soil stabilization efforts were finished on the Sheep Fire containment lines in 2020, and the WFMC prioritized additional restoration/treatment actions within two post-fire recovery objectives: noxious weed/cheatgrass control and big sagebrush habitat restoration. Noxious weed treatment continued opportunistically throughout the Sheep Fire footprint in 2023. Cheatgrass treatments were completed adjacent to approximately 13.7 km (8.5 mi) of a two-track road in 2021 and was revisited to assess treatment efficacy in 2022. DOE-ID and agency stakeholders collaborated to seed sagebrush on portions of the Sheep Fire during the winter of 2019/2020. The seeding was completed across a target area of approximately 10,100 ha (25,000 ac) in and adjacent to the SGCA. Because of poor initial germination and establishment from the aerial seeding, a total of 45,000 seedlings were planted in the Sheep Fire in October 2021, and an additional 45,000 seedlings were planted in October 2022. Although cheatgrass control treatments had not been implemented in their entirety prior to the end of the five-year timeframe implementation associated with the Sheep Fire recovery plan, DOE-ID, the INL contractor, and agency partners continue to pursue treatment options through BIL funding initiatives.

Emergency wildland fire response and associated soil stabilization actions are addressed in the INL Wildland Fire EA (DOE 2003). Because there have been changes in vegetation condition and land cover over the past twenty years, updates to the wildland fire management and recovery plans are necessary. The INL contractor is currently in the process of updating wildland fire management plans and developing a scientifically based framework for post-fire ecological resource assessment and treatments to be considered for use in post-fire recovery plans. These updates are based on the recommendations by the WFMC after the Sheep Fire and the 2020 fires. DOE will perform the necessary NEPA analysis to assess any potential impacts attributed to the implementation of updated plans. Updated plans and additional NEPA analysis will facilitate a more comprehensive and effective response to wildland fire management and post-fire restoration in the future.

9.4.2 Restoration and Revegetation

Revegetation for Soil Stabilization

Revegetation with native species is required on the INL Site for activities that disturb or remove soil and vegetation where the area will not be physically stabilized and maintained as sterile. These areas are left exposed and vulnerable to erosion and to infestations of invasive or noxious weeds. Areas requiring revegetation are evaluated for appropriate revegetation methods based on site condition and disturbance size. The baseline condition of areas that may be disturbed are characterized prior to disturbance, partly to assess the native species present. The native species observed inform an appropriate seed mix that is to be used during revegetation efforts following the disturbance. Revegetation strategies on the INL Site include, but are not limited to, hand-broadcasting seed, seedbed preparation, soil augmentation, drill seeding, and planting nursery stock.

In 2023, one revegetation project was initiated by INL's Facility and Site Services (F&SS), NRG, and CRMO on approximately 0.20 ha (0.5 ac) to address soil stabilization. The project occurred in a culturally sensitive area impacted by livestock and contained little to no vegetation along the historic Birch Creek channel. Because of the cultural resource sensitivities, F&SS and NRG staff coordinated closely with the CRMO to minimize impacts to the soil surface throughout the project footprint. Restoration treatments were implemented as described in Section 9.1.1 and initial treatment results will be assessed in 2024.

Revegetation projects on the INL Site are revisited at least one growing season after the initial revegetation effort, and revegetation assessments are used to determine whether further actions need to be taken. The initial assessment includes collecting qualitative data to provide a rapid characterization of the area. This initial assessment is used to determine whether a more rigorous quantitative assessment is warranted or if the initial revegetation actions were unsuccessful and further revegetation actions are needed. When the initial results indicate substantial progress towards successful stabilization, a quantitative assessment is completed to provide data for a detailed estimate of ground cover by species of the revegetated area for comparison to the background vegetative cover of the surrounding plant community. Revegetation is considered successful if the vegetative cover of desirable species is within an acceptable threshold of background values.

There were two revegetation projects evaluated in 2023 with an initial qualitative assessment. The first revegetation project evaluated was for two areas totaling approximately 0.4 ha (4.75 ac) to address soil stabilization following the placement of excess soil removed during the construction of a new parking lot at Materials and Fuels Complex (MFC). The initial assessment of this area indicated that vegetative cover was relatively high across the revegetation areas; however, undesirable introduced annual species such as saltlover (*Halogeton glomeratus*) and kochia (*Bassia scoparia*) were the most abundant species. Because the most abundant plant species across the revegetation area were non-desirable introduced species, and native species were only sparsely distributed across the area, an additional revegetation plan was recommended to be developed and implemented for this area. The second project that was evaluated was for revegetation of areas impacted by the construction of a new power line totaling about 0.13 ha (0.33 ac). The initial assessment of these areas indicated that vegetative cover ranged from relatively high to very sparse across the areas, and the most abundant plant species were undesirable, introduced species. In the limited areas where they did occur, native species abundance was ranked low, but their presence was encouraging. Native species cover is typically low during the first few years post-planting, and cover from native species would be expected to increase in response to favorable conditions. These areas were recommended to be reevaluated using semi-quantitative methods again in fiscal year (FY) 2025 and additional revegetation actions should be taken where necessary.

Sagebrush Habitat Restoration

Sagebrush habitat restoration on the INL Site is conducted in response to DOE-ID's goal of no net loss of sagebrush habitat. The potential to lose sagebrush habitat on the INL Site occurs primarily from two mechanisms. The first is due to wildland fire, as discussed in Section 9.4.1, which has the potential to remove large tracts of sagebrush habitat and can take more than 100 years to recover naturally (Blew and Forman 2010). The second instance where sagebrush habitat is lost is due to infrastructure expansion and mission critical project activities. The INL contractor implements multiple BMPs to minimize sagebrush habitat loss, such as co-locating infrastructure, but in some cases, removal of sagebrush habitat is necessary to support the INL mission. The INL contractor carries out a compensatory sagebrush mitigation strategy for projects that must remove sagebrush habitat. This strategy outlines an approach for projects to provide funds for sagebrush to be restored in designated priority areas where they can provide the greatest habitat benefit.

Sagebrush habitat restoration has been conducted using containerized sagebrush seedlings (see Figure 9-5) and aerially applying sagebrush seed. Due to the semiarid nature of the local ecosystem, the INL contractor has found that planting sagebrush seedlings results in higher survivorship than trying to establish sagebrush from seed. Therefore, current efforts focus on containerized planting, but DOE-ID and the INL contractor continue to partner with agencies to test and develop additional planting methods.

Figure 9-5. Planters using hoedads to install big sagebrush seedlings on the INL Site.

In 2023, a total of 74,875 sagebrush seedlings were planted. The seedlings were planted across four adjacent strips within a general area totaling 170.6 ha (421.7 ac). Seedlings were funded and acquired in anticipation of the need for compensatory mitigation in response to future INL projects that will remove sagebrush habitat. The 2023 planting was located within portions of the 2010 Middle Butte Fire and the 2007 Twin Buttes Fire. To inform and improve future plantings, different treatments were tested in each strip of the area planted. These treatments include the standard soil medium used over the past several years (control), the addition of vermiculite in the soil medium, the addition of a hydrogel in the soil medium, the addition of a more locally appropriate mycorrhizal inoculant in the soil medium, and the installation of protective cages around a subset of the control group seedlings. As a result of sagebrush habitat restoration on the INL Site since 2015, 330,625 sagebrush seedlings have been planted across 1,159.3 ha (2,864.7 ac).

Seedlings planted on the INL Site are monitored one year and five years after planting to assess survivorship, and planting strategies are adjusted according to past survivorship data.

In addition to planting sagebrush seedlings, INL continued to pursue sagebrush habitat restoration in the Tractor Flats area of the INL Site and adjacent BLM land. In 2023, DOE-ID, INL, USFWS, and BLM received BIL funding to use a commercial seed collection vendor to collect sagebrush seed within the unburned areas of the southern and eastern portion of the INL Site and on adjacent BLM land. In total, 4,467 kg (9,850 lb.) of bulk cleaned seed was collected with 2,608 kg (5,750 lb.) being collected on the INL Site. The seed was cleaned and stored in a BLM seed warehouse and will be used for mechanical planting of approximately 810 ha (2,000 ac) on the INL Site in 2024, as well as a slightly larger area on adjacent BLM land. Seed collection will occur again in 2024, and both agencies will plant again in 2025.

9.4.3 Weed Management

The INL contractor maintains and funds a noxious and invasive weed management program to address the requirements of federal agencies described in EO 13112, “Invasive Species,” as amended by EO 13751, “Safeguarding the Nation from the Impacts of Invasive Species.” The Noxious and Invasive Weed Species Management program on the INL Site fulfills these requirements by first ensuring that prevention of the introduction, establishment, and spread of invasive species is prioritized during all activities. The risks from noxious weeds and invasive species are also minimized by discouraging unnecessary actions that can create spreading vectors or new introductions. Another strategy the INL contractor uses to prevent the introduction of noxious weeds to unaffected areas is focusing treatment efforts along potential vectors, such as perimeter roads, along highways, interior two-track roads, and within facility footprints.

Trained INL Applicators can detect, identify, mark, and in most cases, treat invasive weed species quickly in cooperation with the NRG. Each time noxious and invasive weeds are encountered, INL Applicators use integrated pest management principles that determine whether treatment actions are required and what type of treatment is needed (i.e., biological, cultural, physical, mechanical, or chemical). Noxious weed species and invasive species are typically treated differently from one another on the INL Site. INL Applicators generally treat noxious weeds with pesticide application when the pesticide label allows but, in some cases, certain species are treated using manual or mechanical treatments. Most treatments targeting invasive species that are not designated noxious take place in the form of mechanical removal, such as mowing or trimming. These treatments are often conducted for defensible space around infrastructure. In some cases, following the removal of large infestations of noxious weeds, the INL contractor will revegetate the area with appropriate native species to prevent invasive weeds from returning and promote soil stabilization.

INL Applicators monitor known noxious weed and invasive species locations along with the results of any treatments that have been conducted. This capability allows INL Applicators to understand where, how, and which noxious weeds are spreading on the INL Site so they can more effectively allocate time and resources. This information can be used to determine whether additional treatments are necessary and identify which treatment methods can be applied to achieve greater control and to ensure they are the most effective, cost-efficient, and present little to no risk to people or the environment.

Along with directly targeting and treating weeds, INL has implemented programmatic strategies to reduce the potential introduction and spread of weeds. These include both employee education and work controls. Every year, employees are provided briefings and training material about how to identify, report, and minimize the spread of weeds. Work controls to limit risks of weed introduction and spread during work activities are implemented through the Biological Resource Review (BRR) process. During the BRR process, a natural resource scientist reviews and identifies projects with the potential to create weed vectors or that may require monitoring for noxious weeds and invasive species and provides strategies for addressing those concerns.

All pesticide applications on the INL Site are conducted according to specific pesticide label instructions in compliance with the Federal Insecticide, Fungicide, and Rodenticide Act (1996). All records associated with pesticide applications on the INL Site are kept for a minimum of three years in accordance with Idaho Administrative Procedures Act, “Rules Governing Pesticide and Chemigation Use and Application” (IDAPA 02.03.03). In 2023, 120 new noxious weed observations were made, and 79 pesticide applications were conducted. Additionally, weeds were controlled via shoveling and hand-pulling when appropriate. Noxious weed species targeted and controlled in 2023 were rush skeletonweed (*Chondrilla juncea*), scotch thistle (*Onopordum acanthium*), musk thistle (*Carduus nutans*), Russian knapweed (*Acroptilon repens*), spotted knapweed (*Centaurea stoebe*), leafy spurge (*Euphorbia esula*), plumeless thistle (*Carduus acanthoides*), whitetop (*Lepidium draba*), and Canada thistle (*Cirsium arvense*).

9.4.4 Ecological Support for National Environmental Policy Act

Individual actions performed under Categorical Exclusions at the INL Site are addressed in Environmental Compliance Permits (ECPs). There were 168 new ECPs initiated in 2023. Ecological support for ECPs is carried out predominantly through Technical Point of Contact review and the BRR process for activities outside of facility footprints with the potential to disturb wildlife, vegetation, or soils. There were 16 BRRs initiated in support of ECPs in 2023. The BRR is intended to assess the biological impacts and fulfill any regulatory compliance requirements associated with the project. The first part of the BRR process is collecting a baseline condition of the project site prior to conducting activities. The second part is conducting a follow-up survey of project activities to assess project impacts. The BRR also acts as a tracking mechanism for multiple monitoring requirements that must be reported at the end of the year. Some monitoring requirements that are documented in the BRR include identifying noxious weed locations, evaluating areas requiring soil stabilization, quantifying areas where compensatory sagebrush mitigation may be required, completing nesting bird surveys for compliance with the Migratory Bird Treaty Act, and identifying native plant species that should be used for revegetation.

9.5 INL Site Cultural Resource Management

The INL CRMO resides within the INL Management and Operating contractor, Battelle Energy Alliance, LLC (BEA). Cultural resource professionals within the INL CRMO coordinate cultural resource-related activities at the INL Site and implement the INL Cultural Resource Management Plan (DOE-ID 2016) with oversight by DOE-ID's Cultural Resource Coordinator. Provisions to protect the unique cultural resources of the land and facilities at the INL Site are included in environmental policies issued by BEA and other INL Site contractors and in company procedures that guide work completion. Cultural resource identification and evaluation studies in 2023 included archaeological field surveys, monitoring, and site updates related to INL Site project activities, and the studies supported DOE-ID in facilitating meaningful collaboration with members of the Shoshone-Bannock Tribes and public stakeholders.

9.5.1 Procedure Issuance and Revisions

In 2023, seven internal INL CRMO Management Control Procedures (MCPs) were updated and re-issued that pertain to the comprehensive INL Historic Preservation Program, including Section 106 and Section 110 responsibilities. In addition to the seven MCPs, 13 associated forms (FRMs) were issued or revised in conjunction with procedural updates.

MCP-8008, "Section 106 Compliance," and associated FRMs documenting the Section 106 process were revised for consistency with the fully executable 2023 Programmatic Agreement (2023 PA). These revisions focused on the Stipulation IV Approach to Section 106 Compliance and Appendices C and D of the 2023 PA. Based on the results of two 2022 assessments conducted by INL CRMO, revisions of MCP-8011, "Documentation of a Cultural Resource," and MCP-8012, "Preparation of the Annual Report, Contract Data Requirements List (CDRL F.46)," were undertaken and completed in July 2023 and August 2023, respectively. When the Cultural Resource Database (CRDB) went into production in May 2023, Guide (GDE)-895, "CRDB Field Client Guide," was not up-to-date with modifications made to the CRDB since issuance of the procedural document in September 2021. INL CRMO staff created FRM-3313, "Cultural Resource Database (CRDB) Checklist," as a stop-gap feature to utilize until the CRDB procedure is revised. MCP-8009, "Visual Effects Analyses," was assessed during 2023 and recommended to be revised to bring this document into compliance with MCP-8008, Rev 1. Revisions to these documents are planned for 2024. An assessment for MCP-8016, "Management and Curation of DOE Administered Archaeological Collections," is planned for 2024.

Also planned for 2024, the INL CRMO will proactively revise three procedures related to new information on processes for LI-1017, "Field and Benchtop Use of the Olympus Vanta X-Ray Fluorescence Spectrometer (XRF);" MCP-8003, "Native American Grave Protection and Repatriation Act Inadvertent Discoveries, "based on the pending rule change for the Native American Grave Protection and Repatriation Act, 43 CFR 10 (anticipate in January 2024); and, MCP-8005, "Managing Paleontological Resources," as well as issuance of an Emergency Action Plan for INL CRMO Fieldwork activities, and update Section 106 and Section 110 monitoring forms (FRM-2898 and FRM-3001) to align with the CRDB.

9.5.2 Cultural Resource Database and Development Progress

Since March 2023, creation and management of digital project and resource data has been consolidated in the INL CRMO CRDB. Two integrated applications form the structure of the CRDB: a web application, available to authorized users on the INL network, and a Field Client, installed locally on a device for use when disconnected from the INL Site network during fieldwork. When in the field, cultural resource data can be collected on site with multiple devices, reconciled and uploaded to the database server, and accessed by all INL CRMO staff in the web application. With import and export capabilities, resource data can be moved between State Historic Preservation Office (SHPO) Archaeological Site Inventory and Idaho Historical Sites Inventory Access databases and the CRDB for consultation and review as required. The Idaho Cultural Resource Information System is planned for an online launch in the spring of FY 2024, and the INL CRMO anticipates changes in the submission guidelines.

As phased development of the CRDB continues, the following are planned additions to functionality of the database applications:

- ***Reporting.*** The CRDB is designed to collect key information about projects undertaken as part of Section 106 and Section 110 of the National Historic Preservation Act. Reporting capability for both benchmarks and internal tracking is among the functionality planned for the next development phase.
- ***Environmental Review Process (ERP) integration.*** The ERP system provides for the implementation of NEPA at INL. Since 2022, Section 106 review conducted by the INL CRMO has been integrated into the ERP system and, by extension, the NEPA process. As a result, INL CRMO staff are notified of projects entered in the ERP for environmental and cultural review by email. Future capabilities for the CRDB will include integration with the ERP system, allowing INL CRMO staff to be notified, review, and respond to ERP entries without leaving the CRDB.
- ***Cultural Resource Review (CRR) completion.*** The CRR FRM-3004 documents a Section 106 review completed by the INL CRMO. The currently implemented version of the CRDB was designed to collect information required to complete the CRR. A third development phase is dedicated to the automatic generation of the CRR from the project level data entered by the principal investigator.

As part of the 2023 launch of the CRDB, a Cultural Resource Database Checklist (FRM-3313) was issued, along with a workshop held for all INL CRMO staff on March 27, 2023, to aid in the adoption of the database. In 2024, a full user guide for the CRDB (GDE-895) will be issued by INL CRMO staff and additional training offered, as required.

9.5.3 INL Section 106 Project Reviews

During 2023, the INL CRMO reviewed approximately 450 projects under Section 106 of the National Historic Preservation Act. Increased efficiencies in the review process grew from CRMO integration into the NEPA review process via the rollout of the new ERP system. Until the 2023 PA was fully executed on May 8, 2023, DOE-ID was performing Section 106 responsibilities according to the 2004 PA and the INL Cultural Resource Management Plan (DOE-ID 2016).

As a result of the implementation of the 2023 PA, the INL CRMO revised MCP-8008 (MCP-8008, Rev 1) to better guide the project review process within the one-stop, multidisciplinary, ERP system. The review process includes an analysis for possible exclusions for activities and property types that do not have the potential to affect historic properties. These exclusions are listed in Appendices C and D of the PA (2023) and implemented as part of MCP-8008, Rev 1 (Appendices A, B, and C).

Appendix A in MCP-8008, Rev. 1, includes those actions which do not meet the threshold of a federal undertaking with the potential to affect historic properties according to the Advisory Council on Historic Preservation's 1991 *Balancing Historic Preservation Needs with the Operation of Highly Technical or Scientific Facilities* (Advisory Council on Historic Preservation 1991). Appendix B includes those undertakings that are excluded from project-specific consultation with the SHPO, provided the activity does not affect or have the potential to affect those qualities or settings that make a historic property eligible for the National Register of History Places (NRHP). Appendix C pertains to property types excluded from NRHP evaluation. However, if these property types are associated with an NRHP-eligible site or district, the INL CRMO staff will document the property and submit a CRR and associated Archaeological Site Inventory and/or Idaho Historical Sites Inventory to the INL CRMO manager and DOE for review and concurrence.

INL CRMO staff review project scopes of work and proposed activities and recommend the applicability of these activity type exclusions and document their review and recommendation for each project within the ERP system and internal ERP Tracking Worksheet. Note that all activities under these exclusions are subject to the INL Timeout and Stop Work Authority should cultural resources be unexpectedly encountered at any time. No activities at Experimental Breeder Reactor-I (EBR-I), other than ground disturbance, are excluded due to its National Historic Landmark status.

These changes to the CRMO Section 106 review process streamlined sharing project information and communication, resulting in shorter review times and integration of information required to support decisions. Sixty-one Section 106 reviews (e.g., 33 built environment and 27 archaeological) were issued CRMO project numbers. Of these, three resulted in No Adverse Effect to historic properties and nine required hold points for further review or project-specific instructions. The remainder of the projects resulted in findings of No Historic Properties Affected. Section 106 reviews that did not involve exempt activities and property types were provided to the DOE-ID Cultural Resource Coordinator for review and approval as the 36 CFR 800 agency official prior to completion of the NEPA reviews.

9.5.4 INL Section 110 Research

Class III inventories for Section 110 surveys related to areas identified by the Shoshone-Bannock Tribes and INL CRMO research interests. These interests include the acquisition of data to support the ongoing development of the Precontact Context, Pre-WWII Historic Context, and other active research proposals, in coordination with the Shoshone-Bannock Tribes.

Precontact Context Initiation

As part of DOE-ID commitments to strengthen the INL Site historic preservation program, the INL CRMO, DOE-ID, and Shoshone-Bannock Heritage Tribal Office (HeTO) staff initiated efforts on the Precontact Context (PCC). Precontact refers to the period when the Shoshone and Bannock Tribes occupied North America prior to contact with Europeans and Euroamericans. The Precontact Context identifies the time span as roughly 13,000 years before the present to contact with Lewis and Clark in 1805.

In adherence with commitments outlined in the 2023 PA, as well as the *Secretary of Interior's Standards and Guidelines for Archaeology and Historic Preservation* (Federal Register, Vol. 48, No. 190, 1983), and in partnership with the Shoshone-Bannock Tribes, the INL CRMO is currently developing a context to address the Precontact period. The Shoshone and Bannock PCC will span the vast time frame between 13,000 and 200 years ago, when the ancestral Shoshone and Bannock people first encountered Euroamerican explorers and fur traders in their territory. A proposal outlining the PCC themes, research, and draft property types was submitted to SHPO for review on January 24, 2023. DOE-ID and INL CRMO provided a PCC progress briefing to the Language and Cultural Committee on March 14, 2023. In addition, a meeting with the BLM was hosted by DOE-ID on April 21, 2023 . DOE-ID hosted a PCC briefing and discussion with INL CRMO and SHPO staff on May 12, 2023. In June 2023, HeTO staff Anna Bowers and Kyle Denny accompanied INL CRMO and BLM staff to revisit two sites within the Precontact Context study area located in the Upper Snake Field Office. The sites were chosen based on the presence of rock writing and surface artifact density.

The Shoshone and Bannock PCC represents an organizational framework for the identification of Precontact archaeological resources within the 8-million-acre study area, with the understanding that the Eastern Snake River Plain (ESRP) and surrounding regions were included in the ancestral seasonal round of the Northern Shoshone and Bannock people spanning millennia. Although there is the possibility that other tribes visited the ESRP, the site types identified in this document were developed in collaboration with the Shoshone-Bannock Tribes and directly reflect ancestral Northern Shoshone and Bannock land use patterns, as evidenced by oral histories, oral traditions, historic documents, and ethnographic information.

The final document will serve as a framework for: (1) the identification and characterization of Shoshone and Bannock Precontact archaeological resources/properties within the study area; (2) guidelines regarding the criteria used to evaluate their NRHP significance; and (3) comprehensive preservation planning at the INL Site.

The "*Assessing, Synthesizing,* and *Identification*" phase of the PCC is nearly complete. Roughly 4,000 archaeological localities in the study area have been characterized based on the Shoshone and Bannock seasonal round. Roughly 2,000 diagnostic volcanic glass projectile points housed in the Idaho Museum of Natural History have been analyzed via x-ray fluorescence and assigned a source attribution and 25 bone samples were submitted to an Accelerator Mass Spectrometry laboratory to refine the regional cultural chronology. Phase II (Characterization) will begin in early 2024 and include a comprehensive analysis of geospatial data to address research questions and predictions outlined in the PCC proposal. Although the INL CRMO staff is already utilizing relevant themes and research questions to evaluate NRHP eligibility under Criterion D, formal eligibility, and integrity guidelines (Phase III) will be developed in early spring of 2024.

Pre-WWII Historic Contexts at INL

As part of DOE-ID's commitments to strengthen the INL Site Historic Preservation Program in the 2023 PA, the INL CRMO and DOE-ID initiated efforts to create the pre-WWII historic context in 2023. A proposal was completed and submitted by DOE-ID to SHPO on April 30, 2023. A virtual brief to SHPO was completed on May 12, 2023. To represent the breadth and depth of historic activities at the INL Site during the 1852–1942 period, two context statements were outlined: "Historic Networks: Migration, Transportation, and Trade across the Eastern Snake River Plain, 1852-1942" and "Home on the Plain: Homesteading and Agricultural Settlement on the Eastern Snake River Plain, 1855-1942." Definition of the context statements and associated time periods included establishing a six-million-acre study area, including the INL Site. A review of the current inventory of historic resources at the INL Site allowed for the summation of site types applied in recording historic archaeological resources to date, as well as identifying possible type sites to re-record. The record review found 245 archaeological sites previously recorded at the INL Site in the context time periods, not including linear resources. Based on previously assigned site types and descriptions for these resources, 33 site types were identified from the current inventory of historic archaeological resources, with one additional category for those resources where no type was given (n=1).

The initial research for historic narratives has focused on the acquisition of primary sources from libraries, archives, and special collections relevant to the study area and period of interest. So far, collections held by the following repositories have been reviewed:

- Idaho State University Archives and Special Collections, Pocatello, Idaho
- Bingham County Historical Society, Blackfoot, Idaho
- Brigham Young University—Idaho, Archives and Special Collections, Rexburg, Idaho
- Boise State University Archives and Special Collections, Boise, Idaho
- Idaho State Historical Society Archives, Boise, Idaho.

In addition, research continues to utilize and request items from digital and physical collections, including historic photographs, land entry records, and company minutes (Utah Construction Company), from the following institutions:

- The Library of Congress
- National Archives and Records Administration
- Weber State University
- University of Idaho
- University of Utah.

Other Active Research

There are currently five active multi-year Section 110 research proposals including: "Pluvial Lake Terreton: Building a Multidisciplinary Dataset to Understand Human Land Use During the Terminal Pleistocene" (INL 2017a); "Decoding the Southern Idaho Cultural Landscape Through Volcanic Glass Source Analysis" (INL 2017b); "Pewaishe suakiga/Pekwanishu songaha - It Still Breathes, 10BT1449" (INL/RPT-22-65966); "Examining the Chronology, Distribution, and Source Attributions of Volcanic Glass Haskett Point in the Pioneer Basin of Idaho" (INL/PRO-23-71899); and "Mobility on the Eastern Snake River Plain During the Early Holocene/Middle Holocene Transition: Obsidian Conveyance and Spatial Analysis of Early Holocene and Northern Side-notched Projectile Points."

Pluvial Lake Terreton: Building a Multidisciplinary Dataset to Understand Human Land Use During the Terminal Pleistocene

To better understand the land use practices of the ancestral Shoshone and Bannock people during the Late Pleistocene era, the INL CRMO continues to investigate Lake Terreton and the Big Lost River Trough. Analyses are ongoing and will be integrated with the PCC. The existing collections for Owl Cave (10BV30), now curated at the Museum of Idaho, are also being utilized to address research questions related to the PCC. In FY 2023, a total of 15 bone samples from Owl Cave were dated using Accelerator Mass Spectrometry by the University of Georgia Center for Applied Isotope Studies. These data will be used to refine the regional projectile point chronology, as well as advance our understanding of bison procurement on the ESRP during the past 13,000 years.

Decoding the Southern Idaho Cultural Landscape Through Volcanic Glass Source Analysis

To fully characterize the geographic distribution of Southern Idaho obsidian source groups, the INL CRMO has compiled a comprehensive Idaho Obsidian Reference Collection. The current dataset contains over 2,000 samples of geologic obsidian from 155 locations that correspond to 30 geochemically distinct source groups, a few of which have not been previously defined or recognized by archaeologists and produce a technical report categorizing this collection. In FY 2024, DOE will submit the technical report to cooperating agencies in a memorandum of understanding, including the Idaho Falls District BLM, Caribou-Targhee National Forest, SHPO, and Shoshone-Bannock Tribes.

Pewaishe suakiga/Pekwanishu songaha – It Still Breathes, 10BT1449

Site 10BT1449, located near the Radioactive Waste Management Complex, was originally recorded in 1989 by Idaho State University. During a 1993 monitoring visit, the INL CRMO staff encountered Folsom points and possible channel flakes on the ground surface, in addition to the extensive flake scatter documented during the original recording. In early May of 1993, over 2,000 waste flakes, 11 bifaces, 20 channel flakes, and four Folsom points were collected during these efforts. The site was given Shoshone and Bannock names and fully re-recorded in 2022. The site represents a Folsom surface campsite with a complement of tools and debitage, allowing for a rare comparison with widely recognized Folsom technological patterning (INL/PRO-22-65966). Dr. Daron Duke is collaborating with Dr. Suzann Henrikson of the INL CRMO to characterize the Folsom assemblage recovered from *Pewaishe Suakiga* (10BT1449). This research was approved by DOE-ID and HeTO in February 2022. A detailed analysis is currently underway and should be completed in FY 2024. Dr. Duke has confirmed that 10BT1449 represents the only known Folsom manufacturing site in the Desert West. A co-authored manuscript for peer-review will be completed in FY 2024.

Examining the Chronology, Distribution, and Source Attributions of Volcanic Glass Haskett Points in the Pioneer Basin of Idaho

A PhD candidate at the University of Nevada—Reno is including Haskett projectile points from the INL Site in a geospatial analysis of Haskett projectile points across the Far West (INL/PRO-23-71899). DOE-ID and HeTO staff approved this research on July 13, 2023. This project represents a collaboration with INL CRMO staff to examine whether the distribution of this point type reflects a form of land use and mobility distinct from foragers utilizing fluted technology during the same period. The results of the research will be included in a co-authored manuscript for peer-review and incorporated with the dissertation research.

Mobility on the ESRP During the Early Holocene/Middle Holocene Transition: Obsidian Conveyance and Spatial Analysis of Early Holocene and Northern Side-notched Projectile Points

A Utah State University graduate student is performing a geospatial analysis to examine whether Precontact mobility patterns on the ESRP were influenced by climatic events during the Early Holocene/Middle Holocene transition. This project is being completed as a graduate thesis and is utilizing proxy archaeological data from an eight-million-acre study area to test Long's (2007) hypothesis that the ancestral Shoshone and Bannock people remained in highly productive resource patches, such as Lake Terreton and river corridors, during the Terminal Pleistocene and Early Holocene eras. However, Long (2007) argues that, with the disappearance of Lake Terreton roughly 8,000 years ago, foraging return rates within this patch diminished, prompting the utilization of small, productive resource patches spread across the open ESRP landscape. This hypothesis will be tested against the distribution of projectile points spanning the Terminal Pleistocene and Early Holocene eras, along with associated volcanic glass source attribution data. DOE-ID and the HeTO staff approved this research on July 13, 2023, and the student received geospatial INL Site data the following month. Preliminary results of this research will be presented at the "38th Great Basic Anthropological Conference" in Bend, Oregon. The student hopes to complete the thesis in spring 2024. The results of the research will be integrated with the Shoshone and Bannock PCC.

Built Environment Comprehensive Inventory

In 2023, the INL CRMO continued its efforts to update the Built Environment Inventory on the INL Site. Inventory updates for the Advanced Test Reactor (ATR) Complex, CFA, Critical Infrastructure Test Range Complex, EBR-I and Boiling Water Reactor Experiment Facilities, Idaho Nuclear Technology and Engineering Center, and MFC were completed by the Center for Environmental Management of Military Lands, with final revisions made by INL CRMO staff. DOE-ID submitted these inventories to the SHPO on April 30, 2023. Concurrence was received on May 23, 2023.

The following historic properties were recommended individually eligible:

- CF-638: High Explosives Magazine/Dosimetry Calibration Lab, Criterion A
- CF-642/CF-720: Pump House, CFA Well No. 2), Criterion A
- CF-651/CF-719: (Pump House, CFA Well No. 1), Criterion A
- CF-704: Concussion Wall (CF-633), Criterion A
- TRA-670: ATR Reactor Building, Criterion A
- EBR-601: Experimental Breeder Reactor-I (EBR-I), Criterion A
- Chemical Processing Plant (CPP)-659: New Waste Calcining Facility, Criterion A
- MFC-720: Transient Reactor Test (TREAT) Reactor Building, Criterion A
- MFC-724: TREAT Control Building, Criterion A
- MFC-765: Fuel Conditioning Facility, Criteria A and C
- MFC-767: EBR-II Reactor Plant Building, Criterion C
- MFC-768: Power Plant, Criterion A
- MFC-775: ZPPR Vault Work/Equipment Room, Criterion C
- MFC-776: ZPPR, Criterion C
- MFC-785: Hot Fuel Examination Facility (HFEF), Criteria A and B.

Additionally, potential historic districts were evaluated and three were recommended eligible under Criterion A:

- ATR Historic District, contributing properties (TRA-625, TRA-634, TRA-640, TRA-670, TRA-671, TRA-770, and TRA-771)
- TREAT Historic District, contributing properties (MFC-720, MFC-721, MFC-722, MFC-723, and MFC-724)
- ZPPR Historic District, contributing properties (MFC-774, MFC-775, MFC-776, MFC-777, MFC-784, and MFC-792).

INL CRMO architectural historians completed a draft of the Specific Manufacturing Capability and Test Area North Built Environment Inventory Update during 2023. The research design drew upon feedback received from the SHPO during consultation on previous inventories, including a programmatic approach to periods of significance based on active research programs rather than arbitrary cutoff dates. Buildings, structures, linear features, and objects built during or prior to 1986 were identified based on current documentation. Eighteen buildings, three structures, one linear resource, three objects, and three historic districts were recorded and evaluated.

9.5.5 Cultural Resource Monitoring

Field work in 2023 also included a broad, annual program involving routine visits to monitor current conditions at select previously recorded archaeological resources across the INL Site. In 2023, INL CRMO archaeologists, Shoshone-Bannock Tribes HeTO, and DOE-ID staff monitored site conditions at 11 locations on the INL Site. The data acquired during the 2023 monitoring efforts of these sites allowed for a complete evaluation of their current condition as compared to previous recordings. No impact to historic properties were observed during these monitoring visits in 2023.

9.5.6 Site Stabilization, Restoration, Preservation

Birch Creek Soil and Vegetation Restoration

Discussions between DOE-ID, INL (Natural Resources, F&SS, CRMO), HeTO, and BLM staff continued regarding the restoration efforts at the Birch Creek site (10BT0051). In 2023, INL completed soil testing, identification of seed and plant mixes for restoration, and strategies to increase revegetation success, as well as identification of seed and plant mixes for restoration, and strategies to increase revegetation success. The application of phosphate and elemental sulfur was conducted in the spring following the results of soil testing. The site form and report are anticipated for completion in FY 2024.

Naval Ordnance Test Facility Gun Display Project initiation

In order to prepare for the possibility of a future naval gun installation project and rehabilitation of the Naval Ordnance Test Facility site, the following actions have been taken. A working relationship has been established with Naval Surface Warfare Center Dahlgren, which is willing to donate a 16-inch naval gun and mounting components. Preliminary investigative work has been done to determine what components are necessary for such a display and logistical requirements. INL has given the go-ahead for a project cost-study, and subsurface investigations at the Naval Ordnance Test Facility will take place in the spring of 2024 to determine the condition of the original gun mount base and related infrastructure.

9.5.7 Stakeholder, Tribal, Public, and Professional Outreach

In 2023, the CRMO staff continued public outreach, combining virtual opportunities to expand reach and accommodate schedules with in-person meetings and INL Site visits, as well as presentations and activities at the Museum of Idaho, and via special invitation to events. These included “Secrets of the Owl Cave Bone Bed: Revealing an Ancient Bison Drive in Southern Idaho; Night at the Museum; Jeffrey-Goodale Cutoff of the Oregon Trail” (also as guest speaker at the “46th Actinide Separations Conference” banquet, hosted by INL), and the early historic period on the INL Site between 1805 and 1905, including early exploration and fur trapping in eastern Idaho to stage roads, railroads, and homesteading at the future INL Site. In addition, a virtual archaeology tour (in coordination with DOE-ID and the Shoshone-Bannock HeTO staff) was developed and conducted. These tours included a detailed history of the Precontact period on the ESRP and was co-presented by INL CRMO and HeTO staff members with Tribal perspectives interwoven with archaeological information.

Educational exhibits at the EBR-I Visitor's Center (Figure 9-6), a National Historic Landmark, and the Big Lost River Rest Area on U.S. Highway 20/26 within the boundaries of the INL Site are important tools for public outreach. Face-to-face employee “Ask an Architectural Historian” opportunities and public tours at these facilities were conducted in FY 2023, with a total of 12,653 visitors. In addition to in-person tours, visitors could download a free app (TravelStorys) that provided a virtual tour of the EBR-I museum. EBR-I has maintained the infrastructure necessary for self-guided tours of the facility that is available through a free app. Following the success of the virtual tours of the EBR-I Museum, the INL

CRMO developed and conducted two virtual archaeology tours for over 100 INL employees and members of the public. These tours included discussions of DOE-ID's archaeological responsibilities, eastern Idaho Precontact history, and specific examples of historic sites and nuclear history at the INL Site. INL CRMO staff supported a tour for DOE-ID facility representatives, including stops at the CFA Concussion Wall, EBR-I, and the Heat Transfer Reactor Experiment Engines, Powell Stage Station, Goodale's Cutoff, and the B-24 Bomber Crash Site.

Figure 9-6. Experimental Breeder Reactor – I, a National Historic Landmark located on the INL. *The CRMO assists DOE with fulfilling their Section 110 commitments to public outreach and education. This is an important element of the INL Cultural Resource Management Plan.*

Professional outreach opportunities included archives staff attendance at the "Northwest Archives Conference" in Salem, Oregon, and the "National Association of Government Archives and Record Administration Conference" in Cincinnati, Ohio. In addition, the INL CRMO hosted a symposium at the "Great Basin Anthropological Conference" (October 2023); "From Channel Flakes to Bison Jumps: Current Archaeological Investigations in Southern Idaho." The symposium included 11 presentations by five members of the Archaeological staff, former staff, and collaborating researchers. Presentations/symposiums included:

- Putting the Owl Cave Mammoth Hunters to Bed: New Dates from Layer
- Farthering Folsom: A Technological Analysis of the "It Still Breathes" Site in Eastern Idaho's Pioneer Basin
- Protein Residue Analysis in Archaeology: Preliminary Results of a Contamination Experiment
- Late Pleistocene Haskett Toolstone Use in Southern Idaho
- Sourcing the Obsidian Haskett Projectile Points recovered from the Haskett Type Site (10PR37) in Lake Channel, Idaho
- Investigating the Owl Cave Bison Bone Bed Lithic Assemblage

- The Owl Cave Bison Bone Bed: Evidence of an Early Holocene Mass Kill
- Isotopic Studies on Faunal Remains from Owl Cave Shed Light on Bison Predictability on the ESRP
- Mobility on the ESRP: Obsidian Conveyance and Spatial Analysis of Early Holocene and Northern Side-notched Projectile Points
- Reconstructing Ancient Subsistence Practices: The Fauna from Three Prehistoric Sites in Birch Creek Valley, Eastern Idaho
- Buffalo’s Little Brother's Hill (10BT2303): A Late Holocene Bison Jump in Eastern Idaho.

On April 19, 2023, the Shoshone-Bannock Tribes held an Earth Day celebration for students from the Shoshone-Bannock Junior-Senior High School at the INL Site. The event was organized by the Shoshone-Bannock HeTO and the INL K-12 Science, Technology, Engineering, and Mathematics Education Program with logistical support from the INL CRMO, F&SS, and Fire Department. Activities included a morning visit to Pioneer and the *Pewaishe Suakiga* sites for tribal students, followed by a ceremony for tribal members and DOE-ID and INL staff at CFA. Over 50 students visited the *Pewaishe Suakiga* site, where a Shoshone-Bannock Tribal Elder offered a prayer and the Shoshone-Bannock Air Quality Co-Lead for the Tribal Long-Term Stewardship Program provided a speech on how the lands and ecology of the INL Site were important to the Shoshone-Bannock Tribes. After the INL Site visits, the group gathered at the INL Site Fire Station and performed dances and invited DOE-ID and INL staff to join in the Friendship or Round dance.

INL CRMO staff continue to support DOE-ID with the Shoshone-Bannock relationship by supporting and facilitating attendance at Language and Cultural Committee Meetings, Cultural Resource Working Group Meetings, and an annual update to the Fort Hall Business Council.

INL Contractor Cultural Resource Community of Practice

INL CRMO staff continued to host monthly meetings of the INL Contractor Cultural Resources Community of Practice. Participating laboratories include INL, Los Alamos National Laboratory, Pacific Northwest National Laboratory, National Renewal Energy Laboratory, Oak Ridge National Laboratory, Brookhaven National Laboratory, and Sandia National Laboratory. In 2023, a total of four successful discussions and workshops on a variety of issues proved fruitful for participants. Topics included PAs, NRHP Historic Districts, creative mitigation strategies, sharing processes and procedures, and discussing strategies for memorandum of agreements.

9.5.8 INL Archives and Special Collections

During 2023, the INL Archives and Special Collections office was staffed by an INL archivist and a retained full-time archives intern. Archives staff assisted INL CRMO architectural historians by scanning 384 items for the Specific Manufacturing Capability built environment inventory update conducted in 2023. During the course of the year, 11 procedures, plans, and forms were approved and implemented.

The purpose and mission of the INL Archives and Special Collection have been highlighted in two articles with input from archives staff; “Idaho National Laboratory and Two ISU Alumni Establish and Archive” (Curtis 2023) and “Archivist Brings the Past Into the Present” (Walker 2023). The Archives and Special Collections office received five external requests and six internal requests for accessions, collections, and reviews. The completed requests have resulted in 204 archival quality scans.

The INL Archives and Special Collection office is involved in INL Site Record Center destruction and permanent monthly transfer meetings. This also allows INL archives staff to scan the material of interest for archives purposes. Archives staff worked with the property organizations and created a tagging system to track and access large objects that are administratively controlled.

During FY 2023, INL archives staff completed 17 accessions, including approximately 23,000 archival photographs, five INL-specific booklets and articles, five maps, 310 slides, and 41 archival objects. Metadata for 111 architectural and engineering drawings was completed in the INL Site Records Center transfer/destruction process with the completion of 355 scans. Repairs were completed for 58 damaged architectural drawings. Of note, these accomplishments were completed while the archives space was under renovations to become compliant with National Archives and Records Administration standards for six months of 2023.

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Sage-grouse habitat monitoring

Chapter 10: Quality Assurance of Environmental Surveillance Monitoring Programs

CHAPTER 10

Quality assurance (QA) consists of planned and systematic activities that give confidence in the results of environmental surveillance monitoring programs (NCRP 2012). Environmental surveillance monitoring programs include: air (e.g., air filters, quarterly composites), atmospheric moisture, precipitation, drinking water, surface water, effluents, groundwater, agricultural products (e.g., milk, alfalfa, lettuce, potato, wheat), big game, soil, bats, and direct radiation. Environmental surveillance monitoring programs should provide data of known quality for assessments and decision-making. QA and quality control (QC) programs were maintained by Idaho National Laboratory (INL) Site contractors and laboratories performing environmental analyses.

GEL Laboratories, LLC (GEL) was rigorously assessed and audited in 2023 by the U.S. Department of Energy Consolidated Audit Program-Accreditation Program (DOECAP-AP), third-party accreditation bodies. No major audit findings were identified. Idaho State University's Environmental Assessment Laboratory was listed in the INL contractor respective environmental program's approved vendor list.

Analytical laboratories who seek and maintain accreditation from DOECAP-AP must acquire and analyze proficiency testing (PT) samples from an accredited PT provider. In 2023, GEL acquired and analyzed PT samples from Environmental Resource Associates and Eckert & Ziegler Analytics, Inc. PT programs and overall had acceptable results.

The environmental surveillance monitoring programs sent performance evaluation (PE) samples representing a variety of media for the purpose of demonstrating that a laboratory can successfully analyze samples within performance criteria during 2023. The INL Site contractors had a total of 322 analytes from various PE samples that were evaluated with 90% receiving an agreement evaluation. The nonagreements were reviewed and any unusual conditions were addressed, identified, and, when necessary, corrective actions were prepared to improve processes. Results are summarized in Section 10.4.

The multifaceted approach to QA and QC used by the INL Site contractors provide confidence that all laboratory data reported for 2023 are reliable and of acceptable quality.

10. QUALITY ASSURANCE OF ENVIRONMENTAL SURVEILLANCE MONITORING PROGRAMS

This chapter describes specific measures taken to ensure adequate data quality and summarizes performance.

10.1 Quality Assurance Policy and Requirements

INL Site contractors incorporate appropriate QA requirements and elements from 10 CFR 830, Subpart A, and DOE Order 414.1D, Change 2, to ensure environmental samples are representative and complete and data are reliable and defensible. Additional QA program requirements in 40 CFR 61, Appendix B, Method 114, must be met for all new point sources of radiological air emissions, as required by 40 CFR 61, Subpart H.

10.2 Program Elements and Supporting Quality Assurance Process

According to the National Council on Radiation Protection and Measurements (NCRP 2012), QA is an integral part of every aspect of an environmental surveillance monitoring program from the reliability of sample collection through sample transport, storage, processing, and measurement to calculating results and formulating the report. Uncertainties in the environmental surveillance monitoring process can lead to the misinterpretation of data and errors in decisions based on the data.

Every step in radiological environmental surveillance monitoring should be evaluated for integrity, and actions should be taken to evaluate and manage data uncertainty.

Meeting the requirements of state regulations, U.S. Environmental Protection Agency (EPA) directives, and DOE directives are an important part of developing an environmental sampling program. Gathering quantitative and qualitative environmental data is unique to each surveillance monitoring program. All data from planning, sample collection and handling, sample analysis, data review and evaluation, and reporting is complete, precise, and representative to ensure defensibility (Figure 10-1). Approved, detailed procedures are maintained, adequate training is given, and documents are controlled by the INL Site contractors and analytical laboratories to ensure that data are of acceptable precision and accuracy.

The main elements of environmental surveillance monitoring programs implemented at the INL Site, as well as the QA processes/activities that support them, are shown in Figure 10-1 and discussed below.

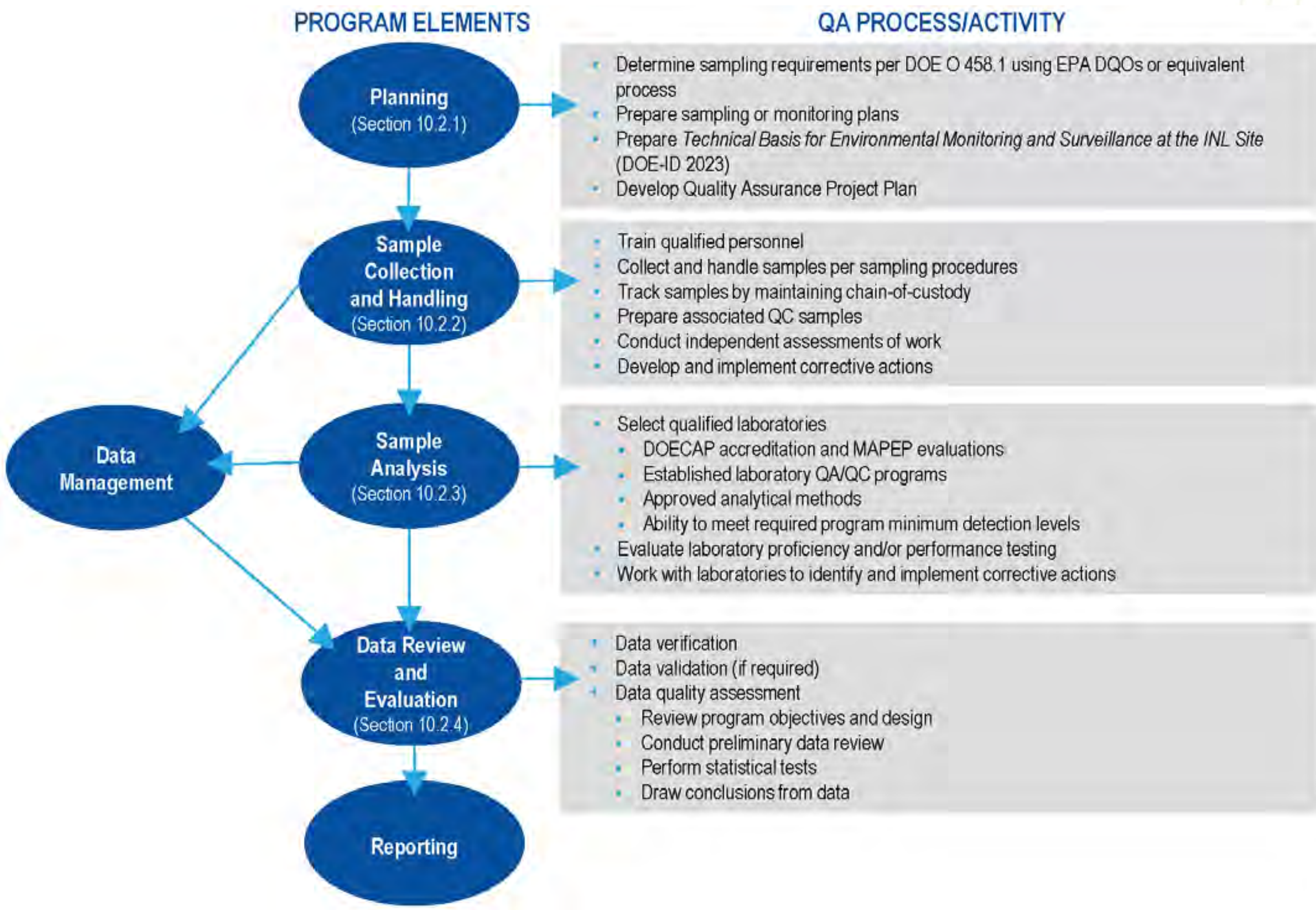

Figure 10-1. Flow of environmental surveillance monitoring program elements and associated QA processes and activities.

10.2.1 Planning

Environmental surveillance monitoring activities are conducted by the following:

- INL contractor
- Idaho Cleanup Project (ICP) contractor
- U.S. Geological Survey (USGS).

Each INL Site contractor determines sampling requirements using the EPA Data Quality Objective (DQO) process (EPA 2006) or its equivalent. During this process, the project manager determines the type, amount, and quality of data needed to meet DOE O 458.1, state and federal regulatory requirements, support decision-making, and address stakeholder concerns. These plans include:

Sitewide Monitoring Plans. The "Idaho National Laboratory Site Environmental Monitoring Plan" (DOE-ID 2021b) and "Idaho National Laboratory Groundwater Monitoring and Contingency Plan Update" (DOE-ID 2021a) summarize the various monitoring programs at the INL Site, including surveillance monitoring for air, water (e.g., surface, drinking, ground), soil, biota, agricultural products, external radiation, ecological, and meteorological monitoring on and near the INL Site; and surveillance/compliance monitoring for effluent on the INL Site. The plans include the rationale for monitoring, the types of surveillance media, where the sampling is conducted, and information regarding access to the analytical results.

QA Project Plan. Implementation of QA elements for sample collection and data assessment activities are documented by each INL Site contractor using EPA's recommended approach. The EPA policy on QA plans is based on the national consensus standard ANSI/ASQC E4-1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs." DQOs are project-dependent and are determined based on the needs of the data users and the purpose for which the data are generated. DQOs, sampling and analysis plans, and the "Technical Basis for Environmental Monitoring and Surveillance at the INL Site" (DOE-ID 2023) are integrated into the INL Site contractors QA project plans. Quality elements applicable to environmental surveillance and decision-making are specifically addressed in the "EPA Requirements for Quality Assurance Project Plans" (EPA 2001).

What is the difference between Quality Assurance and Quality Control in an environmental program?

- Quality assurance (QA) is an integrated system of management activities designed to ensure quality in the processes used to produce environmental data. The goal of QA is to improve processes so that results are within acceptable ranges.
- Quality control (QC) is a set of activities that provide program oversight (i.e., a means to review and control the performance of various aspects of the QA program). QC provides assurance that the results are what is expected.

QA project plans are developed for environmental surveillance monitoring media by each INL Site contractor to ensure that all collected data meet the requirements of all applicable federal and state regulations and DOE directives.

10.2.2 Sample Collection and Handling

Defensible laboratory data is a critical component of any environmental program. Field sample collection and handling coupled with a chain-of-custody that shows unique sample identification, weight, sample preservation, volume, holding time, approved procedures, and request of laboratory analysis are important steps of defendable data.

Strict adherence to program procedures is an implicit foundation of QA. In 2023, samples were collected and handled by trained personnel according to documented program procedures. Sample integrity was maintained through a system of sample custody records. Work execution assessments were routinely conducted by personnel independent of the work activity. Deficiencies were addressed by follow-up and corrective actions. Quality assessments are tracked in contractor-maintained systems.

QC sampling elements, as shown in Figure 10-2, are used by INL Site contractors to validate the collection process and verify the quality of laboratory preparation and analysis. These included the collection of trip blanks, field blanks, equipment blanks, split samples, sample duplicates, and PE samples. Definitions for these elements/terms can be found in Appendix C. Glossary.

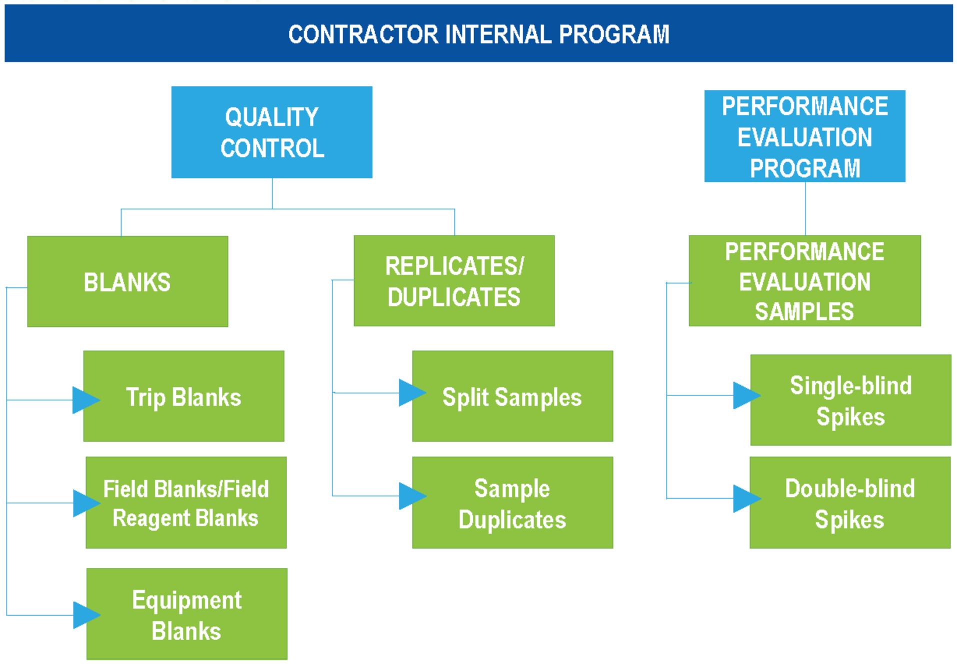

Figure 10-2. QC program sampling elements.

10.2.3 Sample Analysis

The following laboratories show in Table 10-1 were used by the INL Site contractors to analyze environmental surveillance samples in 2023.

Table 10-1. 2023 analytical laboratories used to analyze surveillance media.

ANALYTICAL LABORATORY	MEDIA				
	AIR	WATER	AGRICULTURAL PRODUCTS	BIOTA	SOIL
GEL Laboratories, LLC	X[a]	X[b]	X	X	—[c]
ISU-EAL[d]	X[a]	X[b]	X	X	—
RESL Laboratory	—	X	—	—	—

a. Includes atmospheric moisture.
b. Includes precipitation.
c. Not sampled in 2023.
d. ISU-EAL = Idaho State University-Environmental Assessment Laboratory

Laboratories used for routine analyses of radionuclides in environmental media were selected based on a laboratory's capabilities to meet program objectives, such as the ability to meet required detection levels, and past results in PT programs. The DOECAP-AP, which is comprised of third-party accreditation bodies, issues an annual accreditation certificate to laboratories seeking and maintaining accreditation. The rigorous accreditation process reviews each method, media, and analyte analyzed at the laboratory. An annual audit is performed to evaluate a laboratory's technical capability and competence, along with their proficiency in complying with DOE QA requirements as outlined in the Quality Systems Manual (QSM 2021).

No major audit findings were identified by DOECAP-AP third-party accreditation bodies for GEL that would influence the defensibility or quality of laboratory data in 2023. GEL maintained accreditation for 2023.

For more information on DOECAP-AP, visit the DOE Analytical Services Program webpage at www.energy.gov/ehss/analytical-services-program.

GEL participates in PT programs accredited to ISO 17043 as outlined in the QSM (QSM 2021). The laboratory is responsible for reviewing their PT results and correcting potential quality concerns identified by the PT provider. DOECAP annual accreditation is maintained by achieving two successful studies (e.g., acceptable scores) out of their most recent three attempts. Results for the PT programs are provided in Section 10.3.

The DOE Laboratory Accreditation Program (DOELAP) is responsible for implementing performance standards for DOE contractor external dosimetry program through periodic PT and on-site program assessments. Accreditation must be renewed on a triennial basis following periodic proficiency testing and on-site program assessments. Landauer is accredited through this program.

Laboratory data quality is continually verified by QC samples, as observed in Figure 10-3, and includes calibration verifications, blanks, replicates/duplicates, and intra-laboratory and PT samples.

An analytical laboratory may use several of the laboratory QC measurement elements identified in Figure 10-3. Results of the laboratory QC are presented to the INL Site contractors as a data package and provide assurance that the reported data are usable and defensible.

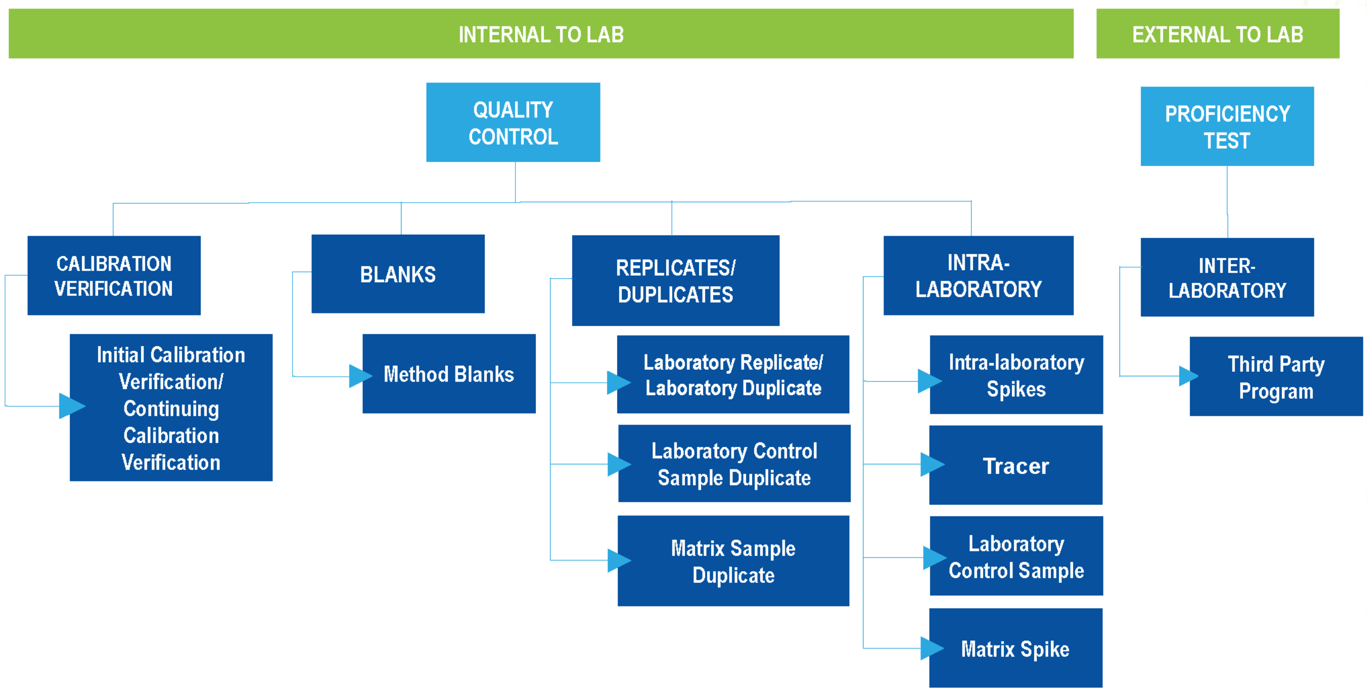

Figure 10-3. Laboratory measurement elements.

10.2.4 QC Data Review and Evaluation

Data that the INL Site contractors generate are routinely evaluated to understand and sustain data quality. This enables programs to determine whether the DQOs established in the planning phase were achieved and whether the laboratory is performing within its QA/QC requirements.

Environmental data may be subject to verification, validation, and quality assessment.

The Environmental Data Warehouse is the official warehouse for long-term management and storage of environmental data collected in support of INL Site contractors. Data stored in the Environmental Data Warehouse is used to support compliance reporting, decision-making, trending, and modeling. Appropriate testing is completed in the event any significant changes are made to the Environmental Data Warehouse database, or the server operating system on which the data system reside, in accordance with the *Software Configuration Management Plan for INL Site Environmental Data Systems* (PLN-3844).

The INL Site contractors send media-specific PE samples to the laboratories for the purpose of testing the laboratories' ability to successfully analyze samples within performance criteria. These are compared with PT results and can provide valuable indicators that further QC testing may be required.

Figure 10-4 shows a decision tree of the process used for reviewing PE sample results along with sample data from the elements listed in Figure 10-2. When PE sample results are in agreement for the INL Site contractors, a review of the remaining data continues. If no issues are identified, the data package is approved. If the PE result is identified as a nonagreement, the INL Site contractor reviews all available PE and PT data.

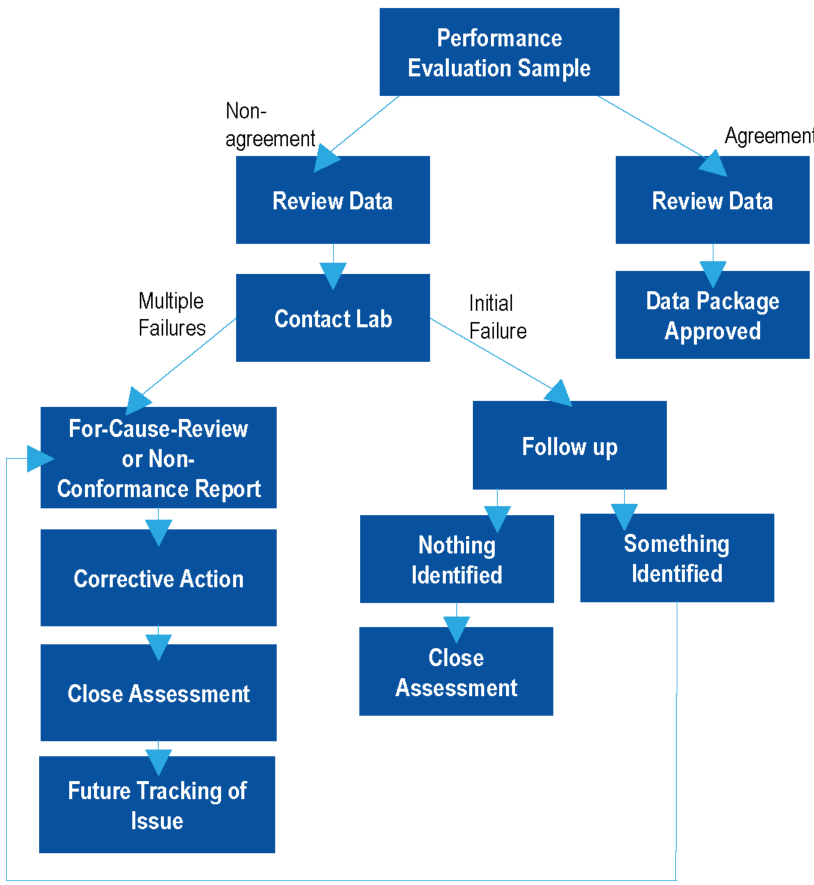

Figure 10-4. Environmental surveillance field sampling data PE review process.

A variety of items that may be considered for review include, but are not limited to, the following questions:

- Did the PE sample provider prepare the sample (single-blind or double-blind) within the range specified by their customer? If yes, begin looking into the other PE and PT results. If not, the PE sample may not be an accurate representation of the project-specific field conditions or field results. If the equipment is calibrated for the field concentration range, and the PE sample is not within that range, then the accuracy and representativeness of the PE sample may be called into question.
- Did the laboratory perform all the required program- and method-specific QC analyses using the process shown in Figure 10-3? Are these QC results within acceptable parameters?
- What does a review of the long-term project results indicate? Are all project-specific and analytic-method-specific PE results within specification? If not, does the laboratory have a history of out-of-specification QC results for a specific analyte?

Upon a review of the entire body of PE evidence and using both objective and subjective professional judgment, the INL Site contractor will determine if the nonagreement result is a one-time anomaly or if the laboratory needs to perform a review.

A "Follow-Up" review occurs after a single failure and may result in the laboratory not identifying any issues leading to the nonagreement result. At this point, the data package has good defensible data if the laboratory passed all their qualifying criteria (Figure 10-3). If a laboratory qualifying criterion is not met, the laboratory will re-prepare and re-analyze the samples. However, if there is not enough of a sample available, the laboratory may flag the data when the laboratory's "QC is Not Within Criteria" (Figure 10-3). When the "Follow-Up" review identifies issue(s), either a "For-Cause-Review" or a "Non-Conformance Report" may be requested.

A "For-Cause-Review" and/or "Non-Conformance Report" may be requested when multiple PE sample issues occur consecutively (e.g., a nonagreement evaluation for the same radionuclide in the same matrix) or as a result of a "Follow-Up" review. The laboratory would perform an investigation (e.g., review/verify sample units, weights, calculations) during a "For-Cause-Review." Whereas a "Non-Conformance Report" would generate a rigorous laboratory review (e.g., interview analysts, historical results). Both the "For-Cause-Review" and "Non-Conformance Report" could result in a "Corrective Action" being issued, which may resolve the problem and prevent future issues from occurring. Upon acceptance of the "Corrective Action," the assessment would be closed, and the issues discussed would be monitored in future data packages.

If the laboratory cannot identify issues following a "For-Cause-Review" and/or "Non-Conformance Report" resulting from multiple PE nonagreement evaluations, the INL Site contractor will work with the laboratory to assist in the investigative process. For example, additional PE samples may be provided to the analytical laboratory to determine whether any problems arise from sample preparation, data calculations, data entry into a database, etc. As a result, the laboratory will provide an acceptable "Corrective Action" to the INL Site contractor. The issue will be monitored for future PE samples. Depending on the severity, the contractor may hold onto the samples until the issue is resolved and may send a letter-of-concern to the laboratory. Based on the outcome of the investigation, the INL Site contractor could terminate the contract and seek another laboratory.

10.3 2023 Interlaboratory Program PT Evaluations

GEL maintained accreditation and had no major findings identified by DOECAP-AP for GEL in 2023. GEL also participated in PT studies for Environmental Resource Associates and Eckert & Ziegler Analytics, Inc. and overall had acceptable results.

Landauer maintained accreditation through DOELAP in 2023.

10.4 2023 INL Site Contractors QC Programs

Individual QC programs include the use of several elements, as shown in Figure 10-2 and Figure 10-3, respectively, to evaluate the performance of a laboratory. Not all QC measurement elements are required unless specifically called out in each INL Site contractor program's contract with the laboratory, or as required by the specific analytical method.

Field QC samples are sent to laboratories along with routine environmental samples to be analyzed in tandem. The samples are prepared in a way that the QC samples are analogous to the field samples. The laboratory is not aware of which samples are blanks, duplicates, or PE samples. Blanks are submitted along with the regular samples to test for the introduction of contamination during the process of field collection, laboratory preparation, and laboratory analysis. Duplicate/replicate samples are submitted with the regular samples to assess field collection, homogeneity, reproducibility, laboratory preparation, laboratory analysis, and precision.

A PE sample where the activity is known by the INL Site contractors, but not the analytical laboratory, is called a "single-blind" PE sample; whereas a PE sample where the activity is unknown to both the INL Site contractors and the analytical laboratory is referred to as a "double-blind" PE sample. PE samples are sent to the laboratory throughout the year. Evaluations of these samples are used to improve accuracy of the data by following the process identified in Figure 10-4.

In addition to the INL Site contractors' PE program, Mixed Analyte Performance Evaluation Program (MAPEP) is an interlaboratory program that uses evaluations to test the ability of the laboratories to correctly analyze radiological, nonradiological, stable organic, and stable inorganic constituents' representative of those at DOE sites. MAPEP provides QA oversight for environmental analytical services by performing a semiannual evaluation of commercial laboratories. GEL participated in the MAPEP Series 48 and 49 during 2023. The Idaho State University-Environmental Assessment Laboratory (ISU-EAL) participated in Series 48. Laboratories publish results from MAPEP in quarterly QA reports. These reports are reviewed by the INL Site contractors and compared with the internal PE results.

In the event a data quality or trending issue is identified, the concern will be documented in an Issues Management System to track resolutions and/or corrective actions.

10.4.1 INL Contractor QC Program

INL Contractor Blanks

No concerns were identified in blanks that would indicate data quality or trending issues with sampling, handling, shipment, or analysis by the laboratory contributed to the actual sample results in 2023:

- ***GEL Laboratories, LLC***
  A total of 170 analytes were analyzed by GEL in various media. The media analyzed included air filters, quarterly air filter composites, atmospheric moisture, precipitation, drinking water, and milk.

- ***ISU-EAL***
  A total of 97 analytes were analyzed by ISU-EAL in various media. The media analyzed included air filters, charcoal cartridges, quarterly air filter composites, milk, and precipitation.

INL Contractor Replicate/Duplicate

No concerns were identified in duplicates/replicates that would indicate data quality or trending issues with sampling, handling, shipment, homogeneity, reproducibility, or preparation and analysis by the laboratory contributed to the actual sample results for 2023:

- ***GEL Laboratories, LLC***
  A total of 607 analytes were analyzed by GEL Laboratories. The media analyzed included air filters, quarterly air filter composites, milk, produce, surface water, effluent, and groundwater.

- ***ISU-EAL***
  A total of 95 analytes were analyzed by ISU-EAL in various media. The media analyzed included air filters, charcoal cartridges, quarterly air filter composites, milk, and drinking water.

INL Contractor PE

In 2023, the INL contractor used GEL, ISU-EAL, and Landauer laboratories to provide analytical results for air (e.g., air filters, quarterly composites), atmospheric moisture, precipitation, drinking water, surface water, effluents, groundwater, agricultural products (e.g., milk, alfalfa, lettuce, potato, wheat), big game, soil, bats, and direct radiation.

Of the PE samples analyzed in 2023 by GEL, ISU-EAL, and Landauer, 191 (87%) PE analytes were in agreement, as indicated in Figure 10-5, with 25 (13%) PE analytes categorized as nonagreements.

How do these discrepancies between expected and actual PE sample results relate to field sample values? If a PE sample registers a result below the anticipated value, it indicates a low bias in the reference sample. This could imply that the true values for field samples from the same batch are understated in the laboratory's reports. On the other hand, if a PE sample records a result above the expected value, it points to a high bias. In this scenario, it is possible that the true values for field samples in the batch exceed the results reported by the laboratory.

Illustrating this point, Figure 10-6 presents a case where a low bias of 35% was found for a plutonium-239 (^{239}Pu) air filter PE composite analyzed during fourth quarter of 2023. Upon applying the 35% low bias correction to the maximum observed ^{239}Pu concentration within the same air filter composite batch. The recalculated value for the routine sample is marginally elevated compared to its initially reported value and below the acceptable derived concentration limit.

However, it's standard practice not to correct laboratory field sample results for low/high biases identified through PE nonagreement. Such discrepancies typically do not influence decision-making regarding that particular analyte for that media, and data is not discarded due to nonagreement. Additional quality assurance and quality control (QA/QC) measures are also under review. PEs provide an opportunity for the INL contractor to work with the laboratory on nonagreements to identify processes, procedures, and methods that will lead to improved accuracy of data.

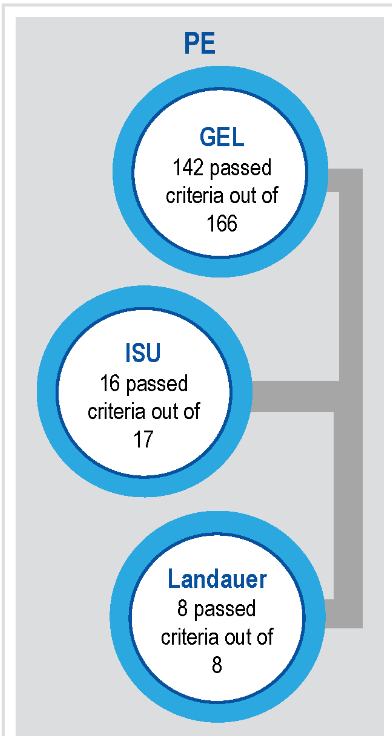

Figure 10-5. INL contractor 2023 PE analyte results.

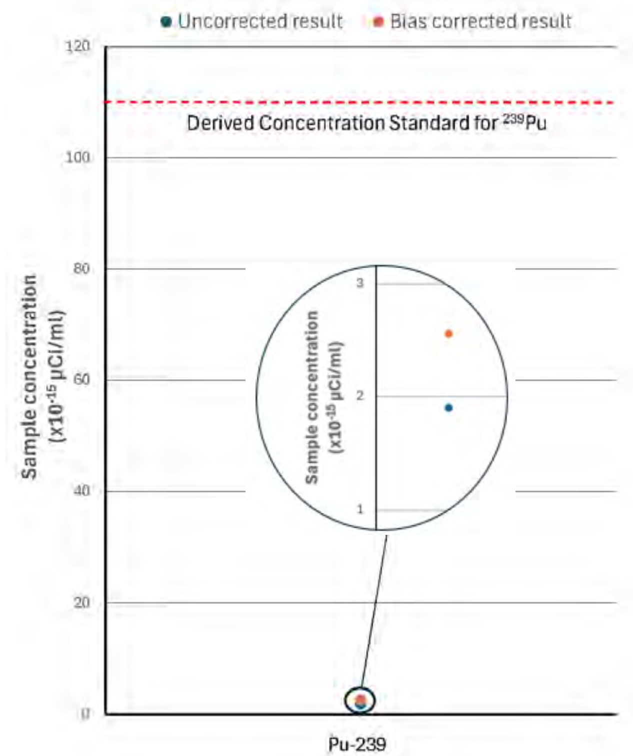

Figure 10-6. Comparison of nonagreement ^{239}Pu PE result to DCS (result correction and non-correction).

The INL contractor worked with the laboratories on nonagreements. Discussion points are listed below.

- ***GEL Laboratories, LLC***

  Air Filter Composites
  GEL received nonagreements for americium-241 (^{241}Am), plutonium-238 (^{238}Pu), ^{239}Pu, uranium-234 (^{234}U), and uranium-238 (alpha emitters) in a first quarter air filter composite PE sample. Results for the analytes exhibited about the same amount of bias when compared to the known values. Even though this was a first occurrence for alpha analytes analyzed by GEL, the laboratory was informed of the nonagreements, prompting GEL to perform an internal investigation. GEL identified an analyst error that occurred in preparation of the aliquot used for analysis that resulted in the low recoveries. The analyst left GEL prior to the internal investigation and audit. The audit reviewed multiple individuals aliquoting filter samples, and all procedures were performed properly.

  Nonagreement evaluations were received for zinc-65 (^{65}Zn) (gamma emitter) and ^{238}Pu and ^{239}Pu (alpha emitters) in a fourth quarter air filter composite PE sample. The INL contractor noted that a similar occurrence happened for ^{65}Zn in the second quarter 2023 PE composite sample. The laboratory was contacted and a request was made to review the ^{65}Zn nonagreement. Based on that review, the laboratory determined the ^{65}Zn nonagreement may be due to the air filter composite being direct counted rather than digested. A recommendation was made by GEL to have the composite samples digested and then counted. The INL contractor will work with the laboratory to determine which process (direct or digestion) will improve the accuracy and precision of the results. The laboratory also reviewed the nonagreements for ^{238}Pu and ^{239}Pu (alpha emitters). The nonagreements were attributed to random counting statistics. The INL contractor reviewed the previous PE air filter composites, MAPEP, and ERA PT results and all analytes of interest for the composites were in agreement. This is a first occurrence for ^{238}Pu and ^{239}Pu and not indicative of a trend.

Agricultural Products

GEL received nonagreement evaluations for ^{65}Zn (gamma emitter) and strontium-90 (^{90}Sr) (beta emitter) in a milk sample. The INL contractor contacted the laboratory and requested a review of these nonagreements. Based on that review, the laboratory determined that the ^{65}Zn (gamma emitter) was an anomaly since no errors were found. The ^{90}Sr (beta emitter) was biased high due to a low yield on the sample; therefore, no further actions were taken. The INL contractor reviewed previous milk PE and PT results and found agreements for ^{90}Sr and ^{65}Zn. The INL contractor will continue to monitor future PE results.

Nonagreement evaluations for gamma emitters were identified for colbalt-57 in alfalfa, cobalt-60 and cesium-137 in lettuce, and ^{65}Zn in potato. Nonagreement evaluations were identified for the beta emitter (^{90}Sr) in alfalfa, lettuce, and grain. The INL contractor requested GEL review all nonagreement evaluations. GEL's investigation determined the nonagreements were due to samples not being completely consumed during the sample preparation. GEL requested the INL contractor to document sample preparation requirements on the chain-of-custody and contact the project manager so the message could be relayed to the analysis team. The INL contractor's corrective action for alfalfa, lettuce, grain, and potato PE samples will be to document on the chain-of-custody required sample preparation comments for each PE sample to either "analyze entire sample" for gamma emitters or to "consume entire sample" for beta emitters. The GEL project manager will be notified of these samples and instructions on the chain-of-custody.

Effluent and Groundwater

A total of 86 effluent and groundwater double-blind PE analytes were analyzed by GEL and evaluated by the PE sample provider in 2023. GEL received a nonagreement for six results. Two of the nonagreements were for gamma spectrometry on ^{241}Am and radium-226 results reported as non-detects; however, a review shows the PE provider prepared both analytes at levels less than the laboratory's contractual detection limits for the specific projects, so the non-detects are the expected results and considered correct. Two alpha spectrometry results received nonagreements, including ^{241}Am and ^{234}U. The remaining two nonagreements were for technetium-99 (^{99}Tc) and ^{90}Sr. The INL contractor requested GEL review and provide follow-up on these four nonagreements to determine whether corrective actions were necessary. GEL's follow-up response indicated the alpha spectrometry nonagreements were due to known sample activity being too close to detection levels. GEL's follow-up review of the ^{99}Tc and ^{90}Sr nonagreements were inconclusive as no errors were identified. The INL contractor reviewed previous PE, MAPEP, and ERA PT results for analytes of interest in effluent and groundwater and found they were in agreement. This is a first occurrence for these four analytes and not indicative of a trend. The INL contractor will continue to monitor GEL's performance on these analytes.

- ***ISU-EAL***

  Drinking Water

  A nonagreement evaluation was identified for gross alpha in drinking water and was a first-time occurrence. The INL contractor requested ISU-EAL to follow-up on the nonagreement. The ISU-EAL investigation identified that the PE sample was not acidified. The INL contractor requested a "For-Cause Review" to look at other samples in the group. ISU-EAL identified that the laboratory technician had acidified the other samples prior to analysis. The INL contractor reviewed all sample results and the results were comparable to historical values.

10.4.2 ICP Contractor QC Program

ICP Contractor Blanks

No concerns were identified in blanks that would indicate data quality or trending issues with sampling, handling, shipment, or analysis by the laboratory contributed to the actual sample results in 2023.

- ***GEL***
  A total of 353 analytes were analyzed by GEL in perched water and groundwater media. A single groundwater result was flagged for noncompliance due to negative chlorine-36 activity.

ICP Contractor Replicate/Duplicate

No concerns were identified in duplicate/replicates that would indicate data quality or trending issues with sampling, handling, shipment, homogeneity, reproducibility, or preparation and analysis by the laboratory contributed to the actual sample results for 2023.

- ***GEL***
  A total of 198 analytes were analyzed by GEL Laboratories in perched water and groundwater media.

ICP Contractor PE

In 2023, the ICP contractor used GEL to provide analytical results for air filters, quarterly composite air filters, perched water, ground water, liquid effluent, and wastewater.

Of the PE samples analyzed in 2023 by GEL, 131 (95%) PE analytes were in agreement with only seven (5%) PE analytes categorized as nonagreements. The ICP contractor worked with the GEL on nonagreements to identify processes, procedures, and methods that will lead to improved accuracy of the data. Discussion points are listed below.

- ***GEL Laboratories, LLC***

  Air Filter Composites
  Results for the air surveillance program were flagged due to low bias for ^{90}Sr, ^{134}Cs, and plutonium-238 (^{238}Pu). The ICP contractor contacted GEL, and it was found that the ^{238}Pu sample in question was not filtered. The ^{134}Cs and ^{90}Sr results did not agree with the known value which GEL attributed to longer counts. These instances were single events and are not indicative of a trend.

  Surface Water
  Results for the surface water program were flagged due to low bias for ^{241}Am and ^{239}Pu. The ICP contractor communicated with GEL, and it was discovered that the results did not agree with the known value due to longer counts. The lab has taken steps to address the confusion and subsequent analyses have proven more reliable. When compared to previous MAPEP and PE results, the results are similar and do not indicate a trend.

10.4.3 USGS QC Program

In 2023, the USGS used the Radiological and Environmental Sciences Laboratory (RESL) to provide analytical results for groundwater monitoring wells. USGS submits field blanks along with regular samples to test for the introduction of contamination during the process of field collection, laboratory preparation, and laboratory analysis.

USGS Blanks

No concerns were identified in blanks that would indicate data quality or trending issues with sampling, handling, shipment, or analysis by the laboratory contributed to the actual sample results in 2023.

- ***RESL***
  A total of 10 analytes were measured in three groundwater samples by RESL laboratories to evaluate blank data quality.

USGS Replicate/Duplicate

No concerns were identified in duplicates/replicates that would indicate data quality or trending issues with sampling, handling, shipment, homogeneity, reproducibility, or preparation and analysis by the laboratory contributed to the actual sample results for 2023.

- ***RESL***
  A total of 27 analytes were measured in nine groundwater samples by RESL laboratories to evaluate reproducibility between environmental and sequentially collected replicates.

10.5 Conclusions

The quality elements presented in Figure 10-1 were implemented in 2023. The field sampling elements (Figure 10-2), laboratory measurements (Figure 10-3), and PE samples were reviewed and evaluated for each INL Site contractor and are summarized in Section 10.4. It has been determined that all laboratory data presented in this report are valid, reliable, and defensible.

10.6 References

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Appendix A: Chapter 5 Addendum

Table A-1. Advanced Test Reactor Complex cold waste pond effluent permit-required monitoring results (2023).[a,b]

PARAMETER	MINIMUM	MAXIMUM	MEDIAN
pH (standard units)	6.26	7.00	6.80
Conductivity (µS/cm)	378	1454	397
Chromium, filtered (mg/L)	0.0026	0.0126	0.00383
Chromium, total (mg/L)	0.00295	0.0129	0.00374
Iron, filtered (mg/L)	0.03U[c]	0.0444	0.03U
Iron, total (mg/L)	0.03U	0.0617	0.03U
Nitrate + nitrite as nitrogen (mg/L)	0.925	4.03	0.975
Solids, total dissolved (mg/L)	192	1,200	215
Sulfate (mg/L)	20.9	667	26.8J[d]

a. Reuse Permit I-161-03 does not specify maximum effluent constituent loading or concentration limits.

b. Duplicate samples collected in July 2023 are included in the statistical summary.

c. U qualifier indicates the result was below the detection limit.

d. J flag indicates the associated value is an estimate and may be inaccurate or imprecise.

Table A-2. Hydraulic loading rates for the Advanced Test Reactor Complex cold waste pond (2023).

	YEARLY TOTAL VOLUME
2023 flow[a]	215.60 MG[b]
Annual permit limit[c]	375 MG
5-yr moving annual average permit limit	300 MG

a. Annual volume is reported for the 2023 permit reporting year. The 2023 volume is estimated due to the flowmeter failing its annual calibration in 2022. A new flow meter was installed and calibrated in June 2023.

b. MG = million gallons.

c. The reuse permit specifies an annual limit based on a twelve-month reuse year from November 1 through October 31.

Table A-3a. Advanced Test Reactor Complex cold waste pond industrial wastewater reuse permit monitoring well results (2023).[a]

WELL NAME	USGS-098 (GW-0161-01)		USGS-065 (GW-161-02)		USGS-076 (GW-161-04)		TRA-08 (GW-161-05)		MIDDLE-1823 (GW-161-06)		USGS-136 (GW-161-08)		STANDARD[b] PCS/SCS
SAMPLE DATE:	05/11/23	09/18/23	05/12/23	09/20/23	05/15/23	09/21/23	05/12/23	09/19/23	05/16/23	09/19/23	05/15/23	09/18/23	
Water table depth (ft) bls[c]	431.25	431.90	477.20	477.77	486.53	487.19	492.34	493.00	496.19	496.86	491.89	492.53	NA[d]
Water table elevation (ft)[e]	4,457.96	4,457.31	4,451.37	4,450.80	4,446.68	4,446.02	4,446.72	4,446.06	4,446.68	4,446.01	4,446.84	4,446.20	NA
Borehole correction factor (ft)[f]	2.53	2.53	NA	NA	NA	NA	0.63	0.63	NA	NA	0.22	0.22	NA
Ph (s.u.)	6.76	7.07	6.59	7.41	6.91	7.07	6.84	7.03	6.88	7.08	6.94	7.03	6.5 to 8.5 (SCS)
Conductivity (µS/cm)	401	417	575	591	415	419	408	407	415	417	414	429	NA
Temperature (ºF)	55.4	55.0	56.5	56.1	55.4	55.2	54.9	56.5	56.3	57.0	58.3	57.0	NA
Nitrite + nitrate as nitrogen (mg/L)	1.24	1.26	1.58J[g]	1.42	2.09R[h]	1.41J	1.17J	1.00	1.05 (1.07)[i]	0.995	1.30R	1.18	10 (PCS)
Sulfate (mg/L)	21.3J	23.4J	129	137	33.4J	34.0	40.3	41.6	30.9J (31.2J)	31.5	30.7J	30.3J	250 (SCS)
Solids, total dissolved (mg/L)	221	211	366	371	226	228	230	228	220 (214)	224	232	222	500 (SCS)
Chromium, total (mg/L)	0.00726	0.00706J	0.0841	0.092	0.0109J	0.0117	0.0201	0.0187	0.0107 (0.0103)	0.0106	0.0151J	0.0172J	0.1 (PCS)
Chromium, filtered (mg/L)	0.00753	0.00718J	0.0828	0.0827	0.0105J	0.0113	0.0198	0.018	0.010 (0.0103)	0.0107	0.0156J	0.0167J	0.1 (PCS)
Iron, filtered (mg/L)	0.03U[j]	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U (0.03U)	0.03U	0.03U	0.03U	0.3 (SCS)

Table A-3a. continued.

WELL NAME	USGS-098 (GW-0161-01)		USGS-065 (GW-161-02)		USGS-076 (GW-161-04)		TRA-08 (GW-161-05)		MIDDLE-1823 (GW-161-06)		USGS-136 (GW-161-08)		STANDARD[b] PCS/SCS
SAMPLE DATE:	05/11/23	09/18/23	05/12/23	09/20/23	05/15/23	09/21/23	05/12/23	09/19/23	05/16/23	09/19/23	05/15/23	09/18/23	

a. Reuse Permit I-161-03 was issued October 30, 2019.

b. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in the Idaho Ground Water Quality Rule, IDAPA 58.01.11.200.01 a and b.

c. bls = below land surface.

d. NA = not applicable.

e. Water table elevation above mean sea level (ft). Elevation data provided using the North American Vertical Datum of 1988 (NAVD 88).

f. The borehole correction factors were determined from gyroscopic surveys conducted by U.S. Geological Survey to reconcile discrepancies in water level measurements from well deviations.

g. J flag indicates the associated value is an estimate and may be inaccurate or imprecise.

h. R flag indicates it is recommended result not be used due to high relative percent difference between the field result and the laboratory quality control duplicate.

i. Results shown in parenthesis are from the field duplicate samples.

j. U qualification indicates the analyte was not detected above the instrument detection limit or the analyte was detected at or above the applicable detection limit but the value is not more than 5 times the highest positive amount in any laboratory blank and is U qualified as a result of data validation.

Table A-3b. Advanced Test Reactor Complex cold waste pond industrial wastewater reuse permit monitoring well results (2023).

WELL NAME	USGS-058[a] (GW-161-07)		STANDARD (PCS/SCS)[b]
SAMPLE DATE:	05/11/23	09/20/23	
Water table depth (ft) bgs[c]	474.46	475.19	NA[d]
Water table elevation (ft)[e]	4,447.43	4,446.70	NA
Borehole correction factor (ft)[f]	NA	NA	NA
pH (s.u.)	6.72	7.17	6.5 to 8.5 (SCS)
Conductivity (µS/cm)	412	418	NA
Temperature (°F)	56.5	56.5	NA
Solids, total dissolved (mg/L)	231	225	500 (SCS)
Sulfate (mg/L)	29.5J[g]	30.2	250 (SCS)

a. Reuse permit I-161-03 only requires water table elevation, water table depth, pH, conductivity, temperature, total dissolved solids and sulfate reported for USGS-058.

b. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in the Idaho Ground Water Quality Rule, IDAPA 58.01.11.200.01.a and b.

c. bgs = below ground surface.

d. NA = not applicable.

e. Water table elevation above mean sea level (ft). Elevation data provided using the North American Vertical Datum of 1988 (NAVD 88).

f. The borehole correction factors were determined from gyroscopic surveys conducted by U.S. Geological Survey to reconcile discrepancies in water level measurements from well deviations.

g. J flag indicates the associated value is an estimate and may be inaccurate or imprecise.

Table A-4. Idaho Nuclear Technology and Engineering Center sewage treatment plant influent monitoring results at CPP-769 (2023).

PARAMETER	MINIMUM	MAXIMUM	MEAN
Biochemical oxygen demand (5-day) (mg/L)	34.8	467	221
Nitrate + nitrite, as nitrogen (mg/L)	0.017 U[a]	1.12	0.119
Total kjeldahl nitrogen (mg/L)	19.9	182	88.2
Total phosphorus (mg/L)	2.29	12.6J[b]	7.48
Total suspended solids (mg/L)	6.7	197	122.1

a. U flag indicates the analyte was analyzed for but not detected above the method detection limit.

b. J flag indicates the material was analyzed for and was detected at or above the detection limit. The associated value is an estimate and may be inaccurate or imprecise.

Table A-5. Idaho Nuclear Technology and Engineering Center sewage treatment plant effluent monitoring results at CPP-773 (2023).

PARAMETER	MINIMUM	MAXIMUM	MEAN
Biochemical oxygen demand (5-day) (mg/L)	5.83	28.6	13.9
Nitrate + nitrite, as nitrogen (mg/L)	0.174J[a]	3.32	1.27
pH (standard units)[b]	6.95	8.83	7.72
Total coliform (MPN[c]/100 mL)[b]	133.3	2419.2	1016.1
Total kjeldahl nitrogen (mg/L)	6.70	36	17.0
Total phosphorus (mg/L)	2.10[a]	53.3	8.62
Total suspended solids (mg/L)	3.7	97	37

a. J flag indicates the parameter was analyzed for and was detected at or above the applicable detection limit. The associated value is an estimate and may be inaccurate or imprecise.
b. As required by the permit, the results for this parameter were obtained from a grab sample.
c. MPN = most probable number.

Table A-6. Idaho Nuclear Technology and Engineering Center new percolation ponds effluent monitoring results at CPP-797 (2023).

PARAMETER	MINIMUM	MAXIMUM	MEAN
Chloride (mg/L)	13.0	539.0	80.8
Chromium (mg/L)	0.00558	8.05	1.64
Coliform, fecal (MPN/100 mL)[a]	1	387	66
Coliform, total (MPN/100 mL)[a]	39.3	2419.2	773.7
Fluoride (mg/L)	0.129	0.297	0.220
Manganese, total (mg/L)	ND (<0.002)[b]	0.00332	0.00211
Nitrate + nitrite, as nitrogen (mg/L)	0.715	3.66	1.50
pH (standard units)[a]	7.05	9.21	8.22
Selenium (mg/L)	ND (<0.002)	ND (<0.002)	ND (<0.002)
Total dissolved solids (mg/L)	186	1220	403
Total phosphorus (mg/L)	0.263	2.66	1.10

a. As required by the permit, the results for this parameter were obtained from a grab sample.
b. ND = Parameter not detected in sample. Value in parentheses is the detection limit.

Table A-7. Hydraulic loading rates for the Idaho Nuclear Technology and Engineering Center new percolation ponds (2023).

	MAXIMUM DAILY FLOW	YEARLY TOTAL FLOW
2023 flow	932,120 gallons	158,361,710 gallons
Permit limit	3,000,000 gallons	1,095 MG[a]

a. MG = million gallons.

Table A-8. Idaho Nuclear Technology and Engineering Center new percolation ponds aquifer monitoring well groundwater results (2023).

PARAMETER	ICPP-MON-A-165 (GW-13006)		ICPP-MON-A-166 (GW-13007)		ICPP-MON-A-164B (GW-13011)		STANDARD PCS/SCS[a]
SAMPLE DATE:	05/16/23	09/19/23	05/16/23	09/19/23	05/15/23	09/18/23	
Water table depth (ft below brass cap)	510.18	510.88	515.76	517.76	508.86	509.54	NA[b]
Water table elevation (at brass cap in ft)[c]	4,446.09	4,445.39	4,446.57	4,444.82	4,446.26	4,444.5	NA
Chloride (mg/L)	30.1J[d]	28.5	19.1J[d]	17.9	10.5J[d]	10.2	250
Chromium (mg/L)	0.00968	0.0173	0.00496	0.00490	0.0115	0.0122	0.1
Coliform, fecal (MPN[e]/100 mL)	<1	<1	<1	<1	<1	<1	<1 CFU[f]/100 mL
Coliform, total (MPN/100 mL)	<1	<1	<1	<1	<1	<1	1 CFU/100 mL[g]
Dissolved oxygen (mg/L)	6.69	6.97	4.79	4.85	6.35	5.79	NA
Electrical conductivity (µmhos/cm)	438	460	327	350	405	417	NA
Fluoride (mg/L)	0.136	0.191	0.180	0.222	0.095J[h]	0.152	4
Manganese, dissolved (mg/L)[i]	NR[j]	NR[j]	NR[j]	NR[j]	NR[j]	NR[j]	0.05
Manganese, total (mg/L)	ND (<0.001)[k]	ND (<0.001)[k]	0.00747	0.0150	ND (<0.001)[k]	0.00124J[h]	0.05
Nitrate/nitrite, as nitrogen (mg/L)	1.24J[d]	1.21	0.385J[d]	0.467	1.09J[d]	1.11	10
pH (standard units)	7.71	7.57	7.65	7.27	7.61	7.50	6.5–8.5
Selenium (mg/L)	ND (<0.0015)[k]	ND(<0.0015)[k]	ND (<0.0015)[k]	ND (<0.0015)[k]	ND (<0.0015)[k]	ND (<0.0015)[k]	0.05
Temperature (°F)	54.80	54.55	53.92	58.29	54.75	54.05	NA
Total dissolved solids (mg/L)	244	236	172	177	222	211	500
Total phosphorus (mg/L)	ND (<0.0500)[k]	0.0430J[h]	ND (<0.0500)[k]	0.0240J[h]	ND (<0.0500)[k]	0.0270J[h]	NA

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in Idaho Ground Water Quality Rule, IDAPA 58.01.11.200.01.a and b.

b. NA = not applicable.

c. Water table elevations referenced to North American Vertical Datum of 1988 (NAVD 88).

d. J flag indicates the parameter was positively identified, but the reported value is an estimate. The results may be biased high.

e. MPN = most probable number.

f. CFU = colony forming unit.

Table A-8. continued.

PARAMETER	ICPP-MON-A-165 (GW-13006)		ICPP-MON-A-166 (GW-13007)		ICPP-MON-A-164B (GW-13011)		STANDARD PCS/SCS[a]
SAMPLE DATE:	05/16/23	09/19/23	05/16/23	09/19/23	05/15/23	09/18/23	

g. An exceedance of the PCS for total coliform is not a violation. If the PCS for total coliform is exceeded, analysis for fecal coliform is conducted. An exceedance of the PCS for fecal coliform is a violation.

h. J flag indicates the material was analyzed for and was detected at or above the applicable detection limit. The associated value is an estimate and may be inaccurate or imprecise.

i. The result of the dissolved concentrations of this parameter are used for SCS compliance determinations.

j. NR = parameter was not a monitoring requirement since the analytical result for total manganese did not exceed the standard in Idaho Ground Water Quality Rule, IDAPA 58.01.11.200.01.b, manganese standard of 0.05 mg/L.

k. ND = Parameter not detected in sample. Value in parentheses is the detection limit.

Table A-9. Idaho Nuclear Technology and Engineering Center new percolation ponds perched water monitoring well groundwater results (2023).

PARAMETER	ICPP-MON-V-191 (GW-13008)		ICPP-MON-V-200 (GW-13009)		ICPP-MON-V-212 (GW-13010)		STANDARD PCS/SCS[a]
SAMPLE DATE:	05/15/23	09/18/23	05/31/23	10/25/23	05/31/23	09/18/23	
Depth to water (ft below brass cap)	Dry[b]	Dry[b]	122.53	113.50	239.67	238.91	NA[c]
Water table elevation (at brass cap in ft)[d]	NA	NA	4,833.07	4,842.1	4,721.74	4,721.5	NA
Chloride (mg/L)	NA	NA	72J[e]	61.9	68.1J[e]	72.2	250
Chromium (mg/L)	NA	NA	0.00712	0.00787	0.0449	0.0232	0.1
Coliform, fecal (MPN[f]/100 mL)	NA	NA	<1	<1	<1	<1	<1 CFU[g]/100 mL
Coliform, total (MPN/100 mL)	NA	NA	<1	<1	1	<1	1 CFU/100 mL[h]
Dissolved oxygen (mg/L)	NA	NA	6.91	5.66	5.38	8.18	NA
Electrical conductivity (µmhos/cm)	NA	NA	603	545	578	599	NA
Fluoride (mg/L)	NA	NA	0.134J[e]	0.286	0.152J[e]	0.219	4
Manganese, dissolved (mg/L)[i]	NA	NA	NR[j]	NR	NR	NR	0.05
Manganese, total (mg/L)	NA	NA	0.00485J[k]	0.00214J[k]	0.0201	0.0130	0.05
Nitrate/nitrite, as nitrogen (mg/L)	NA	NA	2.70J[e]	1.05	1.86J[e]	2.05	10
pH (standard units)	NA	NA	7.60	7.23	7.79	7.87	6.5–8.5
Selenium (mg/L)	NA	NA	ND (<0.0015)[l]	ND (<0.0015)[l]	ND (<0.0015)[l]	ND (<0.0015)[l]	0.05
Temperature (°F)	NA	NA	59.72	59.55	63.30	63.44	NA
Total dissolved solids (mg/L)	NA	NA	307J[e]	292	293J[e]	307	500
Total phosphorus (mg/L)	NA	NA	0.277J[e]	0.402	0.0840J[e]	0.0280J[m]	NA

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in Idaho Ground Water Quality Rule, IDAPA 58.01.11.200.01.a and b.

b. ICPP-MON-V-191 was dry in May and September 2023.

c. NA = not applicable.

d. Water table elevations referenced to North American Vertical Datum of 1988 (NAVD 88).

e. J flag indicates the parameter was positively identified, but the reported value is an estimate. Due to shipping issues the sample was above 4℃ upon receipt.

f. MPN = most probable number.

g. CFU = colony forming units.

Table A-9. continued.

PARAMETER	ICPP-MON-V-191 (GW-13008)		ICPP-MON-V-200 (GW-13009)		ICPP-MON-V-212 (GW-13010)		STANDARD PCS/SCS[a]
SAMPLE DATE:	05/15/2023	09/18/2023	05/31/2023	10/25/2023	05/31/2023	09/18/2023	

h. An exceedance of the PCS for total coliform is not a violation. If the PCS for total coliform is exceeded, analysis for fecal coliform is conducted. An exceedance of the PCS for fecal coliform is a violation.

i. The results of dissolved concentrations of this parameter are used for SCS compliance determinations.

j. NR = not required since the analytical result for total manganese did not exceed the standard in Idaho Ground Water Quality Rule, IDAPA 58.01.11.200.01.b for manganese of 0.05 mg/L.

k. J flag indicates the parameter was analyzed for and was detected at or above the applicable detection limit. The associated value is an estimate and may be inaccurate or imprecise.

l. ND = Parameter not detected in sample. Value in parentheses is the detection limit.

m. J flag indicates that the parameter was analyzed for and was detected at or above the applicable detection limit. The associated value is an estimate and may be inaccurate or imprecise.

Table A-10. Materials and Fuels Complex industrial waste pond effluent monitoring results for the reuse permit (2023).[a,b,c]

PARAMETER	MINIMUM	MAXIMUM	MEDIAN
pH (standard units)	6.68	7.47	7.01
Conductivity[d] (µS/cm)	384	464	403
Chloride[d] (mg/L)	17.9J[e]	26.6	20.1J
Nitrate + nitrite as nitrogen (mg/L)	2.40	3.85J	2.92
Iron (mg/L)	0.03U[f]	0.170	0.03U
Iron, filtered (mg/L)	0.03U	0.03U	0.03U
Manganese (mg/L)	0.002U	0.00421	0.002U
Manganese, filtered (mg/L)	0.002U	0.00364	0.002U
Sodium[d] (mg/L)	18.4	29.1	21.8
Sodium[d], filtered (mg/L)	18.6	26.7	21.8
Solids, total dissolved (mg/L)	208	283	236

a. Liquid effluent results for permit-required constituents collected at the sampling station located on the Industrial Wastewater Collection System (IWCS) primary line prior to discharge into the pond. The results represent effluent contributions from both the IWCS Primary Line and Southwestern Branch Line, which are combined upstream of the sampling station.

b. Duplicate samples were collected in July 2023. The duplicate results are included in the data summary.

c. Reuse permit I-160-02 does not specify maximum constituent loading or concentration limits.

d. Conductivity, chloride and sodium are not required effluent monitoring parameters in the reuse permit.

e. J flag indicates the associated value is an estimate and may be inaccurate or imprecise.

f. U qualifier indicates the result was below the detection limit.

Table A-11. Materials and Fuels Complex effluent hydraulic loading to the industrial waste pond (2023).

	YEARLY TOTAL FLOW
2023 flow[a]	9.435 MG[b]
Annual permit limit[c]	17 MG

a. Annual flow is reported for the 2023 permit reporting year. The annual flow is an estimate due to adjustments during instances when the flow rate exceeded the maximum measurable flow rate of the flow meter.

b. MG = million gallons.

c. The reuse permit specifies an annual limit based on a twelve-month reuse year from November 1 through October 31.

Table A-12. Materials and Fuels Complex industrial waste pond summary of groundwater quality data collected for the reuse permit (2023).

WELL NAME	ANL-MON-A-012 (GW-16001)		ANL-MON-A-013 (GW-16002)		ANL-MON-A-014 (GW-16003)		PCS/SCS[a]
SAMPLE DATE:	05/08/23	09/13/23	05/09/23	09/14/23	05/09/23	09/14/23	
Water table depth (ft bls)[b]	661.85	663.78	650.23	652.11	649.41	651.28	NA[c]
Water table elevation (ft above mean sea level)[d]	4,470.85	4,468.92	4,470.14	4,468.26	4,468.67	4,466.80	NA
Temperature (˚F)	57.0	57.4	53.6	55.9	54.9	57.0	NA
pH (s.u)	6.95	7.02	6.89	6.91	6.75	6.96	6.5 to 8.5 (SCS)
Conductivity (µmhos/cm)	385	369	380 (375)[e]	376	380	368	NA
Nitrite + nitrate as N (mg/L)	3.00	2.65	2.75 (2.78)	2.63	2.90	2.70	10 (PCS)
Total dissolved solids (mg/L)	108	190	124 (186)	210	178	201	500 (SCS)
Iron, total (mg/L)	0.03U[f]	0.03U	0.0635 (0.120)	0.03U	0.03U	0.03U	0.3 (SCS)
Iron, filtered (mg/L)	0.03U	0.03U	0.03U (0.03U)	0.03U	0.03U	0.03U	0.3 (SCS)
Manganese, total (mg/L)	0.002U	0.002U	0.002U (0.00217)	0.002U	0.002U	0.002U	0.05 (SCS)
Manganese, filtered (mg/L)	0.002U	0.002U	0.002U (0.002U)	0.002U	0.002U	0.002U	0.05 (SCS)

a. Primary Constituent Standard (PCS) or Secondary Constituent Standard (SCS) specified in the Ground Water Quality Rule, Idaho Ground Water Quality Rule, IDAPA 58.01.11.200.01.a and b.

b. bls = below land surface.

c. NA = not applicable.

d. Elevations are given in the National Geodetic Vertical Datum of 1929.

e. Duplicate sample results are shown in parentheses.

f. U qualification indicates the analyte was not detected above the instrument detection limit or the analyte was detected at or above the applicable detection limit, but the value is not more than five times the highest positive amount in any laboratory blank.

Table A-13. Advanced Test Reactor Complex cold waste ponds effluent radiological surveillance monitoring results (2023).[a]

PARAMETER	MINIMUM	MAXIMUM	DCS[b] (pCi/L)
Gross alpha (pCi/L ± 1s)[c,d]	ND[e]	6.42 (± 1.84)	NA[f]
Gross beta (pCi/L ± 1s)[g]	ND	10.1 (± 1.44)	NA
Radium-228 (pCi/L ± 1s)[h]	ND	0.755 (± 0.165)	73

a. Monthly samples were analyzed for gross alpha, gross beta, tritium, and gamma-emitting radionuclides including americium-241, antimony-125, cerium-144, cesium-134, cesium-137, cobalt-58, cobalt-60, europium-152, europium-154, europium-155, manganese-54, niobium-95, potassium-40, radium-226, ruthenium-103, ruthenium-106, silver-108m, silver-110m, uranium-235, zinc-65, and zirconium-95.

b. DOE Derived Concentration Standards for ingested water.

c. Result ± 1σ. Results are shown only for constituents with at least one statistically positive detection greater than 3σ.

d. Gross alpha was positively detected in May, July, and December 2023. Results were non-detect for the other nine months of 2023.

e. ND = not detected

f. NA = not applicable. Derived Concentration Standards values are not established.

g. Gross beta was positively detected in January, April, May, June, August, September, and November 2023. Results were non-detect for the other five months of 2023.

h. Additional analysis of radium-226 and radium-228 are performed when gross alpha exceeds a threshold of 5 pCi/L. Radium-226 and radium-228 were analyzed in May, June, and September 2023. Radium-228 was positively detected once in May 2023. Radium-226 was not positively detected.

Table A-14. Groundwater radiological surveillance monitoring results for the Advanced Test Reactor Complex (2023).

MONITORING WELL	SAMPLE DATE	GAMMA EMITTERS[a] (pCi/L)	GROSS ALPHA (pCi/L)	GROSS BETA (pCi/L)	STRONTIUM -90 (pCi/L)	TRITIUM (pCi/L)
PCS/SCS[b]		NA	15	4 mrem/yr[c]	8	20,000
USGS-098	05/11/2023	ND[d]	ND	0.939 (±0.228)[e]	ND	ND
	09/18/2023	ND	1.44 (±0.401)	2.08 (±0.218)	ND	ND
USGS-058	05/11/2023	ND	1.97 (±0.388)	1.15 (±0.174)	ND	ND
	09/20/2023	ND	ND	3.21 (±0.265)	ND	ND
USGS-065	05/12/2023	ND	2.53 (±0.737)	3.36 (±0.472)	ND	845 (±152)
	09/20/2023	ND	ND	3.08 (±0.406)	ND	963 (±168)
TRA-08	05/12/2023	ND	1.20 (±0.351)	1.69 (±0.164)	ND	359 (±105)
	09/19/2023	ND	1.86 (±0.412)	2.75 (±0.214)	ND	463 (±113)
USGS-076	05/15/2023	ND	ND	1.55 (±0.178)	ND	ND
	09/21/2023	ND	ND	1.26 (±0.23)	ND	356 (±116)
MIDDLE-1823	05/16/2023	ND	ND	1.91 (±0.183)	ND	318 (±103)
		[ND][f]	[ND]	[2.13 (±0.251)]	[ND]	[ND]
	09/19/2023	ND	ND	2.12 (±0.222)	ND	333 (±102)
USGS-136	05/15/2023	ND	1.20 (±0.386)	1.19 (±0.177)	ND	549 (±126)
	09/18/2023	ND	1.74 (±0.417)	2.28 (±0.219)	ND	698 (±131)

a. Gamma-emitting radionuclides including americium-241, antimony-125, cerium-144, cesium-134, cesium-137, cobalt-58, cobalt-60, europium-152, europium-154, europium-155, manganese-54, niobium-95, potassium-40, radium-226, ruthenium-103, ruthenium-106, silver-108m, silver-110m, uranium-235, zinc-65, and zirconium-95.

b. Primary Constituent Standards (PCS) in the Ground Water Quality Rule, IDAPA 58.01.11.200.01.a, are provided for perspective.

c. Gross Beta PCS = 4 mrem/yr effective dose, Ground Water Quality Rule, IDAPA 58.01.11.200.01.a. For perspective, the U.S. Environmental Protection Agency public drinking water system regulations also specify a maximum contaminant limit of 4 mrem/yr for gross beta and use a screening level of 50 pCi/L to determine when speciation of individual beta/photon emitters is necessary.

d. ND = not detected.

e. Results shown are for statistically positive detections greater than 3σ, along with the reported 1σ uncertainty.

f. Results from field duplicate samples shown in brackets.

Table A-15. Liquid effluent radiological monitoring results for the Idaho Nuclear Technology and Engineering Center New Percolation Ponds CPP-797 (2023).

SAMPLE DATE	GAMMA EMITTERS[a] (pCi/L)	GROSS ALPHA[b] (pCi/L)	GROSS BETA[b] (pCi/L)	TOTAL STRONTIUM (pCi/L)
PCS/SCS[b]	NA	15	4 mrem/yr[c]	8
January 2023	ND[d]	ND	4.48 (±0.853)	ND
February 2023	ND	ND	3.30 (±0.956)	ND
March 2023	ND	ND	4.82 (±0.487)	ND
April 2023	ND	4.01 (±1.18)	6.38 (±0.593)	ND
May 2023	ND	ND	3.54 (±0.636)	ND
June 2023	ND	ND	3.39 (±0.647)	ND
July 2023	ND	4.48 (±1.21)	9.39 (±0.841)	ND
August 2023	ND	3.39 (±0.783)	7.41 (±0.528)	ND
September 2023	ND	ND	4.54 (±0.702)	ND
October 2023	ND	ND	4.16 (±0.664)	ND
November 2023	ND	ND	5.85 (±0.789)J[e]	ND
December 2023	ND	ND	6.09 (±0.513)	ND

a. Gamma-emitting radionuclides include americium-241, antimony-125, cerium-144, cesium-134, cesium-137, cobalt-58, cobalt-60, europium-152, europium-154, europium-155, manganese-54, niobium-95, potassium-40, radium-226, ruthenium-103, ruthenium-106, silver-108m, silver-110m, uranium-235, zinc-65, and zirconium-95.

b. Detected results are shown along with the reported 1σ uncertainty.

c. Primary constituent standards (PCS) in the Ground Water Quality Rule, IDAPA 58.01.11.200.01.a, are provided for perspective.

d. ND = no radioactivity was detected. The result was not statistically positive at the 95% confidence interval and was below its minimum detectable activity.

e. J flag indicates the associated value is an estimate.

Table A-16. Groundwater radiological monitoring results for the Idaho Nuclear Technology and Engineering Center (2023).

MONITORING WELL	SAMPLE DATE	GROSS ALPHA[a] (pCi/L)	GROSS BETA[a] (pCi/L)
ICPP-MON-A-165	05/16/2023 09/19/2023	ND[b] 3.30 (±1.17)J[c]	2.95 (±0.792) 4.76 (±0.756)
ICPP-MON-A-166	05/16/2023 09/19/2023	ND ND	ND 4.83 (±0.981)
ICPP-MON-V-200	05/31/2023 10/25/2023	ND 2.50 (±0.619)	4.96 (±0.757) 4.97 (±0.396)
ICPP-MON-V-212	05/31/2023 09/18/2023	ND 3.29 (±1.21)J[c]	14.1 (±0.847) 10.3 (±1.07)

a. Detected results are shown along with the reported 1σ uncertainty.

b. ND = no radioactivity was detected. The result was not statistically positive at the 95% confidence interval and was below its minimum detectable activity.

c. J flag indicates the associated value is an estimate.

Table A-17. Radiological Surveillance Monitoring Results for Materials and Fuels Complex industrial waste pond (2023).[a]

PARAMETER[b] (pCi/L)	MINIMUM	MAXIMUM	DCS[c] (pCi/L)
Gross alpha	ND[d]	3.16 (±0.593)	NA[e]
Gross beta	3.38 (± 0.805)	6.38 (± 0.423)	NA
Uranium-238[f]	0.388 (± 0.0571)	0.388 (± 0.0571)	1,400
Uranium-233/234[f]	0.88 (± 0.096)	0.88 (± 0.096)	1,200

a. Samples were analyzed for gross alpha; gross beta; plutonium-241; strontium-90; tritium; gamma-emitting radionuclides, including americium-241, antimony-125, cerium-144, cesium-134, cesium-137, cobalt-58, cobalt-60, europium-152, europium-154, europium-155, manganese-54, niobium-95, potassium-40, radium-226, ruthenium-103, ruthenium-106, silver-108m, silver-110m, uranium-235, zinc-65, zirconium-95; alpha-emitting radionuclides including americium-241, uranium-233/234, uranium-235, uranium-238, plutonium-236, plutonium-238, plutonium-239/240, and plutonium-242.

b. Results shown are for statistically positive detections greater than 3σ, along with the reported 1σ uncertainty. Only parameters with at least one positively detected result are shown.

c. DCS = DOE Derived Concentration Standard for ingested water (DOE-STD-1196-2022).

d. ND indicates the result was below the detection limit.

e. NA = not applicable. DCS values are not established.

f. Parameter was analyzed in August only; therefore, the minimum and maximum are the same.

Table A-18. Groundwater radiological surveillance monitoring results for the Materials and Fuels Complex (2023).

MONITORING WELL	SAMPLE DATE	ALPHA EMITTERS[a] (pCi/L)		GAMMA EMITTERS[b] (pCi/L)	GROSS ALPHA (pCi/L)	GROSSBETA (pCi/L)	TRITIUM (pCi/L)
PCS/SCS[c]		NA		NA	15	4 mrem/yr[d]	20,000
ANL-MON-A-012	05/08/2023	Uranium-233/234 Uranium-238	1.39 (±0.21)[e] 0.905 (±0.161)	ND[f]	2.45 (±0.469)	2.41 (±0.23)	ND
	09/13/2023	Uranium-233/234 Uranium-238	1.35 (±0.19) 0.538 (±0.111)	ND	ND	3.83 (±0.541)	ND
ANL-MON-A-013	05/09/2023	Uranium-233/234	1.58 (±0.229) [1.04 (±0.179)][g]	ND [ND]	1.66 (±0.537) [1.31 (±0.402)]	2.73 (±0.29) [2.93 (±0.286)]	ND [ND]
		Uranium-238	0.627 (±0.131) [0.884 (±0.158)]				
	09/14/2023	Uranium-233/234 Uranium-238	1.3 (±0.163) 0.702 (±0.111)	ND	ND	2.94 (±0.382)	ND
ANL-MON-A-014	05/09/2023	Uranium-233/234 Uranium-238	1.54 (±0.219) 0.334 (±0.0898)	ND	ND	3.3 (±0.261)	ND
	09/14/2023	Uranium-233/234 Uranium-238	1.16 (±0.138) 0.504 (±0.0836)	ND	1.94 (±0.623)	3.11 (±0.386)	ND

a. Alpha-emitting radionuclides include americium-241, uranium 233/234, uranium-235, and uranium-238. Results are shown only for statistically positive detections.

b. Gamma-emitting radionuclides include americium-241, antimony-125, cerium-144, cesium-134, cesium-137, cobalt-58, cobalt-60, europium-152, europium-154, europium-155, manganese-54, niobium-95, potassium-40, radium-226, ruthenium-103, ruthenium-106, silver-108m, silver-110m, uranium-235, zinc-65, and zirconium-95.

c. Primary Constituent Standards (PCS) in the Ground Water Quality Rule, IDAPA 58.01.11.200.01.a, are provided for perspective.

d. Gross Beta PCS = 4 mrem/yr effective dose, Ground Water Quality Rule, IDAPA 58.01.11.200.01.a. For perspective, the U.S. Environmental Protection Agency public drinking water system regulations also specify a maximum contaminant limit of 4 mrem/yr for gross beta and use a screening level of 50 pCi/L to determine when speciation of individual beta/photon emitters is necessary.

e. Results shown are for statistically positive detections greater than 3σ, along with the reported 1σ uncertainty.

f. ND = not detected.

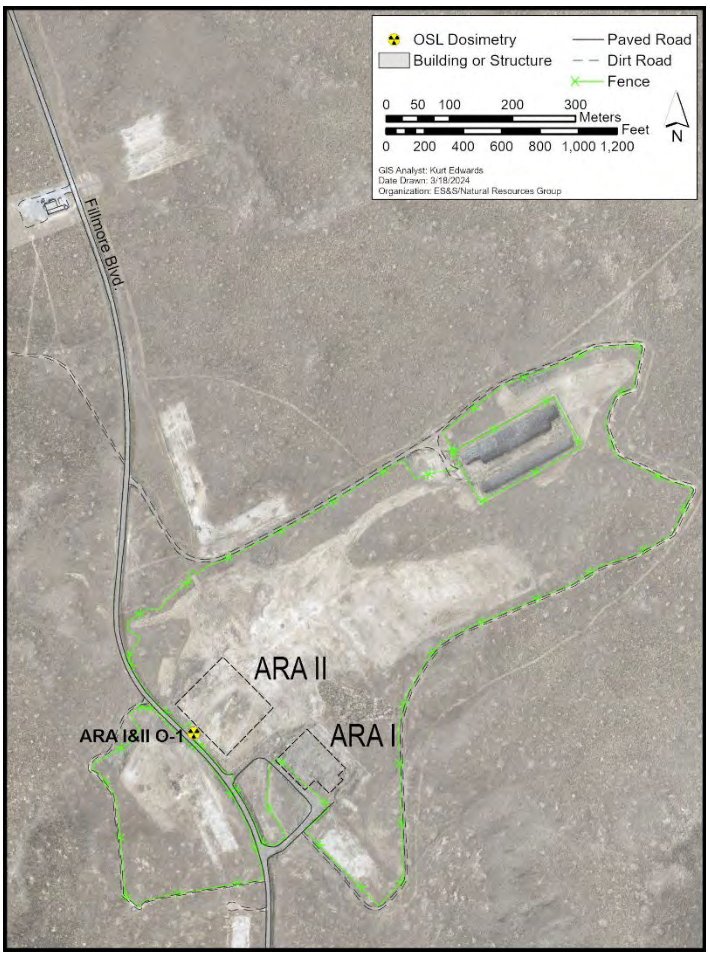
g. Results from field duplicate samples collected from ANL-MON-A-013 on May 9, 2023, shown in brackets.

Appendix B: Dosimeter Measurements and Locations

Table B-1. Results of environmental radiation measurements at Auxiliary Reactor Area (ARA) and Critical Infrastructure Test Range Complex (CITRC) (2023).

LOCATION	mrem[a]	
	NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023
ARA[b] I&II O-1	65	73
PBF[c] SPERT O-1	60	70

a. Millirem (mrem) in ambient dose equivalent.
b. Auxiliary Reactor Area (ARA).
c. Power Burst Facility Special Power Excursion Reactor Test (PBF SPERT).



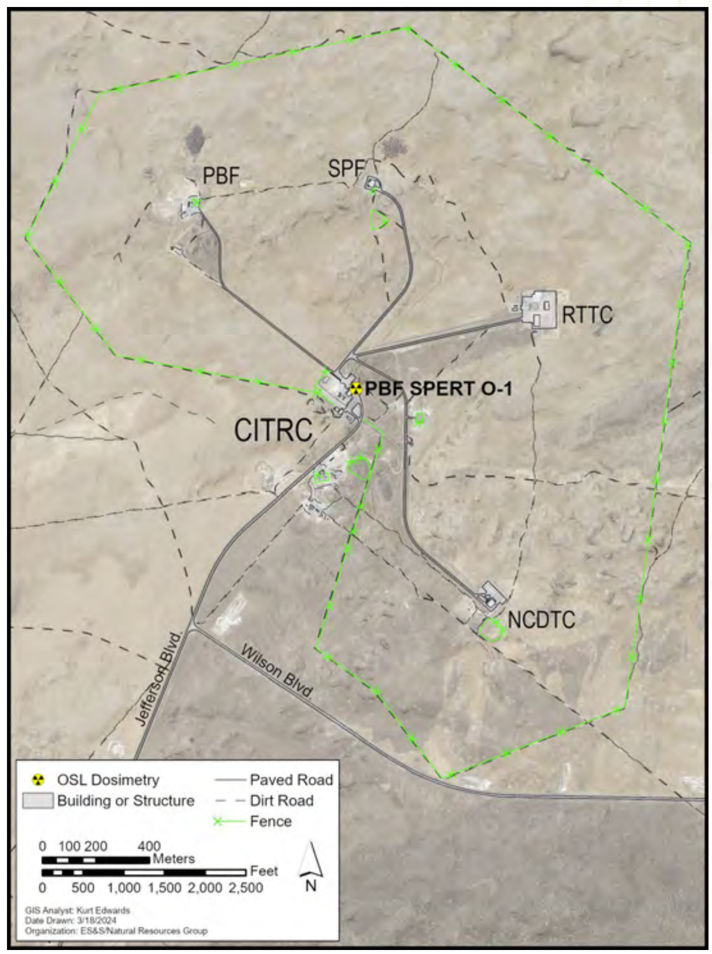


Figure B-1. Environmental radiation measurements at Auxiliary Reactor Area (ARA) and Critical Infrastructure Test Range Complex (CITRC) (2023).

Table B-2. Results of environmental radiation measurements at Advanced Test Reactor (ATR) Complex and Remote-Handled Low-Level Waste Disposal Facility (RHLLW) (2023).

LOCATION	mrem[a]		LOCATION	mrem[a]	
	NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023		NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023
RHLLW[b] O-1	67	64	TRA O-14	53	69
RHLLW O-2	54	75	TRA O-15	63	70
RHLLW O-3	63	69	TRA O-16	61	73
RHLLW O-4	65	72	TRA O-17	58	72
RHLLW O-5	60	64	TRA O-18	62	75
RHLLW O-6	56	64	TRA O-19	62	77
TRA[c] O-1	67	75	TRA O-20	58	77
TRA O-6	63	74	TRA O-21	64	62
TRA O-7	67	79	TRA O-22	63	64
TRA O-8	62	84	TRA O-23	64	76
TRA O-9	60	91	TRA O-24	67	70
TRA O-10	131	139	TRA O-25	57	70
TRA O-11	112	123	TRA O-26	62	78
TRA O-12	68	72	TRA O-27	65	66
TRA O-13	58	80	TRA O-28	62	73

a. Millirem (mrem) in ambient dose equivalent.
b. Remote-Handled Low-Level Waste (RHLLW).
c. Test Reactor Area (TRA).

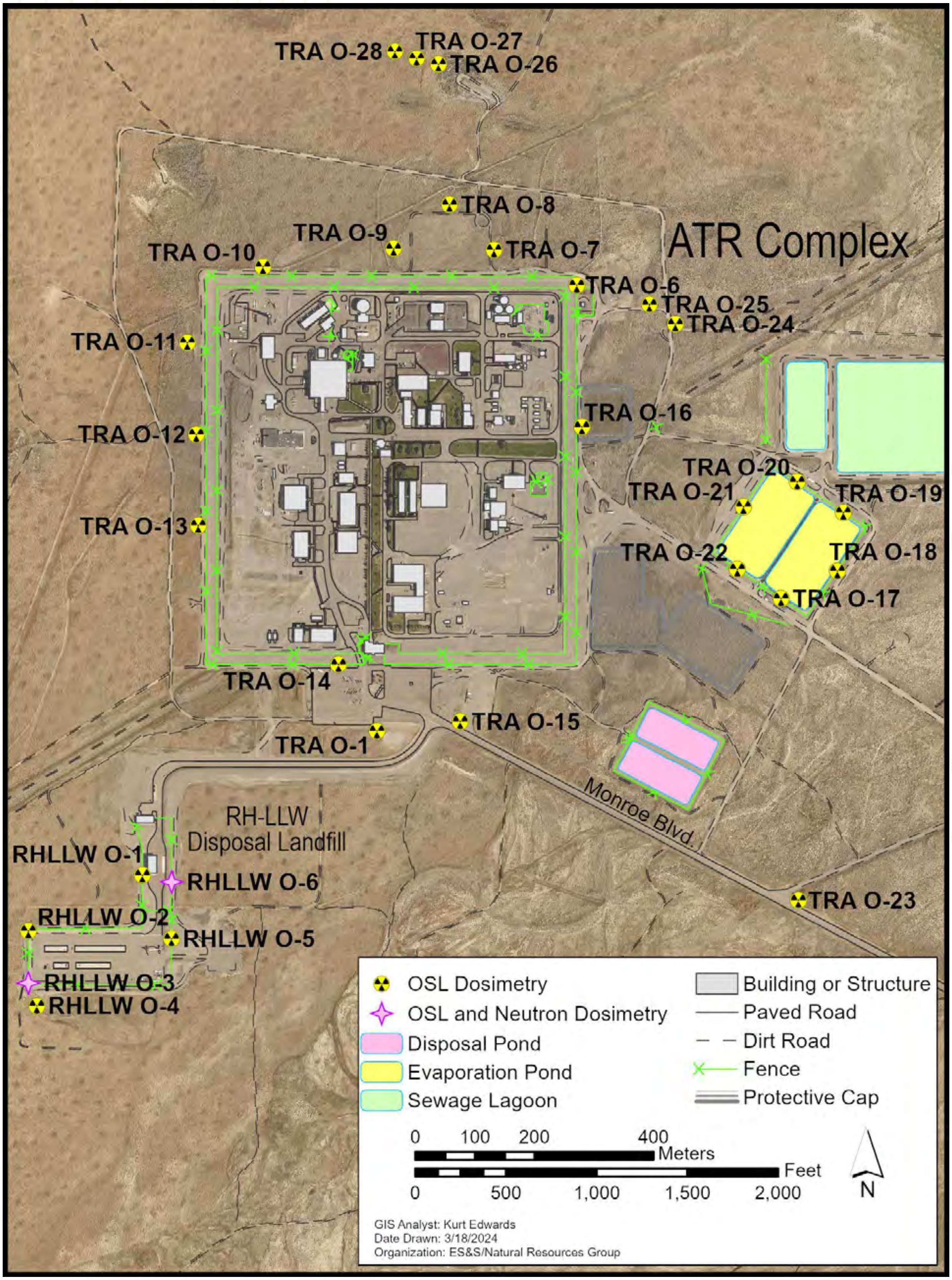


Figure B-2. Environmental radiation measurements at Advanced Test Reactor (ATR) Complex and Remote-Handled Low-Level Waste Disposal Facility (RHLLW) (2023).

Table B-3. Results of environmental radiation measurements at Central Facilities Area (CFA) and Lincoln Boulevard (2023).

LOCATION	mrem[a]	
	NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023
CFA[b] O-1	62	73
LincolnBlvd[c] O-1	58	61

a. Millirem (mrem) in ambient dose equivalent.
b. Central Facilities Area (CFA).
c. Lincoln Boulevard (LincolnBlvd).

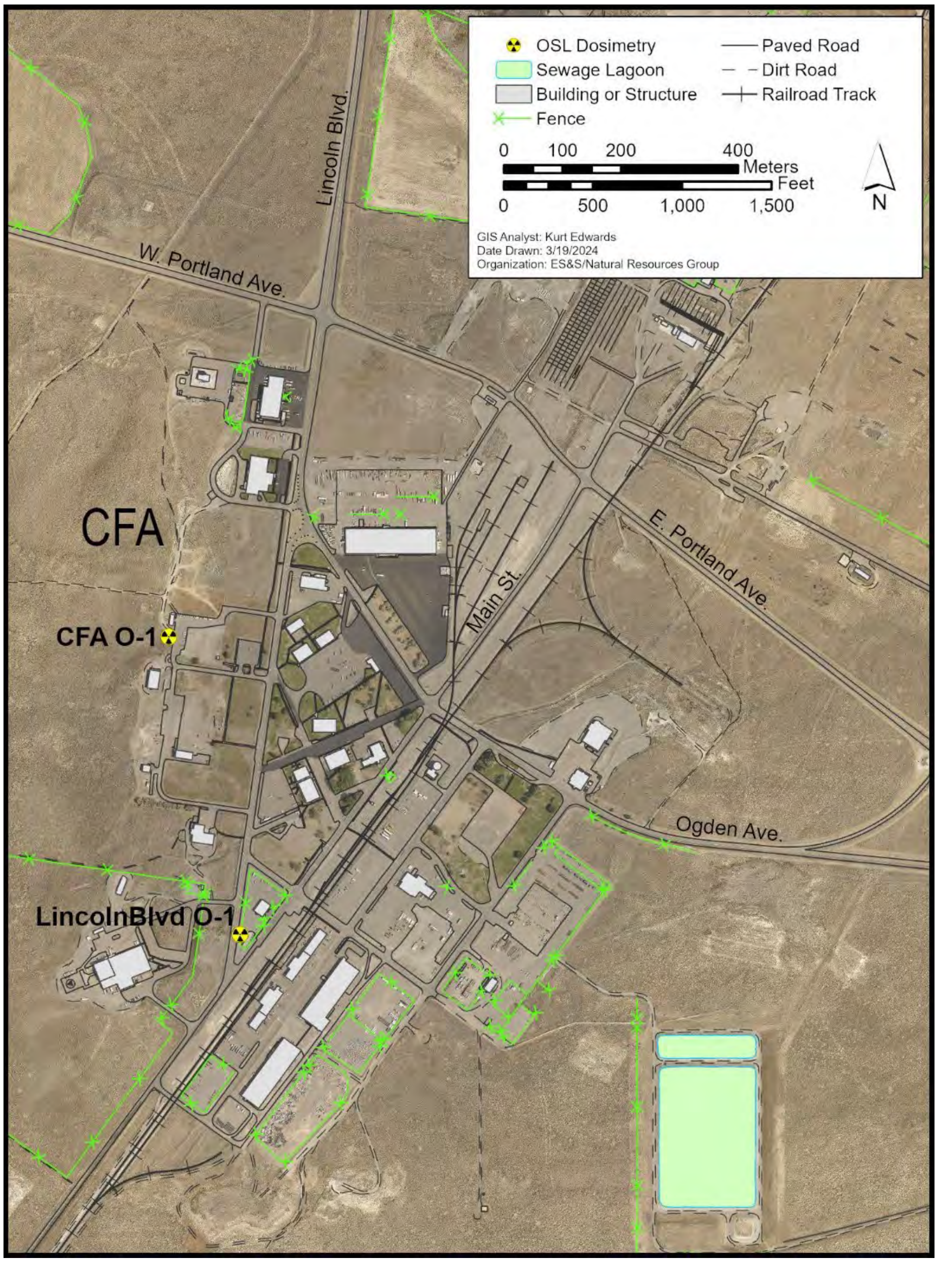


Figure B-3. Environmental radiation measurements at Central Facilities Area (CFA) and Lincoln Boulevard (2023).

Table B-4. Results of environmental radiation measurements at Idaho Nuclear Technology and Engineering Center (INTEC) (2023).

LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023	LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023
ICPP[b] O-9	67	100	ICPP O-26	65	78
ICPP O-14	lost[c]	126	ICPP O-27	180	210
ICPP O-15	178	165	ICPP O-28	176	177
ICPP O-17	66	73	ICPP O-30	196	217
ICPP O-19	82	96	TreeFarm O-1	100	122
ICPP O-20	256	315	TreeFarm O-2	78	87
ICPP O-21	90	96	TreeFarm O-3	81	96
ICPP O-22	79	81	TreeFarm O-4	106	132
ICPP O-25	80	106			

a. Millirem (mrem) in ambient dose equivalent.
b. Idaho Chemical Processing Plant (ICPP).
c. Dosimeter missing from the sample site.

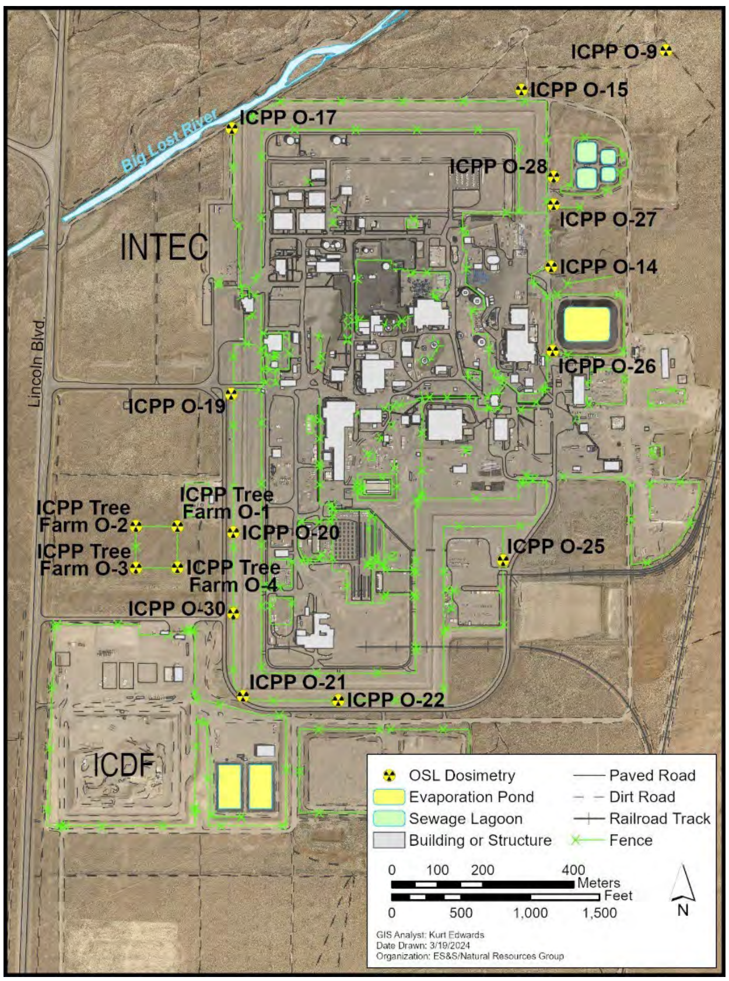


Figure B-4. Environmental radiation measurements at Idaho Nuclear Technology and Engineering Center (INTEC) (2023).

Table B-5. Results of environmental radiation measurements at Idaho National Laboratory Research Center Complex (IRC) (2023).

LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023	LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023
IF[b]-603N O-1	61	54	IF-670N O-31[c]	49	56
IF-603E O-2	49	47	IF-670E O-32	53	48
IF-603S O-3	51	48	IF-670S O-33	58	55
IF-603W O-4	53	62	IF-670D O-34	55	54
IF-627 O-30	48	54	IF-670W O-35	65	53
IF-638N O-1	47	60	IF-689 O-7	57	61
IF-638E O-2	53	53	IF-689 O-8	46	51
IF-638S O-3	66	57	IF-IRC[d] O-39	55	53
IF-638W O-4	50	55			

a. Millirem (mrem) in ambient dose equivalent.
b. Idaho Falls (IF).
c. IF-670 locations fall sampling occurred on 10/2/2023 when INL moved out of the building.
d. INL Research Center (IRC).

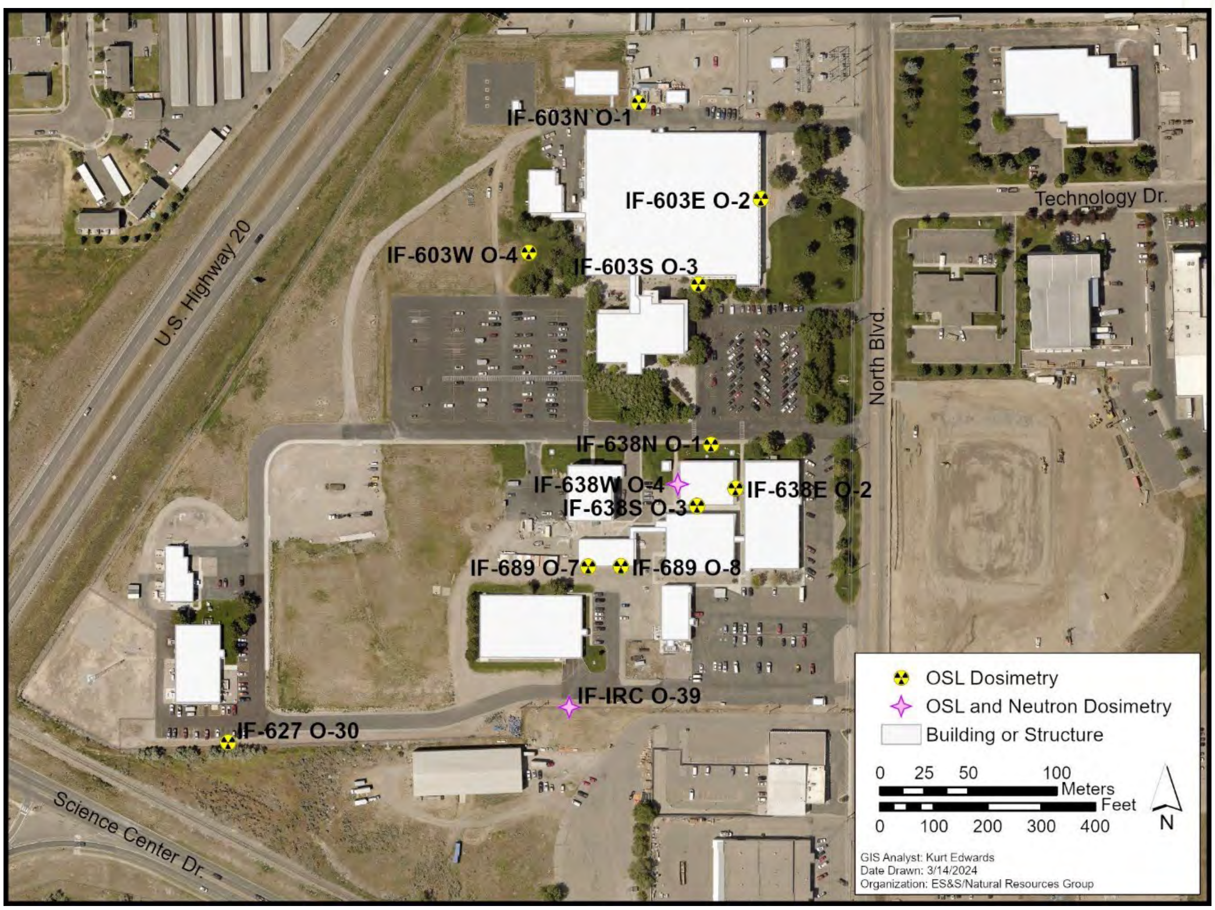


Figure B-5. Environmental radiation measurements at Idaho National Laboratory Research Center Complex (IRC) (2023).

Table B-6. Results of environmental radiation measurements at Materials and Fuels Complex (MFC) and Transient Reactor Test (TREAT) Facility (2023).

LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023	LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023
ANL[b] O-7	56	62	ANL O-24	57	66
ANL O-8	61	59	ANL O-25	59	82
ANL O-12	52	54	ANL O-26	73	89
ANL O-14	56	58	TREAT[c] O-1	54	56
ANL O-15	60	lost[d]	TREAT O-2	62	69
ANL O-16	61	66	TREAT O-3	58	60
ANL O-18	60	63	TREAT O-4	62	67
ANL O-19	50	59	TREAT O-5	54	63
ANL O-20	65	73	TREAT O-6	53	73
ANL O-21	55	69	TREAT O-7	45	74
ANL O-22	63	80	TREAT O-8	56	63
ANL O-23	78	87			

a. Millirem (mrem) in ambient dose equivalent.
b. Argonne National Laboratory (ANL).
c. Transient Reactor Test (TREAT) Facility.
d. Dosimeter missing from the sample site.

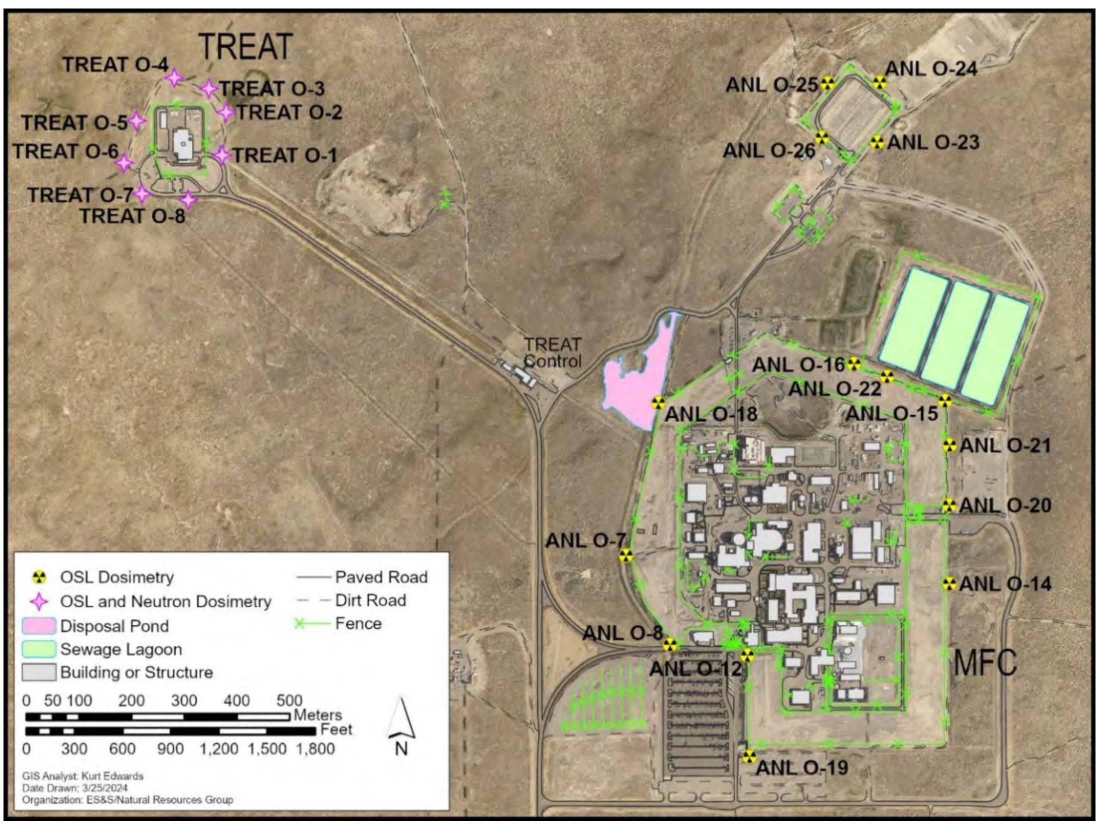


Figure B-6. Environmental radiation measurements at Materials and Fuels Complex (MFC) and Transient Reactor Test (TREAT) Facility (2023).

Table B-7. Results of environmental radiation measurements at Naval Reactors Facility (NRF) (2023).

LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023	LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023
NRF[b] O-11	66	77	NRF O-25	new location	78
NRF O-16	55	69	NRF O-26	new location	75
NRF O-18	64	64	NRF O-27	new location	60
NRF O-19	58	74	NRF O-28	new location	75
NRF O-20	63	68	NRF O-29	new location	62
NRF O-21	61	location end	NRF O-30	new location	66
NRF O-22	61	location end	NRF O-31	new location	76
NRF O-23	50	location end	NRF O-32	new location	73
NRF O-24	56	location end			

a. Millirem (mrem) in ambient dose equivalent.
b. Naval Reactors Facility (NRF).

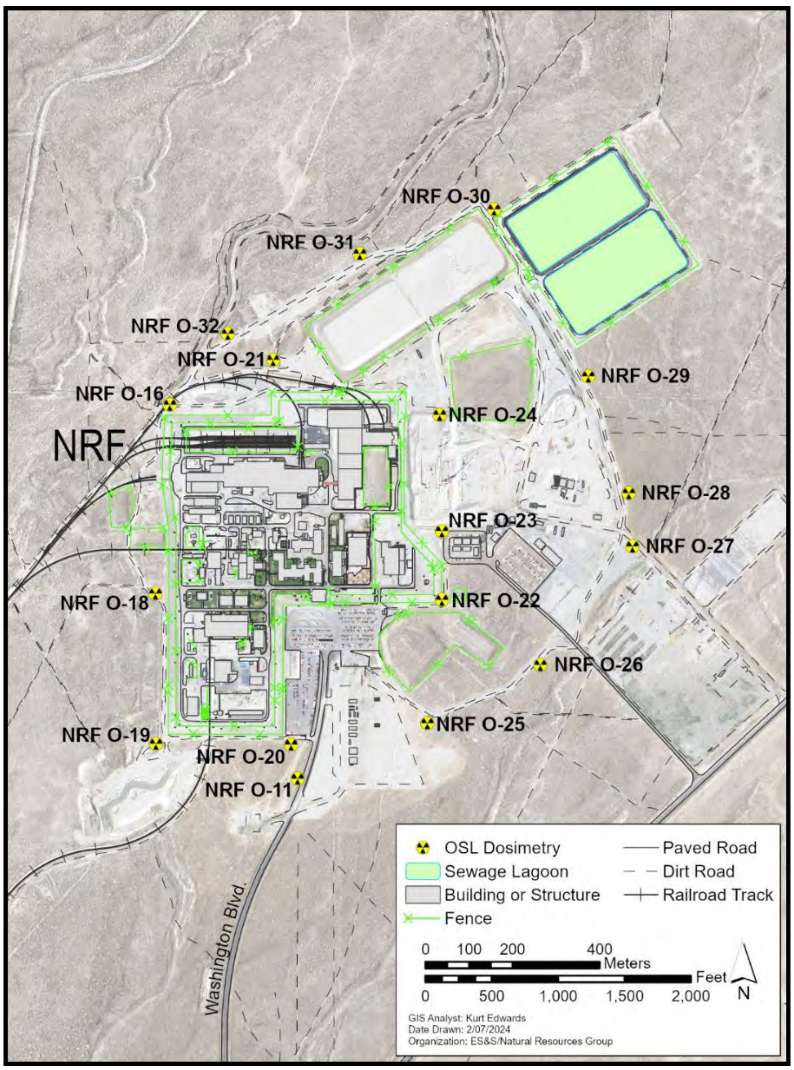


Figure B-7. Environmental radiation measurements at Naval Reactors Facility (NRF) (2023).

Table B-8. Results of environmental radiation measurements at IF-675 Portable Isotopic Neutron Spectroscopy (PINS) Laboratory (2023).

LOCATION	mrem[a]	
	NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023
IF[b]-675E O-31	49	51
IF-675D O-33	57	54
IF-675S O-34	53	lost[c]
IF-675W O-35	56	45

a. Millirem (mrem) in ambient dose equivalent.
b. Idaho Falls (IF).
c. Dosimeter missing from the sample site.

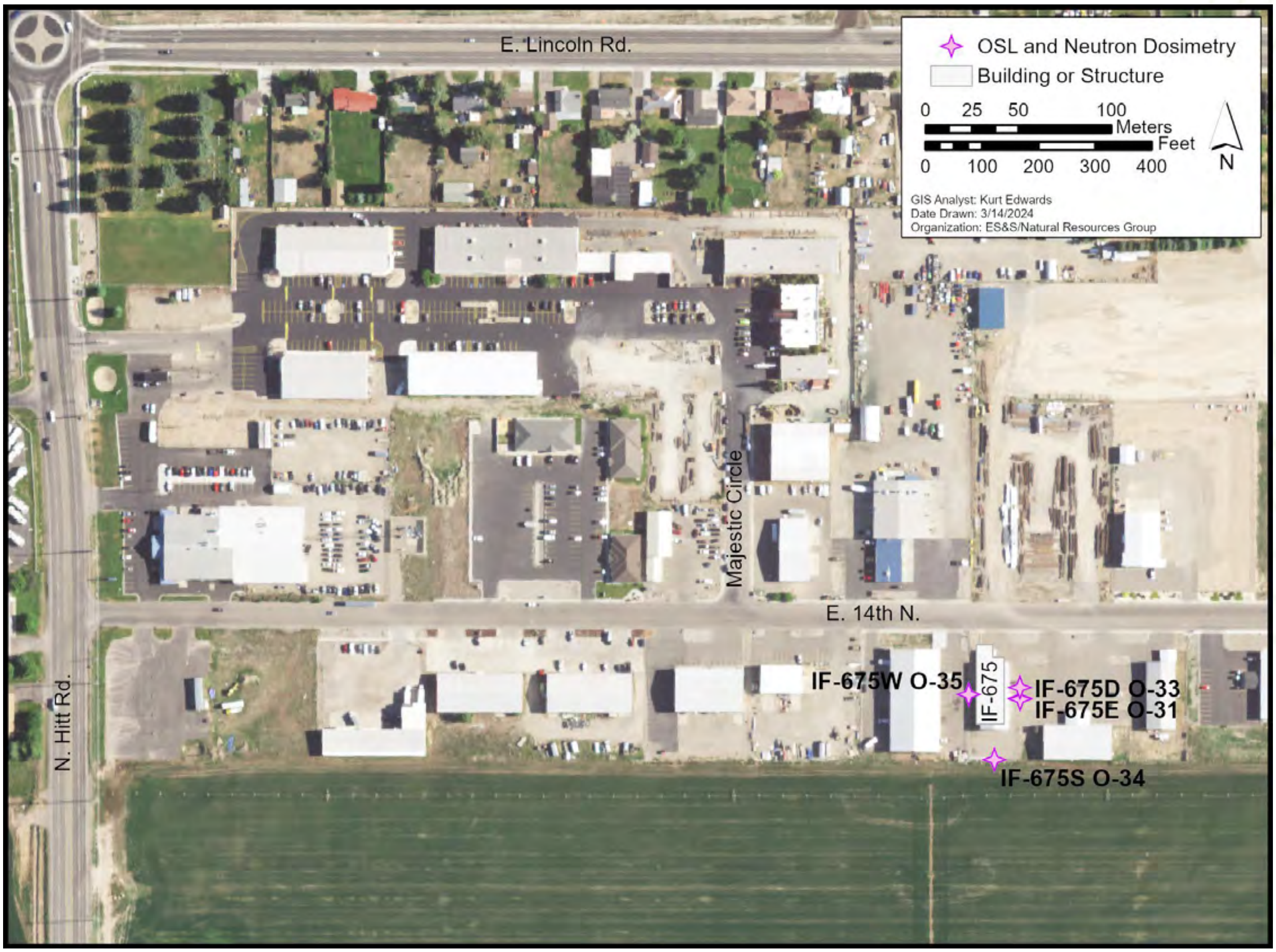


Figure B-8. Environmental radiation measurements at IF-675 Portable Isotopic Neutron Spectroscopy (PINS) Laboratory (2023).

Table B-9. Results of environmental radiation measurements at Radioactive Waste Management Complex (RWMC) (2023).

LOCATION	mrem[a]		LOCATION	mrem[a]	
	NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023		NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023
RWMC[b] O-3A	63	71	RWMC O-25A	58	57
RWMC O-5A	49	63	RWMC O-27A	60	60
RWMC O-7A	56	64	RWMC O-29A	57	63
RWMC O-9A	79	83	RWMC O-39	56	78
RWMC O-11A	61	75	RWMC O-41	109	113
RWMC O-13A	75	88	RWMC O-43	61	62
RWMC O-19A	51	68	RWMC O-46	57	70
RWMC O-21A	60	63	RWMC O-47	55	61
RWMC O-23A	68	73			

a. Millirem (mrem) in ambient dose equivalent.
b. Radioactive Waste Management Complex (RWMC).

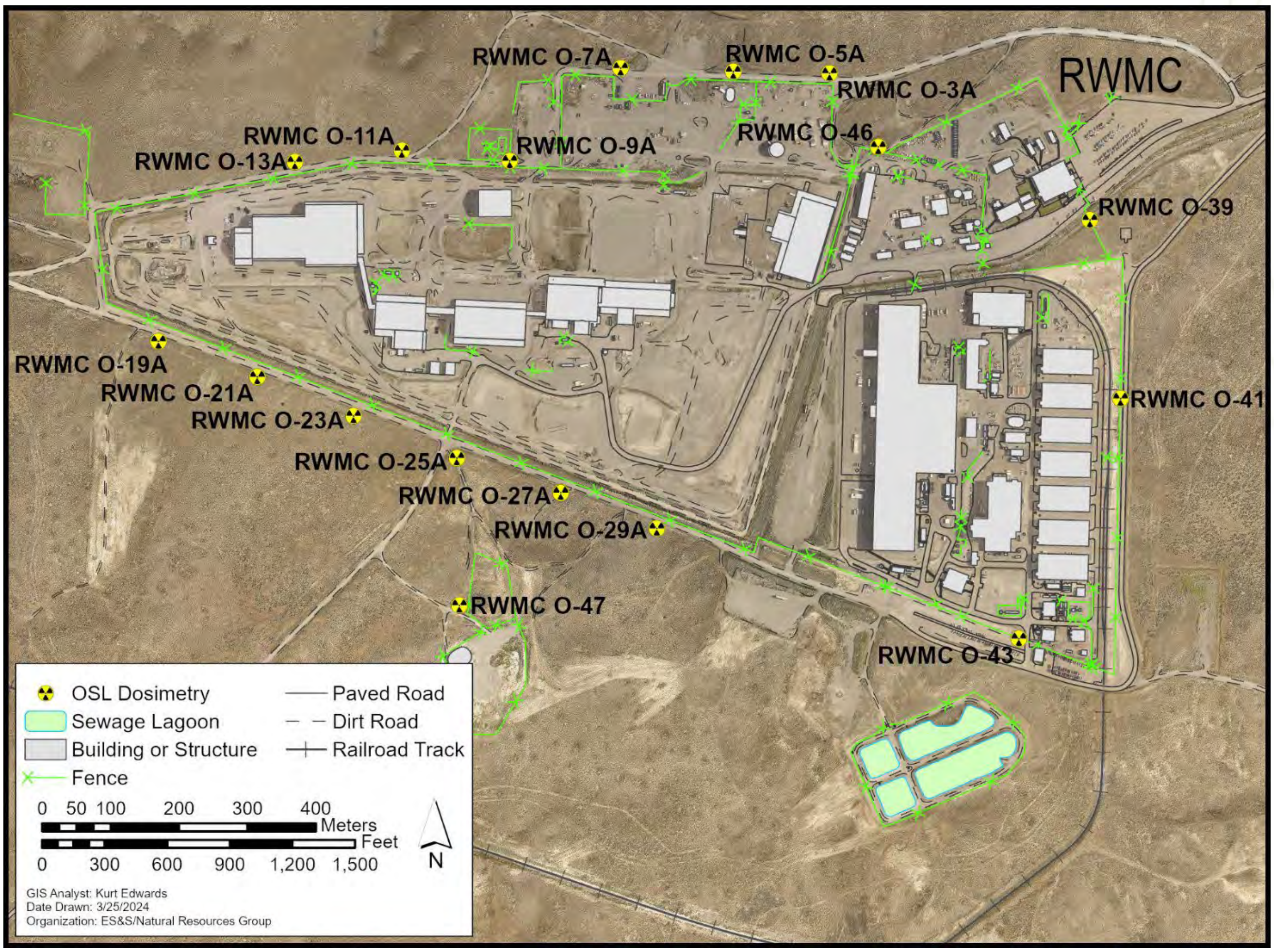


Figure B-9. Environmental radiation measurements at Radioactive Waste Management Complex (RWMC) (2023).

Table B-10. Results of environmental radiation measurements at Specific Manufacturing Capability (SMC) (2023).

LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023	LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023
TAN LOFT[b] O-6	66	69	TAN LOFT O-10	64	69
TAN LOFT O-7	61	69	TAN LOFT O-11	62	66
TAN LOFT O-8	59	71	TAN LOFT O-12	54	61
TAN LOFT O-9	52	50	TAN LOFT O-13	60	65

a. Millirem (mrem) in ambient dose equivalent.
b. Test Area North, Loss-of-Fluid Test (TAN LOFT).

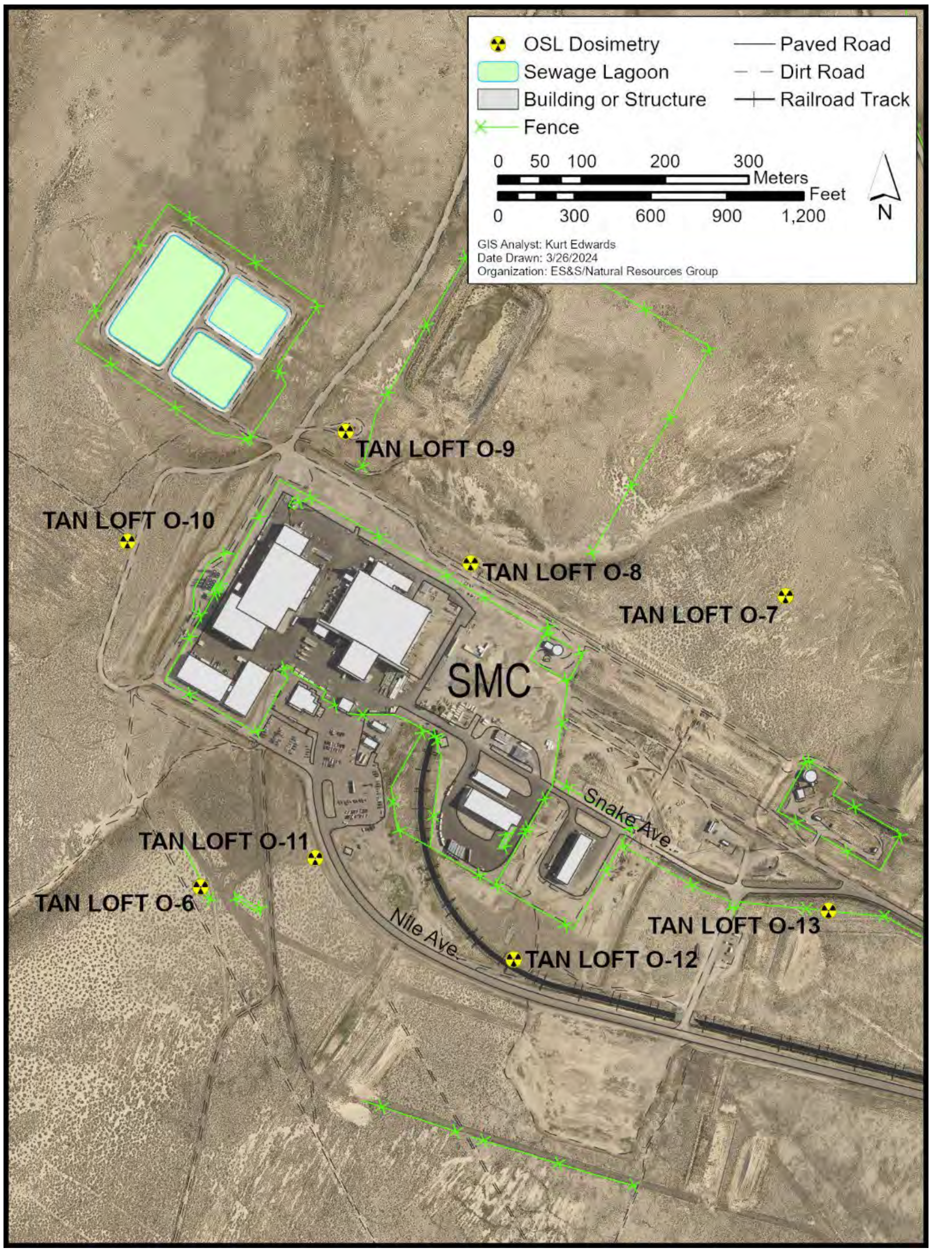


Figure B-10. Environmental radiation measurements at Specific Manufacturing Capability (SMC) (2023).

Table B-11. Results of environmental radiation measurements at sitewide locations (2023).

	mrem[a]			mrem[a]	
LOCATION	NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023	LOCATION	NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023
EFS[b] O-1	64	69	Hwy33 T17 O-3	48	61
Gate4 O-1	62	54	LincolnBlvd[d] O-3	62	68
Haul E O-1	55	61	LincolnBlvd O-5	65	72
Haul W O-2	66	59	LincolnBlvd O-9	63	80
Hwy[c]20 Mile O-266	49	59	LincolnBlvd O-15	66	75
Hwy20 Mile O-270	51	75	LincolnBlvd O-25	59	62
Hwy20 Mile O-276	60	68	Main Gate O-1	60	66
Hwy22 T28 O-1	50	51	Rest[e] O-1	61	58
Hwy28 N2300 O-2	50	57	VanB[f] O-1	59	60

a. Millirem (mrem) in ambient dose equivalent.
b. Experimental Field Station (EFS).
c. Highway (Hwy).
d. Lincoln Boulevard (LincolnBlvd).
e. Rest Area Highway 26 (Rest)
f. Van Buren (VanB).

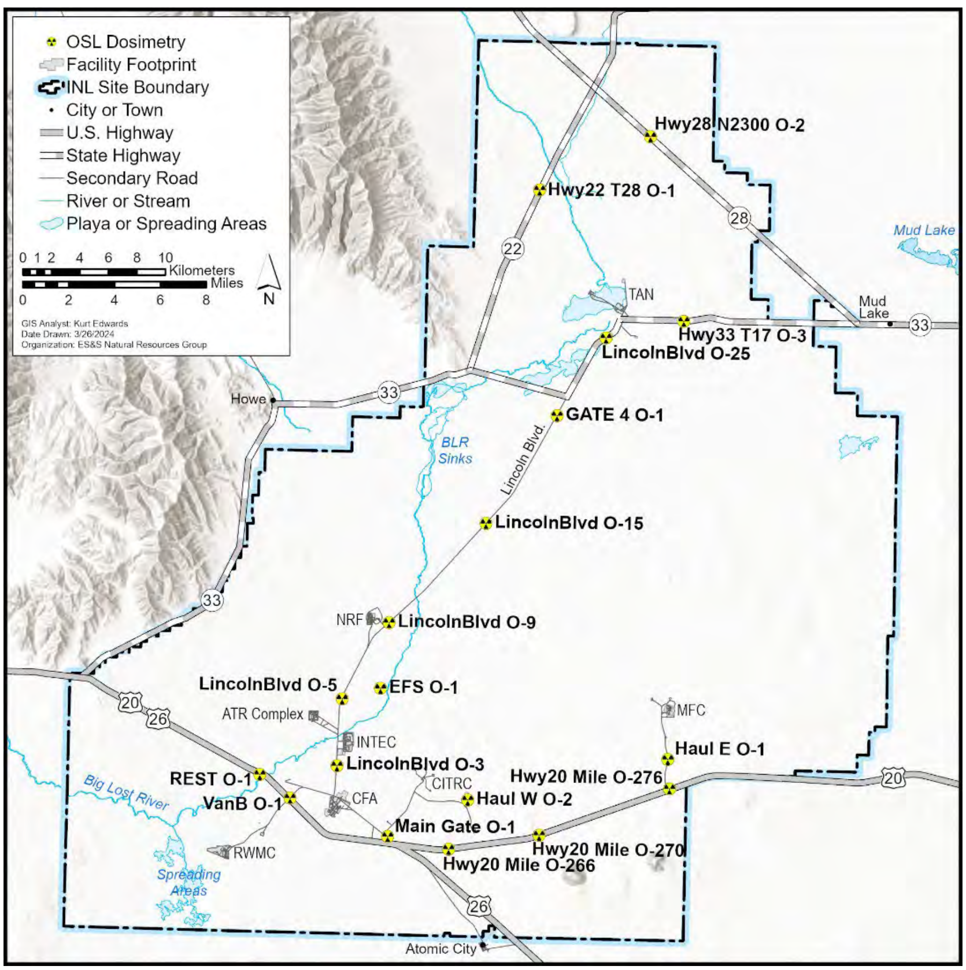


Figure B-11. Environmental radiation measurements at sitewide locations (2023).

Table B-12. Environmental radiation measurements at regional locations (2023).

LOCATION	mrem[a]		LOCATION	mrem[a]	
	NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023		NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023
Aberdeen E-1	56	56	Minidoka E-1	51	62
Arco E-1	53	location end	Monteview E-1	56	location end
Arco O-1	47	56	Monteview O-4	69	57
Atomic City E-1	63	62	Mountain View E-1	55	location end
Atomic City O-2	56	61	Mud Lake E-1	58	location end
Blackfoot O-9	58	56	Mud Lake O-5	65	71
Blue Dome E-1	45	55	Reno Ranch E-1	53	location end
Craters[b] E-1	49	location end	Reno Ranch O-6	53	57
Craters O-7	48	62	Roberts E-1	64	location end
Dubois E-1	52	57	RobNOAA[e]	55	60
Howe E-1	60	location end	RRL[f]3 O-1	60	71
Howe O-3	53	57	RRL5 O-1	73	85
Idaho Falls E-1	56	location end	RRL6 O-1	54	67
Idaho Falls O-10	57	61	RRL17 O-1	56	61
IF[c]-IDA O-38	43	47	RRL24 O-1	56	52
Jackson E-1	54	56	Sugar City E-1	67	87

a. Millirem (mrem) in ambient dose equivalent.
b. Craters of Moon (Craters).
c. Idaho Falls (IF).
d. Roberts National Oceanic and Atmospheric Administration (RobNOAA).
e. Resident Receptor Location (RRL).

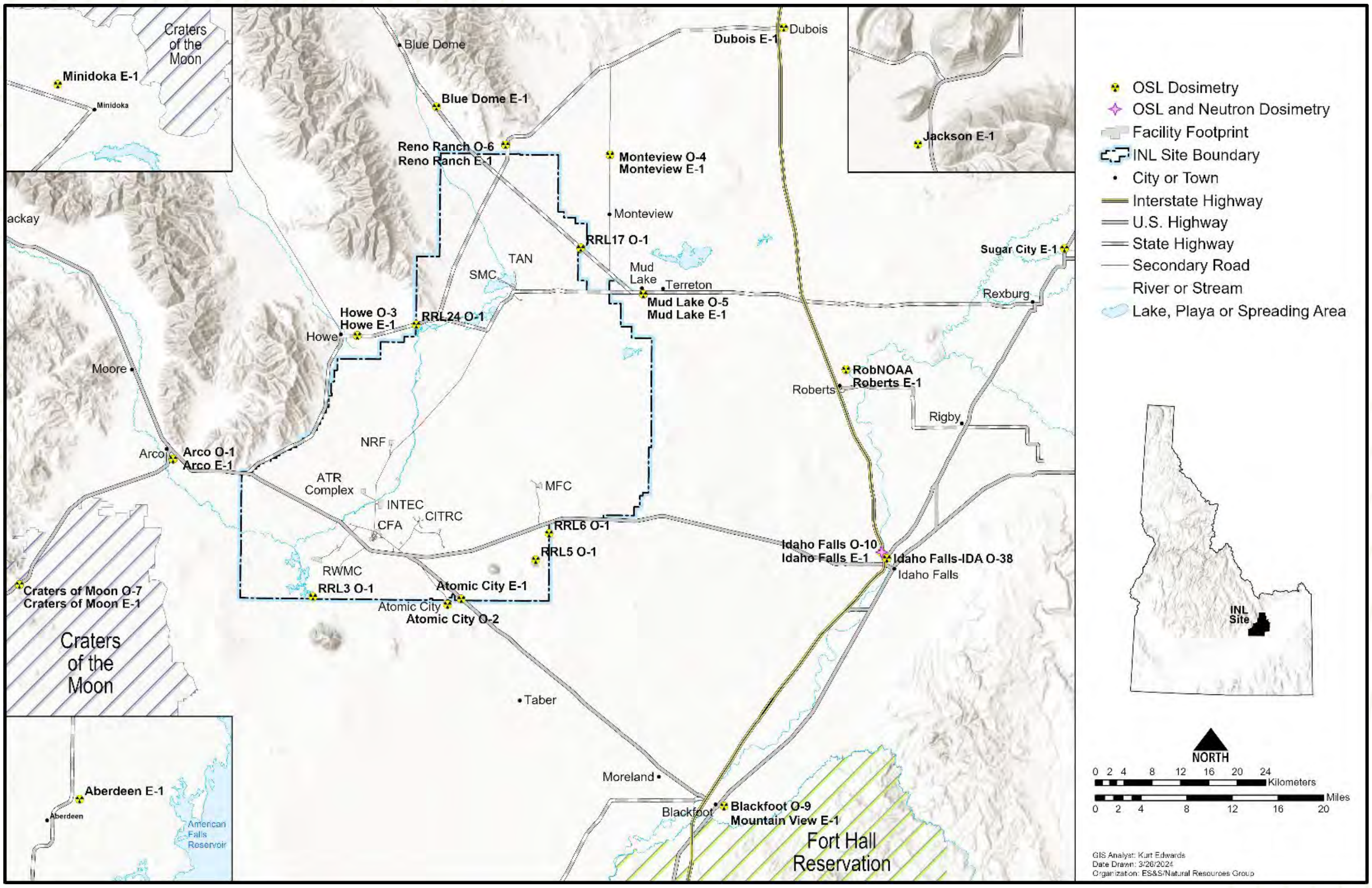


Figure B-12. Environmental radiation measurements at regional locations (2023).

Table B-13. Results of environmental radiation measurements at Willow Creek Building (WCB) and Center for Advanced Energy Studies (CAES) (2023).

LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023	LOCATION	mrem[a] NOV. 2022 – APRIL 2023	mrem[a] MAY 2023 – OCT. 2023
IF[b]-616N O-36	51	48	IF-665 O-4	57	54
IF-665 O-1	50	56	IF-665 O-5	54	58
IF-665 O-2	53	57	IF-665W O-37	49	54
IF-665 O-3	56	57			

a. Millirem (mrem) in ambient dose equivalent.
b. Idaho Falls (IF).

Figure B-13. Environmental radiation measurements at Willow Creek Building (WCB) and Center for Advanced Energy Studies (CAES) (2023).

Table B-14. Results of environmental radiation measurements at Experimental Breeder Reactor-I (EBR-I) (2023).

LOCATION	mrem[a]	
	NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023
EBR1[b] O-1	58	57
EBR1 O-2	71	82
EBR1 O-3	297	265

a. Millirem (mrem) in ambient dose equivalent.
b. Experimental Breeder Reactor I (EBR-I).

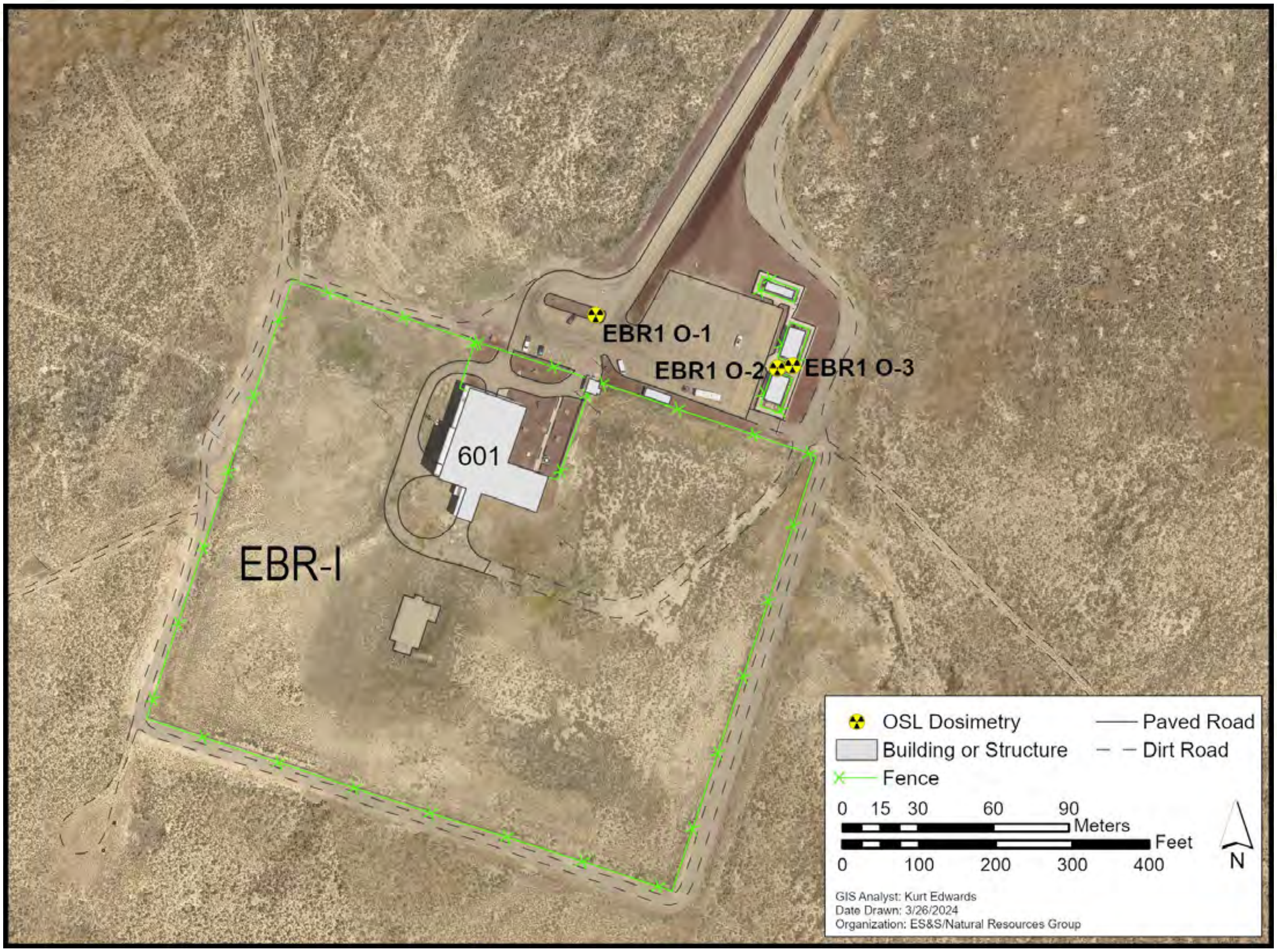


Figure B-14. Environmental radiation measurements at Experimental Breeder Reactor-I (EBR-I) (2023).

Table B-15. Results of environmental radiation measurements at Energy Innovation Laboratory (EIL) (2023).

LOCATION	mrem[a]	
	NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023
IF[b]-688B O-1	49	54
IF-688B O-2	53	45

a. Millirem (mrem) in ambient dose equivalent.
b. Idaho Falls (IF).

Figure B-15. Environmental radiation measurements at Energy Innovation Laboratory (EIL) (2023).

Table B-16. Results of environmental radiation measurements at Lindsay Building IF-695 (2023). *Previously the building number was IF-652A.*

LOCATION	mrem[a]	
	NOV. 2022 – APRIL 2023	MAY 2023 – OCT. 2023
IF-652A[b] O-1	71	61
IF-652A O-2	60	65
IF-652A O-3	lost[c]	75
IF-652A O-4	65	77

a. Millirem (mrem) in ambient dose equivalent.
b. Idaho Falls (IF).
c. Dosimeter missing from the sample site.

Figure B-16. Environmental radiation measurements at Lindsay Building IF-695 (2023). *Previously the building number was IF-652A.*

Appendix C: Glossary

A

accuracy: A measure of the degree to which a measured value or the average of a number of measured values agrees with the “true” value for a given parameter; accuracy includes elements of both bias and precision.

actinides: The elements of the periodic table from actinium to lawrencium, including the naturally occurring radionuclides thorium and uranium and the human-made radionuclides plutonium and americium.

alpha radiation: The emission of alpha particles during radioactive decay. Alpha particles are identical in makeup to the nucleus of a helium atom and have a positive charge. Alpha radiation is easily stopped by materials as thin as a sheet of paper and has a range in air of approximately an inch. Despite its low penetration ability, alpha radiation is densely ionizing and, therefore, very damaging when ingested or inhaled.

ambient dose equivalent: Since the effective dose cannot be measured directly with a typical survey instrument or a dosimeter, approved simulation quantities are used to approximate the effective dose (see **dose, effective**). The ambient dose equivalent is the quantity recommended by the International Commission on Radiation Units and Measurements to approximate the effective dose received by a human from external exposure to ambient ionizing radiation.

anthropogenic radionuclide: Radionuclide produced as a result of human activity (human-made).

aquifer: A geologic formation, group of formations, or part of a formation capable of yielding a significant amount of groundwater to wells or springs.

aquifer well: A well that obtains its water from below the water table.

B

background radiation: Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices. It does not include radiation from source, byproduct, or special nuclear materials regulated by the United States (U.S.) Nuclear Regulatory Commission. The typically quoted average individual exposure from background radiation in southeastern Idaho is 360 millirems per year.

basalt: The most common type of solidified lava; a dense, dark gray, fine-grained, igneous rock that is composed chiefly of plagioclase, pyroxene, and olivine, often displaying a columnar structure.

becquerel (Bq): A quantitative measure of radioactivity. This is an alternate measure of activity used internationally. One Bq of activity is equal to one nuclear decay per second. There are 3.7×10^{10} Bq in 1 Curie (Ci).

beta radiation: Radiation comprised of charged particles emitted from a nucleus during radioactive decay. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta radiation is slightly more penetrating than alpha radiation, and it may be stopped by materials such as aluminum or Lucite panels.

bias: The tendency for an estimate to deviate from an actual or real event. Bias may be the tendency for a model to over- or under-predict.

bioremediation: The process of using various natural or introduced microbes or both to degrade, destroy, or otherwise permanently bond contaminants contained in soil or water or both.

biota concentration guide: The limiting concentration of a radionuclide in soil, sediment, or water that would not cause dose limits for the protection of populations of aquatic and terrestrial biota to be exceeded.

blank: The primary purpose of blanks (e.g., a sample of analyte-free media) is to trace sources of artificially introduced contamination. Laboratory blanks assess the potential of contamination being introduced during the analytical laboratory process whereas field blanks are used to identify potential contamination that occurred during sample collection. See **field blank**, **laboratory blank**, **equipment blank,** and **reagent blank**.

blind sample: Contains a known quantity of some of the analytes of interest added to a sample media being collected. A blind sample is used to test for the presence of compounds in the sample media that interfere with the analysis of certain analytes.

butte: A steep-sided and flat-topped hill.

C

calibration: The adjustment of a system and the determination of system accuracy using known sources and instrument measurements of higher accuracy.

calibration verification: This is used to check that an instrument is within the original calibration of the instrumentation being used for analyses of the samples sent to the laboratory for the requested method and analytes requested on the chain of custody.

chain of custody: A method for documenting the history and possession of a sample from the time of collection, through analysis and data reporting, to its final disposition. An item is considered to be in a person's custody if the item is (1) in the physical possession of that person, (2) within direct view of that person, or (3) placed in a secured area or container by that person.

comparability: A measure of the confidence with which one dataset or method can be compared to another.

composite sample: A sample of environmental media that contains a certain number of sample portions collected over a time period. The samples may be collected from the same location or different locations. They may or may not be collected at equal intervals over a predefined period (e.g., quarterly).

completeness: A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected under optimum conditions.

confidence interval: A statistical range with a specified probability a given parameter lies within that range.

contaminant: Any physical, chemical, biological, radiological substance, matter, or concentration that is in an unwanted location.

contaminant of concern: A contaminant in a given media (usually soil or water) above a risk level that may result in harm to the public or the environment. At the Idaho National Laboratory (INL) Site, this term refers to a contaminant that is above a 10^{-6} (i.e., 1 in 1 million) risk value.

continuing calibration verification (CCV) (also known as initial calibration verification [ICV]): The primary purpose of the CCV/ICV is to check the original calibration of the instrumentation being used to analyze samples for that method and targeted analytes. The CCV/ICV is from an external source that is different than that used in the calibration.

control sample: A sample collected from an uncontaminated area that is used to compare INL Site analytical results to those in areas that could not have been impacted by INL Site operations.

cosmic radiation: Penetrating ionizing radiation, both particulate and electromagnetic, that originates in outer space. Secondary cosmic rays, formed by interactions in the earth's atmosphere, account for about 45 to 50 millirem of the 300 millirem of natural background radiation that an average U.S. citizen receives in a year.

curie (Ci): The original unit used to express the decay rate of a sample of radioactive material. The curie is a unit of activity of radioactive substances equivalent to 3.70×10^{10} disintegrations per second; it is approximately the amount of activity produced by 1 gram of radium-226. It is named for Marie and Pierre Curie who discovered radium in 1898. The curie is the basic unit of radioactivity used in the system of radiation units in the U.S., which is referred to as a "traditional" unit. See **becquerel (Bq)**.

D

data gap: A lack or inability to obtain information despite good faith efforts to gather desired information.

data quality assessment: A data quality assessment includes reviewing data for accuracy, representativeness, and, if available, consistency with historical measurements to ensure that the data support their intended uses. A preliminary data assessment is also performed to determine the structure of the data (i.e., distribution of data [normal, lognormal, exponential, or nonparametric]); identify relationships/associations, trends, or patterns between sample points/variables or over time; identify anomalies; and select the appropriate statistical tests for decision-making.

data validation: A systematic review of a data set to identify outliers or suspect values. More specifically, data validation refers to the systematic process of independently reviewing a body of analytical data against established criteria to provide assurance that the data are acceptable for their intended use. This process may use appropriate statistical techniques to screen out impossible or highly unlikely values.

data verification: The act of reviewing, inspecting, testing, checking, auditing, or otherwise determining and documenting whether items, processes, services, or documents conform to specified requirements. The data verification process involves checking for common errors associated with analytical data. A review is first conducted to ensure all data and sample documentation are present and complete. In addition, the following also may be reviewed: sample preservation and temperature, defensible chain of custody documentation and sample integrity, analytical hold-time compliance, correct test method application, adequate analytical recovery, correct minimum detection limit, possible cross-contamination, and matrix interference (i.e., analyses affected by dissolved inorganic/organic materials in the matrix).

decay products: Decay products are also called “daughter products.” They are radionuclides that are formed by the radioactive decay of parent radionuclides. In the case of radium-226, for example, nine successive different radioactive decay products are formed in what is called a “decay chain.” The chain ends with the formation of lead-206, which is a stable nuclide.

derived concentration standard (DCS): The concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by a single pathway (e.g., air inhalation or immersion, water ingestion), would result in an effective dose of 100 mrem (1 mSv). DOE O 458.1, “Radiation Protection of the Public and the Environment,” establishes this limit, and Department of Energy (DOE) Standard DOE-STD-1196-2022, “Derived Concentration Technical Standard,” provides the numerical values of DCSs.

deterministic effect: A health effect, the severity of which varies with the dose and for which a threshold is believed to exist. Deterministic effects generally result from the receipt of a relatively high dose over a short time period. Skin erythema (reddening) and radiation-induced cataract formation is an example of a deterministic effect (formerly called a nonstochastic effect).

diffuse source: A source or potential source of pollutants that is not constrained to a single stack or pipe. A pollutant source with a large areal dimension.

diffusion: The process of molecular movement from an area of high concentration to one of lower concentration.

direct radiation: External radiation from radioactive plumes or from radionuclides deposited on the ground or other surfaces.

dispersion: The process of molecular movement by physical processes.

dispersion coefficient: An empirical concentration, normalized to a unit release rate, used to estimate the concentration of radionuclides in a plume at some distance downwind of the source. The National Oceanic and Atmospheric Administration prepared the dispersion coefficients for this report, using data gathered continuously at meteorological stations on and around the INL Site and the HYSPLIT transport and dispersion model.

dose: A general term used to refer to the effect on a material that is exposed to radiation. It is used to refer either to the amount of energy absorbed by a material exposed to radiation (see **dose, absorbed**) or to the potential biological effect in tissue exposed to radiation. See **dose, equivalent** and **dose, effective;** see also **dose, population**.

dose, absorbed: The amount of energy deposited in any substance by ionizing radiation per unit mass of the substance. It is expressed in units of rad or gray (Gy) (1 rad = 0.01 gray).

dose, effective (*E*): The summation of the products of the equivalent dose received by specified tissues and organs of the body, and tissue-weighting factors for the specified tissues and organs, and is given by the expression:

$$E=\sum_T w_T \sum_R w_R D_{T,R} \text{ or } E=\sum_T w_T H_T$$

where H_T or $W_R D_{T,R}$ is the equivalent dose in a tissue or organ, T, and w_T is the tissue-weighting factor. The effective dose is expressed in the SI unit sievert (Sv) or conventional unit rem (1 rem = 0.01 Sv). See **dose, equivalent** and **weighting factor**.

dose, equivalent (H_T): The product of absorbed dose in tissue multiplied by a quality factor, and then sometimes multiplied by other necessary modifying factors, to account for the potential for a biological effect resulting from the absorbed dose. For external dose, the equivalent dose to the whole body is assessed at a depth of 1 cm in tissue; the equivalent dose to the lens of the eye is assessed at a depth of 0.3 cm in tissue, and the equivalent dose to the extremity and skin is assessed at a depth of 0.007 cm in tissue. Equivalent dose is expressed in units of rems (or sieverts). It is expressed numerically in rems (traditional units) or sieverts (SI units). See **dose, absorbed** and **quality factor**.

dose, population or collective: The sum of the individual effective doses received in a given time period by a specified population from exposure to a specified source of radiation. Population dose is expressed in the SI unit person-sievert (person-Sv) or conventional unit person-rem (1 person-Sv = 100 person-rem). See **dose, effective**.

dosimeter: Portable detection device for measuring the total accumulated exposure to ionizing radiation.

dosimetry: The theory and application of the principles and techniques involved in the measurement and recording of radiation doses.

double-blind performance evaluation (PE) samples: The value of a double-blind PE sample is unknown to both the laboratory receiving the sample and the INL Site contractor. While the program specifies PE sample matrix and boundaries of the value's range (i.e., the known value must fall between a predetermined minimum and maximum value that corresponds to the specific project or program), the actual value is unknown to both the INL Site contractor and the laboratory.

drinking water: Water for the primary purpose of consumption by humans.

duplicate sample: A sample collected from the same sampling location using the same equipment and sampling technique and placed into an identically prepared and preserved container. Duplicate samples are analyzed independently as an indication of gross errors in sampling techniques. See **replicate sample**.

E

Eastern Snake River Plain Aquifer: One of the largest groundwater "sole source" resources in the U.S. It lies beneath a rolling topography extending some 308 km (191 mi) from Ashton to King Hill, Idaho, and ranges in width from 64 to 130 km (40 to 80 mi). The plain and aquifer were formed by repeated volcanic eruptions that were the result of a geologic hot spot beneath the earth's crust.

ecosystem: The interacting system of a biologic community and its nonliving environment.

effluent: Any gaseous or liquid discharge released to the environment, including storm water runoff at a site or facility.

electrometallurgical treatment: The process of treating spent nuclear fuel using metallurgical techniques.

environment: Includes water, air, and land and the interrelationship that exists among and between water, air, and land and all living things.

environmental indicators: Animal and plant species that are particularly susceptible to decline related to changes, either physical or chemical, in their environment.

environmental media: Includes air, groundwater, surface water, soil, flora, and fauna.

environmental monitoring: Sampling for contaminants in air, water, sediments, soils, agricultural products, plants, and animals, either by direct measurement or by collection and analysis of samples. It is a combination of two distinct activities (effluent monitoring and environmental surveillance) that together provide information on the health of an environment.

equipment blank: Sample prepared by collecting uncontaminated water passed over or through the sampling equipment. This type of blank sample is normally collected after the sampling equipment has been used and subsequently cleaned.

An equipment blank is used to detect contamination introduced by the sampling equipment either directly or through improper cleaning.

exposure: The interaction of an organism with a physical or chemical agent of interest. Examples of such agents are radiation (physical) and carbon tetrachloride (chemical).

exposure pathway: The mechanism through which an organism may be exposed to a contaminant. An example is the surface water pathway, whereby an organism may be exposed to a contaminant through the consumption of surface water containing that contaminant.

external dose or exposure: That portion of the dose received from radiation sources outside the body (i.e., external sources).

extremely hazardous substance: A substance listed in the appendices to 40 CFR 355, "Emergency Planning and Notification."

F

fallout: Radioactive material made airborne as a result of aboveground nuclear weapons testing and deposited on the earth's surface.

field blank: A field blank is collected to assess the potential introduction of contaminants and the adequacy of field and laboratory protocols during sampling and laboratory analysis. In air sampling, a field blank is a clean, analyte-free filter that is carried to the sampling site, exposed to sampling conditions, returned to the laboratory, and treated as an environmental sample. In water sampling, field blanks are prepared at the field site where environmental water samples are collected. A sample of analyte-free water is poured into the container in the field where environmental water samples are collected, preserved, and shipped to the laboratory with field samples. Results include relevant ambient conditions during sampling and laboratory sources of contamination. See **reagent blank**.

field replicates: Two samples collected from a single location at the same time, stored in separate containers, and analyzed independently. In the case of air sampling, two air samplers are placed side by side, and each filter is analyzed separately. Duplicates are useful in estimating the precision resulting from the sampling process. See **sample duplicate (collocated samples)**.

fissile material: Although sometimes used as a synonym for fissionable material, this term has acquired a more restricted meaning. Namely, any material that is fissionable by thermal (slow) neutrons. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

fission: The splitting of the nucleus of an atom (generally of a heavy element) into at least two other nuclei and the release of a relatively large amount of energy. Two or three neutrons are usually released during this type of transformation.

fission products: The nuclei (fission fragments) formed by the fission of heavy elements plus the nuclides formed by the subsequent decay products of the radioactive fission fragments.

fissionable material: Commonly used as a synonym for fissile material, the meaning of this term has been extended to include material that can be fissioned by fast neutrons, such as uranium-238.

follow-up: Contact with an analytical laboratory to perform a review of an initial nonagreement.

for-cause-review: A for-cause-review is performed by an analytical laboratory after a follow-up identifies a cause of a nonagreement for a particular method/analyte/media. The for-cause-review may result in a corrective action. See **follow-up**.

floodplain: Lowlands that border a river and are subject to flooding. A floodplain is comprised of sediments carried by rivers and deposited on land during flooding.

G

gamma radiation: A form of electromagnetic radiation, such as radio waves or visible light but with a much shorter wavelength. It is more penetrating than alpha or beta radiation and capable of passing through dense materials, such as concrete.

gamma spectroscopy: An analysis technique that identifies specific radionuclides that emit gamma radiation. It measures the particular energy of a radionuclide's gamma radiation emissions. The energy of these emissions is unique for each radionuclide, acting as a fingerprint to identify a specific radionuclide.

gross alpha activity: The total radioactivity due to alpha particle emission as inferred from measurements on a dry sample. See **alpha radiation**.

gross beta activity: The total radioactivity due to beta particle emission as inferred from measurements on a dry sample. See **beta radiation**.

groundwater: Water located beneath the surface of the ground (subsurface water). Groundwater usually refers to a zone of complete saturation containing no air.

H

half-life: The time in which one-half of the activity of a particular radioactive substance is lost due to radioactive decay. Measured half-lives vary from millionths of a second to billions of years. Also called physical or radiological half-life.

hazardous air pollutant: Any hazardous chemical as defined under 29 CFR 1910.1200, "Hazard Communication," and 40 CFR 370.2, "Definitions." See **hazardous substance**.

hazardous material: Material considered dangerous to people or the environment.

hazardous substance: Any substance, including any isomers and hydrates, as well as any solutions and mixtures containing these substances, designated as such under Section 311 (b) (2)(A) of the Clean Water Act (CWA); any toxic pollutant listed under Section 307 (a) of the CWA; any element, compound, mixture, solution, or substance designated pursuant to Section 102 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); any hazardous waste having the characteristics identified under or listed pursuant to Section 3001 of the Solid Waste Disposal Act; any hazardous air pollutant listed under Section 112 of the Clean Air Act; and any imminently hazardous chemical substance or mixture to which the U.S. Environmental Protection Agency (EPA) administrator has taken action pursuant to Section 7 of the Toxic Substances Control Act. The term does not include petroleum, including crude oil or any fraction thereof that is not otherwise specifically listed or designated in the first paragraph, and it does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas).

hazardous waste: A waste that is listed in the tables of 40 CFR 261, "Identification and Listing Hazardous Waste," or that exhibits one or more of four characteristics (e.g., corrosivity, reactivity, ignitability, toxicity) above a predefined value.

high-level radioactive waste: Waste material resulting from the reprocessing of spent nuclear fuel, including both liquid and solid materials containing enough radioactivity to require permanent isolation from the environment.

hot spot: (1) In environmental surveillance, a localized area of contamination or higher contamination in an otherwise uncontaminated area. (2) In geology, a stationary, long-lived source of magma coming up through the mantle to the earth's surface. The hot spot does not move but remains in a fixed position. As the crust of the earth moves over a hot spot, volcanic eruptions occur on the surface.

I

infiltration: The process by which water on the ground surface enters the soil or rock.

influent: Any raw or untreated gaseous or liquid stream entering a treatment system, process, or facility.

inorganic: Relating to or belonging to the class of compounds not having a carbon basis; hydrochloric and sulfuric acids are called inorganic substances.

ionizing radiation: Any radiation capable of displacing electrons from atoms or molecules, thereby producing ions. Some examples are alpha, beta, gamma, X-rays, neutrons, and light. High doses of ionizing radiation may produce severe skin or tissue damage.

initial calibration verification (ICV): The primary purpose of the CCV/ICV is to check the original calibration of the instrumentation being used to analyze samples for that method and targeted analytes. The CCV/ICV is from an external source that is different than that used in the calibration. See **continuing calibration verification (CCV).**

inter-laboratory proficiency testing (PT) samples: This is an external PT and inter-laboratory comparison program accredited under the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC 17043:2010[E]). *The Department of Defense (DOD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories* (QSM 2021) requires that laboratories receiving and analyzing samples for DOE contracts successfully participate in a PT program for one year before becoming an accredited laboratory to receive samples for analyses for all analytes, matrices, and methods included in the laboratory's scope of work. The inter-laboratory program requires that participating laboratories must analyze at least two sets of samples during a calendar year.

intra-laboratory PE: This is an internal laboratory quality program using their own known value sample program to test their laboratory for method performance.

intra-laboratory samples: Intra-laboratory known value samples can be used to verify competency of the laboratory analysis method and of the analyst performing the sample preparation and analysis.

isopleth: A line on a map connecting points having the same numerical value of some variable.

isotope: Two or more forms of an element having the same number of protons in the nucleus (or the same atomic number) but having different numbers of neutrons in the nucleus (or different atomic weights). Isotopes of a single element possess almost identical chemical properties. Examples of isotopes are plutonium-238, plutomium-239, and plutonium-241; each acts chemically like plutonium but has 144, 145, and 147 neutrons, respectively.

L

laboratory blank: A sample, usually deionized water, that is intended to contain none of the analytes of interest and is subjected to the same analytical or measurement process as other samples to establish a zero baseline or laboratory background value. Laboratory blanks are run before and after regular samples are analyzed to measure contamination that may have been introduced during sample handling, preparation, or analysis. A laboratory blank is sometimes used to adjust or correct routine analytical results.

laboratory control sample: The primary purpose of the laboratory control sample (accuracy) is to demonstrate that the laboratory can perform the overall analytical approach in a matrix free of interferences (e.g., reagent water, clean sand, or another suitable reference matrix), and its analytical system is in control but does not reflect analytical performance on analyzing real world samples.

laboratory control sample duplicate analysis (accuracy and precision): The laboratory control sample duplicate is used to determine the accuracy and precision as well as the bias of a method in each sample matrix.

laboratory matrix spike: The purpose of the matrix spike (accuracy) sample is to determine if the method is applicable to the sample matrix in question.

laboratory replicate/duplicate: Two aliquots from the same field sample are prepared by the laboratory and analyzed separately using identical procedures to assess the precision of a method in a given sample matrix.

liquid effluent: A liquid discharged from a treatment system, process, or facility.

M

matrices/matrix/media: Refers to the physical form (solid, liquid, or gas) or composition (soil, filter, groundwater, or air) of a sample.

matrix spike duplicate analysis (accuracy and precision): The matrix spike duplicate is used to determine the accuracy and precision as well as the bias of a method in each sample matrix.

maximally exposed individual (MEI): A hypothetical member of the public whose location and living habits tend to maximize his or her radiation dose, resulting in a dose higher than that received by other individuals in the general population.

method blank: A method blank is an analyte-free matrix, such as distilled water, for liquids or cleaned sand for solids and/or soils that is processed in the same way as the INL Site contractor program samples. The main function of the method blank is to document contamination resulting from the analytical laboratory process.

millirem (mrem): A unit of radiation dose that is equivalent to one one-thousandth of a rem.

millisievert (mSv): The International System of Units (SI) for radiation dose and effective dose equivalent. The SI equivalent of the millirem (1 millisievert = 100 millirem).

minimum detection concentration (MDC): The lowest concentration to which an analytical parameter can be measured with certainty by the analytical laboratory performing the measurement. While results below the MDC are sometimes measurable, they represent values that have a reduced statistical confidence associated with them (less than 95 percent confidence).

multi-media: Covering more than one environmental media (e.g., an inspection that reviews groundwater, surface water, liquid effluent, and airborne effluent data).

N

natural background radiation: Radiation from natural sources to which people are exposed throughout their lives. It does not include fallout radiation. Natural background radiation is comprised of several sources, the most important of which are as follows:

- ***cosmic radiation:*** Radiation from outer space (primarily the sun)
- ***terrestrial radiation:*** Radiation from radioactive materials in the crust of the earth
- ***inhaled radionuclides:*** Radiation from radioactive gases in the atmosphere, primarily radon-222.

natural resources: Land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, otherwise controlled by the U.S., any state or local government, any foreign government, or Native American tribe.

noble gas: Any of the chemically inert gaseous elements of the helium group in the periodic table.

non-community water system: A public water system that is not a community water system. A non-community water system is either a transient non-community water system or a non-transient non-community water system.

non-conformance report: A non-conformance report is generated by the analytical laboratory for a more in-depth quality review of the non-agreement for a particular method/analyte/media. The non-conformance report may result in a corrective action.

non-transient non-community water system: A public water system that is not a community water system and that regularly serves at least 25 of the same people for more than six months per year. These systems are typically schools, offices, churches, factories, etc.

O

organic: Relating or belonging to the class of chemical compounds having a carbon basis; hydrocarbons are organic compounds.

optically stimulated luminescence dosimeter (OSLD): Used to measure direct penetrating gamma radiation through the absorption of energy from ionizing radiation by trapping electrons that are excited to a higher energy band. The trapped electrons in the OSLD are released by exposure to green light from a laser.

P

perched water well: A well that obtains its water from a water body above the water table.

performance evaluation (PE) sample: PE samples are prepared samples that contain known values of analyte(s) of interest to the specific project, INL Site contractor program, or laboratory. PE samples are used to assess analytical method specific laboratory performance and to check that the laboratory can be within the criteria set by the specific project or program for known value sample recovery. The samples are matched as closely as possible to the specific media, analytes of interest, and expected concentration or activity levels appropriate for the specific project, program, or use in decision-making. In some cases, the PE sample matrix may differ from the field samples (i.e., using deionized water with a known amount of analyte to simulate an atmospheric moisture sample). The PE samples are generally submitted with batches of field samples so they are processed simultaneously in the laboratory.

person-rem: Sum of the doses received by all individuals in a population.

pH: A measure of hydrogen ion activity. A low pH (0–6) indicates an acidic condition; a high pH (8–14) indicates a basic condition. A pH of 7 indicates neutrality.

playa: A depression that is periodically inundated with water and will retain such water over time. An intermittent or seasonal water body.

plume: A body of contaminated groundwater or polluted air flowing from a specific source. The movement of a groundwater plume is influenced by such factors as local groundwater flow patterns, the character of the aquifer in which groundwater is contained, and the density of contaminants. The movement of an air contaminant plume is influenced by the ambient air motion, the temperatures of the ambient air and of the plume, and the density of the contaminants.

PM_{10}: Particle with an aerodynamic diameter less than or equal to 10 microns.

pollutant: (1) Pollutant or contaminant as defined by Section 101(33) of the CERCLA shall include, but not be limited to, any element, substance, compound, or mixture, including disease-causing agents, which after release into the environment and upon exposure, ingesting, inhalation, or assimilation into an organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction), or physical deformation in such organisms or their offspring. The term does not include petroleum, including crude oil or any fraction thereof that is not otherwise specifically listed or designated as a hazardous substance under Section 101(14) (A) through (F) of CERCLA, nor does it include natural gas, liquefied natural gas, or synthetic gas of pipeline quality (or mixtures of natural gas and such synthetic gas). For purposes of the National Oil and Hazardous Substances Pollution Contingency Plan, the term pollutant or contaminant means any pollutant or contaminant that may present an imminent and substantial danger to the U.S. public health or welfare. (2) Any hazardous or radioactive material naturally occurring or added to an environmental media such as air, soil, water, or vegetation.

polychlorinated biphenyl: Any chemical substance that is limited to the biphenyl molecule that has been chlorinated to varying degrees or any combination of substances that contain such substance.

precision: A measure of mutual agreement among individual measurements of the same property. Precision is most often seen as a standard deviation of a group of measurements.

public water system: A system for the provision to the public of water for human consumption through pipes or other constructed conveyances if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily for at least 60 days out of the year. Includes any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system and any collection or pretreatment storage facilities not under such control that are used primarily in connection with such system. Does not include any special irrigation district. A public water system is either a community water system or a non-community water system.

purgeable organic compound: An organic compound that has a low vaporization point (volatile).

Q

quality assurance (QA): Those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or component will perform satisfactorily and safely in service. QA includes quality control. If quality is the degree to which an item or process meets or exceeds the user's requirements, then QA is the action that provides confidence that quality was in fact achieved.

quality control (QC): Those actions necessary to control and verify the features and characteristics of a material, process, product, service, or activity to specified requirements. The aim of QC is to provide quality that is satisfactory, adequate, dependable, and economic.

quality factor: The factor by which the absorbed dose (rad or gray) must be multiplied to obtain a quantity that expresses, on a common scale for all ionizing radiation, the biological damage (rem or sievert) to the exposed tissue. It is used because some types of radiation, such as alpha particles, are more biologically damaging to live tissue than other types of radiation when the absorbed dose from both is equal. The term, "quality factor," has now been replaced by "radiation weighting factor" in the latest system of recommendations for radiation protection.

R

rad: Short for radiation absorbed dose; a measure of the energy absorbed by any material.

radioactivity: The spontaneous transition of an atomic nucleus from a higher energy to a lower energy state. This transition is accompanied by the release of a charged particle or electromagnetic waves from the atom. Also known as activity.

radioactive decay: The decrease in the amount of any radioactive material with the passage of time due to the spontaneous emission from the atomic nuclei of either alpha or beta particles, often accompanied by gamma radiation.

radioecology: The study of the behavior and the effects of radioactive materials on the environment. Also includes the use of radioisotopes to study the structure and function of ecosystems and their component parts.

radionuclide: A type of atom that emits energy in the form of photons or particles (radiation) during transformation.

radiotelemetry: The tracking of animal movements using a radio transmitter attached to the animal of interest.

reagent blank: A sample of any reagent used for sample preparation subjected to the same analytical or measurement process as a normal sample. A reagent blank is used to show that the reagent used in sample preparation does not contain any of the analytes of interest.

rehabilitation: The planting of a variety of plants to restore an area's plant community diversity after a loss (e.g., after a fire).

relative percent difference: A measure of variability adjusted for the size of the measured values. It is used only when the sample contains two observations, and it is calculated by the following equation:

$$\mathrm{RPD} = \frac{|\mathrm{R1} - \mathrm{R2}|}{(R1 + R2)/2} \times 100$$

where R1 and R2 are the duplicate sample measurement results.

release: Spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of a hazardous substance, pollutant, or contaminant into the environment.

rem (Roentgen Equivalent Man): A unit in the traditional system of units that measures the effects of ionizing radiation on humans.

replicate samples: A sample collected from the same sampling location using the same equipment and sampling technique and placed into an identically prepared and preserved container. Duplicate samples are analyzed independently as an indication of gross errors in sampling techniques. See **duplicate samples**.

reportable quantity: Any hazardous substance under CERCLA, the reportable quantity for which is established in Table 302.4 of 40 CFR 302, "Designation, Reportable Quantities, and Notification." The discharge of which is a violation of federal statutes and requires notification of the regional EPA administrator.

representativeness: A measure of a laboratory's ability to produce data that accurately and precisely represents a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition.

reprocessing: The process of treating spent nuclear fuel for the purpose of recovering fissile material.

resuspension: Windblown reintroduction to the atmosphere of material originally deposited onto surfaces from a particular source.

rhyolite: A usually light-colored, fine-grained, extrusive igneous rock that is compositionally similar to granite.

risk: In many health fields, risk means the probability of incurring injury, disease, or death. Risk can be expressed as a value that ranges from zero (e.g., no injury or harm will occur) to one (e.g., harm or injury will occur).

risk assessment: The identification and quantification of the risk resulting from a specific use or occurrence of a chemical, considering the possible harmful effects on individuals or society from using the chemical in the amount and manner proposed and all possible exposure routes. Quantification ideally requires the establishment of dose-effect and dose-response relationships in likely target individuals and populations.

roentgen (R): The amount of ionization produced by gamma radiation in air. The unit of roentgen is approximately numerically equal to the unit of rem.

S

sample duplicate: Two samples collected from a single location at the same time, stored in separate containers, and analyzed independently. In the case of air sampling, two air samplers are placed side by side, and each filter is analyzed separately. Duplicates are useful in estimating the precision resulting from the sampling process. See **field replicates.**

shielding: The material or process used for protecting workers, the public, and the environment from exposure to radiation.

sievert (Sv): A unit for assessing the risk of human radiation dose, used internationally. One sievert is equal to 100 rem.

sigma uncertainty: The uncertainty or margin of error of a measurement is stated by giving a range of values likely to enclose the true value. These values follow from the properties of the normal distribution, and they apply only if the measurement process produces normally distributed errors; for example, the quoted standard errors are easily converted to 68.3 percent (one sigma), 95.4 percent (two sigma), or 99.7 percent (three sigma) confidence intervals, which are usually denoted by error bars on a graph or by the following notations:

- measured value ± uncertainty
- measured value (uncertainty).

single-blind PE sample: The value of a single-blind PE sample is known to the INL contractor sending the sample but unknown to the laboratory receiving the sample.

sink: Similar to a playa with the exception that it rapidly infiltrates any collected water.

spent nuclear fuel: Uranium metal or oxide and its metal container that have been used to power a nuclear reactor. It is highly radioactive and typically contains fission products, plutonium, and residual uranium.

split sample: A single sample split into two separate samples. Each sample is prepared and analyzed independently as an indication of analytical variability and comparability.

spreading areas: At the INL Site, a series of interconnected low areas used for flood control by dispersing and evaporating or infiltrating water from the Big Lost River.

stabilization: The planting of rapidly growing plants for the purpose of holding bare soil in place.

standard: A sample containing a known quantity of various analytes. A standard may be prepared and certified by commercial vendors, but it must be traceable to the National Institute of Standards and Technology (NIST).

standard deviation: In statistics, the standard deviation (often abbreviated as SD), also represented by the Greek letter sigma σ, is a measure of the dispersion of a set of data from its mean. See **sigma uncertainty.**

stochastic effect: An effect that occurs by chance and which may occur without a threshold level of dose, whose probability is proportional to the dose and whose severity is independent of the dose. In the context of radiation protection, the main stochastic effect is cancer.

storm water: Water produced by the interaction of precipitation events and the physical environment (e.g., buildings, pavement, ground surface).

surface radiation: Surface radiation is monitored at the INL Site at or near waste management facilities and at the perimeter of Site facilities. See **direct radiation**.

surface water: Water exposed at the ground surface, usually constrained by a natural or human-made channel (e.g., stream, river, lake, ocean).

surveillance: Monitoring of parameters to observe trends but which action is not required by a permit or regulation.

T

thermoluminescent dosimeter: A device used to measure radiation dose to occupational workers or radiation levels in the environment. A dosimeter is made of one or more lithium fluoride chips that measure cumulative exposure to ionizing radiation. Lithium fluoride absorbs the energy of radiation and releases it as light when heated.

total effective dose: The sum of the effective dose (for external exposures) and the committed effective dose.

total organic carbon: A measure of the total organic carbon molecules present in a sample. It will not identify a specific constituent (e.g., benzene) but will detect the presence of a carbon-bearing molecule.

toxic chemical: A chemical that can have toxic effects on the public or environment above the listed quantities. See also **hazardous chemical**.

traceability: The ability to trace history, application, or location of a sample standard and like items or activities by means of recorded identification.

Tracer: Tracers are added to samples to determine the overall chemical yield for the analytical preparation steps. Tracers are made of the same element with a different isotope that is chemically similar. An example would be using ^{242}Pu as a tracer when analyzing ^{238}Pu and ^{239}Pu.

transient non-community water system: A water system that is not a community water system and serves an average of 25 individuals for less than six months per year. These systems are typically campgrounds or highway rest stops.

transuranic: Elements on the periodic table with an atomic number greater than uranium (>92). Common isotopes of transuranic elements are neptunium-239 and plutonium-238.

transuranic waste: Waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes (radionuclide isotopes with atomic numbers greater than uranium [92]) per gram of waste with half-lives greater than 20 years.

trip blank: The blank sample results can be used to identify and isolate the source of contamination introduced in the field or the laboratory. A trip blank is a clean sample of matrix taken from the sample preparation area to the sampling site and returned to the analytical laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures.

tritium: A radioactive isotope of hydrogen, having three times the mass of ordinary hydrogen.

V

vadose zone: That part of the subsurface between the ground surface and the water table.

W

water quality parameter: Parameter commonly measured to determine the quality of a body of water or sample (i.e., specific conductivity, pH, temperature, dissolved oxygen content).

weighting factor (wT): A multiplier that is used for converting the equivalent dose to a specific organ or tissue (T) into what is called the effective dose. The goal of this process is to develop a method for expressing the dose to a portion of the body in terms of an equivalent dose to the whole body that would carry with it an equivalent risk in terms of the associated fatal cancer probability. The equivalent dose to tissue (HT) is multiplied by the appropriate tissue-weighting factor to obtain the effective dose (E) contribution from that tissue. See dose, equivalent and dose, effective.

wetland: An area inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and which under normal circumstances does support, a prevalence of vegetation typically adapted to wet conditions that cannot adapt to an absence of flooding. Wetlands generally include playa lakes, swamps, marshes, bogs, and similar areas such as sloughs, prairie potholes, wet meadows, prairie river overflows, mudflats, and natural ponds.

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