DOE/ID-12082(02)

ISSN 1089-5469
STOLLER-ESER-65

Idaho National Engineering and Environmental Laboratory Site Environmental Report Calendar Year 2002

Environmental Surveillance, Education and Research Program

U.S. Department of Energy Idaho Operations Office

September 2003

S. M. Stoller Corp.

This report was prepared for the
U.S. Department of Energy Idaho Operations Office
Under Contract DE-RP07-99ID13658
By the S. M. Stoller Corporation
Environmental Surveillance, Education and Research Program
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Idaho National Engineering and Environmental Laboratory's Environmental Policy

It is the policy of the U.S. Department of Energy (DOE) to conduct research, environmental remediation, and operations at the Idaho National Engineering and Environmental Laboratory (INEEL) in a manner that protects human health and the environment and is in full compliance with environmental laws and regulations.

The INEEL achieves this by integrating environmental requirements and pollution prevention into all work planning and execution, and by taking actions to minimize the environmental impacts of operations. Through employee involvement and management commitment to environmental excellence, the INEEL will:

- Protect the unique natural, biological, and cultural resources of the INEEL.
- Conduct operations and manage hazardous and radioactive materials and wastes in a safe, compliant, and cost-effective manner. This is done by establishing and communicating environmental responsibilities, by providing environmental training to our workforce, and by implementing controls to mitigate environmental hazards.
- Conduct environmental remediation to address contamination from legacy activities and minimize impacts on human health and the environment.
- Develop and deploy new and enhanced environmental technologies and share this expertise with other DOE sites, the local community, and external customers.
- Integrate pollution prevention into project planning, design, and construction to minimize toxicity and volume of waste generated; conserve natural resources and energy; and minimize environmental impacts.
- Conserve natural resources by reusing and recycling materials, purchasing recycled materials, and using recyclable materials.
- Promptly identify noncompliant conditions and encourage full disclosure and open discussion regarding compliance issues. Aggressively work to resolve identified issues.
- Establish documented environmental objectives and milestones, and update them as necessary to reflect the changing needs, missions, and goals of the INEEL.
- Consider the input of our stakeholders when weighing options.
- Measure environmental performance and monitor impacts on the environment, and communicate the results to employees and stakeholders.
- Continuously improve the INEEL environmental management system through self-assessment and corrective action.

This policy applies to all business units and all employees. Every employee and subcontractor is expected to follow this policy and to report environmental concerns to management. Managers shall promote environmental stewardship, take prompt action to address concerns and issues, and have zero tolerance for noncompliance.

INEEL
Idaho National Engineering and Environmental Laboratory
BECHTEL BWXT IDAHO, LLC

Acknowledgments

The following people with the current Environmental Surveillance, Education and Research (ESER) contractor (S. M. Stoller Corporation) have provided primary authorship of portions of this report: Christopher Martin, Marilyn Case, Randall Morris,[1] and Douglas Halford.

The primary authors would like to thank all those who provided data and review time for the completion of this document. In particular, we wish to thank the following people for their assistance: Mark Arenaz, Jack Depperschmidt, Kathleen Hain, Rosemary Haines, Bob Jones, Betsy Jonker, Richard Kauffman, Richard Kimmel, Stacey Madson, John Medema, Don Rasch, Tim Safford, Jeff Shadley, Jeff Snook, Bob Starck, Bob Stump, Jerry Wells, Stephanie Woolf, Patricia Natoni, Brian Edgerton, and Ron Ramsey with the U.S. Department of Energy (DOE) Idaho Operations Office; Leroy Knobel and Betty Tucker with the U.S. Geological Survey; W. Greg Bass with the DOE Chicago Operations Office-Argonne Area Office; Neil Hukari and Richard Eckman of the National Oceanic and Atmospheric Administration; Wendy Dixon of the DOE Pittsburgh Naval Reactors Office, Idaho Branch Office; Eirik Fowler, Mark Hutchinson, Paula Kain, Marty Nolte, Bruce Olenick, and Kelly Willie of Bechtel Bettis Inc.; Brad Andersen, Ben Beus, Bryan Borsella, Teresa Brock, John Gill, Teresa Meachum, Maria Miles, Jeffrey Mousseau, Joan Neff, Paul Ritter, Chris Staley, Leah Street, Jim Tkachyk, and Roger Wilhelmsen with Bechtel BWXT Idaho, LLC; Amy Powell, Maureen Finnerty, Bevin Brush, and Tim Miller of Argonne National Laboratory-West; Wendy Purrington, Alana Jensen, and Brande Hendricks of the S. M. Stoller Corporation; Jeff Einerson (statistician); and Sally Francis (technical editor).

[1] Randall Morris is with North Wind, Inc.

Preface

Every person in the world is exposed to ionizing radiation, which has sufficient energy to remove electrons from atoms, damage chromosomes, and cause cancer. There are three general sources of ionizing radiation: those of natural origin unaffected by human activities, those of natural origin but enhanced by human activities, and those produced by human activities (anthropogenic).

The first general source includes terrestrial radiation from natural radiation sources in the ground, cosmic radiation from outer space, and radiation from radionuclides naturally present in the body. Exposures to natural sources may vary depending on the geographical location and altitude at which the person resides. When such exposures are substantially higher than the average, they are considered to be elevated.

The second general source includes a variety of natural sources from which the radiation has been increased by human actions. For example, radon is a radioactive gas which comes from the natural decay of uranium and is found in nearly all soils. Concentrations of radon inside buildings may be elevated due to the type of soil and rock upon which they are built and may be enhanced by cracks and other holes in the foundation. Another example is the increased exposure to cosmic radiation that airplane passengers receive when traveling at high altitudes.

The third source includes a variety of exposures from human-made materials and devices such as medical x-rays, radiopharmaceuticals used to diagnose and treat disease, and consumer products containing minute quantities of radioactive materials. Exposures may also result from radioactive fallout from nuclear weapons testing, accidents at nuclear power plants, and other episodic events caused by human activities in the nuclear industry. Except for major nuclear accidents, such as the one that occurred at Chernobyl in 1986, exposures to workers and members of the public from activities in the nuclear industry generally are very small compared to exposures from natural sources (UNSCEAR 2000).

To verify that exposures resulting from operations at U.S. Department of Energy (DOE) nuclear facilities remain very small, each site where nuclear activities are conducted operates an environmental surveillance program to monitor the air, water, and other pathways through which radionuclides from operations might conceivably reach workers and members of the public. Environmental surveillance and monitoring results are reported annually to DOE Headquarters.

This report presents a compilation of data collected in 2002 for the environmental surveillance programs conducted on and around the Idaho National Engineering and Environmental Laboratory (INEEL). During 2002, the Environmental Surveillance, Education and Research (ESER) Program was conducted by a team led by the S. M. Stoller Corporation. This team collected 2002 data and prepared this report. During 2002, the INEEL was operated by Bechtel BWXT Idaho, LLC (BBWI). This report refers to BBWI as the Management and Operating (M&O) contractor. The M&O organization responsible for operating each facility conducted effluent and facility monitoring. The U.S. Geological Survey performed groundwater monitoring

both onsite and offsite. The M&O contractor also conducted some onsite groundwater monitoring. The National Oceanic and Atmospheric Administration collected meteorological data.

Argonne National Laboratory-West (ANL-W) and the Naval Reactors Facility (NRF) maintain separate monitoring programs. Both programs collect data similar to the M&O and ESER contractors, but the data are specific to these two facilities. ANL-W provides their information to the ESER contractor for incorporation into this annual report. NRF prepares an independent report, as such their data is briefly summarized here for completeness. The INEEL Oversight Program, under the Idaho Department of Environmental Quality, also continued to maintain independent sample locations and analysis capabilities both on and around the INEEL in 2002.

This report, prepared in accordance with the requirements in DOE Order 5400.1, is not intended to cover the numerous special environmental research programs conducted at the INEEL (DOE 1990). This Annual Site Environmental Report presents summary environmental data that:

(1) Characterize site environmental management performance including data on effluent releases, environmental monitoring, and estimates of radiological doses to the public associated with releases of radioactive material at the INEEL;

(2) Summarize any environmental occurrences and responses made that were reported during the calendar year;

(3) Confirm compliance with environmental standards and requirements; and

(4) Highlight significant programs and efforts, including environmental performance indicators and/or performance measures programs.

Facilities operated under the Naval Nuclear Propulsion Program, like the NRF, are exempt from the provisions for preparing an annual site environmental report. The Naval Nuclear Propulsion Program maintains a separate environmental protection program to ensure compliance with all applicable environmental laws and regulations. NRF issues a separate annual environmental report that provides NRF-specific monitoring data and information. For completeness, data from onsite monitoring programs at NRF are referenced in this report.

REFERENCES

UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation), 2000, *Sources and Effects of Ionizing Radiation*, Vol. 1, UNSCEAR 2000 Report to the General Assembly with Scientific Annexes.

DOE (U.S. Department of Energy), 1990, "General Environmental Protection Program," DOE Order 5400.1, January.

Executive Summary

Each year the U.S. Department of Energy (DOE) publishes the Idaho National Engineering and Environmental Laboratory (INEEL) site environmental report to summarize environmental data, information, and regulations and highlight major environmental programs and efforts. In summary, the results of the monitoring programs for 2002 presented in this report indicate that radioactivity from current INEEL operations could not be distinguished from worldwide fallout and natural radioactivity in the region surrounding the INEEL. Radioactive material concentrations in the offsite environment were below state of Idaho and federal health protection guidelines. Potential doses to the maximally exposed individual and to the surrounding population were estimated to be well below the applicable regulatory limit and far less than doses resulting from background radiation.

Organization of the Report

Individual chapters of the report are designed to:

- Provide an overview of the INEEL site, mission, and history (*Chapter 1*);
- Summarize the status of INEEL compliance with environmental regulations (*Chapter 2*);
- Describe major activities and milestones in environmental restoration, waste management, and other environmental programs, and review INEEL environmental surveillance programs (*Chapter 3*);
- Present and evaluate environmental monitoring results of airborne constituents (*Chapter 4*);
- Present and evaluate environmental monitoring results of waterborne constituents (*Chapter 5*);
- Present and evaluate environmental monitoring results of constituents in other media (*Chapter 6*);
- Discuss the potential radiation dose to the public and to biota from INEEL activities during 2002 (*Chapter 7*);
- Describe ecological research activities that took place on the INEEL (*Chapter 8*); and
- Discuss programs used to ensure environmental data quality (*Chapter 9*).

Chapter highlights are presented below.

Introduction (Chapter 1)

The Atomic Energy Commission created what is now the INEEL as the National Reactor Testing Station in 1949 as a site to build and test nuclear power reactors. The INEEL occupies approximately 2300 km^2 (890 mi^2) of the upper Snake River Plain in southeastern Idaho. Over the life of the INEEL, an assembly of 52 reactors, associated research centers, and waste handling areas have been constructed and tested.

The INEEL serves as a multi-program national laboratory that delivers science and engineering solutions to the world's environmental, energy, and security challenges in four core areas:

- Science-based, engineered solutions to challenges of the DOE's mission areas, other federal agencies, and industrial clients.

- Completion of environmental cleanup at the INEEL.

- Enhancement of scientific and technical talent, facilities, and equipment to best serve national and regional interests.

- Leadership and support to the Environmental Management mission throughout the DOE complex.

There are nine primary facility areas and three smaller secondary facilities at the INEEL and in Idaho Falls. Seven of the nine primary facilities and the three secondary facilities are operated by the INEEL Management and Operating (M&O) Contractor Bechtel BWXT Idaho, LLC. The University of Chicago and Bechtel Bettis, Inc. operate the remaining two primary facilities at the INEEL.

Approximately 8000 people work at the INEEL, making it the largest employer in eastern Idaho and one of the top five employers in the State. The INEEL has a tremendous economic impact on eastern Idaho. The INEEL has infused more than $750 million dollars to the Idaho economy.

Environmental Compliance Summary (Chaper 2)

Table ES-1 presents a brief summary of the INEEL's status of compliance with federal acts in 2002.

Environmental Program Information (Chapter 3)

Many environmental programs help implement the environmental compliance policy for the INEEL. Most of the regulatory compliance activity is performed through environmental monitoring programs, the recently signed Accelerated Cleanup Agreement, the Environmental Restoration Program, and the Waste Management Program.

Table ES-1. Compliance with federal acts in 2002.

Act	What it Addresses	2002 Activities
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	This act provides specific procedures to assess and remediate areas where the release or potential of a release of hazardous substances has occurred.	Work on these sites continued in compliance with CERCLA requirements. Thirteen of 14 enforceable milestones scheduled in the Federal Facility Agreement and Consent Order were met in 2002. Eleven areas have been cleaned and cleanup is in progress at ten other sites.
Resource Conservation and Recovery Act (RCRA)	This act establishes regulatory standards for the generation, transportation, storage, treatment, and disposal of hazardous waste.	In July 2001, DOE received a Notice of Violation (NOV) from the Idaho Department of Environmental Quality (DEQ). A Consent Order to resolve this NOV was negotiated in 2002. The Idaho DEQ conducted a RCRA inspection in October 2002. Four noncompliances were observed and a warning letter issued to the DOE-Idaho Operations Office.
Federal Facility Compliance Act	This act requires the preparation of site treatment plans for the management of mixed wastes stored or generated at DOE facilities.	There were no changes to the Site Treatment Plan in 2002. Seven milestones were completed.
Clean Air Act	This act sets the standards for ambient air quality and for emission of hazardous air pollutants.	Compliance with the Idaho air quality program was primarily administered through the permitting process. The 2002 National Emission Standards for Hazardous Air Pollutants report documented a maximum annual individual dose to a member of the public from INEEL releases of 0.055 mrem/yr, well below the regulatory limit of 10 mrem/yr.
Clean Water Act	This act establishes goals to control pollutants discharged to surface waters of the United States.	All discharges were within permit limits in 2002. Deficiencies identified in the Spill Prevention, Control, and Countermeasures Plans were updated in 2002.
Safe Drinking Water Act	This act establishes primary and secondary standards for drinking water systems.	All drinking water systems were in compliance with drinking water standards.
Toxic Substances Control Act	This act regulates industrial chemicals currently produced or imported into the United States.	The INEEL was in compliance with management of polychlorinated biphenyls in 2002.
Endangered Species Act	This act protects threatened and endangered species and provides a means to conserve their ecosystems. All federal agencies are to protect species and preserve their habitats.	INEEL activities complied with the requirements of this act. No threatened or endangered species were documented at the INEEL in 2002.

Table ES-1. Compliance with federal acts in 2002 (cont.).

Act	What it Addresses	2002 Activities
National Environmental Policy Act	This act requires federal agencies to consider and evaluate potential environmental impacts as a result of federal activities and requires the study of alternatives to mitigate those impacts.	The final Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement was issued in the fall of 2002.
Emergency Planning and Community Right-to-Know Act (EPCRA)	This act provides the public with information about hazardous chemicals and establishes emergency planning and notification procedures to protect the public from chemical releases.	The EPCRA Section 311 and 312 Reports were issued as required in 2002. The Toxic Chemical Release Inventory Report (313) was issued for five chemicals used on the INEEL.

The major objectives of the environmental monitoring programs conducted at the INEEL are to identify the key contaminants released to the environment, to evaluate different pathways through which contaminants move in the environment, and to determine the potential effects of these contaminants on the public and the environment. This is accomplished though sampling and analysis of air; surface, subsurface, and drinking water; soil; wildlife; and vegetation, as well as measurement of direct radiation. During 2002, the prime Management and Operating contractor at the INEEL, Bechtel BWXT Idaho, LLC was responsible for onsite environmental monitoring. The Environmental Surveillance, Education and Research (ESER) Program contractor, which was a team led by the S. M. Stoller Corporation, was responsible for offsite environmental monitoring.

In May 2002, DOE, the Idaho Department of Environmental Quality and the U.S. Environmental Protection Agency signed a letter of intent formalizing an agreement to pursue accelerated risk reduction and cleanup at the INEEL. The intent of accelerating the cleanup of the INEEL yields two significant objectives: (1) risk reduction and continued protection of the Snake River Plain Aquifer and (2) consolidation of Environmental Management activities and reinvestment of savings into cleanup. Nine strategic initiatives were developed around these two objectives to accelerate cleanup.

The Environmental Restoration Program continued progress during 2002 toward final cleanup of contaminated sites at the INEEL. Since the Federal Facility Agreement and Consent Order was signed in December 1991, 22 Records of Decision have been signed and are being implemented; three Remedial Investigation/Feasibility Studies are under development; and more than 70 percent of Comprehensive Environmental Response, Compensation, and Liability Act actions have been completed.

The overall goals of the Waste Management Program are to ensure that workers and the public are protected and the environment is not further impacted. The Waste Management Program provides management services for facility waste streams. The following tasks were accomplished during 2002:

- Seven Site Treatment Plan milestones were met.
- British Nuclear Fuels Limited, Inc. completed construction of the Advanced Mixed Waste Treatment facility in December 2002.
- Six underground tanks in the Idaho Nuclear Technology and Engineering Center Tank Farm have been emptied and one of the tanks as been cleaned to State-approved standards. This leaves only five more tanks to be emptied.
- Over 3988 m^3 (5216 yd^3) of low-level waste was disposed in 2002.
- The Transuranic Waste Program shipped 2075 m^3 (2680 yd^3) of transuranic waste to the Waste Isolation Pilot Plant in Carlsbad, New Mexico.
- The INEEL reported 38 pollution prevention projects, which resulted in a waste reduction of 13,906 metric tons (34,306 tons).

Environmental Monitoring Programs - Air (Chapter 4)

The INEEL environmental surveillance programs, conducted by the Management and Operating (M&O) contractor and the Environmental Surveillance, Education and Research (ESER) contractor, emphasize measurement of airborne radionuclides because air transport is considered the major potential pathway from INEEL releases to receptors. The M&O contractor monitors airborne effluents at individual INEEL facilities and ambient air outside the facilities to comply with appropriate regulations and DOE orders. The ESER contractor samples ambient air at locations within, around, and distant from the INEEL.

An estimated total of 10,442 Ci of radioactivity, primarily in the form of short-lived noble gas isotopes, was released as airborne effluents in 2002. Samples of airborne particulates, atmospheric moisture, and precipitation were analyzed for gross alpha and gross beta activity, as well as for specific radionuclides, primarily tritium, strontium-90, iodine-131, cesium-137, plutonium-239/240, and americium-241. All concentrations were well below regulatory standards and within historical measurements. Table ES-2 summarizes the results of radiological monitoring of environmental media, including air, sampled at INEEL boundary, onsite, and offsite locations.

Nonradiological pollutants, including nitrogen dioxide and particulates, were monitored at select locations around the INEEL. All results were well below regulatory standards.

Environmental Monitoring Programs - Water (Chapter 5)

One potential pathway for exposure (primarily to workers) to the contaminants released from the INEEL is through surface, drinking, and groundwater. The M&O contractor monitors liquid effluents, drinking water, groundwater, and storm water runoff at the INEEL to comply with applicable laws and regulations, DOE orders, and other requirements (e.g., Wastewater Land Application Permit [WLAP] requirements). Argonne National Laboratory West and the Naval Reactors Facility conduct their own WLAP and drinking water monitoring. The U.S. Geological Survey INEEL Project Office performs groundwater monitoring, analyses, and studies of the Snake River Plain Aquifer under and adjacent to the INEEL. This is done through an extensive network of strategically placed observation wells on the INEEL and at locations throughout the Eastern Snake River Plain. The ESER contractor monitors drinking water and surface water at offsite locations.

During 2002, liquid effluent and groundwater monitoring was conducted in support of WLAP requirements for INEEL facilities that generate liquid waste streams covered under WLAP rules. The WLAPs generally require compliance with the Idaho groundwater quality primary and secondary constituent standards in specified groundwater monitoring wells. The permits specify annual discharge volume and application rates and effluent quality limits. As required, an annual report was prepared and submitted to the Idaho Department of Environmental Quality. Additional parameters are also monitored in the effluent in support of surveillance activities. Most wastewater and groundwater regulatory and surveillance results were below applicable limits in 2002.

Samples from public water systems and wells continue to show measurable quantities of carbon tetrachloride at the Radioactive Waste Management Complex production well. The annual average of 2.88 µg/L was below the U.S. Environmental Protection Agency (EPA) established maximum contaminant level (MCL) of 5 µg/L. Trichloroethylene concentrations in samples from the Test Area North drinking water system during 2002 also remained below the MCL. Argonne National Laboratory-West and Naval Reactors Facility systems did not exceed any limits during 2002.

As required by the General Permit for storm water discharges from industrial activities, visual examinations were made and samples were collected from selected locations. Visual examinations showed no deficiencies. Total suspended solids, iron, magnesium, and chemical oxygen demand all exceeded benchmark levels in collected samples. All of these parameters have occurred above benchmark levels in the past. Examination of storm water flow paths showed no deficiencies in storm water protection.

Tritium and strontium-90 continue to be measured in the groundwater under the INEEL. Neither of these radionuclides has been detected off the INEEL since the mid-1980s. A maximum effective dose equivalent of 0.98 mrem/yr (9.8 µSv/yr), less than the 4 mrem/yr (40 µSv/yr) EPA standard for public drinking water systems, was calculated for workers at the Central Facilities Area on the INEEL in 2002.

Table ES-2. Boundary, onsite, and offsite radiological environmental monitoring results for 2002 (data from Chapters 3, 4, 5, and 6).

Media	Sample Type	Analysis	Results
Air	Charcoal cartridge	Radioiodine	Iodine-131 (^{131}I) was not detected in any individual charcoal cartridge collected.
	Particulate filter	Gross alpha and gross beta activity, gamma-emitting radionuclides, strontium-90 (^{90}Sr), americium-241, plutonium-238, and plutonium- 239/240	In general, gross alpha and gross beta activities show levels and seasonal variations not attributable to INEEL releases. Seven of the weekly gross beta results showed statistical differences between boundary and distant locations. In all cases the differences were attributed to natural variation or to inversion conditions. All measurements of specific radionuclides were well below the Derived Concentration Guide (DCG) for radiation protection and within historical results.
	Atmospheric moisture	Tritium	Tritium was detected in 34 of 44 samples. Measurements were well below the DCG and within historical concentrations.
	Precipitation	Tritium	Tritium was detected in 20 of 39 precipitation samples. Measurements were well below the DCG and within historical measurements made at the INEEL and within U.S. Environmental Protection Agency (EPA) Region 10 (ID, OR, WA, and AK) historical levels.
Water	Surface water	Gross alpha and gross beta activity and tritium	Gross alpha activity was not detected in any sample. Nine of 12 samples had measurable gross beta activity below the EPA screening level. Tritium was detected in two samples. The highest level measured was below the EPA Maximum Contaminant Level (MCL).
	Drinking water	Gross alpha and gross beta activity and tritium	Gross alpha activity was detected in one sample at a concentration below the EPA MCL. Gross beta activity was detected in all samples at levels within background levels and below the EPA screening level. Tritium was detected in three drinking water samples at levels well below the EPA MCL.
Agricultural products	Milk, lettuce, wheat, potatoes, and sheep	Gamma-emitting radionuclides and ^{90}Sr	Cesium-137 and ^{90}Sr were detected in samples at levels consistent with fallout. Iodine-131 was detected in one milk sample at a level below the DCG for water.

Table ES-2. Boundary, onsite, and offsite radiological environmental monitoring results for 2002 (cont.) (data from Chapters 3, 4, 5, and 6).

Media	Sample Type	Analysis	Results
Game animals	Ducks, mule deer, elk, and pronghorn	Gamma-emitting radionuclides, ^{90}Sr and specific actinides. Iodine-131 in deer, elk, and pronghorn thyroids	Cesium-137 was detected in muscle samples of mule deer, elk, and pronghorn at levels consistent with fallout. Human-made radionuclides were detected in at least one muscle tissue in 5 of 11 ducks collected from INEEL wastewater ponds. The potential dose from consumption of ducks with the highest concentrations was calculated to be 0.004 mrem (0.001 percent of 352 mrem from background sources).
Soil	Offsite soil composite samples	Gamma-emitting radionuclides, ^{90}Sr and the same actinides analyzed in particulate filters	Radionuclide concentrations detected in soils collected at boundary and distant locations were not statistically different and were consistent with historical measurements. The concentrations are most likely due to weapons testing fallout.
Radiation exposure	Thermoluminescent dosimeters	Gamma radiation	Exposures at boundary and distant locations using environmental dosimeters were similar and showed levels consistent with previous years and background.

Results from a number of special studies conducted by the U.S. Geological Survey of the properties of the aquifer were published during 2002. Several purgeable organic compounds continue to be found in monitoring wells, including drinking water wells at the INEEL. Concentrations of organic compounds were below the EPA MCLs for these compounds except for two wells at the Radioactive Waste Management Complex, where concentrations of carbon tetrachloride slightly exceeded the MCL during certain months (MCL is used for comparison only as the MCL applies only to the distribution system and not the source well).

Drinking water samples were collected from 14 locations off the INEEL and around the Snake River Plain in 2002. Only one sample had measurable gross alpha, three had measurable tritium, and all samples had measurable gross beta activity. None of the samples exceeded the EPA MCL for these constituents.

Offsite surface water was collected from five locations along the Snake River. Nine of 12 samples had measurable gross beta activity, while only two samples had measurable tritium. None of these constituents were above regulatory limits. Onsite sampling of surface water runoff for waste management purposes showed no values above regulatory limits.

Table ES-2 summarizes the results of radiological monitoring of environmental media, including water, collected at INEEL boundary, onsite, and offsite locations.

Environmental Monitoring Programs - Agriculture Products, Wildlife, Soil, and Direct Radiation (Chapter 6)

To help assess the impact of contaminants released to the environment by operations at the INEEL, agricultural products (milk, lettuce, wheat, potatoes, and sheep); wildlife; and soil were sampled and analyzed for radionuclides. In addition, direct radiation was measured on and off the INEEL in 2002.

Some human-made radionuclides were detected in agricultural product, wildlife, and soil samples. For the most part, the results could not be directly linked to operations at the INEEL. With the exception of americium-241 concentrations in soils collected at the Waste Experimental Reduction Facility (WERF), concentrations of radionuclides detected in samples were consistent with fallout levels from atmospheric weapons testing. The maximum levels for these radionuclides were all well below regulatory health-based limits for protection of human health and the environment.

Americium-241 was detected above background levels in soil samples collected around WERF. However, the concentrations were consistent with those measured historically and are attributable to past WERF operations and fallout.

Direct radiation measurements made at offsite, boundary and onsite locations (except RWMC) were consistent with background levels. Direct radiation measurements at the Radioactive Waste Management Complex were greater than background levels but consistent with those made historically.

Table ES-2 summarizes the results of radiological monitoring of environmental media, including biota and soil, collected at INEEL boundary and offsite locations.

Dose to the Public and to Biota (Chapter 7)

Potential radiological doses to the public from INEEL operations were evaluated to determine compliance with pertinent regulations and limits. Two different computer programs were used to estimate doses: CAP-88 computer code and the mesoscale diffusion (MDIFF) air dispersion model. CAP-88 is required by the EPA to demonstrate compliance with the Clean Air Act. The National Oceanic and Atmospheric Administration Air Resources Laboratory-Field Research Division developed MDIFF to evaluate dispersion of pollutants in arid environments such as those found at the INEEL. The maximum calculated dose to an individual by either of the methods was well below the applicable radiation protection standard of 10 mrem/yr. The dose to the maximally exposed individual, as determined by the CAP-88, program was 0.055 mrem (0.55 µSv). The dose calculated by the MDIFF program was 0.04 mrem (0.4 µSv). The maximum potential population dose to the approximately 238,250 people residing within an 80-km (50-mi) radius of any INEEL facility was 0.93 person-rem, well below that expected from exposure to background radiation.

Potential doses to members of the public are summarized in Table ES-3.

The maximum potential individual doses from consuming ducks, big game animals, and marmots at the INEEL, based on the highest concentrations of radionuclides measured in samples of these animals, were estimated to be 0.004 mrem (0.04 µSv),0.043 mrem (0.44 µSv), and 0.003 mrem (0.03 µSv), respectively. These estimates are conservatively high.

Doses were also evaluated using a graded approach for nonhuman biota at the INEEL. Based on this approach, there is no evidence that INEEL-related radioactivity in soil or water is harming populations of plants or animals.

Ecological Research at the Idaho National Environmental Research Park (Chapter 8)

The INEEL was designated as a National Environmental Research Park (NERP) in 1975. The NERP program was established in the 1970s in response to recommendations from citizens, scientists, and members of Congress to set aside land for ecosystem preservation and study. In many cases, these protected lands became the last remaining refuges of what were once extensive natural ecosystems. The NERPs provide rich environments to train researchers and introducing the public to ecological sciences. They have been used to educate grade school and high school students and the general public about ecosystem interactions at DOE sites; to train graduate and undergraduate students in research related to site-specific, regional, national, and global issues; and promote collaboration and coordination among local, regional, and national public organizations, schools, universities, and federal and state agencies

Ecological research at the INEEL began in 1950 with the establishment of the long-term vegetation transect. This is perhaps DOE's oldest ecological data set and one of the oldest

Table ES-3. Summary of annual effective dose equivalents due to INEEL operations (2002).

	Maximum Dose to an Individual [a]		Population Dose
	CAP-88[b]	MDIFF[c]	MDIFF
Dose	0.055 mrem 5.5×10^{-4} mSv	0.04 mrem 4.0×10^{-4} mSv	0.93 person-rem 9.3×10^{-3} person-Sv
Location	Frenchman's Cabin	8.7 km (5.5 mi) W-NW of Mud Lake	Area within 80 km (50 mi) of any INEEL facility
Applicable radiation protection standard [d]	10 mrem (0.1 mSv)	10 mrem (0.1 mSv)	No standard
Percentage of standard	0.55 percent	0.40 percent	-
Natural background	352 mrem (3.6 mSv)	352 mrem (3.6 mSv)	94.400 person-rem (944 person-Sv)
Percentage of background	0.02 percent	0.01 percent	0.001 percent

a. Hypothetical dose to a maximally exposed individual residing near the INEEL.

b. Effective dose equivalent calculated using the CAP-88 code.

c. Effective dose equivalent calculated using MDIFF air dispersion model. MDIFF calucations do not consider occupancy time or shielding by buildings.

d. Although the DOE standard for all exposure modes is 100 mrem/yr as given in DOE Order 5400.5, DOE guidance states that DOE facilities will comply with the EPA standard for the airborne pathway of 10 mrem/yr.

vegetation data sets in the West. Ecological research on the NERPs is leading to planning for better land use, identifying of sensitive areas on DOE sites so that restoration and other activities are compatible with ecosystem protection and management, and increasing contributions to ecological science in general.

The following ecological research projects took place at the Idaho NERP during 2002:

- Monitoring Amphibian and Reptile Populations on the INEEL;
- Behavior, Dispersal, and Survival of Captive-Raised Idaho Pygmy Rabbits Released onto the INEEL in Idaho;
- Alternative Container Design for Large Acreage Revegetation;
- Ecological Impacts of Irrigating Native Vegetation with Treated Sewage Wastewater;

- Natural and Assisted Recovery of Sagebrush in Idaho's Big Desert; and
- The Protective Cap/Biobarrier Experiment.

Quality Assurance (Chapter 9)

Quality assurance and quality control programs are maintained by contractors conducting environmental monitoring and by laboratories performing environmental analyses to ensure precise, accurate, representative, and reliable results and maximize data completeness. Data reported in this document were obtained from several commercial, university, government, and government contractor laboratories. To assure quality results, these laboratories participate in a number of laboratory quality check programs.

Laboratories used by the ESER Program met their quality assurance goals in 2002. A new issue concerning elevated tritium levels detected in atmospheric moisture samples analyzed at the Idaho State University Environmental Assessment Laboratory occurred during the latter half of the year. As of the end of 2002, the laboratory was investigating the possible cause for these elevated readings.

Quality issues that arose with laboratories used by the M&O contractor were addressed with the laboratory and resolved.

Helpful Information

Scientific Notiation

Scientific notation is used to express numbers that are very small or very large. A very small number is expressed with a negative exponent, for example, 1.3×10^{-6}. To convert this number to the decimal form, the decimal point must be moved left by the number of places equal to the exponent (6, in this case). The number, thus, becomes 0.0000013.

For large numbers, those with a positive exponent, the decimal point is moved to the right by the number of places equal to the exponent. The number 1,000,000 can be written as 1.0×10^{6}.

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 1000 of a given unit. One kilometer is, therefore, equal to 1000 meters. Other prefixes used in this report are listed Table P-1.

Table P-1. Unit prefixes used in this report.

Prefix	Abbreviation	Meaning
mega-	M	1,000,000 (1×10^{6})
kilo-	k	1000 (1×10^{3})
centi-	c	1/100 (1×10^{-2})
milli-	m	1/1000 (1×10^{-3})
micro-	µ	1/1,000,000 (1×10^{-6})
nano-	n	1/1,000,000,000 (1×10^{-9})
pico-	p	1/1,000,000,000,000 (1×10^{-12})

Units of Radioactivity, Radiation Exposure, and Dose

The basic unit of radioactivity used in this report is the curie (abbreviated Ci). The curie is historically based on the number of disintegrations that occur in 1 gram of the radionuclide radium-226, which is 37 billion nuclear disintegrations per second. For any other radionuclide, 1 Ci is the amount of the radionuclide that decays at this same rate.

Radiation exposure is expressed in terms of the roentgen (R), the amount of ionization produced by gamma radiation in air. Dose is given in units of roentgen equivalent man or rem, which takes into account the effect of radiation on tissues. For the types of environmental radiation generally encountered, the unit of roentgen is approximately numerically equal to the unit of rem. A person-rem is the sum of the doses received by all individuals in a population.

The concentration of radioactivity in air samples is expressed in units of microcuries per milliliter (µCi/mL) of air. For liquid samples, such as water and milk, the units are in picocuries per liter (pCi/L). Radioactivity in agricultural products is expressed in nanocuries per gram (nCi/g) dry weight. Annual human radiation exposure, measured by environmental dosimeters, is expressed in units of milliroentgens (mR). This is sometimes expressed in terms of dose as millirem (mrem), after being multiplied by an appropriate dose equivalent conversion factor.

The Système International is also used to express units of radioactivity and radiation dose. The basic unit of radioactivity is the becquerel (Bq), which is equivalent to 1 nuclear disintegration per second. The number of curies must be multiplied by 3.7 x 10^{10} to obtain the equivalent number of becquerels. Radiation dose may also be expressed using the Système International unit sievert (Sv), where 1 Sv equals 100 rem.

Uncertainty of Measurements

There is always an uncertainty associated with the measurement of environmental contaminants. For radioactivity, a major source of uncertainty is the inherent statistical nature of radioactive decay events, particularly at the low activity levels encountered in environmental samples. The uncertainty of a measurement is denoted by following the results with an uncertainty ("±") term. This report follows convention in reporting the uncertainty as a 95 percent confidence limit (or interval). That means there is 95 percent confidence that the real concentration in the sample lies somewhere between the measured concentration minus the uncertainty term and the measured concentration plus the uncertainty term.

Negative Numbers as Results

Negative values occur in radiation measurements when the measured result is less than a preestablished average background level for the particular counting system and procedure used. These values are reported as negative, rather than as “not detected” or “zero,” to better enable statistical analyses and observe trends or bias in the data.

Radionuclide Nomenclature

Radionuclides are frequently expressed with the one- or two-letter chemical symbol for the element. Radionuclides may have many different isotopes, which are shown by a superscript to the left of the symbol. This number is the atomic weight of the isotope (the number of protons and neutrons in the nucleus of the atom). Radionuclide symbols used in this report are shown in Table P-2.

Table P-2. Radionuclides and symbols used in this report.

Radionuclide	Symbol	Radionuclide	Symbol
Americium-241	^{241}Am	Plutonium-239/240	$^{239/240}$Pu
Antimony-125	^{125}Sb	Plutonium-240	^{240}Pu
Argon-41	^{41}Ar	Plutonium-241	^{241}Pu
Barium-137	^{137}Ba	Potassium-40	^{40}K
Carbon-14	^{14}C	Radium-226	^{226}Ra
Cesium-137	^{137}Cs	Radium-228	^{228}Ra
Cobalt-60	^{60}Co	Strontium-90	^{90}Sr
Europium-152	^{152}Eu	Tellurium-125m	^{125m}Te
Europium-154	^{154}Eu	Thorium-232	^{232}Th
Gallium-67	^{67}Ga	Tritium	^{3}H
Iodine-129	^{129}I	Uranium-234	^{234}U
Iodine-131	^{131}I	Uranium-238	^{238}U
Krypton-85	^{85}Kr	Xenon-133	^{133}Xe
Krypton-85m[a]	^{85m}Kr	Xenon-135	^{135}Xe
Niobium-95	^{95}Nb	Yttrium-90	^{90}Y
Plutonium-238	^{238}Pu	Zinc-65	^{65}Zn
Plutonium-239	^{239}Pu		

a. The letter 'm' after a number denotes a metastable (transitional isotope normally with very short half-lives) isotope.

Acronyms

AAO	Argonne Area Office (DOE-CH)
AEC	Atomic Energy Commission
ANL-W	Argonne National Laboratory-West
ANOVA	Analysis of Variance
ARA	Auxiliary Reactor Area
ASME	American Society of Mechanical Engineers
BBI	Bechtel Bettis, Inc
BBWI	Bechtel BWXT Idaho, LLC
BCG	Biota Concentration Guides
BNFL	British Nuclear Fuels Limited, Inc.
BORAX	Boiling Water Reactor Experiment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERT	Controlled Environmental Radioiodine Test
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CMS	Community Monitoring Station
CTF	Contained Test Facility
CWA	Clean Water Act
DCG	Derived Concentration Guide
DEQ	(Idaho) Department of Environmental Quality
DOE	U.S. Department of Energy
DOE-CH	U.S. Department of Energy Chicago Operations Office
DOE-HQ	U.S. Department of Energy Headquarters
DOE-ID	U.S. Department of Energy Idaho Operations Office
EA	Environmental Assessment

EAL	Environmental Assessment Laboratory
EBR-I	Experimental Breeder Reactor No. 1
ECF	Expended Core Facility
EDF	Experimental Dairy Farm
EFS	Experimental Field Station
EIS	Environmental Impact Statement
EM	Environmental Management
EML	Environmental Measurements Laboratory
EMS	Environmental Management System
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESER	Environmental Surveillance, Education and Research
ESRF	Environmental Science and Research Foundation
ET	Evapotranspiration
ETR	Engineering Test Facility
FAST	Fluorinel Dissolution Process and Fuel Storage Facility
FDF	Fluorinel Dissolution Facility
FFA/CO	Federal Facility Agreement and Consent Order
FR	Federal Register
GEM	Glovebox Excavation Method
ICPP	Idaho Chemical Processing Plant
IDAPA	Idaho Administrative Procedures Act
IFSF	Irradiated Fuel Storage Facility
IMPROVE	Interagency Monitoring of Protected Visual Environments
INEEL	Idaho National Engineering and Environmental Laboratory

INTEC — Idaho Nuclear Technology and Engineering Center (formerly the Idaho Chemical Processing Plant)

IRC — INEEL Research Center

ISFSI — Independent Spent Fuel Storage Installation

ISO — International Standards Organization

ISU — Idaho State University

LET&D — Liquid Effluent Treatment and Disposal (Facility)

LOFT — Loss-of-Fluid-Test

LTS — Long-Term Stewardship

M&O — Management and Operating

MCL — Maximum Contaminant Level

MDC — Minimum Detectable Concentration

MDIFF — Mesoscale Diffusion Model

MEI — Maximally Exposed Individual

MTHM — Metric Tons Heavy Metal

MTR — Materials Test Reactor

NCRP — National Council on Radiation Protection and Measurements

NEPA — National Environmental Policy Act

NERP — National Environmental Research Park

NESHAP — National Emission Standards for Hazardous Air Pollutants

NIST — National Institute of Standards and Technology

NOAA — National Oceanic and Atmospheric Administration

NOAA ARL-FRD — National Oceanic and Atmospheric Administration Air Resources Laboratory - Field Research Division

NOV — Notice of Violation

NPDES — National Pollutant Discharge Elimination System

NRC — U.S. Nuclear Regulatory Commission

NRF	Naval Reactors Facility
NRTS	National Reactor Testing Station
NWQL	National Water Quality Laboratory (USGS)
OU	Operable Unit
PBF	Power Burst Facility
PCB	Polychlorinated Biphenyls
PCBE	Protective Cap/Biobarrier Experiment
PCS	Primary Constituent Standard
PSD	Prevention of Significant Deterioration
PTC	Permit to Construct
RCRA	Resource Conservation and Recovery Act
RESL	Radiological and Environmental Sciences Laboratory
RI/FS	Remedial Investigation/ Feasibility Study
RML	Radiological Measurements Laboratory (INEEL)
ROD	Record of Decision
RWMC	Radioactive Waste Management Complex
SAR	Sodium Absorption Ratio
SCS	Secondary Constituent Standard
SDA	Subsurface Disposal Area
SMC	Specific Manufacturing Capability
SRPA	Snake River Plain Aquifer
STF	Security Training Facility
TAN	Test Area North
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TLD	Thermoluminescent Dosimeter

TRA	Test Reactor Area
TRU	Transuranic (waste)
TSA	Transuranic Storage Area
TSCA	Toxic Substances Control Act
TSF	Technical Support Facility
USGS	U.S. Geological Survey
WAG	Waste Area Group
WERF	Waste Experimental Reduction Facility
WIPP	Waste Isolation Pilot Plant
WLAP	Wastewater Land Application Permit
WMP	Waste Management Program
WROC	Waste Reduction Operations Complex
WRRTF	Water Reactor Research Test Facility

Units

Btu	British thermal unit	µCi	microcurie (10^{-6} curies)
Bq	becquerel	µg	microgram
cfm	cubic feet per minute	µm	micrometer
Ci	curie	µS	microsiemens
cm	centimeter	mmhos/cm	millimhos per centimeter
cpm	counts per minute	mR	milliroentgen
d	day	mrem	millirem
dl	detection limit	mSv	millisievert
dpm	disintegrations per minute	ng	nanogram
ft	feet	oz	ounce
g	gram	pCi	picocurie (10^{-12} curies)
gal	gallon	ppb	parts per billion
ha	hectare	qt	quart
hr	hour	rem	roentgen equivalent man
in.	inch	R	roentgen
KeV	kilo-electron-volts	sec	second
kg	kilogram	Sv	seivert
L	liter	x^2	unit squared
lb	pound	x^3	unit cubed
m	meter	yd	yard
mi	mile	yr	year
min	minute	<	lesser than
mL	milliliter	>	greater than

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Chapter 1 - Introduction

Chapter Highlights

The Atomic Energy Commission created what is now the Idaho National Engineering and Environmental Laboratory (INEEL) as the National Reactor Testing Station in 1949 as a site to build and test nuclear power reactors. The INEEL occupies approximately 2300 km^2 (890 mi^2) of the upper Snake River Plain in southeastern Idaho. Over the life of the INEEL, an assembly of 52 reactors, associated research centers, and waste handling areas have been constructed and tested.

The INEEL serves as a multi-program national laboratory that delivers science and engineering solutions to the world's environmental, energy, and security challenges in four core areas:

- Science-based, engineered solutions to challenges of the U.S. Department of Energy's (DOE's) mission areas, other federal agencies, and industrial clients.
- Completion of environmental cleanup at the INEEL.
- Enhancement of scientific and technical talent, facilities, and equipment to best serve national and regional interests.
- Leadership and support to the Environmental Management mission throughout the DOE complex.

There are nine primary facility areas and three smaller secondary facilities at the INEEL and in Idaho Falls. Seven of the nine primary facilities and the three secondary facilities are operated by the INEEL Management and Operating (M&O) Contractor Bechtel BWXT Idaho, LLC. The University of Chicago and Bechtel Bettis, Inc. operate the remaining two primary facilities at the INEEL.

Approximately 8000 people work at the INEEL, making it the largest employer in eastern Idaho and one of the top five employers in the State. The INEEL has a tremendous economic impact on eastern Idaho. The INEEL has infused more than $750 million dollars to the Idaho economy.

1. INTRODUCTION

This report presents the results and activities of organizations performing environmental monitoring on the INEEL and surrounding areas for calendar year 2002. Environmental monitoring results are transmitted to the DOE-ID and other government agencies. This Annual Site Environmental Report presents summary environmental data that:

(1) Characterize site environmental management performance including data on effluent releases, environmental monitoring, and estimates of radiological doses to the public associated with releases of radioactive material at the INEEL;

(2) Summarize any environmental occurrences and responses made that were reported during the calendar year;

(3) Confirm compliance with environmental standards and requirements; and

(4) Highlight significant programs and efforts, including environmental performance indicators and/or performance measures programs.

The INEEL is owned by DOE and administered through its Idaho Operations Office. The INEEL Site occupies approximately 2300 km^2 (890 mi^2) of the upper Snake River Plain in southeastern Idaho (Figure 1-1). It is roughly equidistant from Salt Lake City, Utah (328 km

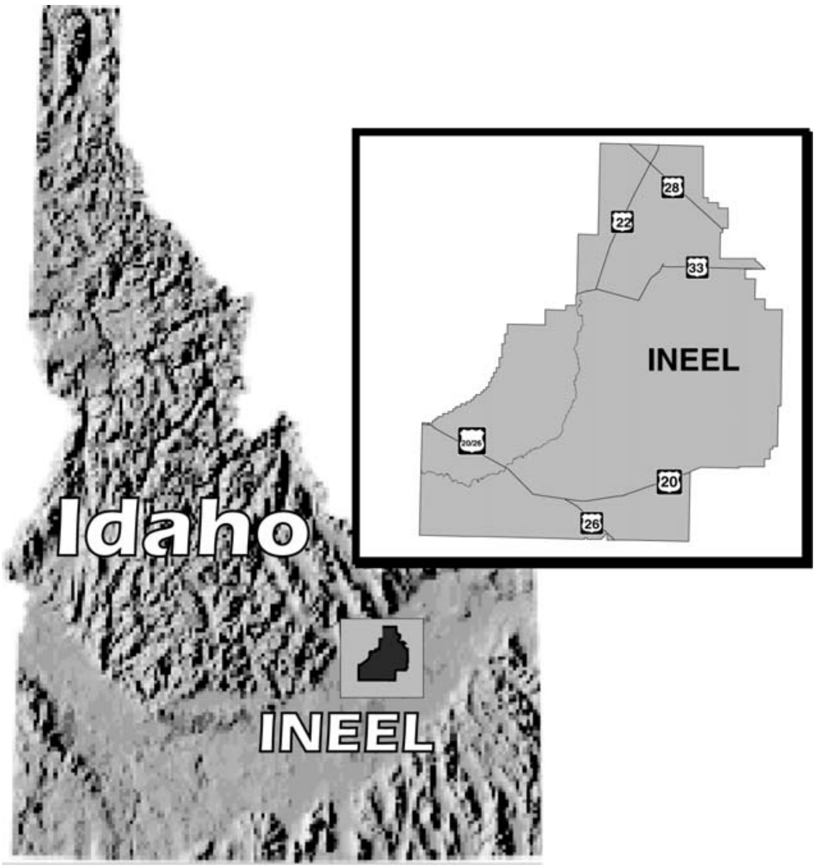


Figure 1-1. Location of the INEEL.

[203 mi]); Butte, Montana (380 km [236 mi]); and Boise, Idaho (450 km [280 mi]). The communities closest to the INEEL are Atomic City (population 25), Arco (population 1022), Howe (population 20), Monteview (population 10), Mud Lake (population 272), and Terreton (population 100). The larger population centers of Idaho Falls (population 51,096), Blackfoot (population 10,552), and Pocatello (population 51,242) are at least 35 km (22 mi) from the nearest INEEL boundary (Figure 1-2). Ten Idaho counties are located in part or entirely within 80 km (50 mi) of the INEEL (Figure 1-2). The INEEL includes portions of five counties (Bingham, Bonneville, Butte, Clark, and Jefferson).

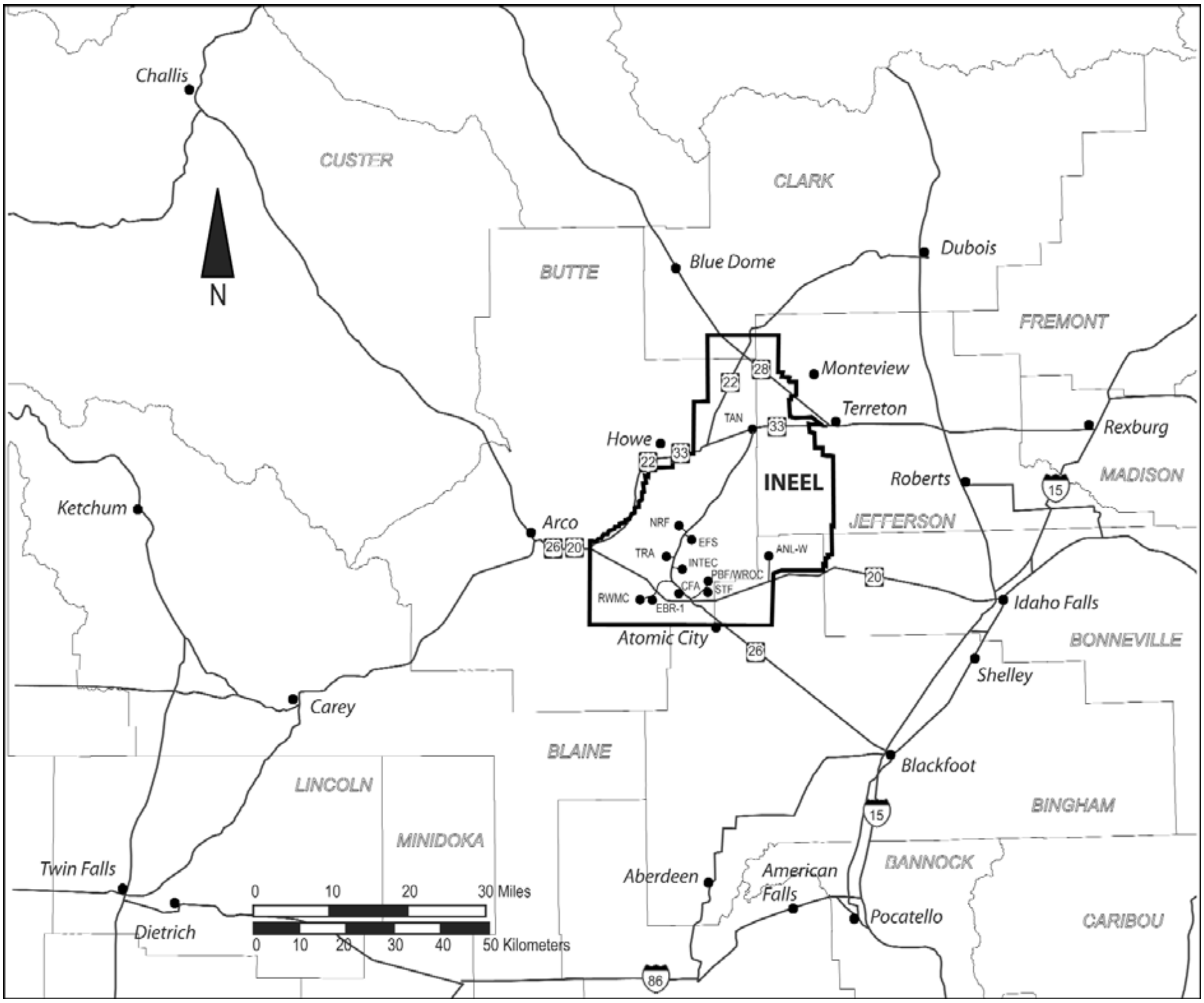


Figure 1-2. Map of the INEEL and surrounding area showing facilities, counties, and cities.

1.1 INEEL Mission and Facilities

The INEEL's vision is to serve as a multi-program national laboratory that delivers science and engineering solutions to the world's environmental, energy, and security challenges. The mission of the INEEL can be divided into four core areas:

- Deliver science-based, engineered solutions to the challenges of DOE's mission areas, other federal agencies, and industrial clients;

- Complete environmental cleanup responsibly and cost effectively using innovative science and engineering capabilities;

- Provide leadership and support to optimize the value of Environmental Management (EM) investments and strategic partnerships throughout the DOE complex; and

- Enhance scientific and technical talent, facilities, and equipment to best serve national and regional interests (INEEL Mission/Vision 2001).

Over the years, various Management and Operating (M&O) contractors have operated the INEEL. During 2002, the INEEL M&O contractor was Bechtel BWXT Idaho, LLC (BBWI). The University of Chicago's Argonne National Laboratory and Bechtel Bettis, Inc. (BBI) operate other facilities. The INEEL operates facilities at the Site and in Idaho Falls, Idaho. There are nine primary facility areas and three smaller secondary facilities at the INEEL and in Idaho Falls (Figure 1-2). These facility areas are described below.

Argonne National Laboratory-West

Argonne National Laboratory-West (ANL-W) is the prime testing center in the United States for demonstration and proof-of-concept of nuclear energy technologies. Research is focused on areas of national concern relating to energy, nuclear safety, nonproliferation, decommissioning and decontamination, and remote handling of nuclear materials. The University of Chicago operates ANL-W for the DOE Chicago Operations Office (DOE-CH). The DOE-CH Argonne Area Office (AAO) oversees local operations.

Central Facilities Area

The Central Facilities Area (CFA) provides centralized support for the INEEL, including administrative offices, research laboratories, medical services, warehouses, crafts, vehicle support, and a cafeteria.

Idaho Falls Facilities

Idaho Falls facilities include the INEEL Research Center (IRC), where researchers conduct fundamental and applied research in science and engineering areas crucial to DOE's national missions. Additional support personnel for the facilities at the INEEL are housed at the Willow Creek Building, Engineering Research Office Building, two DOE buildings, and other office buildings.

Idaho Nuclear Technology and Engineering Center

The primary mission of the Idaho Nuclear Technology and Engineering Center (INTEC) is to safely store spent nuclear fuel and prepare it for shipment to an offsite repository. The facility also develops technology for the safe treatment of high-level liquid radioactive wastes and remediates past environmental releases.

Naval Reactors Facility

The Naval Reactors Facility (NRF) is operated for the U.S. Naval Nuclear Propulsion Program by Bechtel Bettis, Inc. (BBI), Bettis Atomic Power Laboratory-Idaho. Developmental nuclear fuel material samples, naval spent fuel and irradiated reactor plant components/materials are examined at the Expended Core Facility (ECF). The knowledge gained from these examinations is used to improve current reactor designs and to monitor the performance of existing reactors. The naval spent fuel examined at ECF is critical to the design of longer-lived cores, which minimizes the creation of spent fuel requiring long-term disposition. NRF is also preparing the current inventory of naval fuel for dry storage and eventual transportation to a repository.

Radioactive Waste Management Complex

The Radioactive Waste Management Complex (RWMC) manages solid transuranic and low-level radioactive waste. The facility supports research projects dealing with waste retrieval and processing technology and provides temporary storage and treatment of transuranic waste destined for the Waste Isolation Pilot Plant (WIPP) in New Mexico. British Nuclear Fuels Limited, Inc. (BNFL) is conducting the Advanced Mixed Waste Treatment Project which will retrieve mixed transuranic waste in temporary storage, treat the waste to meet disposal criteria, and package the waste for shipment to WIPP.

Test Area North

Located at the north end of the INEEL, Test Area North (TAN) was originally built to house the nuclear powered airplane project during the 1950s. Currently, the TAN facilities support two projects. The Specific Manufacturing Capability (SMC) Project produces protective armor for military vehicles. TAN personnel are also researching technologies for the cleanup of environmental contamination from prior operations. This research includes such alternatives as a biological remediation technique for destroying organic solvents in groundwater.

Test Reactor Area

The Test Reactor Area (TRA) is dedicated to nuclear technology research. The Advanced Test Reactor is used to study the effects of radiation on materials, test nuclear fuels, and produce rare and valuable medical and industrial isotopes.

Power Burst Facility/Waste Reduction Operations Complex

The Power Burst Facility and Waste Reduction Operations Complex (PBF/WROC) provide for the safe treatment, storage, and recycling of the INEEL's mixed and low-level radioactive wastes.

The following sections describe the three secondary facilities at the INEEL.

Experimental Breeder Reactor No. 1

The Experimental Breeder Reactor No. 1 (EBR-I) is a Registered National Historic Landmark located at the INEEL off U.S. Highway 20/26.

At 1:50 p.m., on December 20, 1951, the first usable amount of electricity from a nuclear power reactor was generated. EBR-I's real mission was not to show that electricity could be generated by a nuclear reactor, but it was to determine whether scientists' theoretical calculations on fuel breeding could actually be achieved.

Experimental Field Station

The Experimental Field Station (EFS), first called the Experimental Dairy Farm (EDF), was established to conduct Controlled Environmental Radioiodine Tests (CERTs). The first CERT at EDF was conducted on September 2, 1964. The CERTs at EDF ended in 1970. The EFS was established in 1973 as a major environmental monitoring site with high- and low-volume air samplers. Since that time, the EFS has served as a field station for various experiments, the longest running being the Protective Cap/Biobarrier Experiment (see Chapter 8).

Security Training Facility

The Security Training Facility (STF) area has been used since 1983 for security force practice maneuvers, including small arms target practice in a berm approximately 76 m (250 ft) northeast of the former STF-601 building. The berm was used from approximately 1983 to 1990.

1.2 Physical Setting of the INEEL

The INEEL is located in a large, relatively undisturbed expanse of sagebrush steppe habitat. Approximately 94 percent of the land on the INEEL is open and undeveloped. The Site has an average elevation of 1500 m (4900 ft) above sea level, and it is bordered on the north and west by mountain ranges and on the south by volcanic buttes and open plain (Figure 1-1). Lands immediately adjacent to the INEEL are open rangeland, foothills, or agricultural fields. Agricultural activity is concentrated in areas northeast of the INEEL. Sixty percent of the INEEL is open to livestock grazing.

The climate of the high desert environment of the INEEL is characterized by sparse precipitation (less than 22.8 cm/yr [9 in./yr]), hot summers (average daily temperature of 15.7°C

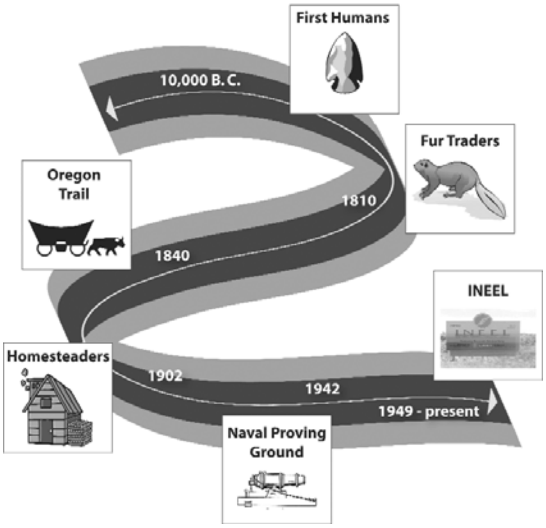
[60.3°F]), and cold winters (average daily temperature of -5.2°C [22.6°F]) (DOE-ID 1989). The altitude, intermountain setting, and latitude of the INEEL combine to produce a semiarid climate. Prevailing weather patterns are from the southwest, moving up the Snake River Plain. Air masses, which gather moisture over the Pacific Ocean, traverse several hundred miles of mountainous terrain before reaching southeastern Idaho. The result is frequently dry air and little cloud cover. Solar heating can be intense with extreme day-to-night temperature fluctuations.

Basalt flows, which produce a rolling topography, cover most of the plain. Vegetation is visually dominated by big sagebrush (*Artemisia tridentata*). Beneath these shrubs are grasses and flowering plants, most adapted to the harsh climate. A recent inventory counted 409 plant species on the INEEL (Anderson et al. 1996). Vertebrate animals found on the INEEL include small burrowing mammals, snakes, birds, and several game species. Published species counts include six fishes, one amphibian, nine reptiles, 164 birds, and 39 mammals (Reynolds et al. 1986).

The Big Lost River on the INEEL flows toward the northeast, ending in a playa area on the northwest portion of the Site. There it evaporates or infiltrates into the subsurface. Surface water does not move offsite. The fractured volcanic rocks under the INEEL, however, form a portion of the eastern Snake River Plain Aquifer, which stretches 267 km (165 mi) from St. Anthony to Bliss, Idaho, and stores one of the most bountiful supplies of groundwater in the nation. An estimated 200 to 300 million acre-ft of water is stored in the aquifer's upper portions. The aquifer is primarily recharged from waters of the Henry's Fork and the South Fork of the Snake River, as well as the Big Lost River, the Little Lost River, Birch Creek, and irrigation. Beneath the INEEL, the aquifer moves laterally to the southwest at a rate of 1.5 to 6 m/d (5 to 20 ft/d) (Lindholm 1996). The Snake River Plain Aquifer emerges in springs along the Snake River between Milner and Bliss, Idaho. The primary use of both surface water and groundwater on the Snake River Plain is crop irrigation.

1.3 History of the INEEL

The geologic events that have shaped the modern Snake River Plain on and near the INEEL took place during the last 2 million years (Lindholm 1996, ESRF 1996). The plain, which arcs from far eastern Oregon across southern Idaho to Yellowstone National Park, marks the passage of the earth's crust over a plume of melted mantle material pressing upward. The resultant rhyolite volcanics are oldest in the western portion of the Snake River Plain and youngest on the Yellowstone Plateau, which overlies the thermal plume today. The plain is a 640-km (400-mi) trail made by the passage of the continent over this hot spot. The basalts that are visible on much of the plain today are younger than the rhyolites they cover. However, many of the rhyolite buttes have pushed up through the overlying basalts and are, therefore, younger than the basalts. The flat basalt cap on Middle Butte is a good illustration of this process.



Humans first appeared on the Upper Snake River Plain approximately 11,000 years ago, likely descendants of people who crossed the Bering Strait land bridge. Tools recovered from this period indicate these earliest human inhabitants were almost certainly hunters of large game. The ancestors of the present-day Shoshone and Bannock people came north from the Great Basin around 4500 years ago (ESRF 1996).

The earliest exploratory visits by European descendants came between 1810 and 1840. Trappers and fur traders were some of the first to make their way across the plain seeking new supplies of beavers for pelts. Between 1840, by which time the fur trade was essentially over, and 1857, an estimated 240,000 immigrants passed through southern Idaho on the Oregon Trail. By 1868, treaties had been signed forcing the native populations onto the reservation at Fort Hall. The 1870s saw miners entering the surrounding mountains, followed by ranchers grazing cattle and sheep in the valleys.

A railroad was opened between Blackfoot and Arco, Idaho, in 1901. By this time, a series of acts (the Homestead Act of 1862, the Desert Claim Act of 1877, the Carey Act of 1894, and the Reclamation Act of 1902) provided sufficient incentive for homesteaders to attempt to build diversionary canals to claim the desert. Most of these canal efforts failed due to 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 Station in Pocatello, Idaho. These guns needed to be tested, and the nearby uninhabited plain was put to use as a gunnery range, then known as the Naval Proving Ground. The Army Air Corps also used the area as a bombing range.

After the war ended, the nation turned to the peaceful uses of atomic power. DOE's predecessor, the Atomic Energy Commission (AEC) needed an isolated location with an ample groundwater supply on which to build and test nuclear power reactors. The relatively isolated Snake River Plain was chosen as the best location. The Naval Proving Ground, thus, became the National Reactor Testing Station (NRTS) in 1949.

By the end of 1951, a reactor at the NRTS (EBR-I) became the first to produce useful electricity. The Site evolved into an assembly of 52 reactors, associated research centers, and waste handling areas. The NRTS was renamed the Idaho National Engineering Laboratory in 1974 and Idaho National Engineering and Environmental Laboratory in January 1997. The AEC was renamed the Energy Research and Development Administration in 1975 and reorganized to the present-day DOE in 1977.

1.4 Regional Economic Impact

Approximately 8000 people work at the INEEL, making it the largest employer in eastern Idaho and one of the top five employers in the State. This number includes about 400 federal employees and 7600 contractor employees.

The INEEL has infused more than $750 million dollars to the Idaho economy through the purchase of goods and services, corporately funded economic development, and contributions to State and local tax base.

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Chapter 2 - Environmental Compliance Summary

Chapter Highlights

Operations at the Idaho National Engineering and Environmental Laboratory (INEEL) are subject to numerous federal and state environmental statutes, executive orders, and U.S. Department of Energy (DOE) orders. As a requirement of many of these regulations, the status of compliance with the regulations and releases of nonpermitted hazardous materials to the environment must be documented. Overall, the INEEL met all its regulatory commitments in 2002 and programs are in place to address areas for continued improvement.

The following are highlights of accomplishments and actions in 2002:

- Under a Federal Facility Agreement/Consent Order (FFA/CO), the INEEL was divided into ten Waste Area Groups containing 25 operable units, which are areas with similar contamination grouped within a single Record of Decision. INEEL completed 22 investigations by the end of 2002. Thirteen of 14 FFA/CO enforceable milestones were met in 2002. The total number of remediated operable units at the end of 2002 was 11. INEEL continues to make progress on remedial actions at ten other operable units.
- The Idaho Department of Environmental Quality (DEQ) conducted a Resource Conservation and Recovery Act inspection at the INEEL on October 7, 2002. Four noncompliances were observed during the inspection. Idaho DEQ issued a warning letter after determining the noncompliances could be corrected without a consent order.
- The new Idaho Nuclear Technology and Engineering Center percolation ponds went into operation in August 2002, replacing the old ponds as required by the Comprehensive Environmental Response, Compensation, and Liability Act Operable Unit 3-13 Record of Decision. Idaho DEQ issued a revised Wastewater Land Application Permit for the new ponds.
- DOE-ID submitted the *2002 INEEL National Emission Standards for Hazardous Air Pollutants-Radionuclides* report to U.S. Environmental Protection Agency (EPA), DOE Headquarters, and state of Idaho officials in June 2003, in compliance with the Clean Air Act.

2. ENVIRONMENTAL COMPLIANCE SUMMARY

This chapter reports the regulatory compliance status of the INEEL, documents any releases of nonpermitted hazardous materials to the environment, and summarizes the permits issued to the INEEL that are required under specific environmental protection regulations. Section 2.1 discusses the compliance status of the INEEL with respect to major environmental acts, agreements, and orders. Section 2.2 discusses environmental occurrences, which are nonpermitted releases that require notification of a regulatory agency outside of the DOE. Section 2.3 presents a summary of environmental permits for the INEEL Site. The programs in place to attain compliance with major acts, agreements, and orders are discussed in Chapter 3.

2.1 Compliance Status

Operations at the INEEL are subject to numerous federal and state environmental statutes, executive orders, and DOE orders. These are listed in Appendix A. This section presents a brief summary of the INEEL's compliance status with those regulations. Table 2-1 shows how the discussion is organized.

Table 2-1. Environmental compliance statutes and orders.

Activity	Governing Statute or Order
Radiation Protection	DOE Order 5400.1, "General Environmental Protection Program"
	DOE Order 5400.5, "Radiation Protection of the Public and the Environment"
Environmental Remediation and Protection	Comprehensive Environmental Response, Compensation, and Liability Act
	Emergency Planning and Community Right-to-Know Act
	National Environmental Policy Act
	Endangered Species Act
	Executive Order 11988 – Floodplain Management
	Executive Order 11990 – Protection of Wetlands
Waste Management	Resource Conservation and Recovery Act
	Federal Facility Compliance Act
	Toxic Substances Control Act
	DOE Order 435.1, "Radioactive Waste Management"
	State of Idaho Wastewater Land Application Permits
	Idaho Settlement Agreement
Air Quality and Protection	Clean Air Act
Water Quality and Protection	Clean Water Act
	Safe Drinking Water Act
Cultural Resources	National Historic Preservation Act
	Native American Graves Protection and Repatriation Act

DOE Order 5400.1, "General Environmental Protection Program"

This Order requires that DOE sites conduct an environmental monitoring program. Program requirements, authorities, and responsibilities for assuring compliance with applicable federal, state, and internal DOE policies are established by the Order. The Order also establishes requirements for notification and followup of environmental occurrences and for routine reporting, including the annual site environmental report.

Section 3.1 describes the INEEL monitoring programs conducted to comply with DOE Order 5400.1.

The site environmental report for calendar year 2002 satisfies the Order's annual site environmental report requirement.

DOE Order 5400.5, "Radiation Protection of the Public and the Environment"

This Order establishes standards and requirements for operations of DOE sites with respect to protection of members of the public and the environment against undue risk from radiation. The standards and guides provided by DOE Order 5400.5 are presented in Appendix A. Concentrations of radionuclides measured by the INEEL environmental programs in 2002 were well below concentration guides established by this Order (see Chapters 4, 5, and 6). Potential doses to members of the public in the vicinity of the INEEL were also estimated to be well below the dose limits established by this Order (see Chapter 7).

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides specific procedures to assess and remediate areas where the release of hazardous substances has occurred. Nuclear research and other operations at the INEEL left behind contaminants that pose a potential risk to human health and the environment. The INEEL was placed on the National Priorities List under CERCLA on November 29, 1989. The Management and Operating (M&O) contractor’s Environmental Restoration Program in accordance with the Federal Facility Agreement and Consent Order (FFA/CO) is conducting environmental restoration activities at the INEEL. The DOE Idaho Operations Office (DOE-ID), the state of Idaho, and the U.S. Environmental Protection Agency (EPA) Region 10 signed the FFA/CO in December 1991. Activities performed by the Environmental Restoration Program are discussed in Chapter 3. Program achievements made in 2002 are summarized below.

Field investigations are used to evaluate potential release sites when existing data are insufficient to indicate that a site needs no further action or where limited field data collection is necessary. After each investigation is completed, a determination is made whether a no further action listing is possible or if it is appropriate to proceed with an interim remedial action or further investigation using a remedial investigation/feasibility study (RI/FS). Results from the RI/FS form the basis for assessment of risks and alternative cleanup actions. After reviewing public comments, DOE-ID, EPA, and the State reach a final decision, which is documented in a Record of Decision (ROD). Cleanup activities then can be designed, implemented, and completed.

The INEEL is divided into ten Waste Area Groups (WAGs) containing 25 areas for conducting environmental investigations. By the end of 2002, 22 investigations were complete. The remaining investigations to be completed include:

- Buried waste at the Radioactive Waste Management Complex (RWMC);
- Soil and groundwater contamination at the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm;
- Snake River Plain Aquifer contamination from the INEEL; and
- Soil contaminated outside facility areas.

Thirteen of 14 FFA/CO enforceable milestones were met in 2002. The 14th milestone is associated with WAG 3 (INTEC) and is discussed further in Chapter 3, Section 3.3. Eleven areas were cleaned up by the end of 2002. Cleanup actions are in progress at ten other areas.

Natural Resource Trusteeship and Natural Resources Damage Assessment - Executive Order 12580, Section 2(d), appoints the Secretary of Energy as the primary Federal Natural Resource Trustee for natural resources located on, over, and under land administered by DOE. Natural resource trustees act on behalf of the public when natural resources may be injured, destroyed, lost, or threatened as a result of the release of hazardous substances. In the case of the INEEL, other natural resource trustees with jurisdiction over trust resources are the state of Idaho and the U.S. Department of Interior (Bureau of Land Management and the U.S. Fish and Wildlife Service).

Past releases of hazardous substances resulted in the INEEL's placement on the National Priorities List. These same releases created the potential for injury to natural resources. DOE is liable under CERCLA for damages to natural resources resulting from releases of hazardous substances to the environment.

Although the ecological risk assessment is a separate effort from the Natural Resources Damage Assessment, it is anticipated that the ecological assessment performed for CERCLA remedial actions can be used to help resolve natural resource issues. Executive Order 12580 allows for this substitution. Ecological risk assessments at the INEEL have been conducted using the established guidance manual for conducting screening level ecological risk assessments (Van Horn et al. 1995).

Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Act (EPCRA) provides the public with information about hazardous chemicals at a facility (such as the INEEL) and establishes emergency planning and notification procedures to protect the public from chemical releases. EPCRA also contains requirements for periodic reporting on hazardous chemicals stored and/or used at a facility. Executive Order 13148, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, requires all federal facilities to comply with the provisions of EPCRA.

311 Report - EPCRA Section 311 reports were submitted quarterly for those chemicals that met the reporting threshold. These reports were sent to local emergency planning committees, the State Emergency Response Commission, and to local fire departments for each quarter in calendar year 2002. These quarterly reports satisfied the 90-day notice requirement for new chemicals brought onsite.

312 Report - Local and State planning and response agencies received the Emergency and Hazardous Chemical Inventory (Tier II) Report for 2002 by March 1, 2003. This report identified the types, quantities, and locations of hazardous and extremely hazardous chemicals stored at INEEL facilities that exceeded

- 10,000 pounds (for Occupational Safety and Health Act hazardous chemicals);
- 500 pounds (for Extremely Hazardous Substances as defined in Title 40 Code of Federal Regulations, Part 355 [40 CFR 355]); or
- the Threshold Planning Quantity, whichever is less.

313 Report - The Toxic Chemical Release Inventory Report was transmitted to the EPA and the state of Idaho by July 1, 2003. The report identifies quantities of 313-listed toxic chemicals available on the INEEL that exceeded a manufacturing, processed or otherwise used threshold, as defined in regulations. Once the threshold exceeded an EPA Form R report must be completed for each specific chemical. These reports describe how the chemical is released to the environment. Releases under EPCRA reporting include transfers to offsite waste storage and treatment facilities, air emissions, recycling, and other activities. Five reports were prepared at the INEEL during 2002 for toluene, ethyl benzene, lead, nitric acid, and polycyclic aromatic compounds. The 313 reports vary year-to-year depending upon the chemical processes at the Site.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to consider and analyze potential environmental impacts of proposed actions and explore appropriate alternatives to mitigate those impacts, including a "no action" alternative. Agencies are required to inform the public of the proposed actions, impacts, and alternatives and consider public feedback in selecting an alternative. DOE implements NEPA according to procedures in 10 Code of Federal Regulations (CFR) 1021 and assigns authorities and responsibilities according to DOE Order 451.1B, "National Environmental Policy Act Compliance Program." Processes specific to DOE-ID are set forth in its NEPA Planning and Compliance Program Manual (DOE-ID 2002). The DOE-ID NEPA Compliance Officer and NEPA Planning Board implement the process.

The DOE-ID issued the Annual NEPA Planning Summary in January 2003. This summary is a requirement of DOE Order 451.1B, and it is prepared to inform the public and other DOE elements of:

- The status of ongoing NEPA compliance activities;
- Environmental assessments (EAs) expected to be prepared in the next 12 months;
- Environmental impact statements (EISs) expected to be prepared in the next 24 months; and
- The planned cost and schedule for completion of each NEPA review identified.

The Annual NEPA Planning Summary can be accessed on the INEEL web page at http://www.inel.gov/publicdocuments/. Ongoing NEPA reviews of INEEL projects are described below.

Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement - This EIS evaluates potential environmental impacts of various alternatives for treating and managing high-level radioactive waste and related radioactive wastes and facilities at the INTEC. DOE received and considered agency and public comments on the draft EIS. In response to those comments and updated information, DOE incorporated changes into the final EIS. The final EIS was issued in the fall of 2002.

In the final EIS, the state of Idaho (a cooperating agency) and DOE identified separate preferred alternatives for waste treatment but identified the same preferred alternative for facilities disposition. The State identified vitrification as its preferred waste treatment alternative, while DOE's preferred alternative is to select from among the options and technologies or one represented by those analyzed in the EIS. The selection would be based on performance factors such as demonstration-scale test data, technical maturity, cost and schedule, ability to meet compliance dates, and public input. A phased decision-making process will be used to implement the proposed action and its preferred alternative. The technology selection phase will focus on four technologies analyzed in the EIS for implementation: calcination, steam reforming, cesium ion extraction, and evaporation to dryness.

The process will involve more than one ROD. The first ROD is anticipated to be issued in 2004, and it will describe the phased decision-making process and schedule, decide on actions such as closure of high-level waste tanks, and describe the public involvement and evaluation processes that will be used in selecting and implementing a treatment technology.

Wildland Fire Management Plan Environmental Assessment - In January 2001, the DOE-ID manager signed a determination to prepare an EA to evaluate pre-fire planning, fire response, and post-fire restoration alternatives. Actions to be analyzed include firebreak construction and maintenance, dust suppression, habitat rehabilitation, and impacts on cultural resources. The draft EA was made available for public review and comment in the fall of 2002. DOE has considered public comments on the draft EA and is in the process of completing the final EA.

Endangered Species Act

The Endangered Species Act provides a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, provides a program for the conservation of such endangered species and threatened species, and takes such steps as may be appropriate to achieve the purposes of the international treaties and conventions on threatened and endangered species. It requires that all federal departments and agencies shall seek to conserve endangered species and threatened species and shall use their authorities in furtherance of the purposes of this act.

Ecological research, field surveys, and NEPA evaluations regarding ecological resources on the INEEL are conducted by the Environmental Surveillance, Education and Research Program (see Chapter 8). Particular emphasis is given to threatened and endangered species and species of special concern identified by the U.S. Fish and Wildlife Service and Idaho Fish and Game Department.

Two federally protected species may occasionally spend time on the INEEL: the threatened Bald eagle (*Haliaeetus leucocephalus*) and the Gray wolf (*Canis lupus*). Gray wolves found in the geographical region that includes the INEEL are identified as an experimental/nonessential population and treated as a threatened species. Bald eagles occasionally winter on part of the INEEL, and there have been unsubstantiated sightings of Gray wolves. Research and monitoring continued on several species of special biological, economic, and social concern, including Townsend's big-eared bat (*Corynorhinus townsendii*), sage grouse (*Centrocercus urophasianus*), elk (*Cervus elaphus*), and pronghorn antelope (*Antilocapra americana*).

Executive Order 11988 - Floodplain Management

Executive Order 11988 - Floodplain Management requires each federal agency to issue or amend existing regulations and procedures to ensure that the potential effects of any action it may take in a floodplain are evaluated and that its planning programs and budget requests reflect consideration of flood hazards and floodplain management. It is the intent of this Executive Order that federal agencies implement floodplain requirements through existing procedures such as those established to implement NEPA. The Code of Federal Regulations (10 CFR 1022) contains DOE policy and floodplain environmental review and assessment requirements through the applicable NEPA procedures (10 CFR 1022). In those instances where impacts of actions in floodplains are not significant enough to require the preparation of an EIS under NEPA, alternative floodplain evaluation requirements are established through the INEEL environmental checklist process.

For the Big Lost River, DOE-ID has directed that all proposed actions be reviewed to identify their location relative to the elevation of the 100-year flood indicated in *Flood Routing Analysis for a Failure of Mackay Dam* for purposes of the NEPA compliance (Koslow and VanHaaften 1986). This analysis involved a 100-year flood in conjuction with the Mackay Dam failure. This direction is considered to be interim and remains in effect until DOE-ID issues a final determination of the 100- and 500-year Big Lost River flood elevations. The project to delineate the Big Lost River 100-year through 10,000-year floodplains using geomorphological models to characterize and estimate the frequency and magnitude of Big Lost River floods on the INEEL continued through 2002. One 30-m (100-ft) and three 3-m (10-ft) trenches were dug to a depth of 1.5 m (5 ft) alongside the Big Lost River in order to expose the geologic record of flooding at the INEEL from the river. The appearance of the trench walls indicates the data obtained at this site will compliment data from other sites adjacent to the river and contribute to reduction in INEEL flood hazard uncertainties. Geologic characterization of the trenches was completed in the fall of 2002, but the trenches are to remain open for about a year to facilitate peer review and flood hazard characterization data and interpretations.

For facilities at Test Area North (TAN), the 100-year floodplain has been delineated in a USGS report (USGS 1997).

Other regulatory requirements for floodplain management include 40 CFR 264, Subpart B, and 40 CFR 761, Subpart D (40 CFR 264 2002, 40 CFR 761 2002). The 40 CFR 264, Subpart B, statute requires hazardous waste storage, treatment, and disposal facilities located in the 100-year floodplain to be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood. The 40 CFR 761, Subpart D, statute requires that any facilities used for storage of polychlorinated biphenyls (PCBs) and PCB items designated for disposal shall not be located at a site that is below the 100-year flood water elevation.

The Resource Conservation and Recovery Act Part B permit for the RWMC required submittal of updated floodplain information to the DEQ. A hydrologic study was conducted to identify the 100-year overland floodplain boundary for the hazardous waste management units at the RWMC, and it concluded they are not within the 100-year floodplain. A report of the study results was submitted to Idaho DEQ in April 2002.

Executive Order 11990 - Protection of Wetlands

Executive Order 11990 - Protection of Wetlands requires each federal agency to issue or amend existing regulations and procedures to ensure wetlands are protected in decision-making. It is the intent of this Executive Order that federal agencies implement wetland requirements through existing procedures such as those established to implement NEPA. Title 10, Part 1022 of the CFR contains DOE policy and wetland environmental review and assessment requirements through the applicable NEPA procedures. In those instances where impacts of actions in wetlands are not significant enough to require the preparation of an EIS under NEPA, alternative wetland evaluation requirements are established through the INEEL environmental checklist process. Activities in wetlands considered waters of the United States or adjacent to waters of the United States may also be subject to the jurisdiction of Section 404 and 402 of the Clean Water Act.

An area of the INEEL identified as a potential jurisdictional wetlands is the Big Lost River Sinks. The U.S. Fish and Wildlife Service National Wetlands Inventory map is used to identify potential jurisdictional wetlands and nonregulated sites with ecological, environmental, and future development significance. In 2002, no actions took place or had an impact on jurisdictional wetlands on the Site, and, to date, no future actions are planned that would impact wetlands. However, private parties do conduct cattle grazing in the Big Lost River Sinks area under Bureau of Land Management permits.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) established regulatory standards for the generation, transportation, storage, treatment, and disposal of hazardous waste. The Idaho DEQ is authorized by EPA to regulate hazardous waste and the hazardous component of mixed waste at the INEEL. Mixed waste contains both radioactive and hazardous materials. The Atomic Energy Act, as administered through DOE orders, regulates radioactive wastes and the radioactive part of mixed wastes.

Idaho DEQ has issued one RCRA Part A permit for the INEEL and seven Part B permits. Five additional Part B permits are pending. DOE, Bechtel BWXT Idaho, LLC, British Nuclear Fuels Limited, Inc., and Idaho DEQ meet quarterly to discuss RCRA-related issues. Summaries of the meetings can be accessed at http://www.inel.gov/publicdocuments/.

Notice of Violation - A multimedia inspection by Idaho DEQ and EPA in July 2001 resulted in the issuance of a notice of violation (NOV) alleging 27 violations of the Idaho Hazardous Waste Management Act. Fines of $156,050 were assessed against the INEEL and Argonne National Laboratory-West (ANL-W). DOE-ID, BBWI, and ANL-W and Idaho DEQ negotiated a consent order to resolve the alleged violations with a final fine amount of $31,050 in 2002.

Idaho DEQ conducted a RCRA inspection at the INEEL on October 7, 2002. Four noncompliances were observed during the inspection. Idaho DEQ issued a warning letter after determining the noncompliances could be corrected without a consent order and were not significant enough to warrant a NOV.

RCRA Closure Plans - The state of Idaho approved closure plans for the following facilities in 2002:

- Test Reactor Area 620 - Catch Tank System;
- Test Reactor Area 73 - Acid and Caustic Storage Tank System;
- Waste Experimental Reduction Facility, Waste Stabilization Units; and
- Idaho Nuclear Technology and Engineering Center, 182 and 183 Tank Systems.

RCRA Reports - As required by the state of Idaho, the INEEL submitted the Idaho Hazardous Waste Generator Annual Report for 2002. The report contains information on waste generation, treatment, recycling, and disposal activities at INEEL facilities.

DOE-ID submitted the INEEL 2002 Affirmative Procurement Report to the EPA, as required by Section 6002 of RCRA and Executive Order 13101. This report provides information on the INEEL's procurement of products with recycled content.

The INEEL RCRA permit for the Hazardous Waste Storage Facility at the Central Facilities Area (CFA) and some areas at ANL-W requires submittal of an annual certification to Idaho DEQ that the INEEL has a waste minimization program in place to reduce the volume and toxicity of hazardous waste. The certification was submitted by July 1, 2002.

Federal Facility Compliance Act

The Federal Facility Compliance Act requires the preparation of site treatment plans for the treatment of mixed wastes stored or generated at DOE facilities. Mixed waste contains both hazardous and radioactive components. The INEEL Proposed Site Treatment Plan was submitted to the state of Idaho and EPA on March 31, 1995. Copies of the plan were also sent to various reading rooms throughout Idaho, the INEEL Citizens Advisory Board, and the Shoshone-Bannock Tribes. This plan outlined DOE-ID's proposed treatment strategy for INEEL mixed waste streams, called the "backlog," and provided a preliminary analysis of potential offsite mixed low-level waste treatment capabilities.

The INEEL Proposed Site Treatment Plan formed the basis for negotiations between the state of Idaho and DOE-ID on the consent order for mixed waste treatment at the INEEL. The Federal Facilities Compliance Act Concent Order and Site Treatment Plan were finalized and signed by the state of Idaho on November 1, 1995.

Two changes to the administrative sections of the plan were negotiated to resolve issues between the State and DOE-ID: (1) DOE reserved its right to challenge the approval authority of the State over offsite wastes, and (2) both parties agreed to immediately modify the plan's schedules to be consistent with the Settlement Agreement and court order issued in October 1995 in the Spent Nuclear Fuel and INEEL Environmental Impact Statement litigation.

There were no changes to the Site Treatment Plan planning dates or milestones in 2002.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA), which is administered by EPA, requires regulation of production, use, or disposal of chemicals. TSCA supplements sections of the Clean Air Act, the CWA, and the Occupational Safety and Health Act. Because the INEEL does not produce chemicals, compliance with TSCA at the INEEL is primarily directed toward use and management of certain chemicals, particularly PCBs.

DOE Order 435.1, "Radioactive Waste Management"

DOE Order 435.1, "Radioactive Waste Management," was issued to ensure that all DOE radioactive waste is managed in a manner that protects the environment and worker and public safety and health. This Order, effective July 1, 1999, replaces DOE Order 5820.2A, "Radioactive Waste Management," and includes the requirements that DOE facilities and operations must meet in managing radioactive waste. The Order is being implemented at the INEEL, as discussed in Sections 3.4 and 6.5.

State of Idaho Wastewater Land Application Permits

DOE-ID has applied for state of Idaho Wastewater Land Application Permits (WLAPs) for all existing land application facilities. Renewal permits have been submitted for the CFA Sewage Treatment Plant, existing INTEC Percolation Ponds, INTEC Sewage Treatment Plant, and TAN/Technical Support Facility Sewage Treatment Plant. Until the renewal permits are finalized, Idaho DEQ has authorized continued use of these facilities under the terms and conditions of the original permits. The new INTEC percolation ponds for disposal of service wastewater went into operation in August 2002, replacing the old ponds as required by the CERCLA ROD for INTEC cleanup.

The Idaho DEQ is reviewing permit applications for the Test Reactor Area Cold Waste Ponds, the Naval Reactors Facility Industrial Waste Ditch, and the ANL-W industrial and sanitary waste ponds.

Idaho Settlement Agreement

On October 16, 1995, DOE, the U.S. Navy, and the state of Idaho entered into an agreement that will guide management of spent nuclear fuel and radioactive waste at the INEEL for the next 40 years. The Agreement makes Idaho the only state with a federal court-ordered agreement limiting shipments of DOE and Naval spent nuclear fuel into the State and setting milestones for shipments of spent nuclear fuel and radioactive waste out of the State. The Settlement Agreement milestones scheduled for 2002 were met as follows:

- Ship at least 3100 cubic meters of transuranic waste out of Idaho. This milestone was due on December 31, 2002, and was met on October 21, 2002.

- Permit and construct the Advanced Mixed Waste Treatment Project Facility. The milestone was due on December 31, 2002, and was met on December 27, 2002.

As part of the Settlement Agreement, the state of Idaho received $30 million from DOE for economic development in eastern Idaho. Idaho awarded grants to the Regional Development Alliance and State universities and colleges to reduce regional economic dependence on the INEEL. These awards have created more than 2600 jobs.

Clean Air Act

The Clean Air Act is the law that forms the basis for the national air pollution control effort. Basic elements of the act include national ambient air quality standards for major air pollutants, hazardous air pollutant standards, state attainment plans, motor vehicle emissions standards, stationary source emissions standards and permits, acid rain control measures, stratospheric ozone protection, and enforcement provisions.

The EPA is the federal regulatory agency of authority, but states may administer and enforce provisions of the act by obtaining EPA approval of a state implementation plan. Idaho has been delegated such authority.

The Idaho air quality program is primarily administered through the permitting process. Potential sources of air pollutants are evaluated against regulatory criteria to determine if the source is specifically exempt from permitting requirements and if the source's emissions are significant or insignificant. If emissions are determined to be significant, several actions may occur:

- Permitting determinations demonstrate that the project/process either is below emission thresholds or listed as exempted source categories in state of Idaho regulations allowing self-exemption;

- Submittal of an application for a Permit to Construct (PTC). If emissions are deemed major under Prevention of Significant Deterioration (PSD) regulations, then a PSD analysis, as described in the regulations, must be completed. If not deemed significant per PSD regulations, an application for a PTC without the additional modeling and analyses is needed. All PTCs are applied for using the state of Idaho air regulations and guidelines.

Permitted sources of air pollutants at the INEEL are listed in Table 2-2.

Table 2-2. Permit summary for the INEEL (2002).

Media/Permit Type	Issuing Agency	Active	Pending
Air[a]			
Permit to Construct	State of Idaho	15	1
NESHAPs (Subpart H)[b]	EPA Region 10	1	0
Operating Permit	State of Idaho	0	1
Groundwater			
Injection Well	State of Idaho	8	0
Well Construction	State of Idaho	1	0
Surface Water			
Wastewater Land Application Permit	State of Idaho	5[c]	4
404 Permit	Corps of Engineers	1	0
Industrial Waste Acceptance	City of Idaho Falls	15	0
RCRA			
Part A	State of Idaho	1	0
Part B[d]	State of Idaho	6[d]	4[d]

a. Air permits do not include permits for the Naval Reactors Facility.

b. NESHAPs = National Emissions Standards for Hazardous Air Pollutants (40 CFR 61, Subpart H, National Emissions Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities).

c. The current permits have expired, continued operation has been allowed by DEQ under the guidelines of those permits.

d. Part B permit is a single permit comprised of several volumes.

Title V Operating Permit - Title V of the 1990 Clean Air Act Amendments required the EPA to develop a federally enforceable operating permit program for air pollution sources to be administered by state and/or local air pollution agencies. The EPA promulgated regulations in July 1992 that defined the requirements for state programs. Idaho has promulgated regulations and EPA has given interim approval of the Idaho Title V Operating Permit program.

The revised INEEL Title V Air Operating Permit Application was submitted to Idaho DEQ in March 2001. The application included ten volumes: one for each of the nine operating areas at the Site and a Sitewide volume that contains information and standards applicable to all areas. Idaho DEQ provided a draft permit for DOE-ID review and comment in mid-2002. A public review of the draft permit will occur in 2003, with issuance of the final permit expected in late 2003.

National Emission Standards for Hazardous Air Pollutants - DOE-ID submitted the *2002 INEEL National Emission Standards for Hazardous Air Pollutants-Radionuclides* report to EPA, DOE Headquarters, and state of Idaho officials in June 2003. This statute requires the use of the CAP-88 computer code to calculate the hypothetical maximum individual effective dose equivalent to a member of the public resulting from INEEL airborne radionuclide emissions. The 2002 calculations for this code are discussed further in Chapter 7.

Clean Water Act

The CWA, passed in 1972, established goals to control pollutants discharged to U.S. surface waters. Among the main elements of the CWA are effluent limitations, set by the EPA, for specific industry categories and water quality standards set by states. The CWA also provided for the National Pollutant Discharge Elimination System (NPDES) permit program, requiring permits for discharges from a point source into surface waters.

The INEEL complies with four CWA permits through the implementation of procedures, policies, and best management practices. The four permits are:

- Section 404 Permit for dredge and fill activities at Spreading Area B located southwest of the RWMC requires elimination of pollutant discharges and reclamation in the area;
- Discharges from Idaho Falls facilities to the City of Idaho Falls publicly owned treatment works;
- NPDES General Permit for Storm Water Discharges from Industrial Activities provides protective requirements for facilities located within the INEEL storm water corridor (63 FR 189); and
- NPDES General Permit for Storm Water Discharges from Construction Activities provides protective requirements for construction activities located within the INEEL storm water corridor (63 FR 31).

Clean Water Act Section 404 Permits - In October 1994, the U.S. Army Corps of Engineers granted a ten-year Section 404 permit that allows DOE-ID to dispose of material associated with the excavation of soil in Spreading Area B to the surrounding spreading area. This area is located southwest of the RWMC. Fill removal activities have since ceased in this area.

National Pollutant Discharge Elimination System Permits - The City of Idaho Falls is authorized by the NPDES permit program to set pretreatment standards for nondomestic discharges to publicly owned treatment works. This program is set out in the Municipal Code of the City of Idaho Falls regulations in Chapter 1, Section 8. Industrial Wastewater Acceptance Forms are obtained for facilities that discharge process wastewater through the City of Idaho Falls sewer system. Twelve Idaho Falls facilities have associated Industrial Wastewater Acceptance Forms for discharges to the city sewer system.

The Industrial Wastewater Acceptance Forms for these facilities contain special conditions and compliance schedules, prohibited discharge standards, reporting requirements, monitoring requirements, and effluent concentration limits for specific parameters. All discharges from INEEL Idaho Falls facilities in 2002 were within compliance levels established on the acceptance forms.

Storm Water Discharge Permits for Industrial Activity - Revised requirements for the NPDES general permit for the discharge of storm water from industrial activities became effective in 2000. The INEEL met the requirements to continue operations under this general permit. A modified NPDES Storm Water Multi-sector General Permit for industrial activities was also published in 2000. The original *INEEL Storm Water Pollution Prevention Plan for Industrial Activities* was implemented in 1993. The most recent revision was completed in January 2001 (DOE-ID 2001). This plan provides for baseline and tailored controls and measures to prevent pollution of storm water from industrial activities at the INEEL. The storm water pollution prevention plan team conducts annual evaluations to determine compliance with the plan and the need for revision. The Environmental Monitoring Unit of the M&O contractor monitors storm water in accordance with the permit requirements. Chapter 5 provides results from this monitoring in 2002.

The National Oceanic and Atmospheric Administration Air Resources Laboratory-Field Research Division provides identification and notification of storm events. Storm water pollution prevention training is provided to INEEL personnel in accordance with the permit requirements.

Storm Water Discharge Permits for Construction Activity - INEEL's General Permit for Storm Water Discharges from Construction Sites was issued in June 1993. The permit has been renewed twice since issuance. The *INEEL Storm Water Pollution Prevention Plan for Construction Activities* was most recently revised in 1998 (DOE-ID 1998). The plan provides for measures and controls to prevent pollution of storm water from construction activities at the INEEL. Worksheets are completed for construction projects and are appended to the plan. Inspections of construction sites are performed in accordance with permit requirements.

Spill Prevention, Control, and Countermeasure Plans - Only the TAN, INTEC, and RWMC are required to have Spill Prevention, Control, and Countermeasure Plans. These INEEL facilities were evaluated in 2001 in accordance with 40 CFR 112. As a result of this evaluation, the current plans were found to lack present requirements. In 2002, the plans were updated to address the deficiencies.

Safe Drinking Water Act

The Safe Drinking Water Act was reauthorized on August 6, 1996. It establishes primary standards for water delivered by systems supplying drinking water to 15 or more connections or 25 individuals for at least 60 days per year. The INEEL drinking water supplies meet these criteria for public water systems and are classified as either nontransient noncommunity or transient noncommunity systems. The INEEL operates 12 active public water systems, two of which serve the Naval Reactors Facility and ANL-W. All INEEL facilities performed sampling of drinking water as required by the State and EPA. Also see Chapter 5 for details on drinking water monitoring results.

National Historic Preservation Act

Preservation of historic properties on lands managed by DOE is mandated under Section 106 of the National Historic Preservation Act and amendments. The act requires that for any federal project that may have an adverse effect on historic property, the agency in charge of the project must take actions to mitigate those adverse effects. This is usually done through a Memorandum of Agreement with the State Historic Preservation Officer.

A comprehensive draft historic context of the INEEL was prepared in 1997 (INEEL 1998). It contains a historic evaluation of all properties built on the INEEL under the DOE-ID's authority and provides the background with which to assess their historic significance. The INEEL plans to finalize the historic context in 2003. It is used to guide a more comprehensive approach to managing the preservation and documentation of buildings scheduled to be modified or dismantled.

In 1999, the National Park Service awarded DOE-ID a $320,000 grant from the President's Save America's Treasures Program for preservation of the Experimental Breeder Reactor No. 1 (EBR-I). EBR-I, the first nuclear reactor to generate usable electricity, is a National Historic Landmark. DOE-ID is working with the National Trust for Historic Preservation to raise matching funds, a requirement of the grant. DOE-ID successfully negotiated with the National Park Service to change the scope of the project to include repair and replacement of damaged brick on the exterior of EBR-I.

Native American Graves Protection and Repatriation Act

The INEEL is located on the aboriginal territory of the Shoshone and Bannock people. The Shoshone-Bannock Tribes are major stakeholders in INEEL activities. They are particularly concerned with how the remains of their ancestors and culture are treated by DOE-ID and its contractors. The Native American Graves Protection and Repatriation Act provides for the protection of Native American remains and the repatriation of human remains and associated burial objects. Repatriation refers to the formal return of human remains and cultural objects to the Tribes with whom they are culturally affiliated. DOE-ID consulted with the Tribes to return a sacred item to a cave on the INEEL where it had been collected in 1989 during archaeological test excavations.

2.2 Environmental Occurrences

Several small spills occurred at the INEEL during 2002 that were not reportable to external agencies under environmental regulations. Only one release was determined to be reportable to external agencies. Release notifications were conducted in accordance with DOE, EPA, and state of Idaho requirements.

On June 26, 2002, at the Power Burst Facility the level in an underground storage tank containing diesel fuel for a heating boiler was noted to be decreasing as indicated by routine operational checks. It was estimated that approximately 54,131 L (14,300 gal) of diesel fuel leaked from the tank between November 2001 and June 2002. An additional 10,762 L (2843 gal) may have leaked from the tank during refilling in the winter heating season of 2000-2001. DOE and the M&O contractor have entered into a consent order with the Idaho DEQ to appropriately address the release and assure sufficient corrective actions are taken.

2.3 Permits

Table 2-2 summarizes permits applied for, and granted to, the INEEL through year-end 2002.

REFERENCES

10 CFR 1021, 2001, “National Environmental Policy Act Implementing Procedures,” *Code of Federal Regulations*, Office of the Federal Register.

10 CFR 1022, 2001, "Compliance with Floodplain/Wetlands Environmental Review Requirements," *Code of Federal Regulations*, Office of the Federal Register.

40 CFR 112, 2002, “Pollution and Response; Non-Transportation - Related Onshore and Offshore Facilities; Final Rule,” *Code of Federal Regulations*, Office of the Federal Register.

40 CFR 264, 2002, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, Office of the Federal Register.

40 CFR 355, 2003, “Emergency Planning and Notification,” *Code of Federal Regulations*, Office of the Federal Register.

40 CFR 761, 2002, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution In Commerce, And Use Prohibitions," *Code of Federal Regulations*, Office of the Federal Register.

63 FR 31, 1998, "Reissuance of NPDES General Permits for Storm Water Discharges From Construction Activities," *Federal Register*, U.S. Environmental Protection Agency, February 17, p. 7857.

63 FR 189, 1998, "Final Modification of the National Pollutant Discharge Elimination System Storm Water Multi-Sector General Permit for Industrial Activities," *Federal Register*, U.S. Environmental Protection Agency, September 30, p. 52430.

Executive Order 12580, “Superfund Implementation,” January 1987.

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Chapter 3 - Environmental Program Information

Chapter Highlights

Many environmental programs help implement the environmental compliance policy for the Idaho National Engineering and Environmental Laboratory (INEEL). Most of the regulatory compliance activity is performed through environmental monitoring programs, compliance agreements, the recent Environmental Management Performance Management Plan for Accelerated Cleanup Agreement of the INEEL, the Environmental Restoration Program, and the Waste Management Program.

The major objectives of the environmental monitoring programs conducted at the INEEL are to identify the key contaminants released to the environment, to evaluate different pathways through which contaminants move in the environment, and to determine the potential effects of these contaminants on the public and the environment. This is accomplished through sampling and analysis of air; surface, subsurface, and drinking water; soil; wildlife; and vegetation, as well as measurement of direct radiation. During 2002, the prime Management and Operating (M&O) contractor at the INEEL, Bechtel BWXT Idaho, LLC was responsible for onsite environmental monitoring. The Environmental Surveillance, Education and Research Program contractor, which was a team led by the S. M. Stoller Corporation, was responsible for offsite environmental monitoring.

In May 2002, the U.S. Department of Energy (DOE), the Idaho Department of Environmental Quality (DEQ), and the U.S. Environmental Protection Agency (EPA) signed a letter of intent formalizing an agreement to pursue accelerated risk reduction and cleanup at the INEEL. The intent of accelerating the cleanup of the INEEL yields two significant objectives: (1) risk reduction and continued protection of the Snake River Plain Aquifer and (2) consolidation of Environmental Management activities and reinvestment of savings into cleanup. Nine strategic initiatives were developed around these two objectives to accelerate cleanup.

The Environmental Restoration Program continued progress during 2002 toward final cleanup of contaminated sites at the INEEL. Since the Federal Facility Agreement and Consent Order was signed in December 1991, 22 Records of Decision have been signed and are being implemented; three Remedial Investigation/Feasibility Studies are under development; and more than 70 percent of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) actions have been completed.

Chapter Highlights (continued)

The Waste Management Program provides management services for facility waste streams. The following tasks were accomplished during 2002:

- Seven Site Treatment Plan milestones were met. British Nuclear Fuels Limited, Inc. completed construction of the Advanced Mixed Waste Treatment Project facility in December 2002.
- Six underground tanks in the Idaho Nuclear Technology and Engineerng Center Tank Farm have been emptied and one of the tanks has been cleaned to State-approved standards.
- Over 3988 m^3 (5216 yd^3) of low-level waste was disposed.
- The Transuranic Waste Program shipped 2075 m^3 (2174 yd^3) of transuranic waste to the Waste Isolation Pilot Plant in Carlsbad, New Mexico, meeting the Settlement Agreement deadline.

3. ENVIRONMENTAL PROGRAM INFORMATION

This chapter highlights the INEEL environmental programs that help implement the environmental policy for the INEEL (see page iii of this report). Much of the regulatory compliance activity is performed through the various environmental monitoring programs (Section 3.1), the recently signed Accelerated Cleanup Agreement (Section 3.2), the Environmental Restoration Program (Section 3.3), and the Waste Management Program (Section 3.4). Sections 3.5 through 3.7 summarize other significant INEEL environmental programs and activities.

3.1 Environmental Monitoring Programs

Environmental monitoring consists of two separate activities: effluent monitoring and environmental surveillance. Effluent monitoring is the measurement of constituents within a waste stream before its release to the environment, such as the monitoring of stacks or discharge pipes. Environmental surveillance is the measurement of contaminants in the environment. Surveillance involves determining whether or not contaminants are present or measurable in environmental media and, if present, in what concentrations they are found. Surveillance monitoring has several different legal drivers. The monitoring done to comply with with Federal Facility Agreement and Concent Order (FFA/CO) RODs is discussed in Section 3.3.

Effluent monitoring is conducted by various INEEL organizations. Airborne effluent measurements and estimates, required under the Idaho State Implementation Plan, are the responsibility of the regulated facilities. At the INEEL, these facilities include Argonne National

Laboratory-West (ANL-W), Central Facilities Area (CFA), Idaho Nuclear Technology and Engineering Center (INTEC), Naval Reactors Facility (NRF), Power Burst Facility/Waste Reduction Operations Complex (PBF/WROC), Radioactive Waste Management Complex (RWMC), Test Area North/Specific Manufacturing Capability (TAN/SMC), and Test Reactor Area (TRA). Descriptions of the airborne effluent monitoring programs are beyond the scope of this document and are not discussed. The Liquid Effluent Monitoring Program and Storm Water Monitoring Program, conducted by the M&O contractor, are designed to demonstrate compliance with the Clean Water Act, Wastewater Land Application Permits, and other water quality permits.

Environmental surveillance is the major environmental monitoring activity conducted at the INEEL. As such, much of the report concentrates on this task. The remainder of this section summarizes environmental monitoring program objectives; the history of environmental monitoring at the INEEL; and information on monitoring of specific environmental media (air, water, agricultural products, animal tissue, and soil), direct radiation, and meteorology.

Results of the environmental monitoring programs for 2002 and additional information on major programs can be found in Chapter 4 (air), Chapter 5 (water), and Chapter 6 (agricultural, wildlife, soil, and direct radiation). Chapter 8 presents 2002 results on current ecological research programs at the INEEL.

Objectives of Environmental Monitoring

Operations of INEEL facilities have the potential to release materials, which may include both radioactive and nonradioactive contaminants, into the environment. These materials can enter the environment through two primary routes: into the atmosphere as airborne effluents and into surface water and groundwater as liquid effluents. Through a variety of exposure pathways (Figure 3-1), contaminants can be transported away from INEEL facilities, where they could potentially impact the surrounding environment and the population living in these areas.

The major objectives of the various environmental monitoring programs conducted at the INEEL are to identify the key pollutants released to the environment, to evaluate different pathways through which pollutants move in the environment, and to determine the potential effects of these pollutants on the public and on the environment.

As discussed previously, monitoring also provides the information to verify compliance with a variety of applicable environmental protection laws, regulations, and permits, described in Chapter 2. The establishment and conduct of an environmental monitoring program at the INEEL is required by the DOE Order 5400.1 (DOE 1993).

The various environmental monitoring programs are also used to detect, characterize, and report unplanned releases; evaluate the effectiveness of effluent treatment, control, and pollution abatement programs; and determine compliance with commitments made in environmental impact statements, environmental assessments, safety analysis reports, or other official DOE documents.

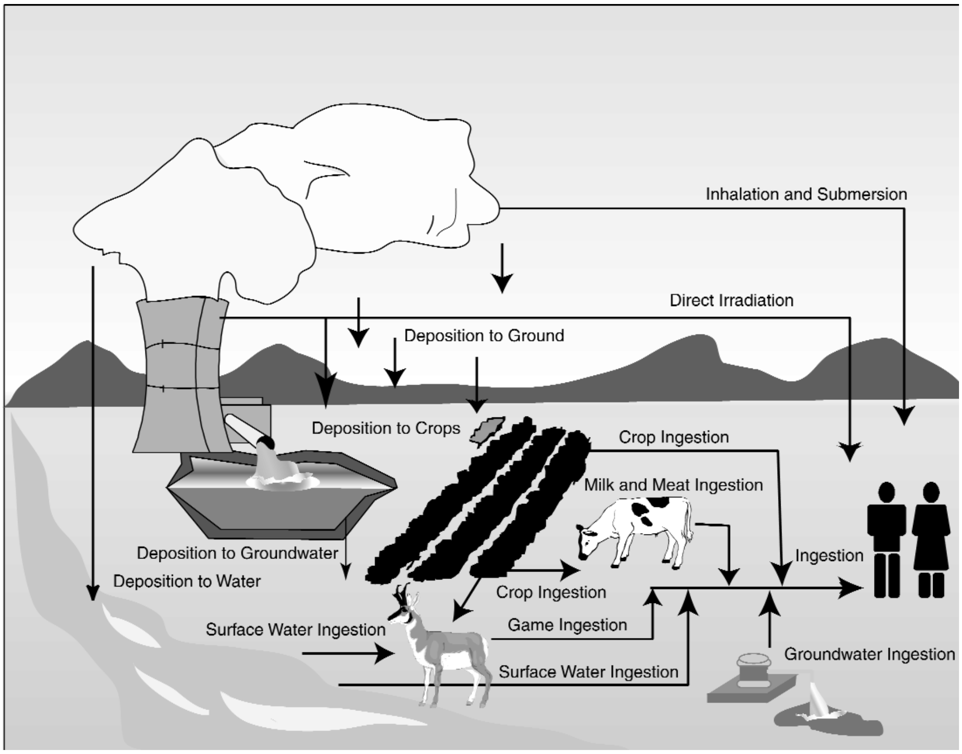

Figure 3-1. Potential exposure pathways to humans from the INEEL.

History of Environmental Monitoring

Environmental monitoring has been performed at the INEEL by DOE and its predecessors, the Atomic Energy Commission and Energy Research and Development Agency, as well as by other federal agencies, various contractors, and State agencies since its inception in 1949.

The organization of environmental monitoring programs has remained fairly constant throughout much of the history of the INEEL. The Atomic Energy Commission's Health Services Laboratory, later named the DOE's Radiological and Environmental Sciences Laboratory (RESL), was responsible for conducting most environmental surveillance tasks from the early 1950s to 1993 both on and off the INEEL Site. Contractors operating the various facilities were responsible for monitoring activities performed within the facility boundaries and for effluent monitoring.

Early monitoring activities focused on evaluating the potential of exposing the general public to a release of radioactive materials from INEEL facilities. Radionuclides were the major contaminants of concern because the INEEL was heavily involved in testing nuclear facilities. DOE and its predecessor agencies sampled and analyzed environmental media that could be affected by atmospheric releases. During those early years, the various M&O contractors conducted sampling of liquid and airborne effluents from facilities to develop waste inventory information.

Throughout the history of the Site, the U.S. Geological Survey (USGS) has monitored groundwater quantity and quality in the Snake River Plain Aquifer, with emphasis on the portion of the aquifer beneath the INEEL. The National Oceanic and Atmospheric Administration (NOAA) has monitored weather conditions at the INEEL since the Site's inception.

At the end of 1993, the DOE environmental monitoring program was divided into separate onsite and offsite programs. Responsibility for the onsite program was transferred to the M&O contractor. During 2002, Bechtel BWXT Idaho, LLC was the prime M&O contractor at the INEEL. The offsite monitoring program was transferred to the Environmental Surveillance, Education and Research (ESER) Program contractor. During 2002, the ESER contractor and offsite monitoring activities were performed by a team led by the S. M. Stoller Corporation.

Air Monitoring

Historical Background - Low-volume air samplers have been operated on and in the vicinity of the INEEL since 1952. Table 3-1 lists the areas where samplers have been located and the dates of operation for these samplers (DOE-ID 1991). Before 1960, radiation detection devices, such as a Geiger-Müller tube, were used to record the amount of radioactivity on the filters. Gross beta measurements were made starting in 1960, and by 1967 the present series of analytical measurements were being performed.

High-volume air samplers were operated at the Experimental Field Station (EFS) and CFA from 1973 until October 1996. In 1996, a program evaluation determined that the cost of operating the high-volume samplers was not commensurate with the data being collected, and operations were suspended. Also in 1973, a high-volume sampler began operation in Idaho Falls as part of the EPA's nationwide Environmental Radiation Ambient Monitoring System.

Tritium in atmospheric moisture has been measured at a minimum of two locations since at least 1973. Some limited monitoring may have been performed before this time.

One monitoring location at CFA collected samples of noble gases, with specific interest in krypton-85 (^{85}Kr) from approximately 1984 until 1992. This station was used to monitor releases of ^{85}Kr from the INTEC during periods when fuel reprocessing was taking place.

Nitrogen dioxide and sulfur dioxide were first monitored for a nine-week period at five onsite locations in 1972. A nitrogen dioxide sampling station operated from 1983 to 1985 to monitor waste calcining operations at INTEC. A sulfur dioxide sampler was also used from 1984 to 1985. The two sampling locations were reactivated in 1988 for nitrogen dioxide, and one station operated from 1989 to 2000 for sulfur dioxide.

The National Park Service, in cooperation with other federal land management agencies, began the Interagency Monitoring of Protected Visual Environments (IMPROVE) program in 1985. This program was an extension of an earlier EPA program to measure fine particles of less than 2.5-µm in diameter ($PM_{2.5}$). These particles are the largest cause of degraded visibility. In May 1992, one IMPROVE sampler was established at CFA on the INEEL and a second was located at Craters of the Moon National Monument as part of the nationwide network. Each of

Table 3-1. Historical low-volume radiological air sampling locations and dates of operations.

Sampling Location	Dates of Operation
Distant Locations	
Aberdeen	1952–1957, 1960–1970
American Falls	1970
Blackfoot	1968–2001
Blackfoot Community Monitoring Station	1983–present
Carey	1961–1970
Craters of the Moon [a]	1973–present
Dubois	2001–present
Dietrich	1961–1970
Idaho Falls	1953–1955, 1956–present
Jackson	2001–present
Minidoka	1961–1970
Pocatello	1969–1980
Rexburg Community Monitoring Station	1983–present
Spencer	1953–1956
Boundary Locations	
Arco	1968–present
Atomic City	1953–1957, 1960–1970, 1973–present
Butte City	1953–1957, 1960–1973
Blue Dome	2001–present
Federal Aviation Administration Tower	1981–present
Howe	1958–present
Monteview	1958–present
Mud Lake	1958–present
Reno Ranch/Birch Creek	1958–2001
Roberts	1960–1970
Terreton	1953–1956, 1964–1965
INEEL Locations	
Argonne National Laboratory -West	1961–present
Aircraft Nuclear Propulsion Program	1953–1955, 1961–1963
Auxiliary Reactor Area	1966–present
Central Facilities Area	1953–present
East Butte	1953–1955
Experimental Breeder Reactor No. 1	1952–1956, 1958–present
Experimental Field Station	1972–present
Fire Station #2	1958–1963
Gas-Cooled Reactor Experiment	1961–1963
Idaho Nuclear Technology and Engineering Center	1953–1956, 1958–1970, 1981–present
Main Gate	1976–present
Mobile Low Power Reactor No. 1	1961–1963
Naval Reactors Facility	1956, 1958–present
Organic Moderated Reactor Experiment	1957–1963
Power Burst Facility	1958–present
Radioactive Waste Management Complex	1973–present
Rest Area, Highway 20	2000–present
Stationary Low-Power Reactor No. 1	1961–1963
Test Area North	1953–1955, 1956–present
Test Reactor Area	1953–1956, 1958–present
Van Buren Gate	1976–present

a. Designated as a boundary location 1973 –1981.

the two samplers collected two 24-hour $PM_{2.5}$ samples a week. Analyses were performed for mass, optical absorption, hydrogen, carbon, nitrogen, oxygen and the common elements from sodium through lead on the periodic table. Operation of the CFA sampler ceased in May 2000 when the EPA removed it from the nationwide network.

Current Programs - Both the ESER and M&O contractors maintain a network of low-volume air samplers to monitor for airborne radioactivity (Figure 3-2). The ESER contractor operates 12 samplers at offsite locations and three onsite samplers. The ESER contractor added a thirteenth offsite sampler in June 2001 at Jackson, Wyoming, in response to public concerns. Two samplers were also moved to two new locations in July 2001 when the leases at the previous stations were terminated by the landlords. The sampler at Blackfoot was moved to Dubois and the sampler at Reno Ranch/Birch Creek was moved to Blue Dome. The M&O contractor maintains 13 onsite and four offsite sampling locations.

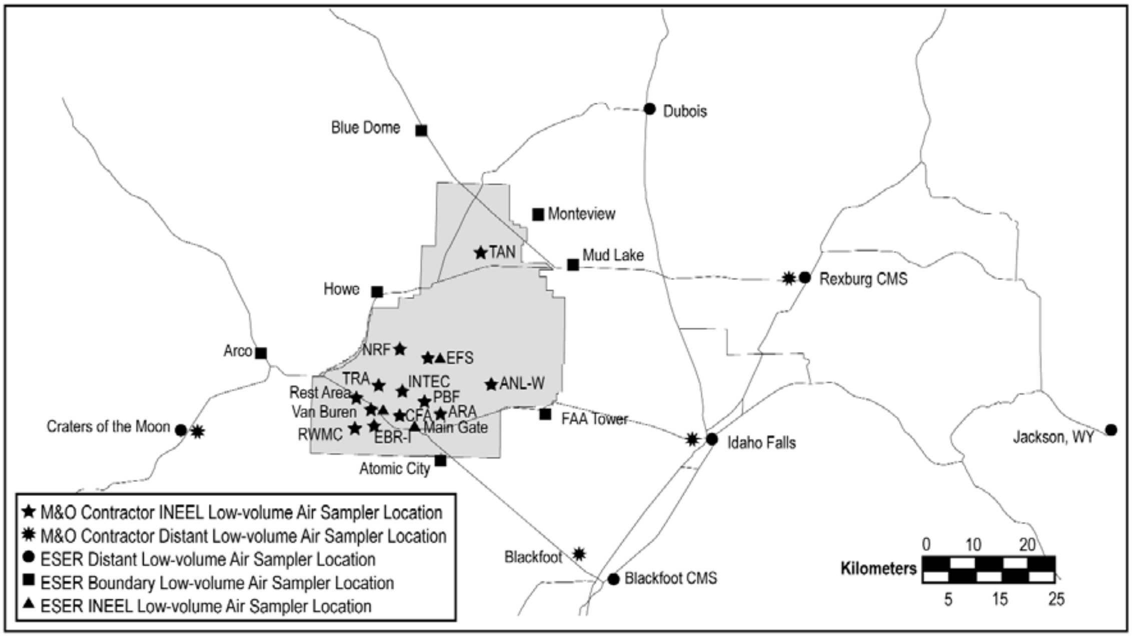

Figure 3-2. ESER and M&O contractor low-volume radiological air sampling locations.

Each low-volume air sampler maintains an average airflow of 50 L/min (2 ft^3/min) through a set of filters consisting of a 1.2-µm pore membrane filter followed by a charcoal cartridge. The membrane filters are 99 percent efficient for airborne particulates with an aerodynamic diameter of 0.32-µm, and higher for larger diameter particulates.

Filters from the low-volume air samplers are collected and analyzed weekly for gross alpha and gross beta activity. Charcoal cartridges are analyzed for iodine-131 (^{131}I) either individually or in batches of up to nine cartridges. During batch counting, if any activity is noted in a batch, each cartridge in that batch is analyzed individually.

Particulate filters are analyzed weekly using a proportional counting system. Filters are analyzed after waiting a minimum of four days to allow naturally occurring radon progeny to decay. Gross alpha and beta analyses are used as a screening technique to provide timely information on levels of radioactivity in the environment.

Specific radionuclide analyses are more sensitive than gross alpha and gross beta analyses for detecting concentrations of human-made radionuclides in air. The particulate filters of the low-volume samplers are composited by location at the end of each quarter, and all composites are analyzed for specific radionuclides by gamma spectrometry. Composites are then submitted for analyses for specific transuranic radionuclides (americium-241 [^{241}Am], plutonium-238 [^{238}Pu], plutonium-239/240 [$^{239/240}$Pu]), and for strontium-90 [^{90}Sr]).

Measurements of suspended particulates are also performed on the 1.2-µm pore membrane filters from the low-volume air samplers. The M&O contractor weighs their filters weekly before and after sampling to determine the amount of material collected. The ESER contractor also weighs their filters weekly before and after use. In both cases, the amount of material collected is determined by subtracting the pre-sampling (clean filter) weight from the postsampling (used filter) weight. The concentration of suspended particulates is calculated by dividing the amount of material collected on the filters by the total volume of air that passed through the filters.

The EPA uses a standard for concentrations of particles with an aerodynamic diameter less than or equal to 10 microns (PM_{10}). The ESER contractor maintains PM_{10} monitors at the Rexburg and Blackfoot Community Monitoring Stations. The M&O contractor operates PM_{10} monitors at various facilities at the INEEL.

Samplers for tritium in atmospheric moisture are located at two onsite and four offsite locations. In these samplers, air is pulled through a column of desiccant material (i.e., silica gel or molecular sieve) at 0.3-0.5 L/hr (0.6-1.0 ft^3/hr). The material in the column absorbs water vapor. Columns are changed when sufficient moisture to obtain a sample is absorbed (typically from one to three times per quarter). The absorbed water is removed from the desiccant through heat distillation. Tritium concentrations are then determined from the absorbed water (distillate) by liquid scintillation counting. Atmospheric concentrations are determined from the tritium concentration in the distillate, quantity of moisture collected, and the volume of air sampled.

Tritium is also monitored using precipitation samples collected on the INEEL monthly at CFA and weekly at the EFS. A monthly sample is also obtained offsite in Idaho Falls. Each precipitation sample is submitted for tritium analysis by liquid scintillation counting. A portion of the monthly sample collection at Idaho Falls is sent to EPA for analysis and reporting in the Environmental Radiation Ambient Monitoring System (ERAMs) at http://www.epa.gov/narel/erams/.

Nitrogen oxides continue to be monitored at two stations on the INEEL (Van Buren Gate and EFS). The IMPROVE sampler station at Craters of the Moon continued operation through 2002.

Water Monitoring

Historical Background - The USGS has conducted groundwater studies at the INEEL since the Site's inception in 1949. The USGS was initially assigned the task to characterize water resources of the area. It has since maintained a groundwater quality and water level measurement program on the INEEL to support research and monitor the movement of radioactive and chemical constituents in the Snake River Plain Aquifer. The first well, USGS 1, was completed and monitored in December 1949. USGS personnel have maintained an INEEL Project Office at CFA since 1958 (USGS 1998).

In 1993, the DOE Idaho Operations Office (DOE-ID) initiated a program to integrate all of the various groundwater monitoring programs on the INEEL. This resulted in the development of the *INEL Groundwater Monitoring Plan* (DOE-ID 1993a) and the *INEL Groundwater Protection Management Plan* (DOE-ID 1993b). The monitoring plan described historical conditions and monitoring programs, and it included an implementation plan for each facility. The protection management plan established policy and identified programmatic requirements.

Sampling and analysis of drinking water both onsite and offsite began in 1958. Analysis for tritium began in 1961. Up to 28 locations were sampled before increased knowledge of the movement of groundwater beneath the INEEL led to a decrease in the number of sampling locations.

A program to monitor lead and copper in drinking water in accordance with EPA regulations has been in place since 1992. Three successive years of monitoring lead and copper levels in drinking water were concluded in 1995. Since regulatory values were not exceeded, this monitoring has been reduced to once every three years beginning in 1998.

As one of the requirements of the National Pollutant Discharge Elimination System General Permit effective October 1, 1992, the INEEL was obligated to develop a storm water monitoring program. Sampling of snowmelt and rain runoff began in 1993, and it included 16 sites at eight INEEL facilities. Samples were collected from storms of at least 0.25 cm (0.1 in.) of precipitation preceded by a minimum of 72 hours without precipitation (63 FR 189 1998).

In September 1998, the EPA issued the "Final Modification of the National Pollutant Discharge Elimination System Storm Water Multi-Sector General Permit for Industrial Activities" (63 FR 189 1998). The permit requires sample collection and laboratory analysis twice during every five-year cycle at potential discharge locations. This usually occurs during years two and four; the INEEL last collected and analyzed storm water samples in 2002. The permit also required continued annual monitoring from coal piles at INTEC whenever there was a discharge to the Big Lost River System. In addition, quarterly visual monitoring was required at all other designated locations.

Current Programs - USGS personnel collect samples from 178 observation or production wells and auger holes and have them analyzed for selected organic, inorganic, and radioactive substances. Sampling is performed on schedules ranging from monthly to annually. These samples are submitted to the RESL at CFA for analysis of radioactive substances and to the USGS

National Water Quality Laboratory in Lakewood, Colorado, for analysis of organic and inorganic substances. The USGS also records water levels at 308 selected wells on schedules ranging from monthly to annually.

The USGS also conducts special studies of the groundwater resources of the Eastern Snake River Plain. The abstract of each study published in 2002 is provided in Appendix C. These special studies provide more specific geological, chemical, and hydrological information on the characteristics of the aquifer and the movements of chemical and radiochemical substances in the groundwater. One special USGS investigation of particular interest is the ongoing annual sampling effort in the area between the southern boundary of the INEEL and the Twin Falls/Hagerman area, known as the Magic Valley Study. This study was prompted by public concern that radiochemical and chemical constituents generated by INEEL facilities could migrate through the Snake River Plain Aquifer to the Snake River in the Twin Falls/Hagerman area. The most recent results of this study are summarized in USGS Open File Report 03-168 (Twining et al. 2003).

The *INEL Groundwater Monitoring Plan* was updated in 2002 to include the monitoring wells, constituent lists, and sampling frequencies of current programs. The updated plan (DOE-ID 2002) does not replace the 1993 plan but uses it as the basis for the information previously presented regarding operational history, contaminant sources, and monitoring networks for each INEEL facility. The updated plan modifies groundwater monitoring recommendations in accordance with more recent requirements in records of decisions, relying on existing multiple groundwater programs rather than a single comprehensive program.

The M&O contractor conducts groundwater monitoring in support of state of Idaho Wastewater Land Application Permit requirements at INTEC and TAN as well as surveillance monitoring at INTEC. In 2002, this included collecting 234 groundwater samples yielding 482 parameter results. ANL-W also performs groundwater surveillance monitoring in support of the Record of Decision (ROD) and a submitted state of Idaho Wastewater Land Application Permit.

The M&O contractor's Drinking Water Program monitors production and drinking water wells for radiological, chemical, and bacteriological contaminants at all their INEEL facilities. Currently, 17 wells and ten distribution systems are monitored. All analyses for the program are conducted using laboratories certified by the state of Idaho or laboratories certified in other states, where this certification is accepted by the state of Idaho. The NRF and ANL-W maintain separate programs for sampling drinking water based on the requirements applicable at their facilities. Radiological and bacteriological samples from ANL-W are sent to the M&O contractor for analysis. ANL-W conducts a separate program for chemical monitoring.

M&O personnel collect quarterly onsite drinking water samples from active systems for radiological analysis. Paragon Laboratory, located in Fort Collins, Colorado, performed these analyses during 2002. Each water sample is submitted for gross analyses for alpha- and beta-emitting radionuclides. Tritium analyses are also performed on all drinking water samples. Strontium-90 analyses are performed on quarterly samples from CFA and INTEC because some water quality monitoring data indicate this water may contain ^{90}Sr concentrations above background levels.

The INEEL Environmental Hygiene Laboratory analyzes drinking water monthly for coliform bacteria. At the end of 2002, this lab temporarily lost its State accreditation and bacteria samples were sent to Microwise in Idaho Falls. If indications of contamination by bacteria are found in a sample, that particular drinking water system is taken out of service until it can be disinfected, resampled, and tested again until it is clear of bacteria. Corrective actions to purify the water may vary among facilities.

The M&O contractor's Drinking Water Program also samples drinking water from wells and distribution systems at INEEL facilities for volatile organic compounds. Chlorinated drinking water systems are also monitored for total trihalomethanes (bromoform, bromodichloromethane, chloroform, and dibromochloromethane). Additional sampling is conducted for a variety of inorganic constituents, including metals, nitrates, and dissolved solids.

Storm water from the coal piles at INTEC did not discharge to the Big Lost River System in 2002; therefore, analytical monitoring was not required. Thus, monitoring in 2002 consisted only of quarterly visual monitoring at 18 locations and analytical monitoring at two RWMC locations.

The ESER contractor collects drinking water samples semiannually from boundary and distant communities. Surface water samples are collected from springs in the Twin Falls/Hagerman area and the Snake River at Idaho Falls and Bliss. Each water sample is analyzed for gross alpha and gross beta activity, and tritium.

Agricultural Products and Vegetation Monitoring

Historical Background - Milk was the first agricultural product to be monitored beginning in at least 1957. The number of samples collected per year has been relatively constant since about 1962. Because of improvements in counting technology, the detection limit for ^{131}I has decreased from about 15,000 pCi/L in early sampling to the current detection level of about 2 pCi/L.

Wheat was first sampled as part of the radioecology research program in about 1962. The current monitoring program dates back to 1963. Potatoes were first collected in 1976 as part of an ecological research project. Regular potato sampling was resumed in 1994 in response to public concern. Lettuce has been collected since 1977.

Current Programs - Milk samples are collected from both commercial and single-family dairies. A 2-L (0.5-gal) sample is obtained from each location monthly, except in Idaho Falls where a sample is collected weekly. Milk from each location is analyzed for ^{131}I, and one analysis for ^{90}Sr and tritium at each location is performed during the year.

Wheat samples are collected from grain elevators in the region surrounding the INEEL. All wheat samples are analyzed for ^{90}Sr and gamma-emitting radionuclides.

Potato samples are collected from storage warehouses in the vicinity of the INEEL, with three to five samples from distant locations. The potatoes, with skins included, are cleaned and weighed before processing. All potato samples are analyzed for ^{90}Sr and gamma-emitting radionuclides.

Lettuce samples are obtained from private gardens in communities in the vicinity of the INEEL. Samples are washed to remove any soil as in normal food preparation, dried, reduced to a powdered form, and weighed. All lettuce samples are analyzed for ^{90}Sr and gamma-emitting radionuclides.

The M&O contractor annually collects perennial and grass samples from around the major waste management facilities. These samples are analyzed for gamma-emitting radionuclides. ANL-W also collects vegetation samples annually from around the Industrial Waste Pond and along the Industrial Waste Ditch. These samples are analyzed for selected alpha, beta, and gamma radionuclides.

Animal Tissue Monitoring

Historical Background - Monitoring of game animals has focused on research into the movement of radionuclides through the food chain. Rabbit thyroids and bones were first sampled in 1956. In 1973, routine sampling of game animal tissues was instituted; the first studies on waterfowl that were using waste disposal ponds containing various amounts of radionuclides occurred the following year. Waterfowl studies have covered the periods 1974-1978, 1984-1986, and 1994-present. In 1998, the collection of waterfowl became part of the regular surveillance program.

Mourning doves were collected in 1974 and 1975 as part of a radioecology research project. Routine dove sampling as part of the environmental surveillance program was initiated in 1996.

Sheep that have grazed onsite have been part of the routine monitoring program since a special study was conducted in 1975. Beef cattle were also monitored biennially during the period 1978 to 1986.

Yellow-bellied marmots were first collected in 1998 as part of a special study initiated in response to concerns by Native Americans, who hunt and consume them. They were monitored again in 2000.

Current Programs - Muscle, liver, and thyroid are collected from game animals accidentally killed on INEEL roads. Thyroid samples are placed in vials and analyzed by gamma spectrometry specifically for ^{131}I. Muscle and liver samples are processed, placed in a plastic container, and weighed before gamma spectrometry analysis.

Waterfowl samples are collected from waste disposal ponds at four facilities on the INEEL. Control samples are also taken in areas distant from the INEEL. Waterfowl samples are separated into an external portion (consisting of the skin and feathers); edible portion (muscle, liver, and gizzard tissue); and remainder portion. All samples are analyzed by gamma spectrometry. Selected samples are also analyzed for ^{90}Sr and transuranic radionuclides.

Mourning doves are collected from the vicinity of INTEC and TRA waste ponds and from a control area distant to the INEEL. Because of the small size of a typical dove, muscle tissues from several doves collected at the same location are composited into one sample. Samples are analyzed for gamma-emitting radionuclides, ^{90}Sr, and transuranic radionuclides.

Sheep are sampled from grazing areas on the INEEL and from control areas offsite. Muscle and liver samples are collected and analyzed for gamma-emitting raionuclides. Thyroid samples are analyzed by gamma spectrometry for ^{131}I.

Marmots are collected from the RWMC and from a control location. Muscle, viscera, and hair-skin/bone samples are analyzed for transuranic radionuclides and ^{90}Sr.

Soil Monitoring

Historical Background - Soil sampling has been included as part of routine monitoring programs since the early 1970s, although some limited soil collection was performed around various facilities as far back as 1960. Offsite soil sampling at distant and boundary locations was conducted annually from 1970 to 1975. The collection interval was extended to every two years starting in 1978. Soil samples in 1970, 1971, and 1973 represented a composite of five cores of soil 5 cm (2-in.) in depth from a 1-m^2 (approximately 10 ft^2) area. In all other years, the five cores were collected from two depths 0-5 cm (0-2 in.) and 5-10 cm (2-4 in.) within a 100-m^2 (~1076 ft^2) area.

A soil sampling program began in 1973 around onsite facilities. Soils at each facility were sampled every seven years. In 2001, all locations were sampled as the frequency was increased to every two years.

Current Programs - Twelve offsite locations are sampled by the ESER program in even numbered years. Following collection, soil samples are dried for at least three hours at 120˚C (250˚F) and sieved. Only soil particles less than 500-µ in diameter (35 mesh) are analyzed. All offsite samples are analyzed for gamma-emitting radionuclides, ^{90}Sr, and transuranic radionuclides.

The M&O contractor now performs soil sampling on a two-year rotation. One hundred one sites were sampled in 2002. All sites are analyzed insitu for gamma emitting radionuclides and ^{90}Sr. Approximately 10 percent of the sites have a physical sample collected for laboratory analysis of gamma-emitting and transuranic radionuclides. Samples are collected from 0-5 cm (0-2 in.) and sieved at the sample site with the 35-mesh fraction being collected. The M&O contractor also performs annual sampling of the CFA sewage treatment plant irrigation spray field to show compliance with the Wastewater Land Application Permit soil loading limits.

ANL-W collects soil samples annually at locations along the major wind directions and at crosswind locations. Samples are analyzed for low-level gamma-emitting radionuclides and uranium, plutonium, and thorium isotopes. Sufficient material to fill a 500 mL (16 oz.) wide mouth jar is collected from 0-5 cm (0-2 in.) depth within an approximately 1-m^2 (~10-ft^2) area.

Direct Radiation Monitoring

Historical Background - Measurements of radiation in the environment have been made on the INEEL since 1958. The technology used for radiation measurements at fixed locations has evolved from film badges to thermoluminescent dosimeters (TLDs). In addition to these locations, surveys using hand-held and vehicle-mounted, radiation instruments have been

conducted since at least 1959. Aerial radiological surveys were also performed in 1959, 1966, 1974, 1982, and 1990.

Current Programs - Environmental TLDs are used to measure ambient ionizing radiation exposures. The TLDs measure ionizing radiation exposures from all external sources. External sources include natural radioactivity in the air and soil, cosmic radiation from space, fallout from nuclear weapons tests, radioactivity from fossil fuel burning, and radioactive effluents from INEEL operations and other industrial processes.

At each location, a dosimeter holder containing four individual chips is placed 1 m (3 ft) above ground level. The M&O contractor maintains dosimeters at 13 offsite locations and 135 locations on the INEEL. The ESER contractor has dosimeters at 14 offsite locations. The dosimeter card at each location is changed semiannually, and cumulative gamma radiation is measured by the M&O contractor Dosimetry Unit.

In addition to TLDs, the M&O contractor uses a mobile global positioning system radiometric scanner arrangement to conduct gamma radiation surveys. Two plastic scintillation detectors and radiometric and global positioning system equipment are mounted on a four-wheel drive vehicle. The vehicle is driven slowly across the area to be surveyed while radiometric and location data are continuously recorded.

ANL-W conducts annual surface radiation surveys of wastewater ditches using handheld portable beta-gamma meters.

Meteorological Monitoring

Historical Background - The NOAA Air Resources Laboratory-Field Research Division (NOAA ARL-FRD) began work at the INEEL in 1948 as a Weather Bureau Research Station. The first meteorological observation station established to support the Site began operation in 1949 at CFA. The network of stations expanded in the 1950s to provide more closely spaced data. The current mesonet was designed and constructed in the 1990s.

Current Programs - NOAA ARL-FRD currently maintains a network of 36 meteorological stations in the vicinity of the INEEL. These stations provide continuous measurements of a variety of parameters, including air temperature at two or three elevations, wind direction and speed, relative humidity, barometric pressure, solar radiation, and precipitation. In addition, continuous measurements of wind speed/direction and air temperature at various heights above the ground are taken using a wind profiling system and a radio acoustic sounding system located on the INEEL. Data are transmitted via radio and telephone to the NOAA ARL-FRD Idaho Falls facility, where they are stored in a computerized archive.

Monitoring and Surveillance Committee

The INEEL Monitoring and Surveillance Committee was formed in March 1997 and holds bimonthly meetings to coordinate activities between groups involved in INEEL-related onsite and offsite environmental monitoring. This standing committee brings together representatives of DOE (Idaho, Chicago, and Naval Reactors); INEEL contractors; ANL-W; NRF; Shoshone-

Bannock Tribes; Idaho INEEL Oversight Program; NOAA; and USGS. The Monitoring and Surveillance Committee has served as a valuable forum to review monitoring, analytical, and quality assurance methodologies; to coordinate efforts; and to avoid unnecessary duplication.

Monitoring Summary

Tables 3-2 through 3-5 present a summary of the environmental surveillance programs conducted by the ESER contractor, the M&O contractor, ANL-W, and the USGS, respectively, in 2002.

3.2 Accelerated Cleanup of the INEEL

In May 2002, DOE, the DEQ, and the EPA signed a letter of intent formalizing an agreement to pursue accelerated risk reduction and cleanup at the INEEL. The letter provides the foundation for a collaborative plan for the accelerated cleanup of the INEEL.

The DOE-ID and its contractors, in consultation with the state of Idaho and EPA, developed the EM Performance Management Plan for Accelerated Cleanup of the INEEL describing the approach to accelerate the reduction of environmental risk at the INEEL by completing its cleanup responsibility faster and more efficiently. The plan will fulfill the following two visions:

- By 2012, the INEEL will have achieved significant risk reduction and will have placed materials in safe storage ready for disposal.
- By 2020, the INEEL will have completed all active cleanup work with potential to further accelerate cleanup to 2016.

The vision for accelerating cleanup of the INEEL results in two objectives: (1) risk reduction and continued protection of the Snake River Plain Aquifer and (2) consolidation of Environmental Management activities and reinvestment of savings into cleanup.

Nine strategic initiatives were developed around these objectives to accelerate cleanup. They include:

- Accelerate Tank Farm Closure;
- Accelerate high-level waste calcine removal from Idaho;
- Accelerate consolidation of spent nuclear fuel to the INTEC;
- Accelerate offsite shipments of transuranic waste stored in the transuranic waste storage area;
- Accelerate remediation of miscellaneous contaminated areas;
- Eliminate onsite treatment and disposal of low-level and mixed low-level waste;
- Transfer all Environmental Management-managed special nuclear material offsite;

Table 3-2. ESER environmental surveillance program summary (2002).

Medium Sampled	Type of Analysis	Locations and Frequency		Minimum Detectable Concentration
		Onsite	Offsite	
Air (low volume)	Gross alpha	3 weekly	14 weekly	1×10^{-15} ì Ci/mL
	Gross beta	3 weekly	14 weekly	2×10^{-15} ì Ci/mL
	Specific gamma	3 quarterly	14 quarterly	3×10^{-16} ì Ci/mL
	^{238}Pu	1-2 quarterly	7 quarterly	2×10^{-18} ì Ci/mL
	$^{239/240}$Pu	1-2 quarterly	7 quarterly	2×10^{-18} ì Ci/mL
	^{241}Am	1-2 quarterly	7 quarterly	2×10^{-18} ì Ci/mL
	^{90}Sr	1-2 quarterly	7 quarterly	6×10^{-17} ì Ci/mL
	^{131}I	3 weekly	14 weekly	2×10^{-15} ì Ci/mL
	Total particulates	3 quarterly	14 quarterly	10 ì g/m^3
Air (high volume)[a]	Gross beta	None	1, twice per week	1×10^{-15} ì Ci/mL
	Gamma scan	None	If gross $\beta > 1$ pCi/m^3	1×10^{-14} ì Ci/mL
	Isotopic U and Pu	None	1 annually	2×10^{-18} ì Ci/mL
Air (PM_{10})	Weighing filter	None	3 weekly	± 0.000001 g
Air (atmospheric moisture)	Tritium	None	4 locations, 2 to 4 per quarter	2×10^{-13} ì Ci/mL (air)
Air (precipitation)	Tritium	1 weekly/ 1 monthly[b]	1 monthly	100 pCi/L
Drinking Water	Gross alpha	None	13 semiannually	3 pCi/L
	Gross beta	None	13 semiannually	2 pCi/L
	Tritium	None	13 semiannually	300 pCi/L
Surface Water	Gross alpha	None	5 semiannually	3 pCi/L
	Gross beta	None	5 semiannually	2 pCi/L
	Tritium	None	5 semiannually	300 pCi/L
Animal Tissue (sheep)[c]	Specific gamma	4 annually	2 annually	5 pCi/g
	^{131}I	4 annually	2 annually	3 pCi/g
Animal Tissue (game)	Specific gamma	Varies annually[d]	Varies annually	5 pCi/g
	^{131}I			3 pCi/g
Agricultural Products (milk)	^{137}Cs	None	1 weekly	1 pCi/L
	^{131}I	None	1 weekly/9 monthly	3 pCi/L
	^{90}Sr	None	9 annually	5 pCi/L
	Tritium	None	9 annually	300 pCi/L
Agricultural Products (potatoes)	Specific gamma	None	8 annually	0.1 pCi/g
	^{90}Sr	None	8 annually	0.2 pCi/g
Agricultural Products (wheat)	Specific gamma	None	11 annually	0.1 pCi/g
	^{90}Sr	None	11 annually	0.2 pCi/g
Agricultural Products (lettuce)	Specific gamma	None	9 annually	0.1 pCi/g
	^{90}Sr	None	9 annually	0.2 pCi/g
Soil	Specific gamma	None	12 biennially	0.001 pCi/g
	^{238}Pu	None	12 biennially	0.005 pCi/g
	$^{239/240}$Pu	None	12 biennially	0.1 pCi/g
	^{241}Am	None	12 biennially	0.005 pCi/g
	^{90}Sr	None	12 biennially	0.05 pCi/g
Direct Radiation Exposure (TLDs)	Ionizing radiation	None	14 semiannually	5 mR

a. Filters are collected by ESER personnel and sent to EPA for analysis. Data are reported by EPA's Environmental Radiation Ambient Monitoring System (ERAMS) at http://www.epa.gov/narel/erams/.

b. A portion of the monthly sample collected at Idaho Falls is sent to EPA for analysis and are reported by ERAMS.

c. Onsite animals grazed on the INEEL for at least two weeks before being sampled. Offsite animals never grazed on the INEEL and are controls.

d. Only animals that are road-killed or died of natural causes are sampled onsite. No controls are collected except for specific studies (i.e., ducks).

Table 3-3. M&O contractor site environmental surveillance program summary (2002).

Medium Sampled	Type of Analysis	Locations and Frequency		Minimum Detectable Concentration
		Onsite	Offsite	
Air (low volume)	Gross alpha	13 weekly	4 weekly	1 x 10^{-15} ì Ci/mL
	Gross beta	13 weekly	4 weekly	5 x 10^{-15} ì Ci/mL
	Specific gamma	13 quarterly	4 quarterly	—[a]
	^{238}Pu	13 quarterly	4 quarterly	2 x 10^{-18} ì Ci/mL
	^{241}Am	13 quarterly	4 quarterly	2 x 10^{-18} ì Ci/mL
	^{90}Sr	13 quarterly	4 quarterly	2 x 10^{-14} ì Ci/mL
	Particulate matter	13 quarterly	4 quarterly	10 ì g/m^3
Air (atmospheric moisture)	Tritium	2 to 4 per quarter	2 to 4 per quarter	1 x 10^{-11} ì Ci/mL (water)
Air	Nitrogen oxides	Continuous	—[b]	NA[c]
Air	Sulfur dioxide	Continuous	—	NA
Soil	Specific gamma	Varies annually[d]	—	0.1 pCi/g
	Pu isotopes	Varies annually	—	0.003 pCi/g
	^{241}Am	Varies annually	—	0.003 pCi/g
	^{90}Sr	Varies annually	—	0.06 pCi/g
Vegetation	Specific gamma	Varies annually[d]	—	1 x 10^{-7} ì Ci/g
	^{238}Pu	Varies annually	—	1.2 x 10^{-8} ì Ci/g
	$^{239/240}$Pu	Varies annually	—	6 x 10^{-10} ì Ci/g
	^{241}Am	Varies annually	—	1.2 x 10^{-8} ì Ci/g
	^{90}Sr	Varies annually	—	1.2 x 10^{-8} ì Ci/g
Drinking Water	Gross alpha	12 quarterly	—	1 pCi/L
	Gross beta	12 quarterly	—	4 pCi/L
	Tritium	12 quarterly	—	1,000 pCi/L
	^{90}Sr	4 quarterly	—	2 pCi/L
	Other radionuclides	12 quarterly	—	[a]
	Volatile organics	10 annually/ 4 quarterly	—	0.5 ppb
	Semivolatile organics	12 triennially	—	0.5 ppb
	Inorganics	12 triennially	—	0.5 ppb
Direct Radiation Exposure (TLDs)	Ionizing radiation	135 semiannually	13 semiannually	5 mR
Direct Radiation Exposure (mobile radiation surveys)	Gamma radiation	Facilities and INEEL roads[e]	—	NA

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

b. Denotes that the M&O contractor does not collect samples from offsite locations for this parameter.

c. NA = not applicable. This information is recorded as an instrument reading at the time of inspection.

d. Onsite soil sampling is performed each year at different onsite facilities on a rotating two-year schedule.

e. Surveys are performed each year at different onsite facilities on a rotating three-year schedule. All INEEL roadways over which waste is transported are surveyed annually.

Table 3-4. ANL-W site environmental surveillance program summary (2002).

Medium Sampled	Type of Analysis	Frequency	Minimum Detectable Concentration
Airborne Effluents	Nitrogen oxides	Continuous	NA[a]
Airborne Effluents	Sulfur dioxide	Continuous	NA
Soil	Specific gamma	7 annually	0.7 pCi/g
	Pu, Th, U isotopes	7 annually	0.005 pCi/g
	Metals	1 annually	Varies by analyte
Vegetation	Specific gamma	8 annually	0.7 ì Ci/g
	Pu, Th, U isotopes	8 annually	0.005 ì Ci/g
Drinking Water	Gross alpha	1 quarterly	3 pCi/L
	Gross beta	1 quarterly	2 pCi/L
	Tritium	1 quarterly	400 pCi/L
	Inorganics	1 every 9 years	Varies by analyte
	Lead/copper	20 triennially	1.94 ì g/L/6 ì g/L
	Nitrate	1 annually	0.1 mg/L
	Cyanide	1 triennially	10 ì g/L
	Arsenic	1 triennially	1.7 ì g/L
	Coliform bacteria	1 quarterly	NA
	Volatile organics	1 every six years	Varies by analyte
	Semivolatile organics	1 every six years	Varies by analyte
Surface Water	Inorganics	1 annually	Varies by analyte
	Anions	2 annually	Varies by analyte
	Gross Alpha	3 monthly	3 pCi/L
	Gross Beta	3 monthly	2 pCi/L
	Gamma Spec	3 monthly	Varies by analyte
	Tritium	3 monthly	400 pCi/L
	Water Quality Parameters[b]	3 monthly	Varies by analyte
Groundwater	Inorganics	5 semiannually	Varies by analyte
	Anions (Cl, SO_4, NO_3)	5 semiannually	Varies by analyte
	TOC[c]	5 semiannually	260 ì g/L
	TOX[c]	5 semiannually	2.4 ì g/L
	Gross Alpha	5 semiannually	3 pCi/L
	Gross Beta	5 semiannually	2 pCi/L
	Uranium isotopes	5 semiannually	Varies by analyte
	Tritium	5 semiannually	400 pCi/L
	Water Quality Parameters[d]	5 semiannually	Varies by analyte
Direct Radiation Exposure (HPICs)[e]	Ionizing radiation	4 Continuous	10 ì R
Direct Radiation Exposure (portable radiation survey)	Gamma radiation	1 annually	NA

a. NA = not applicable. This information is recorded as an instrument reading at the time of inspection.
b. Surface water quality parameters include pH, temperature, specific conductivity, dissolved oxygen, and turbidity/ total dissolved solids.
c. TOC = Total Organic Carbon; TOX = Total Organic Halogens.
d. Groundwater quality parameters include pH, total alkalinity, bicarbonate alkalinity, carbonate alkalinity, total dissolved solids, and specific conductivity.
e. HPIC = High Pressure Ionization Chamber.

Table 3-5. U.S. Geological Survey monitoring program summary (2002).

Constituent	Groundwater		Surface water		Minimum Detectable Concentration
	Number of Sites	Number of Samples	Number of Sites	Number of Samples	
Gross Alpha	52	64	4	8	3 pCi/L
Gross Beta	52	64	4	8	3 pCi/L
Tritium	163	250	4	8	400 pCi/L
Specific Gamma	93	126	4	8	—[a]
Strontium-90	107	182	—[b]	—	5 pCi/L
Americium-241	20	34	—	—	0.05 pCi/L
Plutonium Isotopes	20	34	—	—	0.04 pCi/L
Specific Conductance	169	261	4	8	Not applicable
Sodium Ion	148	168	—	—	0.1 mg/L
Chloride Ion	162	251	4	8	0.1 mg/L
Nitrates (as nitrogen)	108	128	—	—	0.05 mg/L
Sulfate	108	125	—	—	0.1 mg/L
Chromium (dissolved)	82	116	—	—	0.005 mg/L
Purgeable Organic Compounds[c]	28	51	—	—	0.0002 mg/L
Total Organic Carbon	50	52	—	—	0.1 mg/L
Trace Elements	9	12	—	—	Varies

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

b. No surface water samples collected for this constituent.

c. Each purgeable organic compound water sample is analyzed for 60 volatile organic compounds.

- Remediate buried waste in the RWMC; and
- Accelerate consolidation of INEEL facilities and reduce footprint.

At the 2020 end state, some activities will continue: shipment of spent nuclear fuel to a repository; retrieval, treatment, packaging, and shipment of calcined high-level waste to a repository; and final dismantlement of remaining Environmental Management buildings. These activities will be complete by 2035 with the exception of some minor activities leading to long-term stewardship (see Section 3.4). Even with these continuing activities, the cleanup costs can be reduced by up to $19 billion, and the cleanup schedule can be completed decades earlier. The Performance Management Plan is a living document that will be revised and improved as necessary to reflect the decisions and progress made toward accelerated cleanup.

3.3 Environmental Restoration Program

Since the FFA/CO was signed in December 1991, the INEEL has cleaned up sites containing asbestos, petroleum products, acids and bases, radionuclides, unexploded ordnance and explosive residues, polychlorinated biphenyls (PCBs), heavy metals, and other hazardous materials. The INEEL Environmental Restoration Program continued progress toward final cleanup of contaminated sites at the INEEL during 2002. Cleanup of this contamination is being conducted under the CERCLA. By the end of 2002:

- Twenty-two RODs have been signed and are being implemented;
- Three Remedial Investigation/Feasibility Studies (RI/FSs) are under development; and
- More than 70 percent of CERCLA remedial actions are complete.

Comprehensive RI/FSs have been completed for Waste Area Groups (WAGs) 1, 2, 3, 4, 5, 8, 9, and 10. The comprehensive RI/FSs, which take an average of 40 months to complete, accomplish the following:

- Determine the cumulative risks for an entire WAG by assessing the combined impact of all release sites within that group;
- Review assumptions used in each previous investigation, including "No Further Action" sites, Track 1 and 2 limited field investigations, RI/FSs, and interim actions;
- Identify data gaps and recommend actions, such as field sampling or historical document research, to resolve questions;
- Perform feasibility studies to evaluate remedial alternatives for the entire WAG;
- Develop proposed plans presenting the alternatives and recommending a preferred alternative; and

- Develop RODs selecting the alternative and resolving public comments.

The general procedure for all comprehensive investigations begins with developing a work plan outlining potential data gaps and release sites that may require more field sampling. When the investigation is complete, DOE, EPA and the State hold public comment meetings on the proposed cleanup alternative. A complete catalog of documentation associated with the INEEL Environmental Restoration Program is contained in the CERCLA Administrative Record at http://ar.inel.gov/.

Waste Area Group 1 - Test Area North

In 2002, the agencies started development on an amendment to the Operable Unit 1-10 ROD which will select a new remedy for the V-tanks. The originally selected remedy included removing and shipping of the tank contents to an out-of-state treatment facility. The treated tank contents, contaminated soils, and the tanks were to be disposed at the WAG 3 INEEL CERCLA Disposal Facility or other acceptable facility. The out-of-state treatment facilities are no longer available and there are no other out-of-state treatment facilities capable of directly treating the tanks' contents. Therefore, the agencies have agreed to amend the ROD to reevaluate several new and previously considered remedies.

A technology evaluation completed in 2002 considered the feasibility and reliability of two dozen potential technologies, including all that were evaluated during the original 1997 feasibility study for this site. The results of this evaluation will be published in 2003, after which a new plan for remediating this site will be developed. WAG 1 continued treatment and monitoring of groundwater, with more than 450 million L (119 million gal) treated in 2002.

Waste Area Group 2 - Test Reactor Area

Remediation activities at WAG 2 are nearly complete. In 2002, investigation continued of newly identified sites that may contain contamination. Institutional controls were maintained and an annual inspection report was published.

Waste Area Group 3 - Idaho Nuclear Technology and Engineering Center

The following accomplishments were achieved at the WAG 3 in 2002:

- The new percolation ponds were put into service 16 months ahead of the FFA/CO schedule.

  Located just over 3.2 km (2 mi) southwest of the INTEC, these ponds replace the older ponds that were closer to the facility and were a source of water that could potentially transport contaminants underneath the INTEC downward to the aquifer. A groundwater sampling program at INTEC confirmed that relocation of the percolation ponds is slowly reducing the perched water below the facility;

- Completed construction of the INEEL CERCLA Disposal Facility Landfill Cell 1 and Evaporation Ponds, and

- Submitted the Operable Unit 3-13 Other Surface Soils (Group 3) draft Prioritization and Site Grouping Report for agency review on May 24, 2002, ahead of the May 26, 2002, enforceable milestone date.

EPA issued a Notice of Violation to DOE-ID on December 9, 2002, for failing to submit a complete Remedial Action Report for Operable Unit 3-1, Group 1, by the established FFA/CO deadline. The State, EPA, and DOE-ID will resolve this issue through formation of a Dispute Resolution Committee comprised of representatives from each of the agencies.

Waste Area Group 4 - Central Facilities Area

Cleanup activities at the WAG 4 are nearly complete. The following accomplishments were achieved at the WAG 4 in 2002:

- Removed sewage drainfield components and soil, and nearly completed the drainfield cover; and

- Removed lead-contaminated soils from transformer yard for offsite disposal.

Waste Area Group 5 - Power Burst Facility/Waste Reduction Operations Complex

Cleanup activities at the WAG 5 are nearly complete. The following accomplishments were achieved at the WAG 5 in 2002:

- Completed final remediation of the sanitary waste system and an underground tank containing radionuclides and PCBs, which included removing or abandoning four inactive waste system sites;

- Completed the first phase of cleanup at the ARA; and

- Completed removal of numerous mixed waste incinerator components.

Waste Area Group 6/10 - Experimental Breeder Reactor No. 1/ Boiling Water Reactor Experiment, Miscellaneous Sites, Snake River Plain Aquifer

The following accomplishments were achieved at the WAG 6/10 in 2002:

- Transmitted the draft Operable Unit 10-08 RI/FS work plan to the DOE-ID for transmittal to the agencies in March;

- Transmitted the Draft Record of Decision for EBR-I/Boiling Water Reactor Experiment (BORAX) Areas and Miscellaneous Sites to the agencies in April;

- Completed draft ROD for the EBR-I/BORAX areas and miscellaneous sites;

- Submitted ROD for the comprehensive examination of impacts on the Snake River Plain

Aquifer and miscellaneous sites, which incorporated the public's suggestion to prioritize higher-risk sites so they are addressed first;

- Submitted draft RI/FS Work Plan for Sitewide groundwater;
- Submitted draft final OU 10-04 Comprehensive RI/FS ROD to agencies for review in July;
- Completed the work plan for the cleanup investigations of INEEL Sitewide groundwater contamination; and
- Completed a report on conceptual models of subsurface contaminant transport in the INEEL subsurface.

Waste Area Group 7 - Radioactive Waste Management Complex

The WAG 7 also includes the Subsurface Disposal Area (SDA), a 39-ha (97 acre) disposal area containing buried hazardous and radioactive waste. Organic solvents contained in this waste are a source of groundwater contamination and are being removed by an ongoing cleanup action. Projects are currently underway to gain more information about the contents of the pits and trenches of the SDA to aid decision-makers in determining the best treatment technology. The following accomplishments were achieved at the WAG 7 in 2002:

- Continued the Organic Contamination in the Vadose Zone Project, which vacuums solvent vapors that have escaped from buried waste. The vapors are brought to the surface and destroyed using thermal and catalytic processes. Since the beginning of operations in January 1996, more than 61,689 kg (136,000 lb) of these contaminants have been removed and destroyed, including more than 38,500 kg (~85,000 lb) of carbon tetrachloride; and
- Ongoing studies identified several different remediation options for the entire SDA, including transurance, mixed, and low-level radioactive waste.

In 2002, the State, EPA, and DOE-ID agreed on new enforceable deadlines for both Pit 9 and the comprehensive RI/FS for the SDA. The agencies also agreed on a revised technical approach, the Glovebox Excavator Method or GEM project to demonstrate retrieval from a small ara. This limited demonstration will be followed by a complete remediation of Pit 9, called the Stage III project.

At GEM, workers will remotely excavate wastes and examine them in a shielded confinement structure or glovebox. The glovebox operates under negative air pressure to prevent contamination from escaping. The waste will be treated for shipment to the WIPP. Construction was initiated in 2002 for the glovebox excavator, four months ahead of schedule, and it was 45 percent complete by the end of the calendar year. The GEM project will retrieve 57 to 96 m^3 (75 to 125 yd^3) of waste buried in a portion of the 0.4 ha (1-acre) Pit 9 and sample the underlying soils. Excavation could begin as early as September 2003.

New enforceable deadlines established for Pit 9 resulted in new enforceable deadlines for the comprehensive investigation. The revised schedule calls for the draft remedial investigation and

baseline risk assessment by August 31, 2005; the draft feasibility study by December 31, 2005; and the draft ROD by December 31, 2006.

Waste Area Group 8 - Naval Reactors Facility

NRF receives and inspects spent nuclear fuel from defense activities. Remote-handled low-level waste from these operations is currently sent to the RWMC for disposal. The following accomplishment was achieved at the WAG 8 in 2002:

- Completed Phase I remedial actions at three of the remaining five sites of concern.

Waste Area Group 9 - Argonne National Laboratory-West

ANL-W has a long history in nuclear technology, including the development of instruments for assaying transuranic waste. In addition to being a partner in nuclear energy research and development, ANL-W facilities and expertise are used to support INEEL's management of transuranic waste.

Contaminated sites at ANL-W include tanks and wastewater handling/disposal systems, such as ditches and ponds. DOE has been testing the use of plants to remove both radioactive and nonradioactive constituents from contaminated soils at several sites at ANL-W. The results are promising and have been supported through additional testing. Soil verification sampling, scheduled for 2003, is expected to show these sites have met their remediation goals. The following accomplishment was achieved at WAG 9 in 2002:

- Continued phytoremediation program.

The end of calendar year 2002 marked the fourth year of phytoremediation. The DOE Chicago Operations Office believes the remediation goals have been met at each of the sites, thereby excluding the need to continue with phytoremediation. Soil sampling will be performed in 2003 to confirm this.

CERCLA Public Health Assessment

The Agency for Toxic Substances and Disease Registry is conducting a public health assessment of the INEEL as required by CERCLA for all sites on the National Priorities List. The focus of the public health assessment is to provide information that will further the goal of preventing and mitigating exposures to hazardous substances released to the environment. A draft of the public health assessment was submitted to interested federal, State, and Tribal government agencies for review in 2002. After these reviews are completed, the Agency will release a draft for public review and comment.

3.4 INEEL Long-term Stewardship Program

Completing the remediation activities at the INEEL in compliance with the regulatory agreements governing them will result in residual contamination remaining at some locations onsite. The sites where residual contaminants remain will require long-term stewardship (LTS) to prevent unacceptable contact between waste residue and the public and to initiate subsequent cleanup activities in the event of an unforeseen increase in contaminant transport through the soil or groundwater. The term LTS refers to all activities necessary to protect human health and the environment following completion of remediation, disposal, or stabilization of a site or a portion of a site. The INEEL considers the scope of LTS to also include conserving ecological and cultural resources and maintaining awareness of changes in technology, regulations, and policy affecting these stewarded sites.

While LTS activities such as monitoring groundwater, conducting surveillance of remedies and maintenance of caps and landfills, and restricting access to residually contaminated sites have been conducted for years at the INEEL under the auspices of several different programs, DOE recognized that management advantages could be gained by consolidating these similar activities into one program. In fiscal year 2000, DOE-ID developed a schedule for creating an INEEL LTS Plan, which would describe the strategic and tactical elements of a consolidated LTS Program at the INEEL. Creation of an LTS Program represents a management consolidation of post-remediation responsibilities, regardless of what law or agreement governs the remedy. Consolidating these activities does not change any agreed-upon obligations for the operation, maintenance, monitoring, institutional control, or post-closure care identified in RODs, Hazardous Waste Management Act/Resource Conservation and Recovery Act (RCRA) closure plans, or other agreements. Rather, creation of the INEEL LTS Program is a way to implement post-remediation responsibilities agreed to under a variety of regulations in a more efficient and focused manner.

Development of INEEL LTS Plan

The INEEL LTS Plan (DOE 2002) consists of two parts: (1) a strategic portion, in which the overall vision, mission, objectives, and goals of the program will be captured and (2) a tactical portion, which will document the specific activities and schedules necessary to achieve the vision, mission, objectives, and goals.

In 2002, an LTS Strategic Plan was developed. Regulators, environmental advocates, State and local governments, federal and State land and resource management agencies, the Shoshone-Bannock Tribes, and the general public helped develop the vision, mission, and objectives of the INEEL LTS Program that forms the foundation of the INEEL LTS Strategic Plan. The INEEL LTS Implementation Plan, identifying the tactical activities necessary for achieving the strategic elements, will be developed in fiscal year 2003. Combined, the two documents will constitute the INEEL LTS Plan.

3.5 Waste Management Program

The mission of the Waste Management Program (WMP) at the INEEL is to provide safe, compliant, and cost-effective management services for facility waste streams. Safe operations and compliance with federal, State, and local regulations are the highest priorities along with meeting the commitments made in the Idaho Settlement Agreement and the INEEL Site Treatment Plan. The main goals of the program are to reducing the total amount of wastes generated and to dispose of wastes.

Federal Facility Compliance Act

The Federal Facility Compliance Act requires the preparation of a site treatment plan for the cleanup of mixed wastes (those containing both radioactive and nonradioactive hazardous materials) at the INEEL.

In accordance with the final Site Treatment Plan, the INEEL began receiving offsite mixed waste for treatment in January 1996. The INEEL received mixed waste from other sites within the DOE complex including Hanford, Los Alamos, Paducah, Pantex, Sandia, and six locations managed by the Office of Naval Reactors. The INEEL stopped receiving offsite mixed waste for treatment at the Waste Experimental Reduction Facility (WERF) in 2000. The INEEL is storing the backlog of mixed waste in Resource Conservation and Recovery Act-permitted storage at WROC and INTEC. Disposal of the backlog mixed waste will occur by no later than 2006.

Treatment of the majority of the offsite waste was performed at the WROC until fiscal year 2000 using incineration, stabilization, neutralization, and carbon absorption technologies. Disposition of INEEL-generated mixed waste will be obtained from offsite commercial treatment and disposal vendors. Other offsite mixed wastes may be treated at the Advanced Mixed Waste Treatment Project Facility.

During 2002, seven Site Treatment Plan milestones were met:

- Commercial treatment backlog 207 m^3 (7310 ft^3);
- High-Level Waste Evaporator processing 644 m^3 (22,743 ft^3);
- Mercury waste shipment offsite;
- The ANL-W Sodium Components Maintenance Shop treated a backlog of 2.4 m^3 (85 ft^3);
- High-efficiency particulate air filter leach backlog treatment of 4.5 m^3 (159 ft^3) of backlogged filters;
- Debris treatment begin operation; and
- Advanced Mixed Waste Treatment Project, begin system testing.

Advanced Mixed Waste Treatment Project

The overall goal of the Advanced Mixed Waste Treatment Project is the treatment of alpha-containing low-level mixed and transuranic (TRU) wastes for final disposal by a process that minimizes overall costs while ensuring safety. This will be accomplished through a private sector treatment facility with the capability to treat specified INEEL waste streams and the flexibility to treat other INEEL and DOE regional and national waste streams. The facility will treat waste to meet the most current requirements; reduce waste volume and life-cycle cost to DOE; and perform tasks in a safe, environmentally compliant manner.

A contract for treatment services was awarded to British Nuclear Fuels Limited, Inc. in December 1996. They completed construction of the facility in December 2002, fulfilling a Settlement Agreement milestone. The project is slated to treat or repackage and ship starting in 2003.

High-Level Waste and Facilities Disposition

In 1953, reprocessing of spent nuclear fuel began at the INTEC, resulting in the generation of high-level waste, including radioactive liquid waste and sodium-bearing liquid waste. Those wastes were placed into interim storage in underground tanks at the INTEC Tank Farm. Treatment of those wastes began in 1963 through a process called calcining. The resultant waste form, known as calcine, was placed in storage in stainless steel bins at the Calcine Solids Storage Facility. Processing of spent nuclear fuel was curtailed in 1992. The INEEL completed calcining of all nonsodium-bearing liquid high-level waste on February 20, 1998, four months ahead of the June 30, 1998 Idaho Settlement Agreement milestone. Calcining of sodium-bearing liquid waste began immediately following completion of nonsodium liquid waste treatment, more than three years ahead of the Settlement Agreement milestone. DOE plans to process sodium-bearing waste into solid forms suitable for permanent disposal in a manner consistent with the Idaho High-Level Waste Advanced Disposition Final Environmental Impact Statement published September 2002 (DOE/EIS 0287). DOE plans on processing this waste on a schedule that meets the required date of 2012.

The calciner was placed on standby in 2000 while DOE determines whether to upgrade and permit the facility to current standards or develop a new method of treating the remaining stored liquid high-level waste. Treatment alternatives for the remaining liquid and calcined wastes were evaluated in the Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement (see Chapter 2, National Environmental Policy Act). The remaining 3.7 million L (1 million gal) of sodium-bearing liquid waste is stored in 1.14-million L (300,000-gal) underground tanks in the Tank Farm and the 4400 m^3 of mixed high-level waste calcine in bin sets. As of 2002, six of these tanks have been emptied and one of the tanks has been cleaned to State-approved RCRA standards.

Low-Level Radioactive Waste

Significant accomplishments were achieved during 2002 in the disposal of low-level waste stored and generated at the INEEL. Activities at the RWMC SDA were highlighted by the disposal of over 3988 m^3 (5216 yd^3) of legacy and newly generated low-level waste.

Transuranic Waste

The TRU Program accomplished a significant goal in 2002. The INEEL shipped 2075 m^3 (2713 yd^3) of TRU waste to the WIPP in Carlsbad, New Mexico. When combined with 2001 TRU waste shipments, this met the commitment to ship 3100 m^3 (4055 yd^3) of TRU waste to

WIPP two months ahead of the December 31, 2002, Settlement Agreement deadline. Approximately 60 percent of DOE's current inventory of contact-handled TRU waste is at the RWMC.

Waste Minimization/Pollution Prevention

The mission of the INEEL Pollution Prevention Program is to reduce the generation of wastes and pollutants by implementing cost-effective pollution prevention and waste minimization techniques, practices, and policies. Pollution prevention and waste minimization also required by various federal statutes, including but not limited to, the Pollution Prevention Act; RCRA; Executive Order 12856; and Executive Order 12873 (Federal Acquisition, Recycling, and Waste Prevention).

It is the policy of the INEEL to incorporate pollution prevention and waste minimization into every activity. Pollution prevention is one of the key underpinnings of the INEEL Environmental Management System (see Section 3.6). It functions as an important preventive mechanism because generating less waste reduces waste management costs, compliance vulnerabilities, and the potential for releases to the environment. The INEEL is promoting the inclusion of pollution prevention into all planning activities as well as the concept that pollution prevention is integral to mission accomplishment.

In 2002, the INEEL reported 38 pollution prevention projects, which resulted in a waste reduction of 13,906 metric tons (34,306 tons) and decreased the cost of operations by more than $9 million. Noteworthy pollution prevention accomplishments in 2002 include:

- Over 90,720 kg (200,000 lb) of radioactively contaminated lead from dismantled casks and shielding was fabricated into lead bricks and reused/recycled by the Idaho State University Accelerator Center, eliminating the need for waste processing and disposal as well as avoiding purchase of new lead bricks.

- The INEEL Excess Warehouse promoted surplus sales to the public for a variety of items including desks, chairs, used tires, scrap metal, and computer components, resulting in avoided waste disposal costs of $5,472,772. In addition to the cost savings, $294,284 in sales receipts will help to fund Warehouse operating expenses.

3.6 Environmental Management System

DOE-ID and the INEEL M&O contractor continued to make progress on the effort initiated in 1997 to develop and implement an INEEL-wide Environmental Management System (EMS). The EMS will meet the requirements of International Standards Organization (ISO) 14001, an international voluntary standard for environmental management systems. This standard is being vigorously embraced worldwide and within the DOE complex.

An EMS provides an underlying structure to make the management of environmental activities more systematic and predictable. The EMS focuses on three core concepts: pollution prevention, environmental compliance, and continuous improvement. The primary system components are (1) environmental policy, (2) planning, (3) implementation and operation, (4) checking and corrective action, and (5) management review. DOE-ID is pursuing an EMS enhancement development initiative for the Idaho workforce, and the M&O contractor is working on a parallel effort for the INEEL.

An audit and onsite readiness review conducted in 2001 by an independent ISO 14001 auditor concluded that INEEL was ready for a formal registration audit. A registration audit was conducted May 6-10, 2002, by a third-party registrar. There were no nonconformances identified during the audit and the lead auditor recommended ISO 14001 registration for INEEL facilities, which was received in June 2002. A semi-annual ISO 14001 surveillance conducted in November 2002, supporting maintenance of the registration, found no nonconformances with the ISO standard and highlighted the high degree of professionalism, environmental awareness, and ownership shown by INEEL personnel.

3.7 Other Major Environmental Issues and Activities

Decontamination, Decommissioning, and Demolition Activities

Decontamination, decommissioning, and demolition activities at the INEEL are primarily concerned with the safe and compliant decontamination and decommissioning of inactive facilities. These facilities fall under two broad categories: (1) structures potentially suitable for reuse and (2) structures not suitable for reuse. In the last four years more than 100 buildings have been demolished. Specific projects at various facilities are described below. In 2002, 43 buildings across the INEEL were closed, saving about $2.8 million in maintenance and operating costs.

Test Area North - The Maintenance Building (TAN-615) was decommissioned and decontaminated in 2002. Actions included removing radiologically contaminated hot spots and demolition and final grading of concrete flooring, sump, footings, and the building footprint. TAN-615 was a 390-m^2 (4200-ft^2) steel-framed building constructed in 1956 that housed general maintenance shops.

Power Burst Facility/Waste Reduction Operations Complex - Buildings housing equipment associated with WERF were decontaminated as part of a RCRA Closure in 2002. The WERF incinerator and all auxiliary systems were removed and will be disposed at an offsite facility. The WERF sizing and compaction building was decontaminated and demolished in 2002. The entire closure process will be completed by 2004.

Central Facilities Area - CFA Building 617 was demolished in 2002. The building was over 1022 m^3 (11,000 ft^2) and housed laundry facilities.

Spent Nuclear Fuel

Spent nuclear fuel (SNF) is defined as fuel that has been withdrawn from a nuclear reactor following irradiation and the constituent elements have not been separated. Upon removal, SNF contains some unused enriched uranium and radioactive fission products. Because of its radioactivity (primarily from gamma rays), it must propertly shielded. A large amount of DOE's spent nuclear fuel is from national defense and other programmatic missions. Most of the fuel stored at the INEEL is at the INTEC.

For several years, spent nuclear fuel was reprocessed so recovered fissile material could be reused. However, the need for fuel-grade uranium and plutonium decreased. A 1992 decision to stop reprocessing left a large quantity of spent nuclear fuel in storage.

DOE's spent nuclear fuel is stored in both wet and dry storage. Dry storage is preferred because it reduces concerns about corrosion and is less expensive to monitor. An effort is underway to put spent nuclear fuel in temporary dry storage so that it can be quickly readied for transport once a repository is completed. The INEEL's goal is to begin shipping spent nuclear fuel to a national repository by September 30, 2015. The Idaho Settlement Agreement, and a similar agreement with the state of Colorado, requires that all spent nuclear fuel must be out of Idaho by January 1, 2035.

Spent nuclear fuel transfers and storage facilities are described below.

Fluorinel Dissolution Process and Fuel Storage Facility - This INTEC facility CPP-666, also called FAST, is divided into two parts: a spent fuel storage area and the Fluorinel Dissolution Facility (FDF). This facility went operational in 1983. The storage area consists of six storage pools where spent nuclear fuel is stored under about 11 million L (3 million gal) of water, which provides protective shielding and cooling. Fuel formerly managed in the three storage pools at CPP-603, has been transferred to the newer underwater storage pools at FAST or to dry storage. Eventually, all spent nuclear fuel will be removed from underwater storage pools and placed in a dry storage system in preparation for shipment to a repository. The FDF includes a hot cell with 1.8-m (6-ft) thick concrete walls, where spent nuclear fuel was reprocessed by dissolving it in an acid solution, then chemically separating the uranium or plutonium from the waste products. The FDF was shut down after reprocessing ended in 1992.

Irradiated Fuel Storage Facility - The Irradiated Fuel Storage Facility (IFSF), the dry side of the Wet & Dry Fuel Storage Facility (CPP-603), provides dry storage for spent nuclear fuel. The original facility (the wet side - basins) went operational in 1953. The IFSF was added later and went operational in 1973. The facility has 636 storage positions and is over half full. The majority of the spent nuclear fuel stored at the IFSF came from the Fort St. Vrain commercial reactor in Colorado. These shipments stopped in 1991. Current and projected receipts at the IFSF include foreign and domestic research reactor fuel and spent nuclear fuel from two INEEL facilities: the Materials Test Reactor (MTR) and the PBF.

More than 98 cans of spent nuclear fuel in wet storage in the MTR canal and an additional 7 cans of spent nuclear fuel from ATR-603 Plug Storage Cells were transferred to interim dry storage at the IFSF in 2002.

TAN Hot Shop/Manufacturing & Assembly Facility - TAN Hot Shop/Manufacturing & Assembly Facility, TAN-607, contains a hot shop (for handling spent nuclear fuel), and a spent fuel storage basin. TAN-607 went operational in 1955. Loss-of-Fluid Test, commercial, and test reactor SNF (3.6891 MTHM) was transferred from wet storage in the basin, dried, placed within three casks, and the casks relocated to the storage pad, TAN-791, in 2002. In addition, 0.0385 MTHM of epoxied spent nuclear fuel from the TAN-607 Hot Shop was transferred to TAN-791.

TMI-2 Independent Spent Fuel Storage Installation - The Independent Spent Fuel Storage Installation (ISFSI) CPP-1774 is a new NRC-licensed dry storage area for spent fuel and debris from the Three-Mile Island reactor accident. Fuel and debris was transferred to the TAN for examination, study, and storage following the accident. After examination the spent fuel and debris were transferred to the ISFSI. The ISFSI provides safe, environmentally secure, aboveground storage for the spent fuel and debris, which is kept in metal casks inside concrete vaults.

Power Burst Facility - The PBF, built in 1970, supported DOE and NRC studies of reactor fuel during normal and off-normal operating conditions. The PBF operated as a one-of-a-kind facility, with the ability to subject fuel samples to extraordinary power surges in milliseconds, causing the fuel to fail in an isolated, contained system. The NRC then used that information in developing safe operating limits for the commercial nuclear industry. In 1985, the PBF reactor was placed on standby status. In 1998, the PBF was placed in shutdown status and is currently preparing for defueling. PBF fuels kept in the PBF Pool (PBF-620) are being prepared for transfer to the IFSF in 2003.

Peach Bottom Fuel Storage Facility - The Peach Bottom Fuel Storage Facility, CPP-749 consists of below ground vaults for the dry storage of spent nuclear fuel. Located on approximately 5 paved acres, this facility houses 193 underground vaults of various sizes for the dry storage of nuclear fuel rods. The vaults are generally constructed of carbon steel tubes with some of them containing concrete plugs. All of the tubes are totally below grade and are accessed from the top using equipment specifically designed for this use. This facility stores Peach Bottom fuel as well as other unirradiated fuels.

Fort Saint Vrain Independent Spent Fuel Storage Installation - The Department manages this off site NRC-licensed dry storage facility containing about 2/3 of the spent nuclear fuel generated by the Ft. St. Vrain reactor in Ft. St. Vrain, Colorado.

Sagebrush Steppe Ecosystem Reserve

In 1999, DOE signed a Memorandum of Understanding with the Bureau of Land Management, the U.S. Fish and Wildlife Service, and the Idaho Fish and Game Department to establish the INEEL Sagebrush Steppe Ecosystem Reserve. The reserve includes approximately 30,000 ha (74,000 acres) of high-desert land within the INEEL boundaries that are used by 270 animal species and 400 plant species and compose one of the last undisturbed sagebrush steppe ecosystems in the United States. It is part of a complex wide effort by DOE to identify, protect, and conserve environmentally significant parcels of land in partnership with federal and state agencies.

The agreement charters the Bureau of Land Management with the development of a management plan that will provide management direction to DOE for protection of this unique

habitat for scientific study and the benefit of future generations. The Bureau of Land Management issued the draft management plan for public review and comment in September 2002 and held several public meetings to discuss the draft plan. Among the issues discussed in the plan are wildfire and wildfire suppression, livestock grazing, road management, and protection of cultural and tribal resources. The Bureau of Land Management is also working on a National Environmental Policy Act environmental assessment for the reserve that will be released in 2003.

Water Integration Project

DOE-ID established the Water Integration Project in January 2002 to better coordinate operations, scientific research, and subsurface monitoring programs at the INEEL. The ultimate goal of the program is to reduce risk to the public, workers, and the environment. The project objectives are to

- Enhance scientific understanding of surface water, groundwater, and contaminant movement at the INEEL;
- Strengthen and better coordinate groundwater and vadose zone monitoring programs;
- Improve the technical basis for making cleanup decisions to ensure that the Snake River Plain Aquifer is protected for the long term;
- Identify and fill gaps in understanding of contaminant and water movement;
- Establish an expert peer review panel to review the project's technical products;
- Emphasize clarity, consistency, and accessibility in information management; and
- Engage the public and stakeholder organizations in meaningful dialogue throughout the life of the project.

For more information, access the Water Integration Project website at http://www.inel.gov/environment/water/.

Environmental Oversight and Monitoring Agreement

The Environmental Oversight and Monitoring Agreement between DOE-ID, DOE Naval Reactors, Idaho Branch Office, and the state of Idaho maintains the State's program of independent oversight and monitoring established under the first agreement creating the state of Idaho INEEL Oversight Program. The main objectives as established under the current five year agreement are to

- Assess the potential impacts of present and future DOE activities in Idaho;
- Assure citizens of Idaho that all present and future DOE activities in Idaho are protective of the health and safety of Idahoans and the environment; and

- Communicate the findings to the citizens of Idaho in a manner that provides them the opportunity to evaluate potential impacts of present and future DOE activities in Idaho.

The INEEL Oversight Program's main activities include environmental surveillance, radiological emergency planning and response, impact assessment, and public information. More information can be found on the Oversight Program website at http://www.oversight.state.id.us/.

Citizens Advisory Board

The INEEL Citizens Advisory Board, one of the Environmental Management Site-Specific Advisory Boards, was formed in March 1994. Its charter is to provide input and recommendations on DOE Environmental Management's strategic decisions that impact future use, risk management, economic development, and budget prioritization activities.

The Citizens Advisory Board has produced 101 recommendations during its tenure. In 2002, the Board made recommendations on the following 14 topics:

- Draft DOE Long-Term Stewardship Strategic Plan;
- Implementation of the DOE Long-Term Stewardship Strategic Plan;
- Implementation of the DOE Long-Term Stewardship Plan at the INEEL;
- Community Forum to Define the Future of the INEEL;
- Proposed Plan for Operable Unit 10-04; Waste Area Group 6 and 10;
- INEEL Long-Term Stewardship Vision, Mission, Goals, and Objectives;
- Public Involvement to Support Priority Setting for the Expedited Cleanup Agreement at the INEEL;
- Science and Technology Budget for Fiscal Year 2003;
- Draft DOE-ID Strategic Plan;
- Stakeholder Involvement Plan for the INEEL Water Integration Project;
- Draft Environmental Management Performance Management Plan for Accelerating Cleanup of the INEEL;
- Draft INEEL Wildland Fire Management Environmental Assessment;
- Site Transition Framework for Long-Term Stewardship; and
- Final Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement.

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Chapter 4 - Environmental Monitoring Program - Air

Chapter Highlights

The Idaho National Engineering and Environmental Laboratory (INEEL) environmental surveillance programs, conducted by the Management and Operating (M&O) contractor and the Environmental Surveillance, Education and Research (ESER) contractor, emphasizes measurement of airborne radionuclides because air transport is considered the major potential pathway from INEEL releases to receptors. The M&O contractor monitors airborne effluents at individual INEEL facilities and ambient air outside the facilities to comply with appropriate regulations and Department of Energy (DOE) Orders. The ESER contractor samples ambient air at locations within, around, and distant from the INEEL.

An estimated total of 10,442 curies of radioactivity, primarily in the form of short-lived noble gas isotopes, was released as airborne effluents in 2002. Samples of airborne particulates, atmospheric moisture, and precipitation were analyzed for gross alpha and gross beta activity, as well as for specific radionuclides, primarily tritium, strontium-90, iodine-131, cesium-137, plutonium-239/240, and americium-241. Results do not indicate any link between radionuclides released from the INEEL and environmental concentrations measured offsite. All concentrations were well below regulatory standards and within historical measurements.

Nonradiological pollutants, including nitrogen dioxide and particulates, were monitored at select locations around the INEEL. All results were well below regulatory standards.

4. ENVIRONMENTAL MONITORING PROGRAMS - AIR

This chapter presents the results of radiological and nonradiological analyses performed on airborne effluents and ambient air samples taken at locations both on the INEEL and offsite. Results from sampling conducted by the M&O contractor and the ESER contractor are presented. Results are compared to the U.S. Environmental Protection Agency (EPA) health based levels established in environmental statutes and/or the U.S. Department of Energy (DOE) Derived Concentration Guide (DCG) for inhalation of air (Appendix A).

4.1 Purpose and Organization of Air Monitoring Programs

The facilities operating on the INEEL release both radioactive and nonradioactive constituents into the air. Various pathways (such as air, soil, plants, animals and groundwater) may transport radioactive and nonradioactive materials from the INEEL to nearby populations. These transport pathways have been ranked in terms of relative importance (EG&G 1993). The results of the ranking analysis indicates that air is the most important transport pathway. The INEEL environmental surveillance programs, conducted by the M&O contractor and the ESER contractor, emphasize measurement of airborne radionuclides because air has the potential to transport a large amount of activity to a receptor in a relatively short period and can result in direct exposure to offsite receptors. Table 4-1 summarizes the air monitoring activities conducted by each organization at the INEEL.

The M&O contractor monitors airborne effluents at individual INEEL facilities and ambient air outside the facilities to comply with applicable statutory requirements and DOE orders. The M&O contractor collected approximately 3400 air samples, primarily on the INEEL, for analyses in 2002.

The ESER contractor collects samples from over an approximately 23,309 km^2 (9,000 mi^2) area of southeastern Idaho at locations on, around, and distant to the INEEL. The ESER Program collected approximately 2600 air samples, primarily off the INEEL for analyses in 2002.

Section 4.2 summarizes results of air monitoring by the M&O and ESER contractors. Section 4.3 discusses air sampling performed by the M&O contractor in support of waste management activities. Section 4.4 summarizes selected air results.

Unless specified otherwise, the radiological results presented in the following sections are those that are greater than two times the associated analytical uncertainty (see Appendix B for information on statistical methods). Each individual result is reported as the measurement plus or minus 2 standard deviations (± 2s) uncertainty for that radiological analysis.

4.2 Air Sampling

Airborne effluents are measured at regulated facilities as required under Idaho State regulations. Monitoring or estimating effluent data is the responsibility of programs associated with the operation of each INEEL facility and not the environmental surveillance programs.

Environmental surveillance of air pathways is the responsibility of the M&O contractor (specifically, the Site Environmental Surveillance Program) and the ESER contractor. Figure 4-1 shows the surveillance air monitoring locations for the INEEL environmental surveillance programs.

The INEEL environmental surveillance programs contractors collect filters from a network of low-volume air monitors weekly. Air flows at an average of about 57 L/min (2 cfm) through a set of filters consisting of a 5-cm (2 in.) 1.2-µm pore membrane filter followed by a charcoal cartridge. The membrane filters are analyzed weekly for gross alpha and gross beta activity.

Table 4-1. Air monitoring activities by organization.

	Airborne Effluent Monitoring Programs	Environmental Surveillance Programs									
Area/Facility [a]	Airborne Effluents [b]	Low-Volume Charcoal Cartridges (iodine-131)	Low-volume Gross Alpha	Low-volume Gross Beta	Specific Radionuclides [c]	Atmospheric Moisture	Precipitation	Suspended Particulates	Filtered Particulates (PM_{10})[d]	Nitrogen Dioxide	IMPROVE samplers
Argonne National Laboratory-West											
ANL-W	◆				◆						
Management and Operating Contractor											
INTEC	◆										
TAN	◆										
PBF/WROC	◆										
INEEL		◆	◆	◆	◆	◆		◆	◆	◆	
Naval Reactors Facility											
NRF[f]	◆										
Environmental Surveillance, Education and Research Program											
INEEL/Regional		◆	◆	◆	◆	◆	◆	◆	◆		◆[e]
National Oceanic and Atmospheric Administration											
INEEL/Regional						◆	◆	◆	◆		
INEEL Oversight Program Environmental Surveillance Program[g]											
INEEL/Regional		◆				◆	◆		◆		

a. ANL-W = Argonne National Laboratory-West, INTEC = Idaho Nuclear Technology and Engineering Center, TAN = Test Area North, PBF/WROC = Power Burst Facility/Waste Reduction Operations Complex, and NRF = Naval Reactors Facility.

b. Facilities with stacks that require continuous monitoring for compliance with 40 Code of Federal Regulations (CFR) 61, Subpart H, National Emissions Standards for Hazardous Air Pollutants (NESHAP) Regulation. The exception is NRF. See footnote f.

c. PM_{10} = particles with an aerodynamic diameter less than or equal to 10 microns.

d. Gamma-emitting radionuclides and strontium-90, plutonium-238, plutonium-239/240, and americium-241.

e. The IMPROVE samplers are operated by the National Park Service for the Environmental Protection Agency.

f. NRF is not required to continuously monitor any stack for NESHAP compliance. However, NRF has a number of stacks and vents with emissions that are monitored and calculated by NRF for confirmation that emissions continue to be below regulatory limits. The NRF source terms are included in the INEEL's calculation of the annual dose to the public for NESHAP compliance (Chapter 7).

g. This program, administered by the state of Idaho, generates data that can be used to verify and supplement the results reported by the Management and Operating Contractor and the Environmental Surveillance, Education and Research Program. The data are reported separately by the state of Idaho and are not reported in this report.

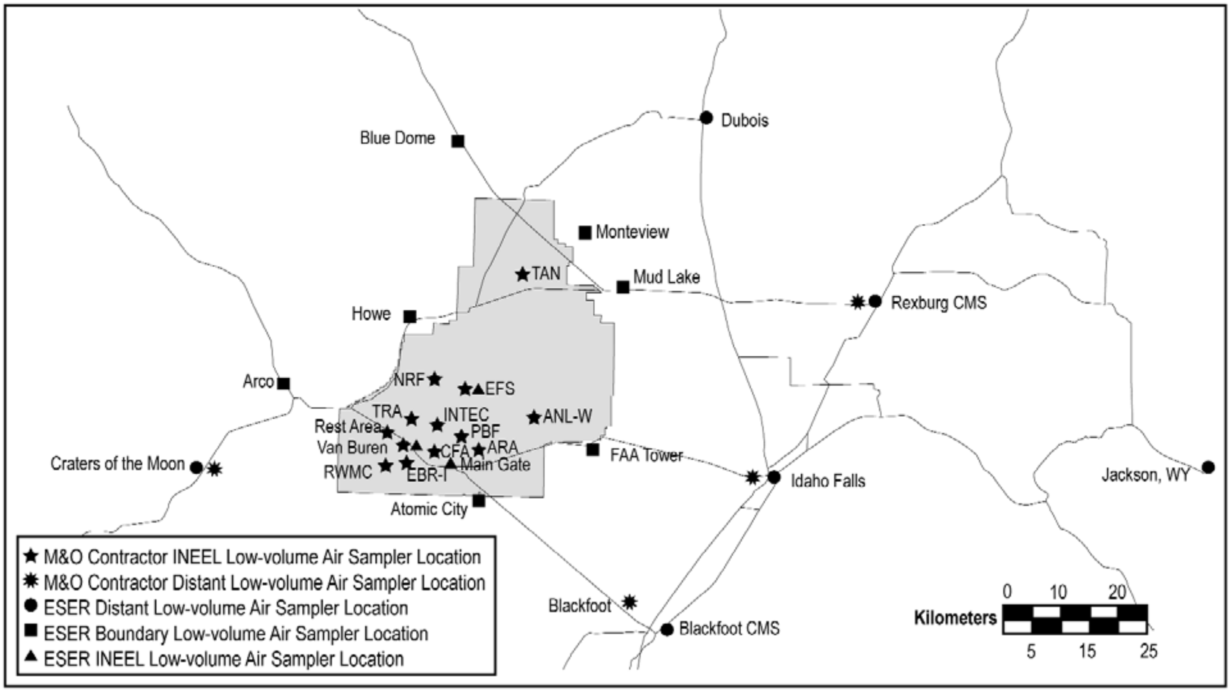


Figure 4-1. INEEL environmental surveillance air sampling locations.

Filters are then composited quarterly by location for analyses of gamma-emitting radionuclides using gamma spectrometry and for specific alpha- and beta-emitting radionuclides using radiochemical techniques. In addition to the membrane filter samples, charcoal cartridges are collected and analyzed weekly specifically for iodine-131 (^{131}I), using gamma spectrometry.

There is no requirement to monitor the dust burden at the INEEL, but the M&O and the ESER contractors monitor this to provide comparison information for other monitoring programs and to the DOE-Idaho Operations Office (DOE-ID). The suspended particulate dust burden is monitored with the same low-volume filters used to collect the radioactive particulate samples by weighing the filters before and after their use in the field.

The M&O and the ESER contractors also monitor particles with an aerodynamic diameter less than or equal to 10 microns (PM_{10}) to comply with EPA air quality standards.

Sulfur dioxide measurements were recorded in past years to confirm that the INEEL does not release significant amounts of sulfur dioxide with respect to national ambient air quality standards. The M&O contractor no longer monitors sulfur dioxide.

Tritium in water vapor in the atmosphere is monitored by the M&O and ESER contractors using samplers located at two onsite locations (Experimental Field Station [EFS] and Van Buren Boulevard) and five offsite locations (Atomic City, Blackfoot, Craters of the Moon, Idaho Falls, and Rexburg). Air passes through a column of absorbent material (silica gel or molecular sieve) that absorbs water vapor in the air. Columns are changed when the material absorbs sufficient moisture to obtain a sample. Water is extracted from the material by distillation and collected.

Tritium concentrations are then determined by liquid scintillation counting of the water extracted from the columns.

Airborne Effluents

During 2002, a reported 10,442 Ci of radioactivity was released to the atmosphere from all INEEL sources. *The National Emissions Standards for Hazardous Air Pollutants (NESHAP) - Calendar Year 2002 INEEL Report for Radionuclides* (DOE-ID 2002) describes three categories of airborne emissions. The first category includes sources that require continuous monitoring under the NESHAP regulation. The second category consists of releases from other point sources. The final category is nonpoint, or diffuse, sources. These include radioactive waste ponds and contaminated soil areas. The NESHAP document only reports the first category results, whereas all three categories are included in Table 4-2 of this report.

The largest facility contributions to the total emissions came from the Idaho Nuclear Technology and Engineering Center (INTEC) at over 80 percent, Test Reactor Area (TRA) at 13 percent, and Argonne National Laboratory-West at 6 percent (Table 4-2). Approximately 88 percent of the radioactive effluent was in the form of noble gases (argon, krypton, and xenon). Most of the remaining 12 percent was tritium.

Low-volume Charcoal Cartridges

Both the ESER and M&O contractors collected charcoal cartridges weekly and analyzed them for gamma-emitting radionuclides. Charcoal cartridges are used primarily to collect gaseous radioiodines. If traces of any human-made radionuclide were detected, the filters were individually analyzed. During 2002, the ESER contractor analyzed 841 cartridges, looking specifically for ^{131}I. No ^{131}I was detected in any of the individual ESER samples. No iodine was detected in samples collected by the M&O contractor.

Low-volume Gross Alpha

Particulates filtered from the air were sampled from 28 locations weekly as part of the INEEL environmental surveillance programs (see Figure 4-1). All were analyzed for gross alpha activity and gross beta activity. Gross alpha concentrations found in ESER contractor samples, both on and offsite, tended to be higher than those found in M&O contractor samples at common locations. Reasons for differences in concentrations measured at the same locations are likely due to differences in laboratory analytical techniques and instrumentation, as different analytical laboratories were used. Both sets of data indicated gross alpha concentrations at distant locations were generally equal to or higher than at boundary and onsite locations.

Weekly gross alpha concentrations in ESER contractor samples that exceeded their 2s uncertainty ranged from a minimum of $(0.62 \pm 0.59) \times 10^{-15}$ µCi/mL at Blue Dome in April to a maximum of $(7.0 \pm 1.2) \times 10^{-15}$ µCi/mL during December at the Blackfoot Community Monitoring Stations (CMS). Concentrations measured by the M&O contractor that exceeded their 2s uncertainty ranged from a low of $(1.1 \pm 1.0) \times 10^{-15}$ µCi/mL in January at TRA to a high of $(5.1 \pm 1.3) \times 10^{-15}$ µCi/mL at TRA in December.

Table 4-2. Radionuclide composition of INEEL airborne effluents (2002).[a]

Effluent Type[b]	Radionuclide	Half-Life	Airborne Effluent (Ci)[c] ANL-W	CFA	INTEC[d]	RWMC	PBF	NRF	TAN	TRA	Total
Noble gases	^{85}Kr	10.7 yr	641	--	7,540	--	6.96×10^{-4}	0.12	2.11×10^{-6}	--	**8181**
	^{41}Ar	1.83 h	--	--	--	--	--	--	--	1050	**1050**
	^{135}Xe	9.10 h	--	--	--	--	--	--	--	11.20	**11.2**
	^{133}Xe	5.25 d	--	--	--	--	--	--	--	5.09	**5.09**
	^{85m}Kr	4.4 h	--	--	--	--	--	--	--	1.88	**1.88**
Particulates	^{60}Co	5.27 yr	--	8.49×10^{-6}	5.88×10^{-4}	8.17×10^{-16}	1.49×10^{-6}	3.8×10^{-7}	1.57×10^{-6}	0.020	**0.026**
	$^{90}Sr/^{90}Y$	28.6 yr	3.40×10^{-6}	1.69×10^{-6}	0.11	5.16×10^{-10}	7.40×10^{-6}	1.1×10^{-4}[e]	1.74×10^{-5}	5.59×10^{-4}	**0.11**
	$^{137}Cs/^{137}Ba$	30.2 yr	--	6.93×10^{-6}	0.11	8.17×10^{-17}	4.32×10^{-5}	2.7×10^{-4}	1.24×10^{-4}	1.12×10^{-4}	**0.11**
	$^{125}Sb/^{125m}Te$	2.73 yr	--	--	5.04×10^{-5}	--	7.15×10^{-9}	--	1.12×10^{-11}	1.12×10^{-10}	**5.11×10^{-5}**
	^{241}Pu	13.2 yr	--	--	.023	--	5.6×10^{-9}	--	7.71×10^{-9}	1.89×10^{-5}	**0.023**
	^{154}Eu	16 yr	--	--	2.99×10^{-4}	--	2.66×10^{-9}	--	5.86×10^{-10}	7.52×10^{-5}	**3.74×10^{-4}**
	^{152}Eu	12.7 yr	--	--	1.81×10^{-4}	--	1.72×10^{-9}	--	1.28×10^{-10}	7.01×10^{-5}	**2.51×10^{-4}**
	^{241}Am	458 yr	--	--	--	--	--	--	--	2.10×10^{-5}	**2.10×10^{-5}**
	^{239}Pu	2.4×10^{4} yr	2.32×10^{-7}	1.40×10^{-10}	7.88×10^{-4}	5.16×10^{-10}	1.34×10^{-7}	5.6×10^{-6}[e]	2.40×10^{-8}	1.04×10^{-5}	**8.05×10^{-5}**
	^{240}Pu	6,580 yr	--	--	4.00×10^{-4}	--	2.30×10^{-11}	--	3.57×10^{-9}	4.20×10^{-5}	**4.42×10^{-4}**
	^{238}Pu	87.7 yr	--	6.67×10^{-11}	1.91×10^{-4}	--	3.40×10^{-10}	--	1.99×10^{-10}	2.67×10^{-6}	**1.93×10^{-4}**
Tritium, ^{14}C, and Iodine Isotopes	Tritium	12.3 yr	4.84	--	872	51.0	4.35	.051	0.13	250	**1180**
	^{14}C	5,700 yr	--	--	1.04×10^{-3}	0.86	1.22×10^{-3}	0.37	2.62×10^{-16}	1.06×10^{-6}	**1.24**
	^{129}I	1.6×10^{7} yr	--	--	0.12	--	1.51×10^{-7}	--	1.82×10^{-6}	9.08×10^{-6}	**0.12**
	^{131}I	8.04 d	--	--	--	--	--	1.2×10^{-7}	--	.0046	**0.0046**
	Total		**646.78**	**1.47×10^{-4}**	**8410**	**51.90**	**4.35**	**0.54**	**0.13**	**1330**	**10,442**

a. Radioactive release information provided by Bechtel/Babcock and Wilcox, Idaho, LLC. June 2002.
b. Includes only those radionuclides with releases greater then 1×10^{-7} Ci.
c. A double dash signifies the radionuclide was not released to air from that facility during the calendar year.
d. Most of the INTEC emissions are from the Three Mile Island Dry Fuel Storage Facility and are based on conservative calculations.
e. Values for ^{90}Sr and ^{239}Pu reported by NRF are actually gross beta and gross alpha results, respectively, but are reported as these radionuclides for ease of comparison.

Figure 4-2 displays the median weekly gross alpha concentrations for the ESER and M&O contractors at INEEL, boundary, and distant station groups. Each weekly median was computed using all measurements, including those less than their associated 2s uncertainties. These data are typical of the annual natural fluctuation pattern for gross alpha concentrations in air. The highest median weekly concentration of gross alpha occurred for the distant group in the third quarter of 2000. The maximum median weekly gross alpha concentration was 5.5 x 10^{-15} µCi/mL and is below the DCG for the most restrictive alpha-emitting radionuclide in air [americium-241 (^{241}Am)] of 20 x 10^{-15} µCi/mL.

Annual median gross alpha concentrations calculated by the ESER contractor (Table 4-3) ranged from 1.1 x 10^{-15} µCi/mL at Blue Dome to 2.0 x 10^{-15} µCi/mL at Rexburg CMS. M&O contractor data indicated an annual median range of 0.5 x 10^{-15} µCi/mL at the Radioactive Waste Management Complex (RWMC) and INTEC to 1.6 x 10^{-15} µCi/mL at Rexburg (Table 4-3). Confidence intervals are not calculated for annual medians.

Gross alpha concentrations were, in general, typical of those measured previously and well within the range of measurements observed historically. Gross alpha activity measured in filters from 1997 through 2002 at levels greater than their 2s uncertainty ranged from a minimum of (0.3 ± 0.2) x 10^{-15} to (7.4 ± 5.1) x 10^{-15} µCi/mL.

Low-volume Gross Beta

Gross beta concentrations in ESER contractor samples were fairly consistent with those found in M&O contractor samples.

Weekly gross beta concentrations in ESER contractor samples that exceeded their 2s uncertainty ranged from a low of (0.7 ± 0.1) x 10^{-14} µCi/mL during November at the Blackfoot CMS to a high of (13.1 ± 0.4) x 10^{-14} µCi/mL at the Main Gate in December. Concentrations measured above 2s by the M&O contractor ranged from a low of (0.6 ± 0.4) x 10^{-14} µCi/mL at the Rest Area in April to a high of (11.3 ± 0.8) x 10^{-14} µCi/mL at the EFS in December.

Figure 4-3 displays the median weekly gross beta concentrations for the ESER and M&O contractors at INEEL, boundary, and distant station groups. These data are typical of the annual natural fluctuation pattern for gross beta concentrations in air, with higher values generally occurring at the beginning and end of the calendar year during winter inversion conditions. The highest median weekly concentration of gross beta was detected in the fourth quarter of 2002. Each median value was calculated using all measurements, including those less than their associated 2s uncertainties. The maximum median gross beta concentration was 1.2 x 10^{-14} µCi/mL and is significantly below the DCG of 300 x 10^{-14} µCi/mL for the most restrictive beta-emitting radionuclide in air (radium-228 [^{228}Ra]).

Annual median gross beta concentrations are shown in Table 4-4. ESER contractor annual median gross beta concentrations ranged from 2.5 x 10^{-14} µCi/mL at Rexburg CMS to 2.9 x 10^{-14} µCi/mL at EFS. M&O contractor data indicated an annual median range of 2.1 x 10^{-14} µCi/mL at the RWMC to 3.2 x 10^{-14} µCi/mL at EFS. In general, the levels of airborne radioactivity for the three groups (INEEL, boundary, and distant locations) tracked each other

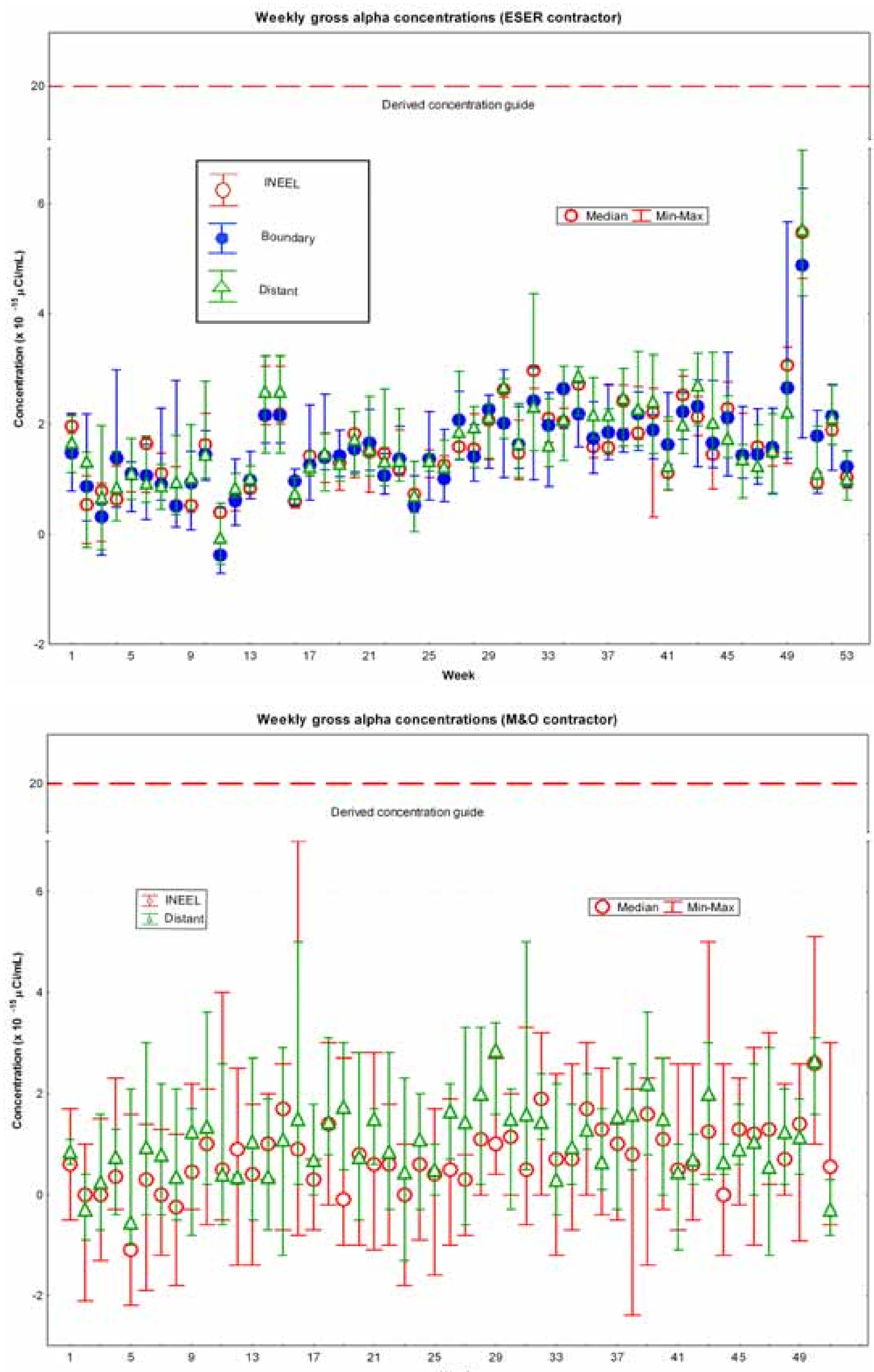


Figure 4-2. Median weekly gross alpha concentrations in air (2002).

Table 4-3. Gross alpha activity in air (2002).[a]

ESER Contractor Data			Concentration[b]	
Group	**Location**	**No. of Samples**	**Range of Samples**	**Annual Median**
Distant	Blackfoot CMS	53	-0.05 – 6.97	1.46
	Craters of the Moon	53	-0.39 – 4.89	1.41
	Dubois	53	-13.43 – 21.30	1.49
	Idaho Falls	53	0.18 – 5.34	1.91
	Jackson	53	0.14 –4.32	1.53
	Rexburg CMS	52	0.57 – 6.35	1.98
			Distant Median:	**1.58**
Boundary	Arco	106[c]	-0.16 – 6.44	1.64
	Atomic City	53	-0.58 – 5.40	1.48
	Blue Dome	53	-3.91 – 3.73	1.13
	Federal Aviation Administration Tower	52	-0.54 – 4.85	1.36
	Howe	106[c]	-2.53 – 5.17	1.66
	Monteview	52	-0.38– 5.67	1.50
	Mud Lake	53	-0.71 – 6.27	1.93
			Boundary Median:	**1.56**
INEEL	EFS	53	-0.12 – 5.47	1.54
	Main Gate	53	-0.17 – 6.28	1.55
	Van Buren	53	-0.32 – 4.64	1.50
			INEEL Median:	**1.50**
M&O Contractor Data			**Concentration[a]**	
Group	**Location**	**No. of Samples**	**Range of Samples**	**Annual Median**
Distant	Blackfoot	53	-1.00 – 3.60	1.00
	Craters of the Moon	53	-1.10 – 3.10	0.50
	Idaho Falls	53	-1.30 – 3.60	1.10
	Rexburg	53	-0.80 – 5.00	1.60
			Distant Median:	**1.00**
INEEL	ANL-W	53	-1.40 – 4.00	0.80
	ARA	52	-1.60 – 3.00	0.70
	CFA	53	-1.20 – 2.20	0.60
	EBR-I	51	-1.90– 2.50	0.70
	EFS	51	-1.20 – 5.00	0.60
	INTEC	53	-1.40– 3.70	0.50
	NRF	53	-2.40– 3.20	0.60
	PBF	54	-0.80 – 4.00	1.20
	Rest Area	53	-1.80 – 3.40	0.80
	RWMC	52	-2.20– 2.00	0.50
	TAN	53	-0.80– 2.80	0.60
	TRA	52	-2.10 – 5.10	0.90
	Van Buren	53	-1.80 – 7.00	0.90
			INEEL Median:	**0.70**

a. All values are x 10^{-15} µCi/mL.

b. All measurements, including those less than two times their analytical uncertainty, are included in this table and in computation of annual median values. A negative result indicates that the measurement was less than the laboratory background measurement.

c. Includes duplicate measurements at this station.

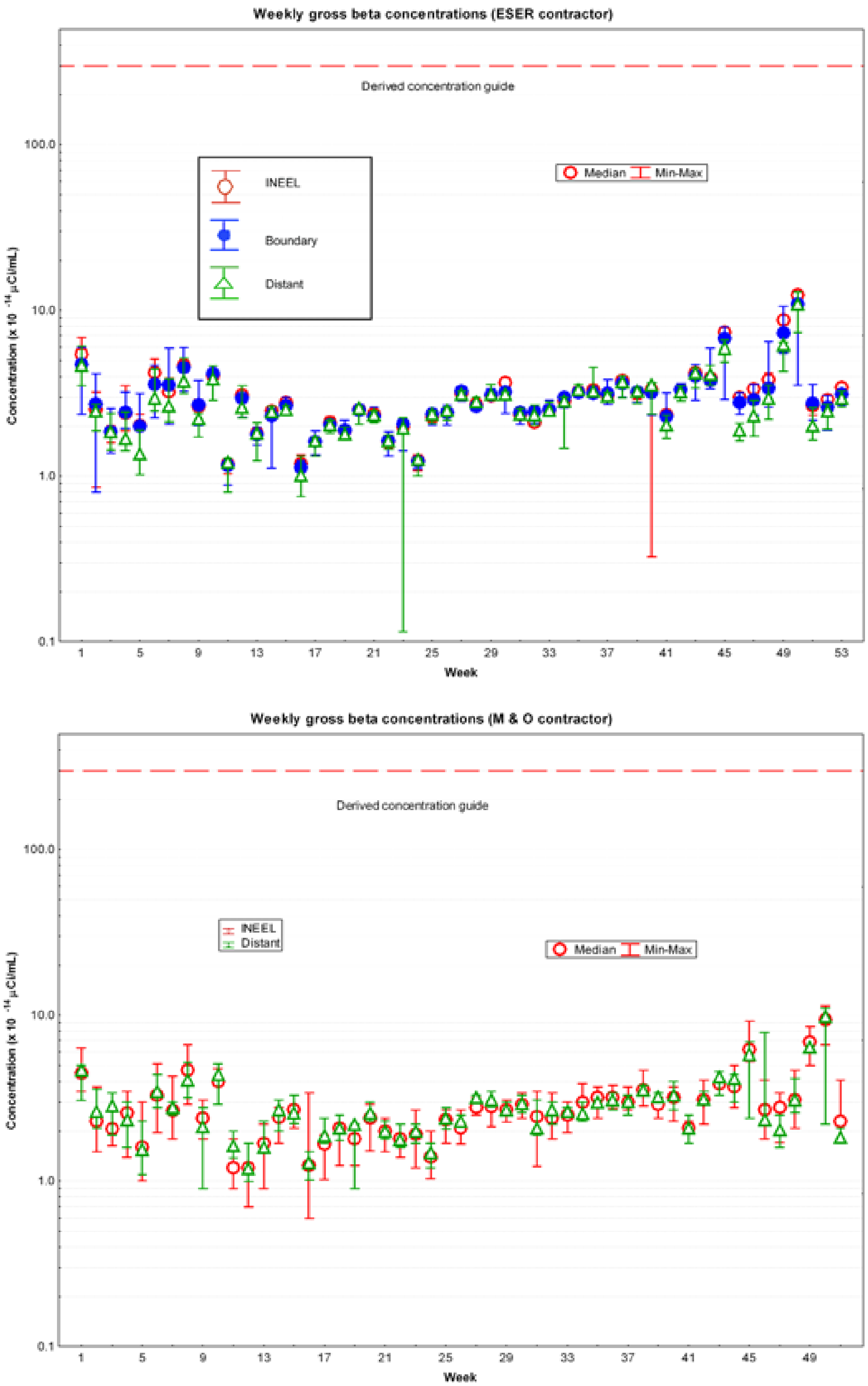


Figure 4-3. Median weekly gross beta concentrations in air (2002).

Table 4-4. Gross beta activity in air (2002).

ESER Contractor Data			Concentration[a]	
Group	**Location**	**No. of Samples**	**Range of Samples**	**Annual Median**
Distant	Blackfoot CMS	53	0.8 – 12.94	2.52
	Craters of the Moon	53	0.96 – 9.64	2.54
	Dubois	53	1.16 – 10.73	2.57
	Idaho Falls	53	0.12 – 11.0	2.82
	Jackson	53	0.92 – 11.9	2.62
	Rexburg CMS	52	0.76 – 7.37	2.51
			Distant Median:	**2.58**
Boundary	Arco	106[b]	1.05 –11.23	2.90
	Atomic City	53	0.88 – 10.33	2.72
	Blue Dome	53	-0.15 – 7.96	2.39
	Federal Aviation Administration Tower	52	0.80 – 11.0	2.53
	Howe	106[b]	1.00 – 11.00	2.87
	Monteview	52	1.10 – 10.54	2.83
	Mud Lake	53	1.29 – 11.26	3.09
			Boundary Median:	**2.74**
INEEL	EFS	53	1.19 – 12.37	2.94
	Main Gate	53	0.86 – 13.08	2.84
	Van Buren	53	1.04 – 11.04	2.86
			INEEL Median:	**2.90**
M&O Contractor Data			**Concentration[a]**	
Group	**Location**	**No. of Samples**	**Range of Samples**	**Annual Median**
Distant	Blackfoot	51	1.18 – 11.0	2.70
	Craters of the Moon	51	0.99 – 7.80	2.40
	Idaho Falls	51	1.20 – 9.60	2.70
	Rexburg	51	0.90 – 9.90	3.00
			Distant Median:	**2.69**
INEEL	ANL-W	52	0.90 – 9.00	2.40
	ARA	49	1.00 – 8.20	2.90
	CFA	51	0.82 – 9.40	2.50
	EBR-I	49	0.90 – 9.20	2.60
	EFS	49	1.20 – 11.30	3.20
	INTEC	51	0.70 – 9.60	2.70
	NRF	51	1.03– 9.60	2.77
	PBF	51	1.20 – 9.60	2.60
	Rest Area	51	0.60 – 9.80	2.60
	RWMC	51	0.61 – 6.60	2.13
	TAN	51	1.05 – 7.90	2.50
	TRA	50	1.02 – 9.80	2.62
	Van Buren	49	1.20 – 9.40	2.80
			INEEL Median:	**2.70**

a. All values are x 10^{-14} µCi/mL. All measurements, including those less than two times their analytical uncertainty, are included in this table and in computation of annual median values. A negative result indicates that the measurement was less than the laboratory background measurement.

b. Includes duplicate measurements at this station.

closely throughout the year. This indicates that the pattern of fluctuations occurred 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 INEEL.

In addition, all results greater than 2s reported by the ESER contractor are well within measurements taken within the last seven years (Figure 4-4). Figure 4-4 is a histogram of all measurements (greater than 2s) made from 1996 through 2002. The results are grouped by category and then plotted by frequency of occurrence of each category of values. The curve drawn on the figure best fits the frequency distribution of observed results and represents a lognormal function. This type of fit is typical of environmental measurements. The best estimate of central tendency of data that are lognormally distributed is the geometric mean, which is the mean of the logarithms of the results. The geometric mean of the historical data measured above the 2s uncertainty level is 3.3 x 10^{-14} Ci/mL, and the 95 percent confidence interval of these data (based on two standard geometric deviations of the mean) ranges from 0.8 x 10^{-14} to 14.5 x 10^{-14} µCi/mL. The maximum concentration measured in 2002 is within this confidence interval.

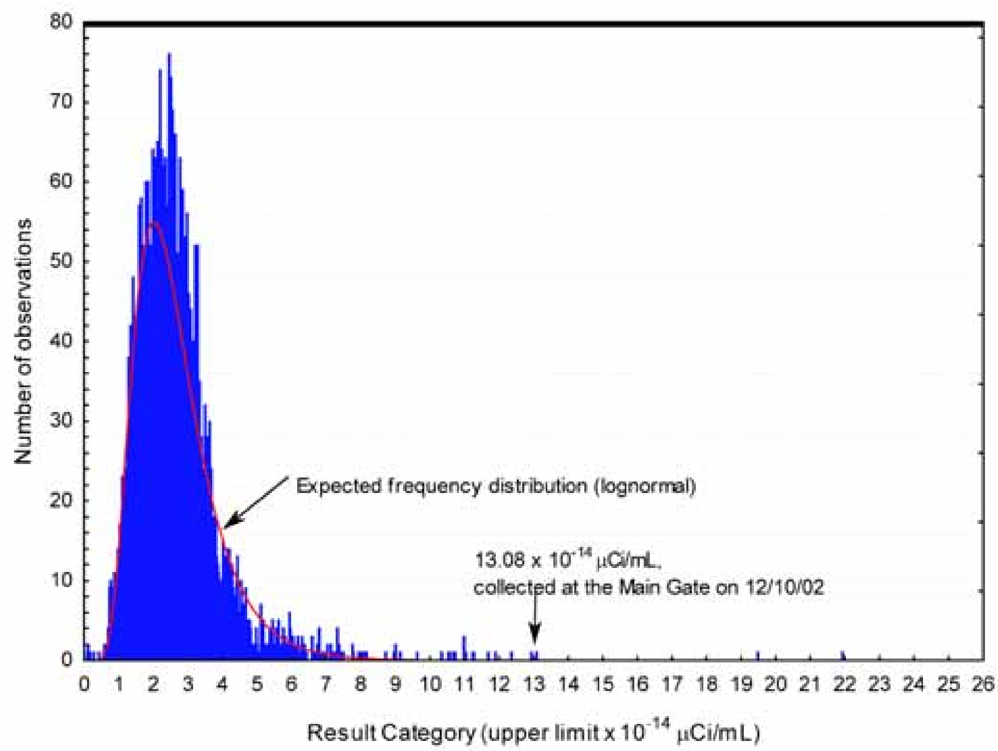


Figure 4-4. Frequency distribution of gross beta activity detected above the 2s level in air filters collected by the ESER contractor from 1996 to 2002.

Statistical Comparisons

Gross beta concentrations can vary widely from location to location as a result of a variety of factors, such as local soil type and meteorological conditions. When statistical differences are found in gross beta activity, these and other factors are examined to identify the cause for the differences, including a possible INEEL release.

Statistical comparisons were made using the gross beta radioactivity data collected from the onsite, boundary, and distant locations (see Appendix B for a description of statistical methods). Figure 4-5 is a graphical comparison of all gross beta concentrations measured during 2002 by the ESER contractor. The results are grouped by location (i.e., INEEL, boundary and distant stations). Visually, there appeared to be no difference between locations. The figure also shows that the largest measurement was well below the DCG for the most restrictive beta-emitting radionuclide (^{228}Ra) in air of 300 x 10^{-14} µCi/mL. If the INEEL were a significant source of offsite contamination, concentrations of contaminants would be statistically greater at boundary locations than at distant locations. There were no statistical differences between annual concentrations collected from INEEL, boundary, and distant locations in 2002.

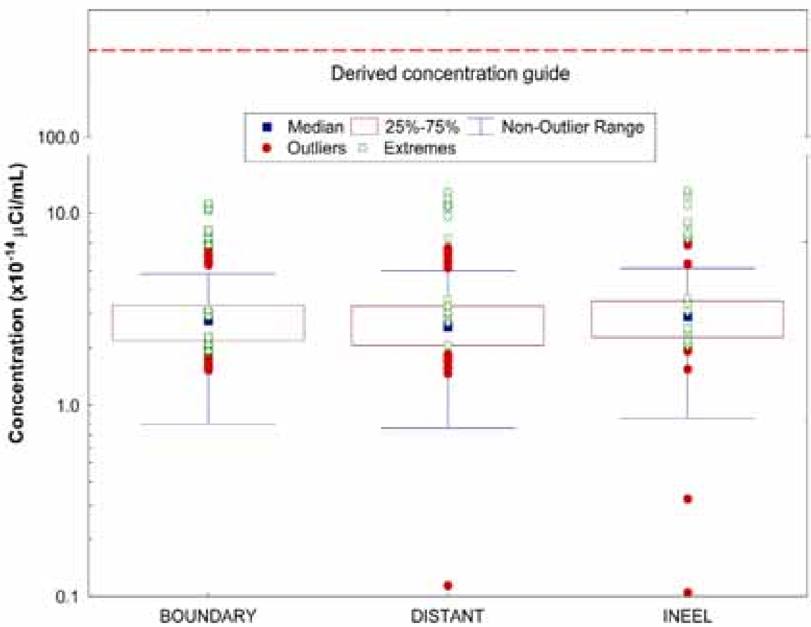


Figure 4-5. Comparison of gross beta concentrations measured in air at distant, boundary, and INEEL locations by the ESER contractor (2002).
(Terms are defined in Appendix B.)

There were a few statistical differences between weekly boundary and distant data sets collected by the ESER contractor during seven weeks of 2002. Concentrations collected during one week in January and two weeks each in November and December were greater for the boundary group than for the distant group. Results measured for the distant group were greater than boundary results during one week in July and one week in August. The differences observed in the winter months are associated with northern boundary locations (Howe, Monteview, and Mud Lake) and appear to be related to wind-driven suspension of particulates from surrounding fields and to the influence of inversion conditions. The differences observed in the summer months are attributed to natural variation in the data.

The M&O contractor data were grouped into INEEL and distant data sets. There were no statistical differences between data obtained from INEEL and distant locations.

Specific Radionuclides in Air

Human-made radionuclides were observed in some ESER contractor quarterly composite samples (Table 4-5). Most of these values were in the range where actual detection is questionable (that is, they just exceeded their respective 2s values).

No anthropogenic radionuclides were detected in quarterly samples collected by the M&O contractor.

Since mid-1995, the ESER contractor has detected ^{241}Am in air samples, although there has been no discernable pattern with respect to time or location. Americium-241 was again detected in fifteen 2002 quarterly composite samples. A frequency plot of ^{241}Am concentrations detected in both ESER and M&O contractors sample over the past 10 years is shown in Figure 4-6. The data appear to be lognormally distributed, which is typical of environmental data. All results detected above the 2s level during 2002 were within the range measured for the ten-year set of data and are well below the ^{241}Am DCG of 20,000 x 10^{-18} µCi/mL.

Plutonium-238 (^{238}Pu) was detected in one sample at a level significantly below the DCG of 30,000 x 10^{-18} µCi/mL. Plutonium-239/240 ($^{239/240}$Pu) was also detected in 25 composite samples. These levels were also significantly below the $^{239/240}$Pu DCG of 20,000 x 10^{-18} µCi/mL. Plutonium is a residual product of nuclear fission. The concentrations measured in ESER samples are consistent with worldwide levels related to atmospheric nuclear weapons testing and are well within measurements taken within the past 10 years by the ESER and M&O contractors (Figure 4-7).

Cesium-137 (^{137}Cs) was detected in one sample at a level below the DCG of 4 x 10^{-10} µCi/mL. Strontium-90 (^{90}Sr) was detected in one sample. The value measured is much below the DCG of 9,000,000 x 10^{-18} µCi/mL.

Atmospheric Moisture

During 2002, the ESER contractor collected a total of 44 atmospheric moisture samples using silica gel from four locations, including Atomic City, Blackfoot, Idaho Falls, and Rexburg. Table 4-6 presents the range of values for each station by quarter. Atmospheric moisture samples were also collected at these locations using drierite (primarily $CaSO_4$)during the first two quarters of 2002. However, it was determined that the material contains a contaminant that is released during the extraction process and this contaminant interfers with the liquid scintillation analysis. For this reason, the drierite results are considered to be invalid and the material is no longer used as a collection medium.

Tritium was detected in 34 of the samples. Samples that exceeded their respective 2s values ranged from a low at Idaho Falls of (1.2 ± 0.9) x 10^{-13} µCi/mL in the third quarter of 2002, to a high of (93.4 ± 4.9) x 10^{-13} µCi/mL at Idaho Falls in the second quarter of 2002.

These detected radioactive concentrations were similar at distant and boundary locations. This similarity suggests that the detections probably represent tritium from natural production in the atmosphere by cosmic ray bombardment, residual weapons testing fallout, and possible analytical

Table 4-5. Human-made radionuclides in ESER contractor air samples (2002).

ESER Contractor Samples[a]				
Location	**^{241}Am**	**^{137}Cs**	**^{238}Pu [$^{239/240}$Pu] [b]**	**^{90}Sr**
First Quarter 2002				
Arco (Q/A-1)	No detections	No detections	1.2 ± 1.1[1.2 ± 1.1]	No detections
Atomic City	No detections	No detections	[1.7 ± 1.5]	No detections
Blackfoot CMS	No detections	No detections	[2.7 ± 2.1]	No detections
Dubois	2.1 ± 1.9	No detections	[1.72 ± 1.7]	No detections
Mud Lake	8.4 ± 4.1	No detections	[2.9 ± 2.4]	No detections
Main Gate	No detections	1242.7±1149.5	No detections	No detections
Second Quarter 2002				
Arco	No detections	No detections	[2.2 ± 1.6]	No detections
Arco (Q/A-1)	No detections	No detections	[3.6 ± 2.3]	No detections
Atomic City	2.6 ± 2.1	No detections	[2.3 ± 1.4]	No detections
Blackfoot CMS	No detections	No detections	[4.0 ± 3.5]	No detections
Blue Dome	2.2 ± 1.7	No detections	No detections	No detections
Dubois	2.2 ± 1.9	No detections	[2.0 ± 1.6]	No detections
Jackson, WY	No detections	No detections	[4.4 ± 2.3]	No detections
Main Gate	2.3 ± 1.9	No detections	[2.2 ± 2.1]	No detections
Mud Lake	3.1 ± 2.0	No detections	No detections	No detections
Third Quarter 2002				
Blackfoot CMS	2.5 ± 2.3	No detections	[2.2 ± 2.0]	No detections
Craters of the Moon	1.71 ± 1.7	No detections	No detections	No detections
EFS	2.1 ± 1.7	No detections	No detections	No detections
FAA Tower	2.8 ± 2.3	No detections	[2.6 ± 2.5]	No detections
Howe (Q/A-2)	No detections	No detections	[2.8 ± 2.6]	No detections
Idaho Falls	No detections	No detections	[2.7 ± 2.6]	No detections
Monteview	2.5 ± 2.3	No detections	[2.2 ± 2.0]	No detections
Rexburg CMS	No detections	No detections	[2.3 ± 2.0]	No Detections
Fourth Quarter 2002				
EFS	No detections	No detections	[2.1 ± 1.4]	No detections
FAA Tower	No detections	No detections	[1.8 ± 1.5]	No detections
Howe	1.6 ± 1.2]	No detections	[3.9 ± 2.2]	No detections
Howe (QA-2)	No detections	No detections	[2.1 ± 1.3]	No detections
Idaho Falls	2.1 ± 1.7	No detections	[2.6 ± 1.9]	No detections
Monteview	No detections	No detections	[1.89 ± 1.2]	No detections
Mud Lake	No detections	No detections	No detections	30.6 ± 30.0
Van Buren	2.6 ± 2.1	No detections	[1.6 ± 1.3]	No detections

a. Concentrations shown are result x 10^{-18} µCi/mL air ± 2 standard deviations.

b. Where only a single value without brackets is shown, it refers to ^{238}Pu. Where only a single value with brackets is shown, it refers to $^{239/240}$Pu.

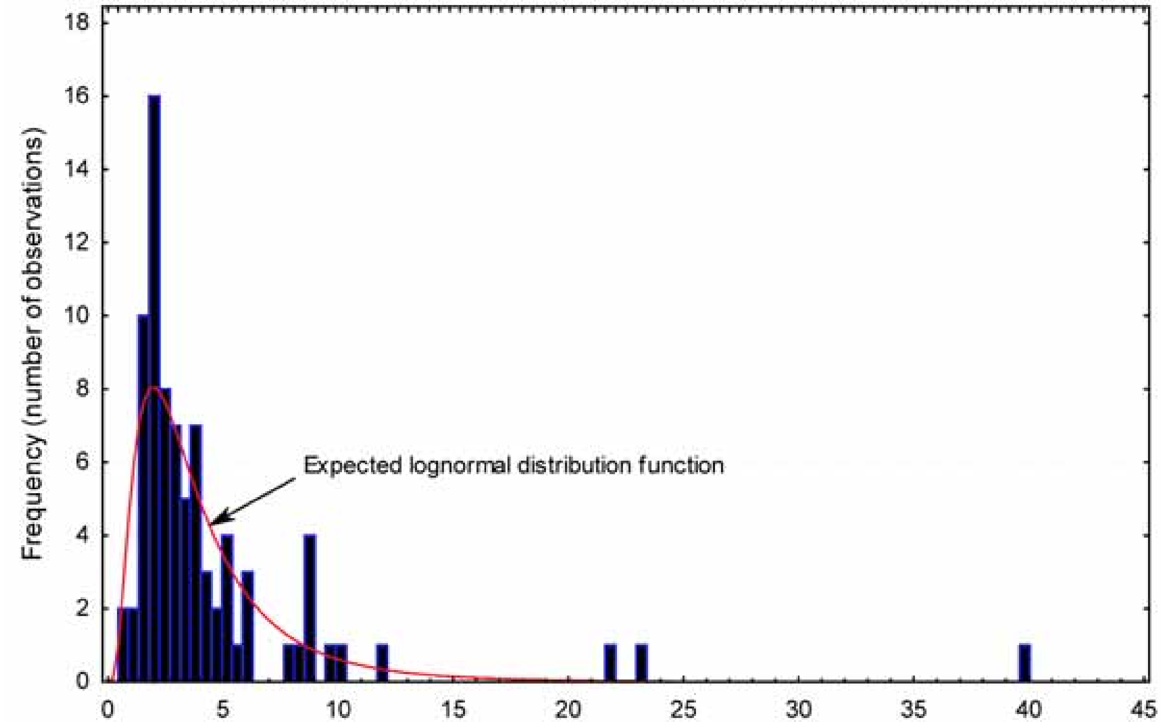


Figure 4-6. Frequency distribution of ^{241}Am concentrations detected above the 2s level in air filters collected by the ESER and M&O contractors from 1993 to 2002.

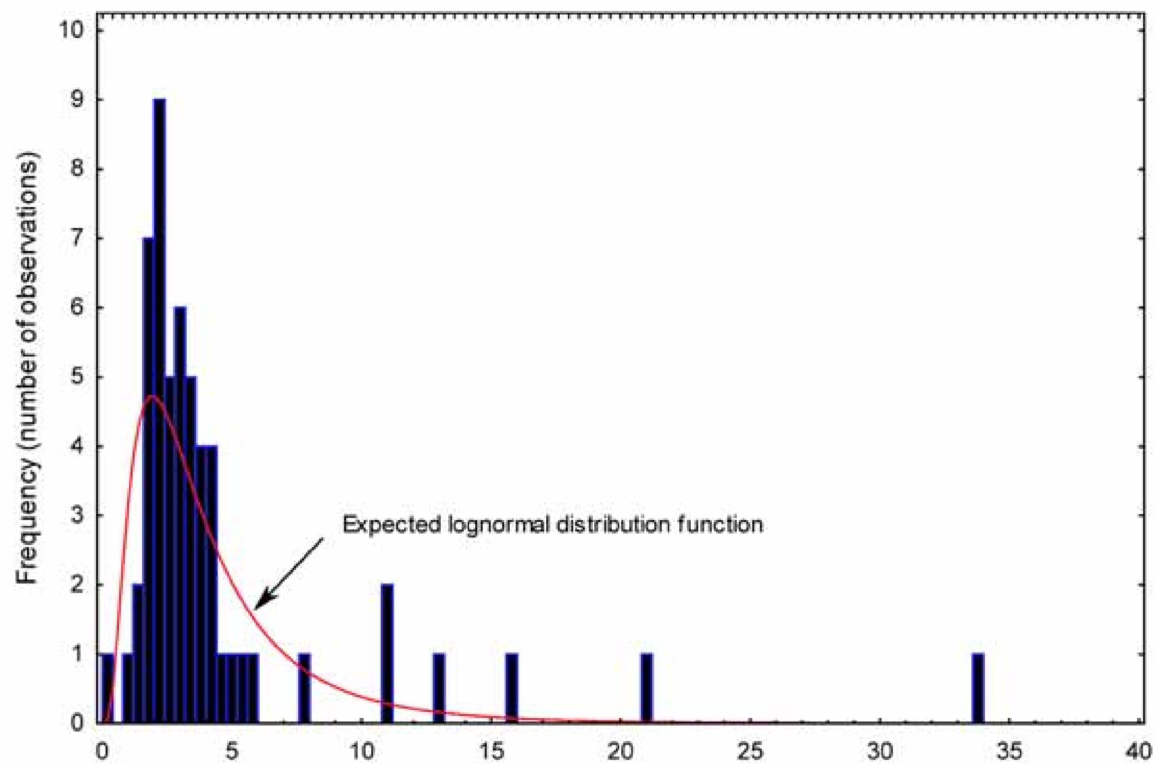


Figure 4-7. Frequency distribution of $^{239/240}$Pu concentrations detected above the 2s level in air filters collected by the ESER and M&O contractors from 1993 to 2002.

Table 4-6. Tritium concentrations in ESER contractor atmospheric moisture samples (2002).

	Range[a]			
Location	**First Quarter**	**Second Quarter**	**Third Quarter**	**Fourth Quarter**
Atomic City	1.3 ± 0.6 – 3.2 ± 0.7	3.5 ± 1.2 – 15.8 ± 1.3	4.1 ± 1.2 – 66.7 ± 6.2	38.0 ± 22.3
Blackfoot	1.3 ± 0.6	–[b]	3.7 ± 3.3 – 11.3 ± 7.0	–[c]
Idaho Falls	2.3 ± 1.3 – 4.9 ± 1.8	3.5 ± 1.0 – 93.4 ± 4.9	1.2 ± 0.9 – 10.9± 1.4	6.4 ± 2.4
Rexburg	3.4 ± 1.5	–[b]	3.8 ± 3.3	2.4 ± 2.2 – 2.1 ± 1.6

a. All values are x 10^{-13} ì Ci/mL of air ± 2s and represent results greater than their associated 2s uncertainties.

b. No sample collected during the second quarter of 2002.

c. No result was greater than its 2s uncertainty.

variations, rather than tritium from INEEL operations. The highest observed tritium concentration (from the fourth quarter at Atomic City) is over nine orders of magnitude below the DCG for tritium in air (as HTO) of 2 x 10^{-2} µCi/mL.

The M&O contractor also collected atmospheric moisture samples at the EFS and at Van Buren Boulevard on the INEEL. They collected from one to three samples at each location each quarter. Laboratory analyses indicated that all samples were below the detection limit of 1 x 10^{-11} µCi/mL.

Precipitation

The ESER contractor collects precipitation samples weekly at the EFS and monthly at the Central Facilities Area (CFA) and offsite in Idaho Falls. A total of 39 precipitation samples were collected during 2002 from the three sites. Tritium concentrations were measured above the 2s level in 20 samples and results ranged from 15.9 ± 14.3 to 290.0 ± 59.4 pCi/L. Table 4-7 shows the maximum concentration by quarter for each location. The highest radioactivity was from a sample collected at CFA during the third quarter and is far below the DCG level for tritium in water of 2 x 10^{6} pCi/L. The concentrations are well within the normal range observed historically at the INEEL. The maximum concentration measured since 1998 was 553 ± 78 pCi/L, measured at the EFS in 2000. The results are also well within measurements made by the EPA in Region 10 (Alaska, Idaho, Oregon, and Washington) for the past ten years (http://www.epa.gov/enviro/html/erams/).

Table 4-7. Tritium concentrations in ESER contractor precipitation samples (2002).

	Maximum Concentration[a]			
Location	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
CFA	15.9 ± 14.3	–[b]	290.0 ± 59.4	212.0 ± 58.7
EFS	86.8 ± 60.4	–[b]	230.0 ± 59.1	140.0 ± 64.0
Idaho Falls	94.7 ± 61.0	–[b]	121.0 ± 57.3	120.0 ± 57.9

a. All values are in picocuries per liter (pCi/L) ± 2s and represent results greater than their associated 2s uncertainties.

b. No results greater than ± 2s.

Suspended Particulates

In 2002, both the ESER and M&O contractors measured concentrations of suspended particulates using filters collected from the low-volume air samplers. The filters are 99 percent efficient for collection of particles greater than 0.3 µm in diameter. Unlike the fine particulate samplers discussed in the next section, these samplers do not selectively filter out particles of a certain size range, so they collect the total particulate load greater than 0.3 µm in diameter.

Mean annual particulate concentrations from ESER contractor samples ranged from 7.83 µg/m^3 at Blue Dome to 34.8 µg/m^3 at the Rexburg CMS. In general, particulate concentrations were higher at distant locations than at the INEEL stations. This is mostly due to agricultural activities in offsite areas.

The annual means of total suspended particulate concentrations measured by the M&O contractor ranged from 11.6 µg/m^3 at TAN to 37.0 µg/m^3 at Rexburg. Sample particulate concentrations were generally higher at distant locations than at the INEEL stations.

Filtered Particulates

The EPA's air quality standard is based on concenrations of "particles with an aerodynamic diameter less than or equal to 10 microns" (PM_{10}) (40 Code of Federal Regulations [CFR] 50.6 2001). Particles of this size can reach the lungs and are considered to be responsible for most of the adverse health effects associated with airborne particulate pollution. The air quality standards for PM_{10} are an annual average of 50 µg/m^3, with a maximum 24-hour concentration of 150 µg/m^3.

The ESER contractor collected 49 valid 24-hour samples at Rexburg from January through December 2002. A valid sample is one that has run for the proper length of time (24 hours continuously) and that has a beginning weight less than the ending weight (does not yield a negative weight). Concentrations of PM_{10} particulates collected at Rexburg ranged from 0.07 to 58.4 µg/m^3. At the Blackfoot CMS, 52 valid samples were collected from January through December. Concentrations ranged from 0.5 to 79.0 µg/m^3. At Atomic City, 49 valid samples were collected from January through December. Concentrations ranged from 16.7 to 92.5 µg/m^3. All results were less than the EPA standard for a maximum 24-hour concentration.

Nitrogen Dioxide

The M&O contractor monitored ambient nitrogen dioxide continuously at Van Buren Boulevard and the EFS (Figure 4-1) throughout 2002. At Van Buren Boulevard, quarterly mean concentrations ranged from 0.6 µg/m^3 (0.6 ppb) to 1.3 µg/m^3 (1.2 ppb), with an annual mean of 1.1 µg/m^3 (1.1 ppb). These concentrations are significantly lower than the EPA national primary ambient air quality standard of 100 µg/m^3 (54 ppb) (40 CFR 50.4 2001). The maximum 24 hour concentration measured was 11.7 µg/m^3 (3.9 ppb) on December 10.

Quarterly means at EFS ranged from 1.5 µg/m^3 (1.5 ppb) in the fourth quarter to 2.4 µg/m^3 (2.4 ppb) in the third quarter. Because of equipment failure no data were collected in the fourth quarter of 2002. For the three quarters collected, the mean concentration was 1.8 µg/m^3 (1.8 ppb), again well below the EPA standard of 100 µg/m^3 (54 ppb). The maximum 24 hour average concentration was 4.1 µg/m^3 (4.1 ppb) on September 7.

All quarterly concentrations in 2002 remained below 50 percent of the annual standard throughout the period of monitoring.

IMPROVE Samplers

Interagency Monitoring of Protected Visual Environments (IMPROVE) samplers began continuous operation at Craters of the Moon National Monument and CFA during the spring of 1992. The EPA removed the CFA sampler from the national network in May 2000, when the location was determined to be no longer necessary. The most recent data available for the station at Craters of the Moon are through November 2002.

The IMPROVE samplers measure several elements, including aluminum, silicon, calcium, titanium, and iron. These elements are derived primarily from soils and show a seasonal variation, with lower values during the winter when the ground is often covered by snow. Potassium is also measured and may be derived from soils, but it is also a component of smoke.

Other elements are considered tracers of various industrial and urban activities. Lead and bromine, for example, result from automobile emissions. Annual concentrations of lead at IMPROVE sites in the mid-Atlantic states are commonly in the range of 2 to 6 ng/m^3, or up to ten times higher than at the two southeast Idaho sites. Selenium, in the 0.1 ng/m^3 range at Craters of the Moon, is a tracer of emissions from coal-fired plants. At Mammoth Cave in Kentucky, annual selenium concentrations of 1.4 ng/m^3 from natural sources have been reported.

Fine particles with a diameter less than 2.5 microns ($PM_{2.5}$) are the size fraction most commonly associated with visibility impairment. At Craters of the Moon, $PM_{2.5}$ has ranged over the period of sampler operation from 409 to 25,103 ng/m^3, with a mean of 3443 ng/m^3.

4.3 Waste Management Surveillance Monitoring

2002 Gross Alpha and Gross Beta Air Monitoring Results

Gross alpha and gross beta concentration data were obtained from PM_{10} monitors for most ambient air measurement locations during 2002. Five of the locations with PM_{10} monitors also had suspended particulate monitors in place, and suspended particulate monitors were used exclusively at five locations in the Test Area North/Special Manufacturing Capability (TAN/SMC) area (locations 101, 102, 103, 104, and 105).

Measurements from the five locations with both PM_{10} and suspended particulate monitors were compared by analyzing the paired data from both types of monitors. These five locations included

- Location 2 at the Subsurface Disposal Area (SDA);
- Control location 15 at the Stored Waste Examination Pilot Plant (SWEPP);
- Locations 20 and 26 at the SWEPP; and
- Location 300 at the Waste Experimental Reduction Facility (WERF).

Based on these paired data, the average 2002 gross alpha and beta concentrations measured by suspended particulate monitors are still larger than that measured by PM_{10} monitors. The mean difference in gross alpha concentration measured by the suspended particulate monitors as compared to paired values measured by PM_{10} monitors was 0.32×10^{-15} µCi/mL. For gross beta concentrations, the mean difference was 3.46×10^{-15} µCi/mL. The difference in the gross alpha and gross beta measurements for 2002 were statistically significant (using a paired t-test).

To determine if the difference between the PM_{10} and suspended particulate monitors is a function of the level of activity, the concentration difference was plotted against the concentration from the suspended particulate monitors for both gross alpha and gross beta (refer to Figures 4-8 and 4-9, respectively). The horizontal axis shown on Figures 4-8 and 4-9 represents the activity as measured by the suspended particulate monitors. The vertical axis corresponds to the difference between the PM_{10} measurement and the suspended particulate measurement at the same location and time. If there were no difference between the two monitors, the graph should show a horizontal line at 0. If the measurements differed only because of random error, the data points in the graphs should be scattered randomly about a horizontal line centered at zero. The significant downward sloping regression line indicates that, as the measurements got larger, the differences between the two monitor types increased. At low concentrations, where the analytical error is a big component of measurements, PM_{10} concentrations may be higher or lower than suspended particulate concentrations. However, the higher the concentration, the more likely the PM_{10} monitors will measure less activity than the suspended particulate monitors and the greater the difference between the two monitor types.

Average concentrations of PM_{10} and suspended particulate monitor data from the paired locations over a 2-year period are presented in Figures 4-10 and 4-11 for gross alpha and gross beta, respectively. Data in the graphs were smoothed using polynomial smoothing to indicate the

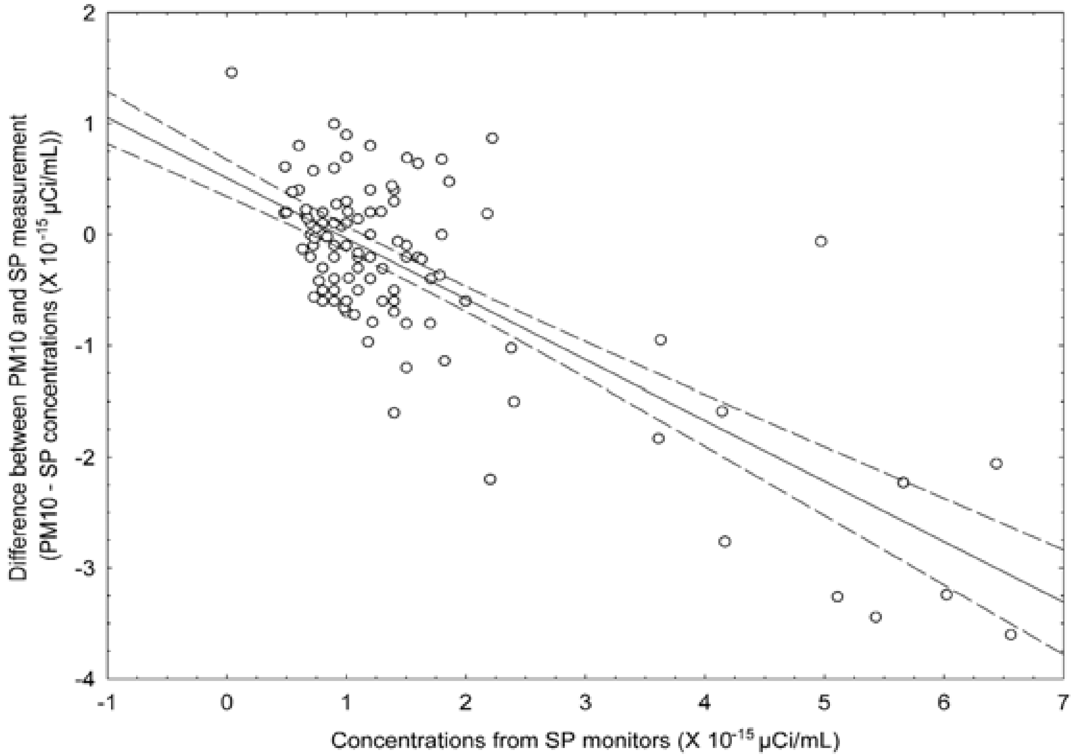


Figure 4-8. Gross alpha regression plot of differences between PM_{10} and suspended particulate monitors (2002) (locations 2, 15, 20, 26, and 300).

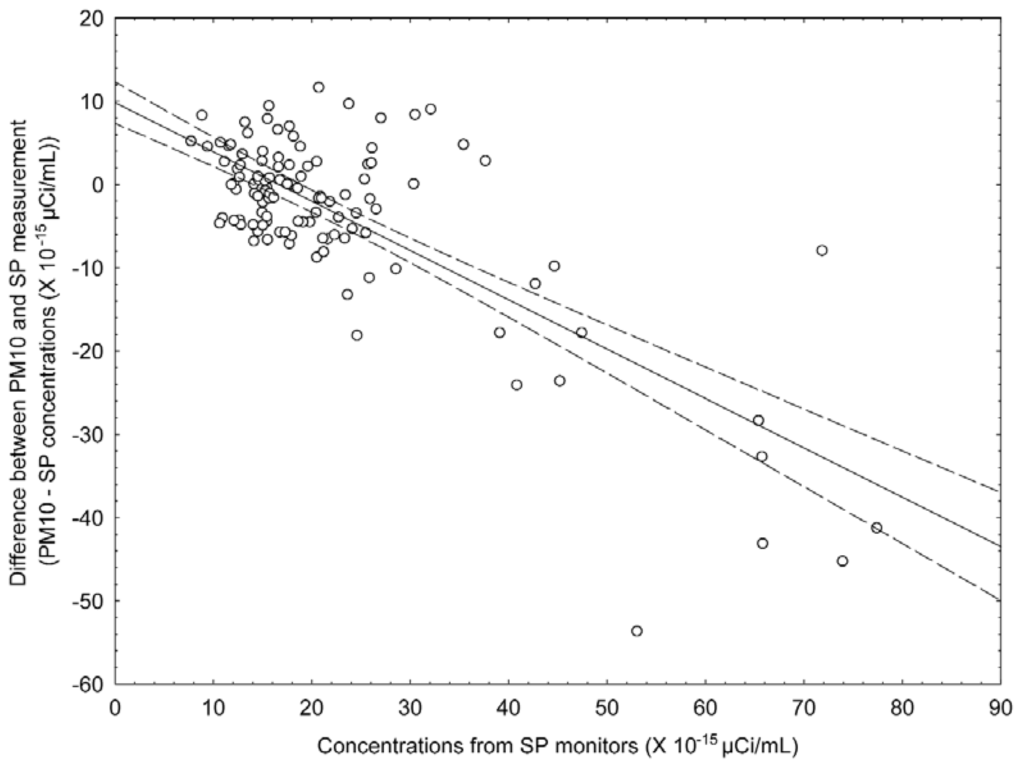


Figure 4-9. Gross beta regression plot of differences between PM_{10} and suspended particulate monitors (2002) (locations 2, 15, 20, 26, and 300*).*

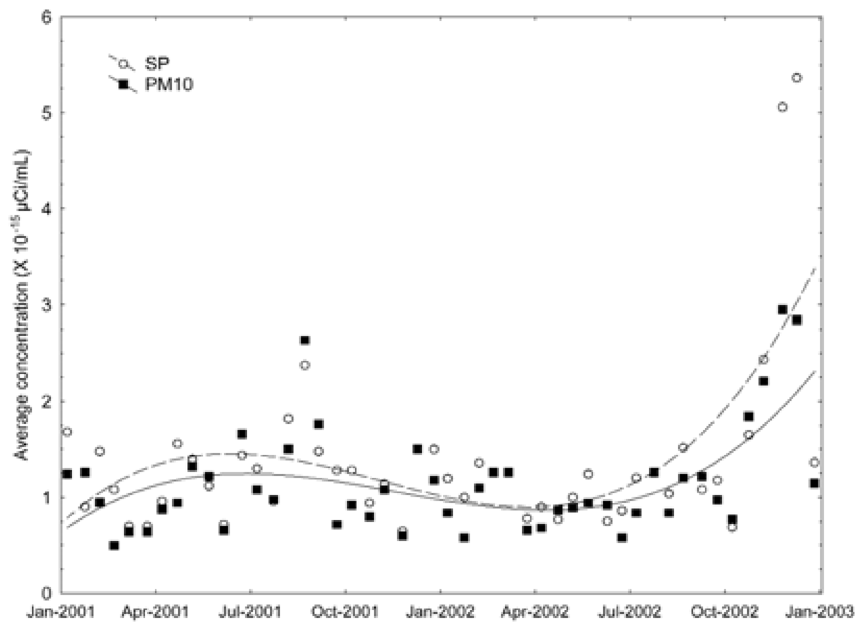


Figure 4-10. Gross alpha average concentration by monitor type (2001-2002) (locations 2, 15, 20, 26, and 300).

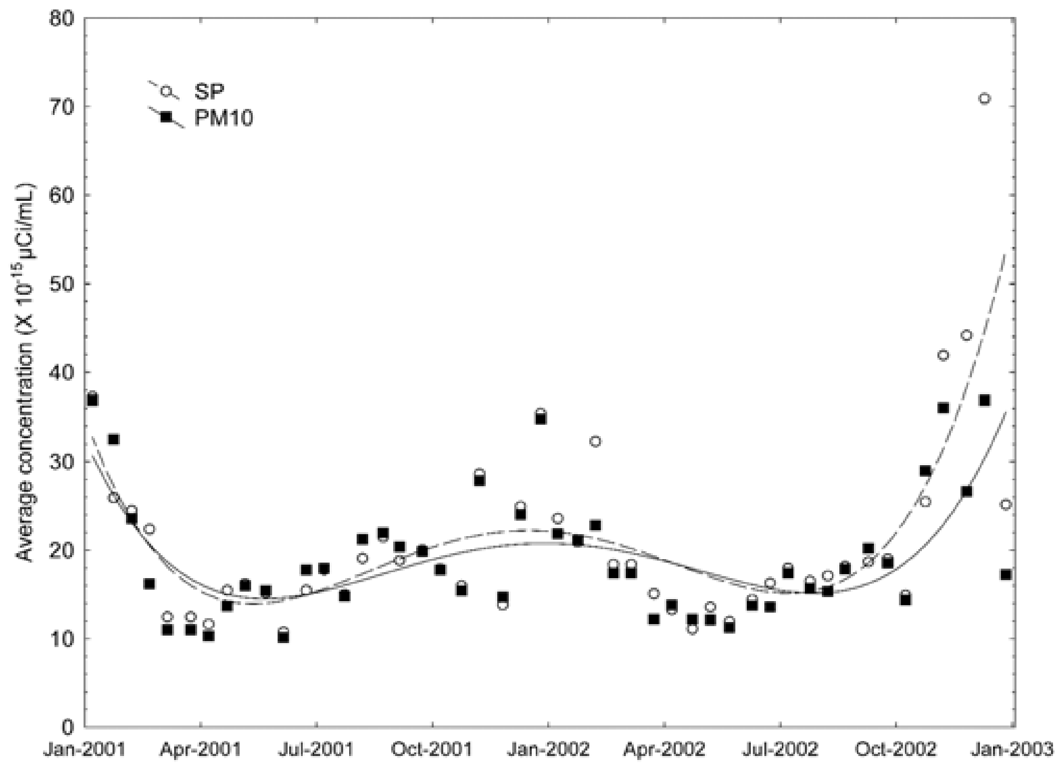


Figure 4-11. Gross beta average concentrations by monitor type (2001-2002) (locations 2, 15, 20, 26, and 300).

general trend in monitor type differences over time. Average monitor concentration from the suspended particulate monitors are higher than the average concentration from the PM_{10} monitors throughout most of the period presented for both gross alpha and gross beta, with average monitor concentrations being higher at the end of 2002 for both gross alpha and gross beta.

The differences in the average monitor concentrations might be attributed in part to fluctuations in the size of the particles released from processes operating at a particular time and/or differences in monitor design. PM_{10} monitors are designed to only admit particles less than 10 microns in diameter, while the suspended particulate monitors admit larger particles. Therefore, since the suspended particulate monitors admit larger particles, the suspended particulate monitors would, on average, measure higher concentrations than the PM_{10} monitors. In summary, the significant differences in monitor design or possible air flow around the monitors must be taken into account when analyzing the data.

Trend Analysis

To indicate the general trend in concentrations over the year, graphs of gross alpha and gross beta concentrations from all locations (except the three control locations) are presented in Figures 4-12 through 4-15. Data were smoothed using polynomial smoothing and second or third degree polynomials were fit to the four data sets (gross alpha and beta for both suspended particulate and PM_{10} monitors).

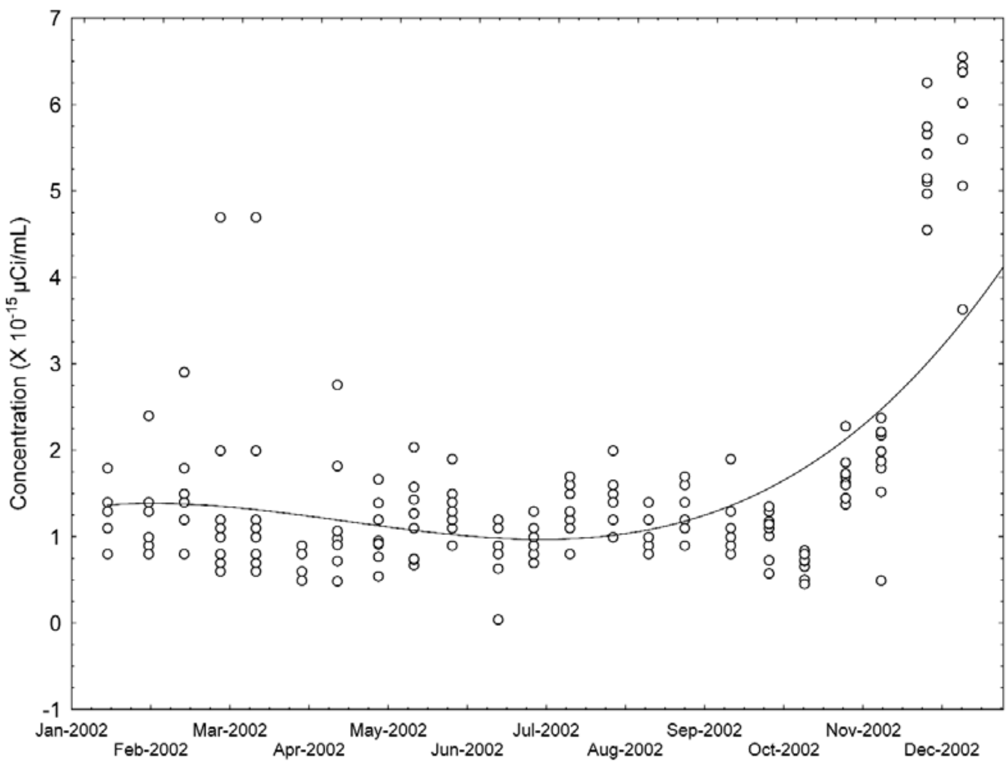


Figure 4-12. Gross alpha concentrations from suspended particulate monitors (2002) (third order polynomial).

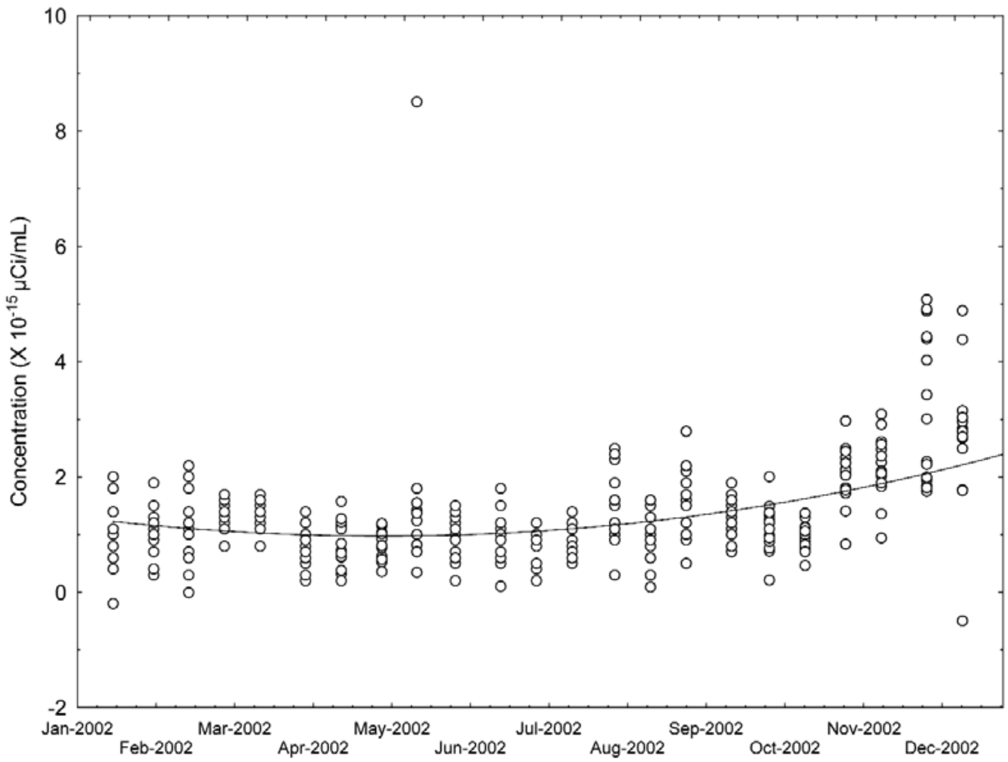


Figure 4-13. Gross alpha concentrations from PM_{10} monitors (2002) (third order polynomial).

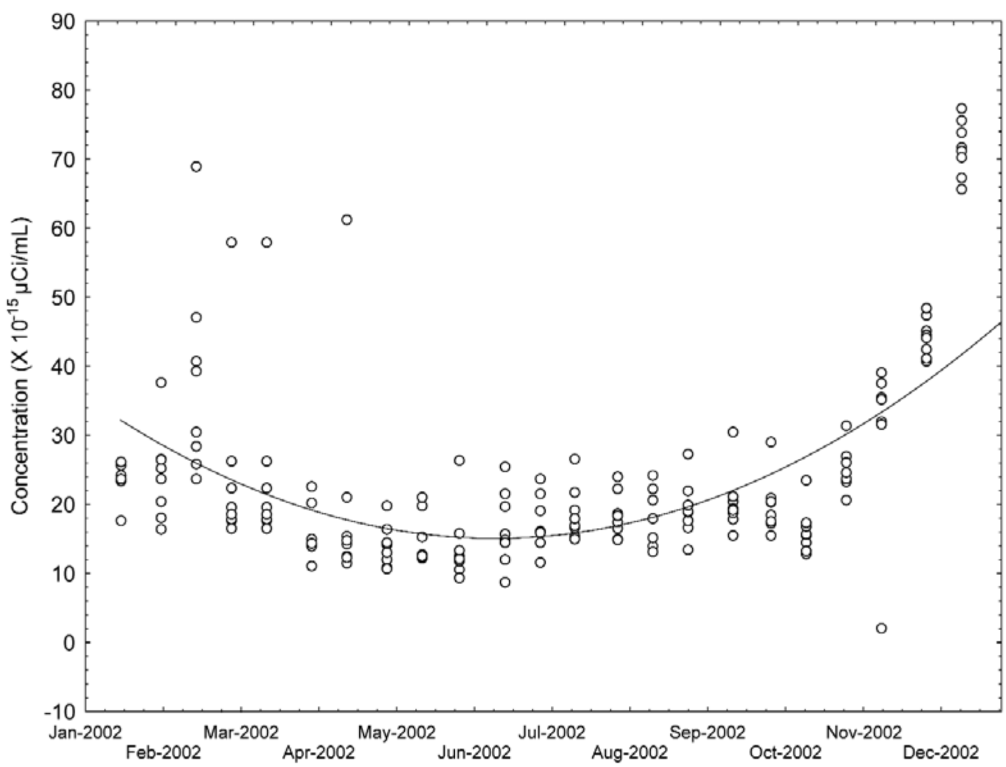


Figure 4-14. Gross beta concentrations from suspended particulate monitors (2002)

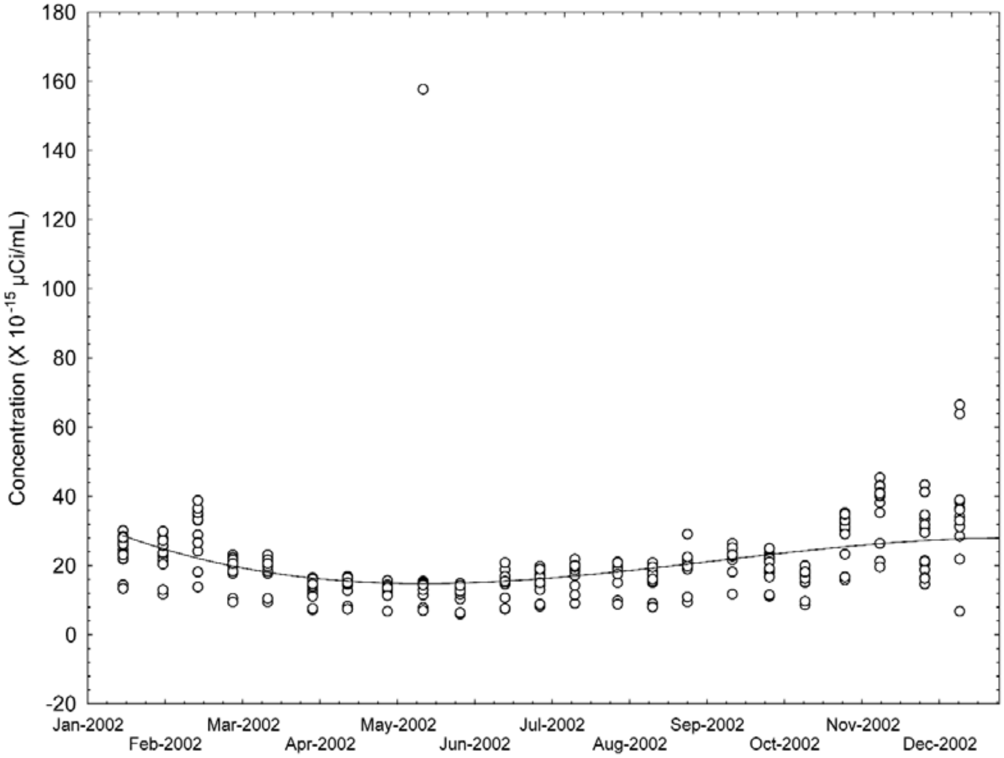


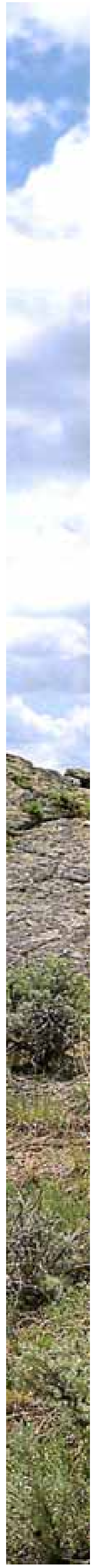
Figure 4-15. Gross beta concentrations from PM_{10} monitors (2002) (third order polynomial).

Trends in gross alpha concentrations for both suspended particulate and PM_{10} monitors (Figures 4-12 and 4-13) cycled during the year, but they were generally higher at the end of the year than at the start of the year. Gross beta concentrations from both monitor types (Figures 4-14 and 4-15) were the lowest during the early summer.

Comparisons by Facility

Figures 4-16 and 4-17 are box and whisker plots that compare gross alpha and gross beta concentrations for each monitor type by facility. Box and whisker plots are used to graphically display the differences in median values between groupings. For each group, the figures show the median value of all the data and a box indicating the 25th and 75th percentile range based on all the data. As stated on the plots, the whiskers indicate the nonoutlier minimum and maximum values within each grouping. For these plots, an outlier is defined as those values that are either greater than or less than one and one-half times the range of the box. Extreme values are those that are either greater than or less than three times the range of the box. The intent of using this type of graph is to visually depict differences in the medians of the groupings; therefore, the outliers are not shown since the scale required to show the extremes could mask most of the visual differences in the median values. While these outliers are not presented in these plots, they are included in the calculation of the median values.

Figures 4-16 and 4-17 present summarized 2001 and 2002 data by facility and monitor type to indicate short-term changes in levels. The data are the same for the suspended particulate monitors from the WERF control location and for the SWEPP control location.



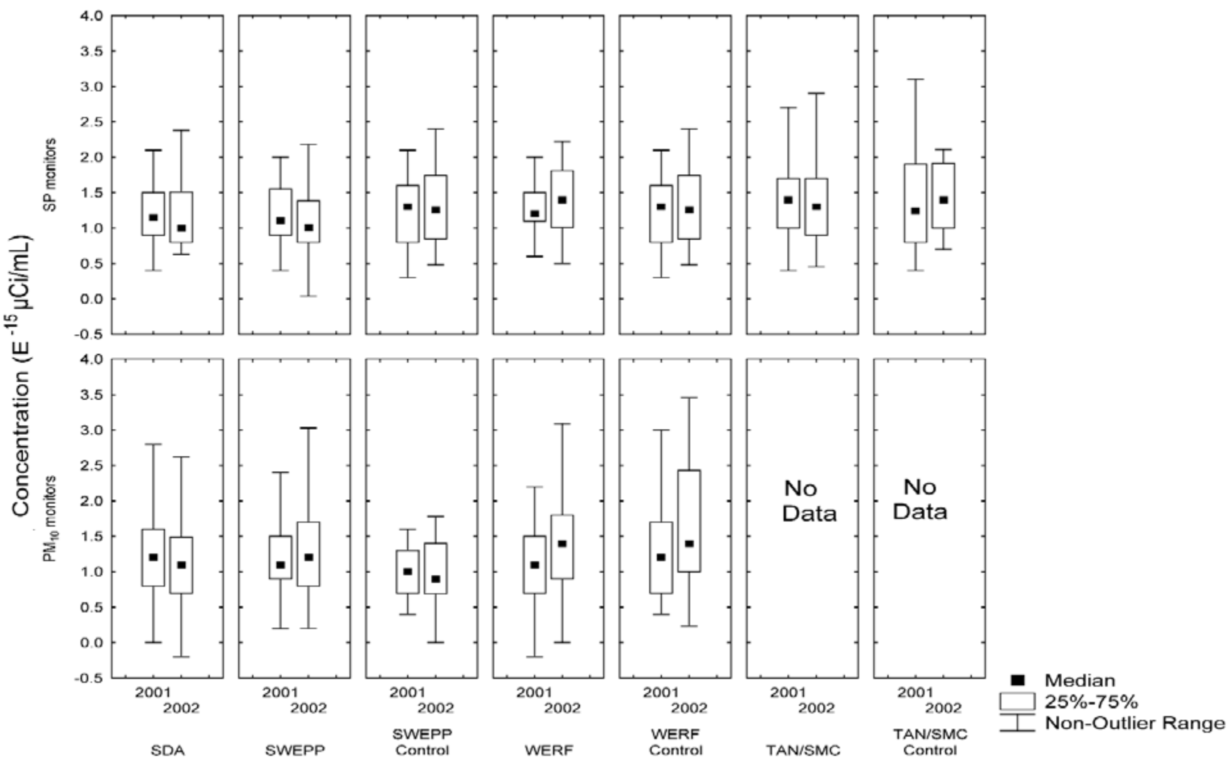


Figure 4-16. Gross alpha concentrations, by year, facility, and monitor type.

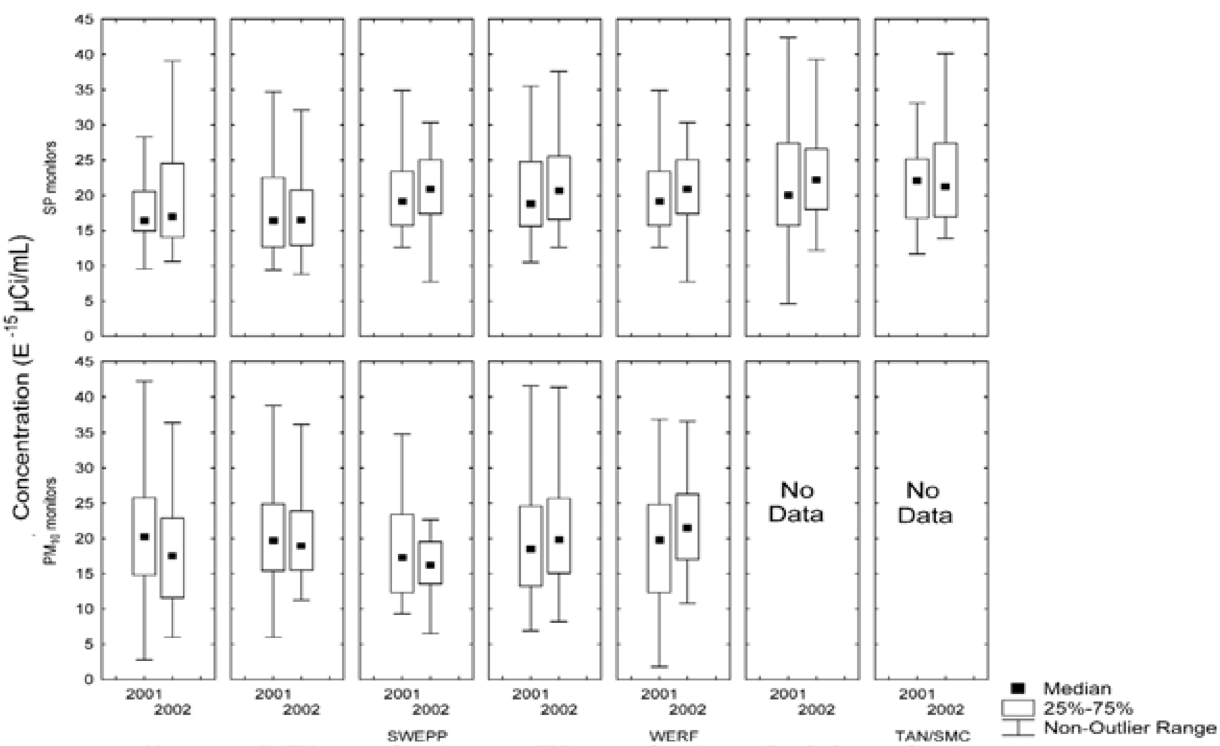


Figure 4-17. Gross beta concentrations, by year, facility, and monitor type.

As with past analysis of gross alpha values, values varied very little among facility groupings during 2002 (see Figure 4-16). Median suspended particulate monitor concentrations slightly decreased from 2001 to 2002 for all facility groupings except the WERF and the TAN/SMC control grouping, which slightly increased. For this analysis, the data presented for the suspended particulate monitors from the WERF control location are the same as that from the SWEPP control location. For the PM_{10} monitors, the median concentrations decreased for the SDA and the SWEPP control groupings and increased for the other groupings. To test for statistical significance of the variations in medians of gross alpha concentrations from 2001 to 2002, the Kruskal-Wallis significance tests were performed on data from each facility grouping. Only the changes in median values from 2001 to 2002 for the gross alpha PM_{10} monitors at WERF were found to be statistically significant at the 0.05 level. For the remaining facility/monitor type groupings, the changes in gross alpha median values from 2001 and 2002 were found to be not significant.

Variability among facility groupings during 2002 for median gross beta concentrations is graphically presented in Figure 4-17. Median gross beta concentrations from suspended particulate monitors increased slightly from 2001 to 2002 for most location groupings, while the TAN/SMC control grouping decreased slightly. Median gross beta concentrations from PM_{10} monitors increased for the WERF and WERF control location and decreased for all other groupings. Only the change in the median PM_{10} monitor concentrations from 2001 to 2002 for the SDA grouping was found to be significant at the 0.05 level using the Kruskal-Wallace test, while none of the changes in suspended particulate monitor gross beta concentrations from 2001 to 2002 were found to be significant.

Cesium-137 was the only human-made, gamma emitting radionuclide that exceeded the laboratory stated detection limit in 2002. It was detected at TAN-102 at a level of $1.5 \pm 0.4 \times 10^{-15}$ (Ci/mL). This represents 0.0004 percent of the DCG.

Plutonium-239/240 was detected on the second quarter 2002 alpha/beta composite at location SDA 4.2 at a concentration on $1.82 \pm 0.31 \times 10^{-17}$ Ci/mL. This is 0.091 percent of the DCG. No other alpha- or beta-emitting isotopes were detected.

Tables 4-8 and 4-9 summarize 2001 and 2002 gross alpha and gross beta means, medians, maximum, and minimum values.

4.4 Summary

An estimated total of 10,442 Ci of radioactivity, primarily in the form of short-lived noble gas isotopes, was released as airborne effluents. The M&O, and ESER contractors sampled a variety of media in 2002 to assess if operations at the INEEL are releasing contaminants to the environment in significant levels. Although some contaminants were detected, they could not be directly linked to operations at the INEEL. The maximum levels for the contaminants found were all well below regulatory health based limits for protection of human health and the environment. Nonradiological pollutants, including nitrogen dioxide and particulates, were monitored at select locations around the INEEL. All results were well below regulatory standards.

Table 4-8. Summary statistics for gross alpha concentrations.

Monitor Type	Facility	Year	Number of Samples	Mean (x^{-15} µCi/mL)	Median (x^{-15} µCi/mL)	Minimum (x^{-15} µCi/mL)	Maximum (x^{-15} µCi/mL)
Suspended Particulate	SDA	2001	24	1.19	1.15	0.40	2.10
	SDA	2002	24	1.50	1.00	0.63	6.44
	SWEPP	2001	48	1.24	1.10	0.40	3.20
	SWEPP	2002	47	1.46	1.01	0.04	6.56
	SWEPP Control	2001	25	1.28	1.30	0.30	3.70
	SWEPP Control	2002	24	1.55	1.26	0.48	4.17
	WERF	2001	25	1.30	1.20	0.60	2.20
	WERF	2002	24	1.59	1.40	0.50	5.43
	TAN/SMC	2001	93	1.45	1.40	0.40	4.10
	TAN/SMC	2002	94	1.70	1.30	0.45	6.38
	TAN/SMC Control	2001	24	1.36	1.25	0.40	3.10
	TAN/SMC Control	2002	24	1.73	1.40	0.70	5.99
PM_{10}	SDA	2001	138	1.24	1.20	-1.40	3.40
	SDA	2002	142	1.22	1.10	-0.49	8.51
	SWEPP	2001	139	1.17	1.10	-4.00	3.20
	SWEPP	2002	139	1.40	1.20	0.20	5.08
	SWEPP Control	2001	23	1.09	1.00	0.40	3.10
	SWEPP Control	2002	24	0.95	0.90	0.00	2.55
	WERF	2001	68	1.14	1.10	-0.20	3.10
	WERF	2002	72	1.42	1.40	0.00	3.09
	WERF Control	2001	23	1.29	1.20	0.40	3.00
	WERF Control	2002	24	1.65	1.40	0.24	3.46

Table 4-9. Summary statistics for gross beta concentrations.

Monitor Type	Facility	Year	Number of Samples	Mean (x^{-15} μCi/mL)	Median (x^{-15} μCi/mL)	Minimum (x^{-15} μCi/mL)	Maximum (x^{-15} μCi/mL)
Suspended Particulate	SDA	2001	24	19.13	16.40	9.60	46.20
	SDA	2002	24	21.46	170.00	10.60	71.80
	SWEPP	2001	48	18.64	16.35	9.40	38.60
	SWEPP	2002	47	20.57	16.50	8.80	77.40
	SWEPP Control	2001	25	20.91	19.20	12.60	44.20
	SWEPP Control	2002	24	26.05	20.95	7.740	65.80
	WERF	2001	25	20.41	18.80	10.50	35.50
	WERF	2002	24	23.59	20.75	12.60	65.70
	TAN/SMC	2001	93	23.06	20.10	4.60	71.00
	TAN/SMC	2002	94	26.56	22.15	2.11	75.60
	TAN/SMC Control	2001	24	23.19	22.05	11.70	49.50
	TAN/SMC Control	2002	24	25.12	21.25	13.90	71.10
PM_{10}	SDA	2001	138	21.35	20.25	2.80	43.20
	SDA	2002	142	20.12	17.55	6.00	158.00
	SWEPP	2001	139	21.17	19.70	6.00	45.30
	SWEPP	2002	139	21.34	19.00	11.30	43.10
	SWEPP Control	2001	23	18.80	17.30	9.30	34.80
	SWEPP Control	2002	24	17.25	16.15	-0.60	37.10
	WERF	2001	68	20.33	18.50	6.90	44.30
	WERF	2002	72	21.20	19.85	8.240	41.30
	WERF Control	2001	23	21.48	19.80	1.80	51.10
	WERF Control	2002	24	22.91	21.55	10.80	43.40

REFERENCES

40 CFR 50.6, 2001, "National Primary and Secondary Ambient Air Quality Standards for Particulate Matter," *Code of Federal Regulations*, Office of the Federal Register.

40 CFR 50.4, 2001, "National Primary Ambient Air Quality Standards for Nitrogen Oxides," *Code of Federal Regulations*, Office of the Federal Register.

DOE-ID, 2002, *National Emissions Standards for Hazardous Air Pollutants (NESHAPs) - Calendar Year 2002 INEEL Report for Radionuclides*, DOE/ID 10890(02), June.

EG&G, 1993, *New Production Reactor Exposure Pathways at the INEEL*, EGG NPR-8957.

Chapter 5 - Environmental Monitoring Programs - Water

Chapter Highlights

One potential pathway for exposure (primarily to workers) to contaminants released from the Idaho National Engineering and Environmental Laboratory (INEEL) is through surface water, drinking water, and groundwater. The Management and Operating contractor monitors liquid effluents, drinking water, groundwater, and storm water runoff at the INEEL to comply with applicable laws and regulations, U.S. Department of Energy (DOE) orders, and other requirements (e.g., Wastewater Land Application Permit [WLAP] requirements). Argonne National Laboratory-West (ANL-W) and the Naval Reactors Facility (NRF) conduct their own WLAP and drinking water monitoring. The U.S. Geological Survey (USGS) INEEL Project Office performs groundwater monitoring, analyses, and studies of the Snake River Plain Aquifer under and adjacent to the INEEL. The Environmental Surveillance, Education and Research (ESER) program contractor monitors drinking water and surface water at offsite locations.

During 2002, liquid effluent and groundwater monitoring was conducted in support of WLAP requirements for INEEL facilities that generate liquid waste streams covered under WLAP rules. The WLAPs generally require compliance with the state of Idaho groundwater quality primary and secondary constituent standards in specified groundwater monitoring wells. The permits specify annual discharge volume and application rates and effluent quality limits. As required, an annual report was prepared and submitted to the Idaho Department of Environmental Quality (DEQ). Additional parameters are also monitored in the effluent in support of surveillance activities. Most wastewater and groundwater regulatory and surveillance results were below applicable limits in 2002.

Samples from public water systems and wells continue to show measurable quantities of carbon tetrachloride at the Radioactive Waste Management Complex production well. The annual average of 4.3 µg/L was below the U.S. Environmental Protection Agency (EPA) established maximum contaminant level (MCL) of 5 µg/L. Trichloroethylene concentrations in samples from the Test Area North (TAN) drinking water Well #2 during 2002 also remained below the MCL. ANL-W and NRF systems were sampled as required by regulations and found to be below all limits during 2002.

Chapter Highlights (continued)

As required by the General Permit for storm water discharges from industrial activity, visual examinations were made and samples were collected from selected locations. Visual examinations showed no deficiencies. Total suspended solids, iron, magnesium, and chemical oxygen demand all exceeded benchmark levels in collected samples. All of these parameters have occurred above benchmark levels in the past. Examination of storm water flow paths showed no deficiencies in storm water protection.

Tritium and strontium-90 continue to be measured in the groundwater under the INEEL. Neither of these radionuclides has been detected off the INEEL since the mid-1980s. A maximum effective dose equivalent of 0.98 mrem/yr (9.8 μSv/yr), less than the 4 mrem/yr EPA standard for public drinking water systems, was calculated for workers at the Central Facilities Area (CFA) on the INEEL in 2002.

Results from a number of special studies conducted by the U.S. Geological Survey of the properties of the aquifer and the water within it were published during 2002. Several purgeable organic compounds continue to be found in monitoring wells, including drinking water wells at the INEEL. Concentrations of organic compounds were below the EPA MCLs for these compounds except for two wells at the Radioactive Waste Management Complex, where concentrations of carbon tetrachloride slightly exceeded the MCL during certain months.

Drinking water samples were collected from 14 locations off the INEEL and around the Snake River Plain in 2002. One sample had measurable gross alpha activity, three had measurable tritium, and all samples had measurable gross beta activity. None of the samples exceeded the EPA MCL for these constituents.

Offsite surface water was collected from five locations along the Snake River. Nine of 12 samples had measurable gross beta activity, while only two samples had measurable tritium. None of these constituents were above regulatory limits. Onsite sampling of surface water runoff for waste management purposes showed no values above regulatory limits.

5. ENVIRONMENTAL MONITORING PROGRAMS - WATER

Operations at facilities located on the INEEL release radioactive and nonradioactive constituents into the environment. This chapter presents results from radiological and nonradiological analyses of liquid effluent, drinking water, groundwater, surface water, and storm water samples taken at both onsite and offsite locations. Results from sampling conducted by the Management and Operating (M&O) contractor; ANL-W, the USGS; and the ESER contractor are all presented here. Results are compared to the EPA health-based MCL for drinking water and/or the DOE Derived Concentration Guide (DCG) for ingestion of water.

This chapter begins with a general overview of the various organizations responsible for monitoring of water at the INEEL in Section 5.1. Sections 5.2 and 5.3 describe liquid effluent and groundwater monitoring as required by permits and that are done for surveillance activities only, respectively. The INEEL drinking water programs are discussed in Section 5.4. Sections 5.5 and 5.6 describe groundwater monitoring and aquifer studies. Radiological and nonradiological monitoring of groundwater at the INEEL is discussed in Section 5.7. Section 5.8 describes storm water and surface water monitoring. Section 5.9 summarizes onsite waste management water surveillance activities.

5.1 Organization of Monitoring Programs

The M&O contractor monitors liquid effluents, drinking water, groundwater, and storm water runoff at the INEEL to comply with applicable laws and regulations, DOE orders, and other requirements (e.g., Wastewater Land Application Permit requirements).

The ESER contractor monitors drinking water and surface water at offsite locations and collected a total of 93 water samples for analyses in 2002.

The USGS INEEL Project Office performs groundwater monitoring, analyses, and studies of the Snake River Plain Aquifer (SRPA) under and adjacent to the INEEL. This is done through an extensive network of strategically placed observation wells on the INEEL (Figures 5-1 and 5-2) and at locations throughout the Eastern Snake River Plain. Chapter 3 summarizes the USGS routine groundwater surveillance program. In 2002, USGS personnel collected 1915 samples for radionuclides and inorganic constituents including trace elements and 51 samples for purgeable organic compounds.

In addition, through an interagency agreement, the USGS performs groundwater monitoring activities for the NRF. As part of the 2002 NRF sampling program, the USGS performed quarterly sampling from nine NRF wells and four USGS wells, collecting a total of 60 samples. Samples were analyzed for radionuclides, inorganic constituents, and purgeable organic compounds.

ANL-W performs semiannual groundwater monitoring at one upgradient monitoring well, three down gradient monitoring wells and one production well. Samples are analyzed for gross activity (alpha and beta), uranium isotopes, tritium, inorganics and water quality parameters.

ANL-W performs semiannual groundwater monitoring at one upgradient monitoring well, three down gradient monitoring wells and one production well. Samples are analyzed for gross activity (alpha and beta), uranium isotopes, tritium, inorganics and water quality parameters.

Table 5-1 presents the various water-related monitoring activities performed on and around the INEEL.

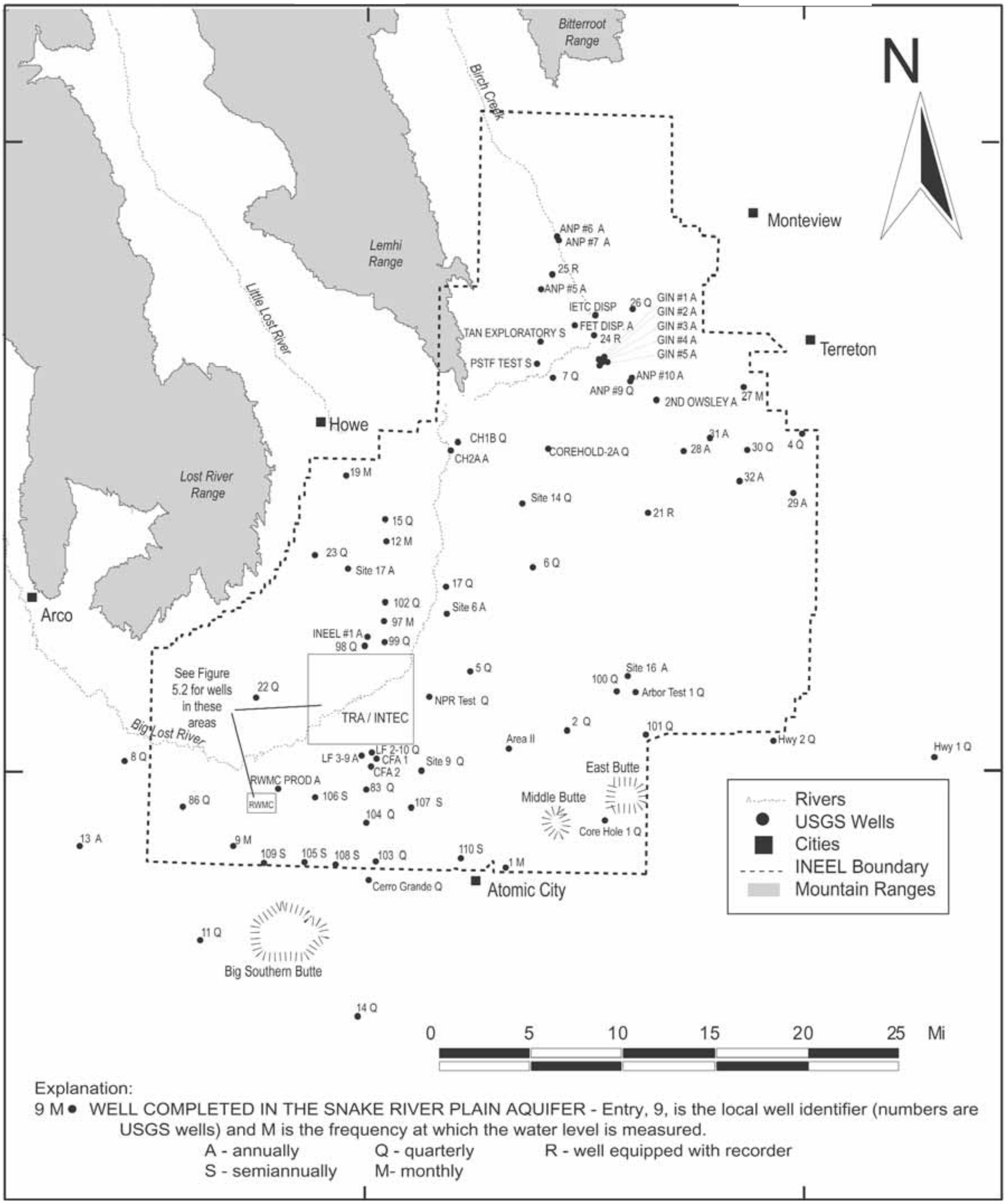


Figure 5-1. USGS well locations (Bartholomay et al. 2000).

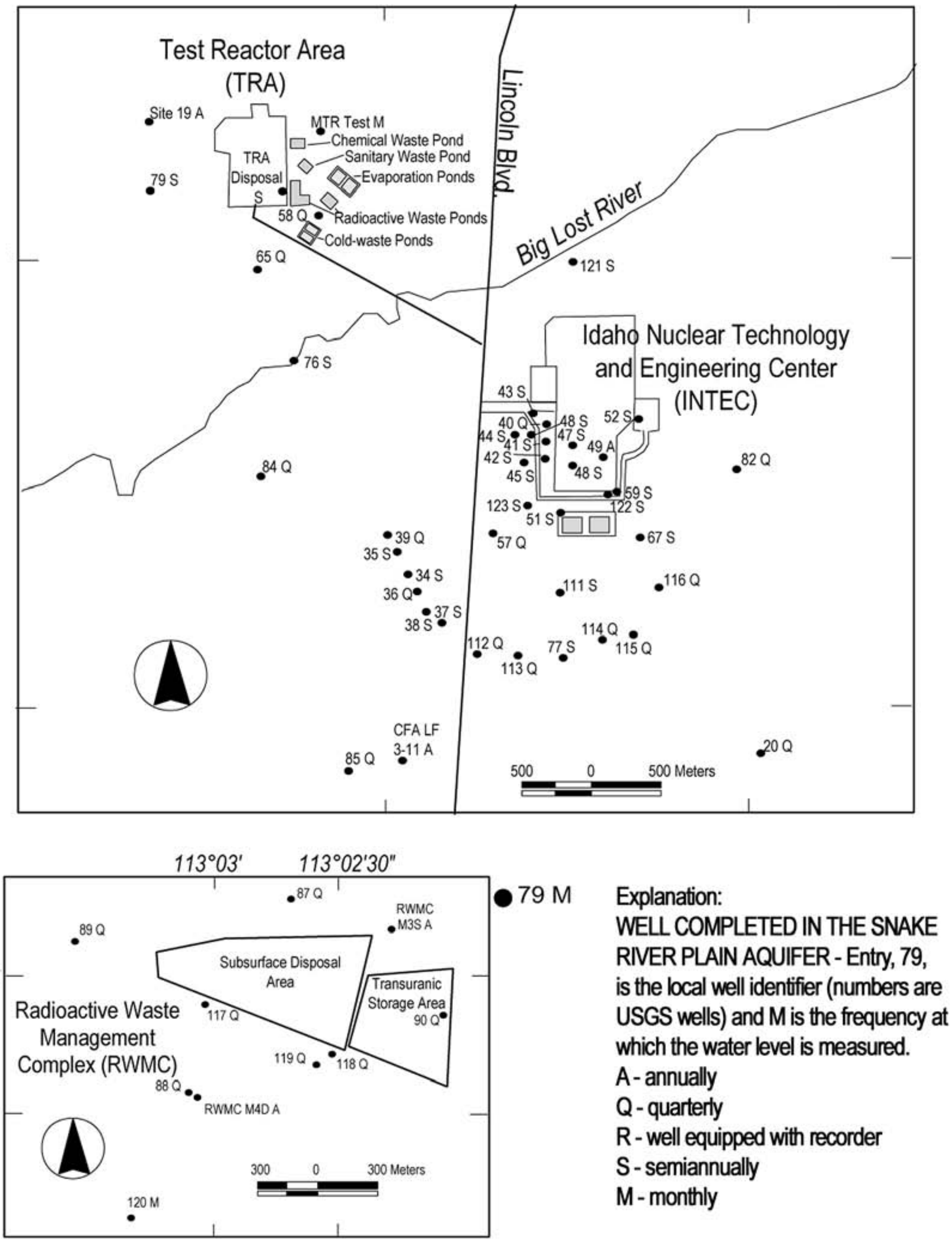


Figure 5-2. USGS well locations at the Idaho Nuclear Technology and Engineering Center, Test Reactor Area, and Radioactive Waste Management Complex (Bartholomay et al. 2000).

Table 5-1. Liquid effluent and water-related monitoring at the INEEL and surrounding area.

Area/Facility[a]	Media: Liquid Effluent (Permitted)	Liquid Effluent (Characterization)	Drinking Water	Groundwater (radiological)	Groundwater (Nonradiological)	Surface Water	Storm Water
Argonne National Laboratory-West							
ANL-W		◆	◆	◆	◆	◆	
Management and Operating Contractor							
CFA	◆	◆	◆	◆	◆		
INTEC	◆	◆	◆	◆	◆		◆
TRA	◆[b]	◆	◆	◆	◆		
TAN	◆	◆	◆	◆	◆		
RWMC		◆	◆	◆	◆	◆	◆
PBF/WROC		◆	◆			◆	◆
WCB	◆						
IRC	◆						
Naval Reactors Facility							
NRF		◆	◆	◆	◆		
Environmental Surveillance, Education and Research Program							
INEEL/Regional			◆			◆	
U.S. Geological Survey							
INEEL/Regional				◆	◆	◆	
INEEL Oversight Program[c]							
INEEL/Regional		◆	◆	◆	◆	◆	◆

a. ANL-W = Argonne National Laboratory-West, CFA = Central Facilities Area, INTEC = Idaho Nuclear Technology and Engineering Center, TRA = Test Reactor Area, TAN = Test Area North, RWMC = Radioactive Waste Management Complex, PBF/WROC = Power Burst Facility/Waste Reduction Operations Complex, WCB = Willow Creek Building, IRC = INEEL Research Center, and NRF = Naval Reactors Facility.

b. IDEQ has not issued a Wastewater Land Application Permit for TRA. However, TRA follows WLAP regulations for the applicable effluent.

c. The INEEL Oversight Program results are presented in annual reports prepared by that organization and are therefore not reported here.

5.2 Liquid Effluent and Related Groundwater Compliance Monitoring

The Liquid Effluent and Groundwater Monitoring Programs conducted by the M&O contractor monitor for nonradioactive and radioactive parameters in liquid waste effluent and groundwater. Wastewater is typically discharged to the ground surface and evaporation ponds. Discharges to the ground surface are through infiltration ponds, trenches, drainfields, or a sprinkler irrigation system at the following areas:

- Infiltration ponds at the Idaho Nuclear Technology and Engineering Center (INTEC) Existing and New Percolation Ponds, Test Area North/Technical Support Facility (TAN/TSF) Sewage Treatment Plant Disposal Pond, Test Reactor Area (TRA) Cold Waste Pond, ANL-W Industrial Waste ditch and pond, ANL-W Sanitary Lagoons, and NRF Industrial Waste Ditch;

- INTEC Sewage Treatment Plant infiltration trenches;

- Septic tank drainfields at various locations on the INEEL; and

- A sprinkler irrigation system at the Central Facilities Area (CFA) used during the summer months to land-apply industrial and treated sanitary wastewater.

Discharge of wastewater to the land surface is regulated under Idaho Wastewater Land Application Permit (WLAP) rules (IDAPA 58.01.17). An approved WLAP will normally require monitoring of nonradioactive parameters in the influent waste, effluent waste, and groundwater, as applicable. These monitoring programs also support WLAP requirements for INEEL facilities that generate liquid waste streams covered under WLAP rules. Table 5-2 lists the six facilities operated by the M&O contractor that require WLAPs and the current permit status of each facility.

The WLAPs generally require compliance with the Idaho groundwater quality primary constituent standards (PCS) and secondary constituent standards (SCS) in specified groundwater monitoring wells (IDAPA 58.01.11). The permits specify annual discharge volume and application rates and effluent quality limits. As required, an annual report is prepared and submitted to the DEQ.

During 2002, the M&O contractor conducted monitoring as required by the permits for each of the first five facilities listed in Table 5-2. The Test Reactor Area (TRA) Cold Waste Pond has not been issued a permit; however, quarterly samples for total nitrogen and total suspended solids are collected to show compliance with the regulatory effluent limits for rapid infiltration systems. The following subsections present results of wastewater and groundwater monitoring for individual facilities conducted for compliance purposes.

Additional parameters are also monitored in the effluent. Section 5.3 discusses the results of liquid effluent surveillance monitoring for individual facilities.

Table 5-2. Current M&O Contractor Wastewater Land Application Permits.

Facility	Permit Status	Explanation
Central Facilities Area Sewage Treatment Plant	WLAP expired	Idaho Department of Environmental Quality (DEQ) issued letter authorizing continued operation under the terms and conditions of original permit until a new permit is issued.
Idaho Nuclear Technology and Engineering Center (INTEC) Existing Percolation Ponds	WLAP expired	Idaho DEQ granted an extension until December 2003. However, on August 26, 2002, wastewater discharged to the INTEC existing percolation ponds was ceased. The DEQ issued a letter acknowledging that the WLAP was considered ineffective as of November 4, 2002.
INTEC New Percolation Ponds	WLAP issued	Idaho DEQ originally issued the WLAP on September 10, 2001. The permit was subsequently modified and a new permit issued on March 28, 2002, and expires on April 1, 2007.
INTEC Sewage Treatment Plant	WLAP expired	Idaho DEQ issued letter authorizing continued operation under the terms and conditions of original permit until a new permit is issued.
Test Area North/ Technical Support Facility Sewage Treatment Plant	WLAP expired	Idaho DEQ issued letter authorizing continued operation under the terms and conditions of original permit until a new permit is issued.
Test Reactor Area Cold Waste Pond	WLAP application submitted to Idaho DEQ	Idaho DEQ has not issued a WLAP. Idaho DEQ authorized INEEL to operate the wastewater land application facility under the conditions and terms of state of Idaho WLAP rules and Idaho DEQ's Handbook for Land Application of Municipal and Industrial Wastewater until a permit is issued. (Johnston 2001)

Idaho Falls Facilities

Description - The City of Idaho Falls is authorized by the Clean Water Act, National Pollutant Discharge Elimination System (NPDES) to set pretreatment standards for nondomestic discharges to publicly owned treatment works. The M&O contractor facilities in Idaho Falls are required to comply with the applicable regulations in Chapter 1, Section 8, of the Municipal Code of the City of Idaho Falls.

Industrial Wastewater Acceptance Forms were obtained for facilities that discharge process wastewater through the City of Idaho Falls sewer system. Twelve M&O contractor Idaho Falls facilities have associated Industrial Wastewater Acceptance Forms for discharges to the city sewer system. The Industrial Wastewater Acceptance Forms for these facilities contain special conditions and compliance schedules, prohibited discharge standards, reporting requirements, monitoring requirements, and effluent concentration limits for specific parameters; however, only the INEEL Research Center has specific monitoring requirements.

Wastewater Monitoring Results - Semiannual monitoring was conducted at the INEEL Research Center in April and October of 2002. Table 5-3 summarizes the 2002 semiannual monitoring results.

Central Facilities Area Sewage Treatment Plant

Description - The CFA Sewage Treatment Plant serves all major facilities at CFA. It is southeast of CFA, approximately 671 m (2200 ft) downgradient of the nearest drinking water well.

Table 5-3. Semiannual monitoring results for INEEL Research Center (2002).[a]

Parameter	INEEL Research Center		Discharge Limit[b]
	April 2002	October 2002	
Cyanide	0.01U[c]	0.01 U	1.04
Silver	0.0025 U	0.0025 U	0.43
Arsenic	0.0025 U	0.0025 U	0.04
Cadmium	0.0005 U	0.0005 U	0.26
Chromium	0.0025 U	0.0025 U	2.77
Copper (regular/duplicate)[d]	0.0356	0.0303/0.0302	1.93
Mercury	0.0002 U	0.0002 U	0.002
Nickel	0.0025 U	0.0025 U	2.38
Zinc (regular/duplicate)[d]	0.0305	0.0231/0.0234	0.90
Lead	0.0015 U	0.0015 U	0.29
Conductivity (µS) (max/avg)[e]	597.5/541.3	997.3/645.6	N/A
pH (standard units) (max/avg)[e]	7.99/7.8	8.05/7.9	5.5–9.0

a. All values are in milligrams per liter unless otherwise noted.

b. Limit as set in the applicable Industrial Wastewater Acceptance Forms.

c. U flag indicates that the result was below the detection limit.

d. Regular and duplicate samples were collected for the October sampling event only. Unless otherwise noted, for parameters for which results were detected, the regular and duplicates were the same.

e. Values represent the maximum and average for the five samples taken over an eight-hour period during semiannual monitoring.

A 1500-L/min (400-gal/min) pump applies wastewater from a 0.2-ha (0.5-acre) lined, polishing pond to approximately 30 ha (74 acres) of desert rangeland through a computerized center pivot irrigation system. The permit limits wastewater application to 25 acre in./acre/yr from March 15 through November 15 and limits leaching losses to 8 cm/yr (3 in./yr).

WLAP Wastewater Monitoring Results - The permit requires influent and effluent monitoring, as well as soil sampling in the application area (see Chapter 6 for results pertaining to soils). Influent samples were collected monthly from the lift station at CFA (prior to Lagoon No. 1) during 2002. Effluent samples were collected from the pump pit starting in June 2002 and continued through September 2002 (the period of pivot operation for 2002). An additional effluent sample was collected on October 1, 2002, for the same parameters (excluding fecal and total coliform). All samples collected were 24-hour composites, except pH and coliform samples, which were collected as grab samples. Tables 5-4 and 5-5 summarize the results.

Table 5-4. CFA Sewage Treatment Plant influent monitoring results (2002).[a,b]

Parameter	Minimum	Maximum	Average[c]	Permit Limit
Biological Oxygen Demand (5-day)	13	88.7	45	NA
pH (standard units) (grab)	6.87	8.9	8.2	NA
Chemical Oxygen Demand	59.5	933.0	201.1	NA
Nitrogen, Nitrate + Nitrite (mg-N/L)	0.159	1.1	0.6	NA
Nitrogen, Total Kjeldahl	7.6	21.2	15.3	NA
Total Suspended Solids	2[d]	223.0	61.2	NA

a. All values are in milligrams per liter unless otherwise noted.

b. A duplicate sample was collected in September for all parameters listed and included in the summaries.

c. Annual average is determined from the average of the monthly values. Half the reported detection limit was used in the yearly average calculation for those data reported as below the detection limit.

d. Sample result was less than the detection limit; value shown is half the detection limit.

Table 5-5. CFA Sewage Treatment Plant effluent monitoring results (2002).[a,b]

Parameter	Minimum	Maximum	Average[c]	Permit Limit
Biological Oxygen Demand (5-day)	1[d]	2.1	1.2	NA
pH (standard units) (grab)	9.75	9.94	9.84	NA
Chemical Oxygen Demand	25.8	32.80	29.85	NA
Nitrogen, Nitrate + Nitrite (mg-N/L)	0.005[d]	0.075	0.038	NA
Total Phosphorus	0.188	0.263	0.238	NA
Nitrogen, Total Kjeldahl	1.15	2.39	1.79	NA
Total Suspended Solids	2[d]	33.7	12.3	NA
Fecal Coliform (colonies/100 mL)[e]	1	4	3	NA
Total Coliform (colonies/100 mL)[e]	1	16	6	NA

a. All values are in milligrams per liter unless otherwise noted.

b. Duplicate samples were collected in September for all parameters (excluding pH, fecal and total coliform) and are included in the summaries.

c. Annual average is determined from the average of the monthly values. Half the reported detection limit was used in the yearly average calculation for those data reported as below the detection limit.

d. Sample result was less than the detection limit; value shown is half the detection limit.

e. Samples for fecal and total coliform were not collected in October.

Daily influent flows averaged less than 398,000 L/d (105,000 gal/d). Total influent flow volume was approximately 144 million L (38 million gal) for the 2002 calendar year. Discharge to the pivot averaged 652,754 L/d (172,458 gal/d) when it operated. A total of 54.8 million L (14.49 million gal) was discharged through the pivot in 2002.

Removal efficiencies for biochemical oxygen demand, chemical oxygen demand, total suspended solids, and total nitrogen were calculated to estimate treatment in the lagoons. During the 2002 calendar year, all average removal efficiencies were higher than the previous year, and treatment in the lagoons was sufficient to produce a good quality effluent for land application.

Soil and weather conditions, combined with the relatively low volume of wastewater applied, resulted in no leaching loss for the year, compared to the permit limit of 8 cm/yr (3 in./yr). As a result, land application of wastewater had a negligible impact on soils and groundwater.

WLAP Groundwater Monitoring Results - The WLAP does not require groundwater monitoring at the CFA Sewage Treatment Plant.

Idaho Nuclear Technology and Engineering Center Existing Percolation Ponds

Description - The INTEC generates an average of 3.8 to 7.6 million L/d (1 to 2 million gal/d) of nonhazardous process wastewater during normal operations. This wastewater, commonly called service waste, was discharged to the Existing Percolation Ponds via the service waste system. Wastewater was discharged to the INTEC Existing Percolation Ponds from January 1, 2002, through August 25, 2002. Beginning August 26, 2002, the wastewater was routed to the INTEC New Percolation Ponds.

The Percolation Ponds receive only nonhazardous wastewater. Wastewater with the potential to contain hazardous constituents is disposed of in accordance with the applicable Resource Conservation and Recovery Act requirements. Sanitary wastes from restrooms and the INTEC cafeteria are either discharged to the INTEC Sewage Treatment Plant or directed to onsite septic tank systems.

The service waste system serves all major facilities at INTEC. This process-related wastewater from INTEC operations consists primarily of steam condensates, noncontact cooling water, reverse osmosis products, water softener and demineralizer regenerate, and boiler blowdown wastewater.

All service waste enters building CPP-797, the final sampling and monitoring station, before discharge to the Percolation Ponds. In CPP-797, the combined effluent is measured for flow rate and monitored for radioactivity, and samples are collected for analyses. No radioactivity is expected; however, if radioactivity is detected above a specified level, contaminated waters are directed to a diversion tank rather than discharged to the Percolation Ponds. Two sets of two pumps transfer the wastewater from CPP-797 to the Percolation Ponds.

WLAP Wastewater Monitoring Results - The WLAP for the Existing Percolation Ponds requires effluent monitoring as well as groundwater sampling. A 24-hour flow-proportional composite sample is collected monthly from the sample point located in CPP-797 and analyzed. Table 5-6 summarizes the effluent results from the INTEC Existing Percolation Ponds.

Based upon analytical results, the quality of wastewater discharged to the Existing Percolation Ponds in 2002 is consistent with previous years. The permit does not specify concentration limits for effluent to the ponds; however, concentrations were compared to the applicable state of Idaho

Table 5-6. Summary of INTEC Existing Percolation Pond effluent monitoring results (2002).[a,b]

Parameter	Minimum	Maximum	Average[c]	Permit Limit[d]
pH (composite)	7.9	8.3	8.1	NA
Chloride	87.3	360	182	NA
Fluoride	0.2	0.27	0.22	NA
Nitrogen, as Nitrite (mg-N/L)	0.0015[e]	0.002[e]	0.002	NA
Nitrogen, as Nitrate (mg-N/L)	0.75	0.93	0.87	NA
Total Dissolved Solids	375	835	523	NA
Nitrogen, Total Kjeldahl	0.075[e]	0.21	0.107	NA
Total Nitrogen (calculated)	0.88665[e]	1.0370[e]	0.9764	20
Silver	0.0007[e]	0.001[e]	0.001	NA
Aluminum	0.00315[e]	0.0096	0.0063	NA
Arsenic	0.00165[e]	0.00235[e]	0.00200	NA
Cadmium	0.00015[e]	0.00030[e]	0.00023	NA
Chromium	0.00315[e]	0.0061	0.0053	NA
Copper	0.0013	0.0053	0.0027	NA
Iron	0.0075[e]	0.0240	0.0145	NA
Mercury	0.0000415[e]	0.00004[e]	0.00004	NA
Manganese	0.00025[e]	0.0012	0.0007	NA
Sodium	58.8	192.0	119.6	NA
Selenium	0.0018[e]	0.0020[e]	0.0018	NA

a. All values are in milligrams per liter unless otherwise noted.

b. Discharge to the Existing Percolation Ponds ceased in August. Therefore, this monitoring point was sampled for eight months.

c. Annual average is determined from the average of the monthly values. Half the reported detection limit was used in the yearly average calculation for those data reported as below the detection limit.

d. Effluent limit specified in IDAPA 58.01.17.600.06.B, Wastewater Land Application Permit Rules.

e. Sample result was less than the detection limit; value shown is half the detection limit.

groundwater PCS and SCS. Yearly average effluent concentrations for all constituents, except total dissolved solids, met these standards. The SCS for total dissolved solids is 500 mg/L. During the 2002 application year, the SCS for total dissolved solids was exceeded four times, and the yearly average concentration was 523 mg/L.

The flow volumes to the Existing Percolation Ponds were recorded daily from the flow meter located in CPP-797. Total flow discharged in 2002 to the Exiting Percolation Ponds was 1.52×10^9 L (401.9×10^6 gal). Total flow during the 2002 permit year was well below the permit limit of 3.45×10^9 L/yr (912×10^6 gal/yr).

WLAP Groundwater Monitoring Results - To measure potential percolation pond impacts to groundwater, the WLAP requires that groundwater samples be collected semiannually from four monitoring wells:

- One background aquifer well (USGS-121) up gradient of INTEC;
- One aquifer well (USGS-048) immediately up gradient of the Percolation Ponds; and
- Two aquifer wells (USGS-112 and -113) down gradient of the Percolation Ponds, which serve as points of compliance.

Analytical results for 2002 were very similar to those of previous years with the exception of iron in well USGS-112 and total Kjeldahl nitrogen (TKN) in well USGS-048. Table 5-7 shows the parameter concentrations as well as the groundwater quality PCS and SCS for the April and September/October WLAP groundwater sampling.

The iron concentration in well USGS-112 exceeded the SCS of 0.3 mg/L in both the April and September samples. The April iron concentration was 1.4 mg/L, and the September iron concentration was 1.7 mg/L. These concentrations were significantly higher than those from the previous year's sampling events (0.12 mg/L for April 2001 and 0.093 mg/L for October 2001). It is expected that corrosion of the carbon steel casing and the galvanized riser pipe and not the discharge of effluent to the Existing Percolation Ponds may be contributing to the elevated iron concentrations. Subsequent to the September 2002 sampling event, a 6.1-m (20-ft) section of the old riser pipe was replaced with new galvanized pipe.

The October 2002 concentration for TKN in well USGS-048 was 3.9 mg/L and is significantly higher than expected when compared to previous sampling events. The April 2002 TKN concentration was undetected at 1 mg/L. From 1997 through 2001, the highest detected TKN concentration in well USGS-048 was 0.34 mg/L. During 2002, only one effluent sample had detectable levels (0.21 mg/L) of TKN. Because of the low effluent TKN concentration and the fact that well USGS-048 is upgradient of the Existing Percolation Ponds, it is highly unlikely that the effluent would be the cause of the elevated TKN in the well. The TKN result is not representative of historical TKN concentrations in USGS-048 or in the effluent and may have been an anomaly.

Table 5-7. INTEC Existing Percolation Ponds groundwater data for April and September/October 2002.

	USGS-048 (GW-013004)		USGS-112 (GW-013001)		USGS-113 (GW-013002)		USGS-121 (GW-013003)		PCS/SCS[a]
Depth to Water Table (m [ft])	140.61 (461.32)	141.31 (463.61)	144.34 (473.57)	146.47 (480.56)	143.30 (470.14)	146.69 (481.25)	139.49 (457.64)	139.14 (456.51)	
Sample Date **Parameter**	4/9/02	10/16/02	4/9/02	9/25/02	4/16/02	9/25/02	4/17/02	10/16/02	
TKN	1.0[b] U[c]	3.9	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	NA[d]
Chloride	28.2	43.7	108	106	175	169	12.0	12.0	250 (350)[e]
TDS	268	276	406	463	542	672	206	222	500 (800)[e]
Sodium	15.7 R[f]	22.4	55.3 R[f]	51.7	85.3 R[f]	79.0	9.0 R[f]	8.59	NA
NO_3-N	2.77[g]	3.43	3.51[g]	3.14	2.5[g]	2.02	0.79R[g,h]	0.79	10
NO_2-N	0.10 U	0.10 U	0.10 U	0.10 U	0.1 U	0.10 U	0.10 U	0.10 U	1
NO_3-N +NO_2-N	2.51	3.4	3.15	3.08	2.07	2.18	0.77	0.77	10
Arsenic	0.0027 U	0.0022 U	0.0027 U	0.0022 U	0.0027 U	0.0022 U	0.0027 U	0.0032	0.05
Cadmium	0.0008 U	0.0006 U	0.0008 U	0.0006 U	0.0008 U	0.0006 U	0.0008 U	0.0006 U	0.005
Chromium	0.0065	0.0076	0.0070	0.0065	0.0062	0.0052	0.0047	0.005	0.1
Mercury	0.00012	0.00013	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.002
Selenium	0.0033 U	0.0026 U	0.0033 U	0.0026 U	0.0033 U	0.0026 U	0.0033 U	0.0026 U	0.05
Silver	0.0012 U	0.0018 U	0.0012 U	0.0018 U	0.0012 U	0.0018 U	0.0012 U	0.0018 U	0.1
Fluoride	0.20	0.3	0.20	0.20	0.20	0.20	0.20	0.3	4
Iron	0.0741	0.027 U	1.4	1.79	0.0558	0.027 U	0.0387 U	0.027 U	0.3
Manganese	0.0005 U	0.0004 U	0.0154	0.0225	0.0005 U	0.0004 U	0.0005 U	0.0004 U	0.05
Copper	0.0036 U	0.0078	0.012 U	0.0162	0.0036 U	0.0032 U	0.0036 U	0.0032 U	1.3
Aluminum	0.0461 U	0.0212 U	0.0461 U	0.0221	0.0461 U	0.0212 U	0.0461 U	0.0212 U	0.2
pH	7.85	7.88	7.92	NR[i]	7.81	7.64	8.02	8.06	6.5–8.5

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in IDAPA 58.01.11.200.01.a and b.

b. All concentrations are in milligrams per liter, except pH, which is in standard units.

c. U flag indicates that the result was reported as below the detection limit.

d. NA = Not applicable.

e. The permit specifies exceptions for chloride and total dissolved solids limits of 350 mg/L and 800 mg/L, respectively.

f. R flag indicates that the result was rejected during validation. The result was not used in the annual average calculations. The April sodium results were rejected because of matrix spike and matrix spike duplicate issues.

g. The analytical laboratory failed to perform the NO_3-N analyses as requested. Therefore, the NO_3-N results shown are estimated based on the NO_3-N + NO_2-N results and the NO_2-N results. Because all NO_2-N results were undetected (as expected since the samples were preserved with sulfuric acid), it can be assumed that the NO_3-N + NO_2-N concentrations also represent the NO_3-N concentrations.

h. R flag indicates that the result was rejected during validation. The result was not used in the annual average calculations. The April NO_3-N result was rejected due to the holding time being greatly exceeded.

i. NR = No pH reading was available from this well because of failure of Hydrolab meter.

Idaho Nuclear Technology and Engineering Center New Percolation Ponds

Description - The above description of the INTEC Existing Percolation Ponds applies to the INTEC New Percolation Ponds. The only major difference is that as of August 26, 2002, the wastewater was discharged to the New Percolation Ponds instead of the Existing Percolation Ponds.

The INTEC New Percolation Ponds are designed to function similarly to the Existing Percolation Ponds south of INTEC. The new pond complex is a rapid infiltration system and is comprised of two ponds excavated into the surficial alluvium and surrounded by bermed alluvial material. Each pond is approximately 93 x 93 m (305 × 305 ft) at the top of the berm and is about 3-m (10-ft) deep. Each pond is designed to accommodate a continuous wastewater discharge rate of approximately 11 million L/d (three million gal/d).

During normal operation, wastewater is discharged to only one pond at a time. Periodically, the pond receiving the wastewater will be alternated to minimize algae growth and maintain good percolation rates. Ponds are routinely inspected, and the depth is recorded via permanently mounted staff gauges.

WLAP Wastewater Monitoring Results - The WLAP for the New Percolation Ponds requires effluent monitoring, as well as groundwater sampling. As with the existing percolation ponds, a 24-hour flow-proportional composite sample is collected monthly from the sample point in CPP-797 for all parameters except pH, which is taken as a grab sample as required by the permit. Table 5-8 summarizes the effluent results from the INTEC New Percolation Ponds.

Sample collection for the New Percolation Ponds began in September 2002, after the wastewater was rerouted from the Existing Percolation Ponds to the New Percolation Ponds on August 26, 2002.

The permit does not specify concentration limits for effluent to the ponds; however, concentrations were compared to the applicable state of Idaho groundwater PCS and SCS. Yearly average effluent concentrations for all constituents, except total dissolved solids (TDS), met these standards. The SCS for TDS is 500 mg/L. During the 2002 calendar year, the SCS for TDS was exceeded in the December sample. The yearly average TDS concentration was 558 mg/L.

The flow volumes to the New Percolation Ponds were recorded daily from the flow meter located in CPP-797. Total flow discharged to the New Percolation Ponds in 2002 (from August 26, 2002, through December 31, 2002) was approximately 7.45×10^8 L (1.97×10^8 gal). Total flow during the 2002 permit year was well below the permit limit of 4.145×10^9 L/yr (1.095×10^9 gal/yr).

WLAP Groundwater Monitoring Results - To measure potential impacts to groundwater from the New Percolation Ponds, the permit requires that groundwater samples be collected semiannually from six monitoring wells:

Table 5-8. Summary of INTEC New Percolation Pond effluent monitoring results (2002).[a]

Parameter	Minimum	Maximum	Average[b]	Permit Limit[c]
pH (standard units) (grab)	7.658	8.1	7.8	NA
Chloride	28.47	806	245	NA
Fluoride	0.16	0.23	0.19	NA
Nitrogen, as Nitrite (mg-N/L)[d]	0.00305	1.5 U	0.4 U	NA
Nitrogen, as Nitrate (mg-N/L)	0.89	0.96	0.92	NA
Total Dissolved Solids	313.4	1,265	558	NA
Nitrogen, Total Kjeldahl[d]	0.105	0.12 U	0.12 U	NA
Total Phosphorous	0.0231	0.0684	0.0355	NA
Silver[d]	0.0009	0.002 U	0.001 U	NA
Aluminum	0.00305[e]	0.0198	0.0091	NA
Arsenic[d]	0.00215	0.00245 U	0.00228 U	NA
Cadmium[d]	0.0003	0.0003 U	0.0003 U	NA
Chromium	0.0056	0.0072	0.0064	NA
Copper	0.0008[e]	0.0112	0.0046	NA
Iron	0.00435[e]	0.278	0.0807	NA
Mercury[d]	0.0000415	0.00004 U	0.00004 U	NA
Manganese	0.0005	0.0032	0.0013	NA
Sodium	31.7	95.8	59.8	NA
Selenium	0.0015[e]	0.0046	0.0024	NA
Total Nitrogen[f]	0.11[e]	2.55[e]	0.94	20

a. All values are in milligrams per liter unless otherwise noted.

b. Annual average is determined from the average of the monthly values. Half the reported detection limit was used in the yearly average calculation for those data reported as below the detection limit.

c. Effluent limit specified in IDAPA 58.01.17.600.06.B, Wastewater Land Application Permit Rules.

d. All data, as indicated by the U flag, were reported as below the detection limit. Half of the highest reported detection limit for a particular parameter is used for the annual maximum concentration.

e. Sample result was less than the detection limit; value shown is half the detection limit.

f. Total nitrogen is calculated as the sum of total Kjeldahl nitrogen and nitrate + nitrite.

- One background aquifer well (ICPP-MON-A-167) upgradient of the New Percolation Ponds;
- One background perched water well (ICPP-MON-V-191) north of the New Percolation Ponds and just south of the Big Lost River;
- Two aquifer wells (ICPP-MON-A-165 and -166) downgradient of the New Percolation Ponds; and

- Two perched water wells (ICPP-MON-V-200 and ICPP-MON-V-212) adjacent to the New Percolation Ponds. Well ICPP-MON-V-200 is north of the New Percolation Ponds and well ICPP MON-V-212 is between the two ponds.

The New Percolation Ponds were placed into service on August 26, 2002. Therefore, samples were only collected in October of the 2002 permit year. The permit provides a specified list of parameters to be analyzed for in the groundwater samples. Aquifer wells ICPP MON-A-165 and ICPP-MON-A-166 and perched water wells ICPP-MON-V-200 and ICPP MON V 212 are the permit compliance points. Aquifer well ICPP-MON-A-167 and perched water well ICPP-MON-V-191 are listed in the permit as upgradient, noncompliance points. Contaminant concentrations in the compliance wells are limited by the groundwater PCS and SCS.

Table 5-9 shows water levels (recorded before purging and sampling) and analytical results for all parameters specified by the permit. The concentrations for aluminum, iron, and manganese in aquifer wells ICPP-MON-A-166 and ICPP-MON-A-167 were above the SCS levels. As stated previously, well ICPP-MON-A-166 is a compliance well and is regulated by the permit not to exceed the PCS and SCS levels. Well ICPP-MON-A-167 is the background aquifer monitoring well and is not regulated to these levels by the permit.

The data from the October 2002 sample from perched water well ICPP-MON-V-200 indicate that no PCS or SCS levels were exceeded.

Concentrations of aluminum, iron, and manganese in well ICPP-MON-A-166 from the October sample (Table 5-9) are similar to the pre-operational baseline concentrations for this well. The aluminum, iron, and manganese concentrations in the October sample from well ICPP-MON-A-167 were lower than those in the pre-operational baseline samples. The concentrations of these constituents in well ICPP-MON-A-167 appear to be decreasing over time.

No other PCS or SCS levels were exceeded in any of the permit wells. However, TKN levels in ICPP-MON-A-166 and ICPP-MON-A-167 were higher than expected and significantly higher than in the preoperational baseline samples. There is no PCS or SCS limit for TKN.

It is unlikely that the elevated levels of TKN, aluminum, iron, and manganese in the aquifer wells could be the result of the disposal of wastewater to the new ponds for the following reasons:

- Well ICPP-MON-A-167 was selected as the upgradient (background) monitoring well and should not be affected by discharges to the new ponds;
- The concentrations of TKN, aluminum, iron, and manganese in the effluent since August 26, 2002, are considerably lower than the concentrations in the aquifer wells in October 2002; and
- The wastewater discharged to the New Percolation Ponds is the same wastewater that had been discharged to the Existing Percolation Ponds since 1995, and the concentrations of TKN, aluminum, iron, and manganese in the aquifer wells associated with the Existing Percolation Ponds have not exceeded the SCS levels in the past.

Table 5-9. INTEC New Percolation Ponds groundwater quality data for October 2002.

	ICPP-MON-A-167 (GW-013005)	ICPP-MON-A-165 (GW-013006)	ICPP-MON-A-166 (GW-013007)	ICPP-MON-V-191 (GW-013008)	ICPP-MON-V-200 (GW-013009)	ICPP-MON-V-212 (GW-013010)	PCS/SCS[a]
Depth to Water Table m (ft)	150.77 (494.65)	152.86 (501.5)	153.61 (503.97)	Dry[b]	33.84 (111.04)	74.46 (244.3)	
Sample Date Parameter	10/15/02	10/14/02	10/15/02	Not Sampled[b]	10/14/02	Insufficient Volume[c]	
TKN	2.2[d]	1.0 U[e]	2.2	—[f]	1.0 U	—[f]	NA[g]
NO_3-N	0.24[h]	0.83[h]	0.17[h]	—	1.1[h]	—	10
NO_2-N	0.10 U	0.10 U	0.10 U	—	0.10 U	—	1
Total Phosphorus	0.45	0.10 U	0.10 U	—	0.10 U	—	NA
TDS	219	234	187	—	323	—	500
Chloride	8.4	8.9	8.1	—	33.6	—	250
Fluoride	0.20	0.3	0.3	—	0.3	—	4
Aluminum	6.0	0.0212 U	0.366	—	0.137	—	0.2
Arsenic	0.0025	0.0022 U	0.0027	—	0.0036	—	0.05
Cadmium	0.0006 U	0.0006 U	0.0006 U	—	0.0006 U	—	0.005
Chromium	0.0158	0.0139	0.0071	—	0.0077	—	0.1
Copper	0.021	0.0032 U	0.0032 U	—	0.0032 U	—	1.3
Iron	6.18	0.027 U	0.409	—	0.213	—	0.3
Manganese	0.112	0.00056	0.0947	—	0.0047	—	0.05
Mercury	0.0001 U	0.0001 U	0.0001 U	—	0.0001 U	—	0.002
Selenium	0.0026 U	0.0026 U	0.0026 U	—	0.0026 U	—	0.05
Silver	0.0018 U	0.0018 U	0.0018 U	—	0.0018 U	—	0.1
Sodium	14.1	9.87	12.6	—	65.9	—	NA
pH	7.90	7.74	7.70	—	7.78	—	6.5–8.5

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in IDAPA 58.01.11.200.01.a and b.

b. ICPP-MON-V-191 is a perched well and was dry in October 2002 when permit-required sampling was performed. Therefore, the well could not be sampled.

c. ICPP-MON-V-212 is a perched well, and in October 2002 when permit-required sampling was performed, there was insufficient water volume to obtain the needed samples.

d. All concentrations are in milligrams per liter, except pH, which is in standard units.

e. U-flag indicates that the result was reported as below the detection limit.

f. Because the well could not be sampled, no analyte-specific results are available.

g. NA = Not applicable.

h. The NO_3-N analyses were not requested because of an error in preparing the sampling and analysis plan table before sampling. Therefore, the NO_3-N results shown are estimated based on the NO_3-N + NO_2-N results and the NO_2-N results. Because all NO_2-N results were undetected (as expected because the samples were preserved with sulfuric acid), it can be assumed that the NO_3-N + NO_2-N concentrations also represent the NO_3-N concentrations. (Guymon 2003)

With the exception of TKN, the aluminum, iron, and manganese had been detected in the pre-operational samples at approximately equal or higher concentrations.

One possible explanation for the elevated levels of aluminum, iron, and manganese may be that both wells were insufficiently developed during construction activities. Another possible explanation is that the annular seals were placed incorrectly, thus, allowing bentonite slurry to affect the water quality. The sampling logbook entry for October 2002 described the purge water from ICPP-MON-A-167 as murky and the color of bentonite for the entire purge. Before the next sampling event, additional purging will be performed on wells ICPP-MON-A-166 and ICPP-MON-A-167 to try to remove any residual contaminants that may be in the wells as a result of the well construction activities.

The reason for the higher than expected TKN concentrations in the October 2002 samples from wells ICPP-MON-A-166 and ICPP-MON-A-167 is unknown. However, TKN concentrations, as well as the other permit-required parameter concentrations in the six WLAP monitoring wells, will continue to be evaluated as more data become available.

Idaho Nuclear Technology and Engineering Center Sewage Treatment Plant

Description - The INTEC Sewage Treatment Plant treats and disposes of sanitary and other related nonprocess wastes (cafeteria and building water softeners) using natural biological and physical processes (digestion, oxidation, photosynthesis, respiration, aeration, and evaporation). The INTEC Sewage Treatment Plant consists of

- Two aerated lagoons (Cell Nos. 1 and 2);
- Two quiescent, facultative stabilization lagoons (Cell Nos. 3 and 4);
- Six control stations; and
- Four rapid infiltration trenches.

The six control stations direct the wastewater flow to the proper sequence of lagoons and infiltration trenches. Automatic flow-proportional composite samplers are located at control stations CPP-769 (influent) and CPP-773 (wastewater from the Sewage Treatment Plant to the rapid infiltration trenches). The composite samplers are connected to flow meters, thus, allowing collection of flow-proportional samples.

WLAP Wastewater Monitoring Results - The WLAP requires monthly sampling and analysis of the influent and effluent. Influent samples were collected from control station CPP-769 and effluent samples were collected from control station CPP-773. The WLAP sets effluent limits at CPP-773 for total nitrogen (TKN plus nitrite/nitrate nitrogen) and total suspended solids. Permit-required influent and effluent monitoring results are summarized in Tables 5-10 and 5-11, respectively.

Table 5-10. INTEC Sewage Treatment Plant influent monitoring results (2002).[a]

Parameter	Minimum	Maximum	Average[b]	Permit Limit
Biological Oxygen Demand (5-day)	67.1	151.0	107	NA
Nitrogen, Nitrate + Nitrite (mg-N/L)	0.005[c]	0.209	0.079	NA
Total Phosphorus	3.75	6.38	45.84	NA
Nitrogen, Total Kjeldahl	17.2	47.7	37.7	NA
Total Suspended Solids	45.4	341	144	NA

a. All values are in milligrams per liter unless otherwise noted.

b. Annual average is determined from the average of the monthly values. Half the reported detection limit was used in the yearly average calculation for those data reported as below the detection limit.

c. Sample result was less than the detection limit; value shown is half the detection limit.

Table 5-11. INTEC Sewage Treatment Plant effluent monitoring results (2002).[a,b]

Parameter	Minimum	Maximum	Average[c]	Permit Limit[d]
Biochemical Oxygen Demand (5-day)	7.51	26	15	NA
Conductivity (µS) (composite)	529.1	992	827	NA
Conductivity (µS) (grab)	535	999	819	NA
Chloride	63.4	164	130	NA
Nitrogen, Nitrate + Nitrite (mg-N/L)	0.326	3.61	1.76	NA
Total Phosphorus	1.51	4.61	3.22	NA
Total Dissolved Solids	312	663	505	NA
Nitrogen, Total Kjeldahl	5.61	23.7	12.2	NA
Total Suspended Solids	6.2	107	38	100
Total Coliform (colonies/100 mL)	100	16,000	3,003	NA
Total Nitrogen[e] (mg/L)	5.94	25.37	13.93	20

a. All values are in milligrams per liter unless otherwise noted.

b. A duplicate sample was collected on October 16, 2002, and analyzed for biochemical oxygen demand, chloride, nitrogen, nitrate + nitrite, total phosphorus, total dissolved solids, total Kjeldahl nitrogen, and total suspended solids. The results were included in the summaries.

c. Annual average is determined from the average of the monthly values.

d. Effluent limit specified in Section I, Schedule A, Paragraph 1 of the WLAP.

e. Total nitrogen is calculated as the sum of total Kjeldahl nitrogen and nitrate + nitrite.

Except for the monthly total coliform grab sample, all samples were collected as 24-hour flow proportional composites. Monthly average effluent total suspended solids concentrations remained below the permit limit of 100 mg/L, with an annual average of 34 mg/L. During 2002, the average monthly total nitrogen exceeded the monthly average limit of 20 mg/L during January, February, and March. Typically, the highest nitrogen concentrations occur during the colder months.

Total annual effluent flow to the trenches (measured by the flow meters) was 46.3 million L (12.24 million gal) during 2002, which is well below the permit limit of 78 million L/yr (30 million gal/yr). Although there were several periods throughout the year when the accuracy of the effluent flow meters was suspect, 46.3 million L (12.24 million gal) is considered a conservative value.

WLAP Groundwater Monitoring Results - To measure potential INTEC Sewage Treatment Plant impacts to groundwater, the WLAP requires collecting groundwater samples semiannually from three monitoring wells:

- One background aquifer well (USGS-121) upgradient of INTEC;
- One perched water well (ICPP-MON-PW-024) immediately adjacent to the Sewage Treatment Plant; and
- One aquifer well (USGS-052) downgradient of the Sewage Treatment Plant, which serves as the point of compliance.

Contaminant concentrations in USGS-052 are limited by primary and secondary groundwater standards specified in Idaho regulations. Table 5-12 presents the monitoring results for 2002.

Groundwater samples collected from USGS-052 were in compliance with all permit limits during 2002. Chloride and nitrate concentrations in USGS-052 were elevated compared to USGS-121, as in previous years.

Monitoring well ICPP-MON-PW-024 was completed in the perched water zone approximately 21 m (70 ft) below the surface of the infiltration trenches. Similar to previous years, TDS and chloride concentrations in ICPP-MON-PW-024 approximated those of the effluent. Total coliform was detected in the October 2002 sample from this well and was present also in the effluent. The species of bacteria detected was identified as *Enterobacter cloacae* at a concentration of 30 colonies/100 mL.

Background aquifer well USGS-121 exceeded the PCS level for total coliform in the April sample. The sample result was 38 colonies/100 mL total coliform (Table 5-12). The laboratory identified the coliform species as *Citrobacter fruendii*. Because this is the upgradient (background) well, contamination from the INTEC Sewage Treatment Plant is not expected. Total coliform was absent in the October sample, and fecal coliform was absent in both April and October samples.

Table 5-12. INTEC Sewage Treatment Plant groundwater monitoring results (2002).

	ICPP-MON-PW-024 (GW-011502)		USGS-052 (GW-011501)				USGS-121 (GW-011503)		PCS/SCS[a]
Depth to Water Table m (ft)	18.9 (61.9)	18.8 (61.6)	138.41 (454.10)	138.41 (454.10)	139.07 (456.26)	139.07 (456.26)	139.49 (457.64)	139.49 (456.51)	
Sample Date Parameter	4/8/02	10/16/02	4/16/02	4/16/02[b]	10/7/02	10/7/02[b]	4/17/02	10/16/02	
TKN	1.0[c] U[d]	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	NA[e]
Chloride	103	145	29.6	29.9	29.8	28.6	12.0	12.0	250
TDS	555	574	266	263	275	270	206	222	500
NO_3-N	14.3	5.97	4.7	4.8	4.41	4.4	0.79 R[f]	0.79	10
NO_2-N	0.10 U	0.10 U	0.1 U	0.1 U	0.10 U	0.10 U	0.10 U	0.10 U	1
NO_2-N +NO_3-N	14.1	6.0	4.57	4.59	4.55	4.60	0.77	0.77	10
NH_4-N	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	NA
BOD	2.0 U	9.6	2.1	2.4	9	8.7	2.5	9.5	NA
Total Phosphorus	2.6	2.4	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.1 U	NA
Total Coliform	Absent	30[g]	Absent	Absent	Absent	Absent	38[h]	Absent	1 colony/ 100 mL
Fecal Coliform	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	NA

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in IDAPA 58.01.11.200.01.a and b.
b. Duplicate sample.
c. All concentrations are in milligrams per liter, except pH, which is in standard units.
d. U flag indicates that the result was reported as below the detection limit.
e. NA = Not applicable.
f. R flag indicates that the result was rejected during validation because the holding time was greatly exceeded. The result was not used in the annual average calculations.
g. *Enterobacter cloacae* was speciated in this sample.
h. *Citrobacter fruendii* was speciated in this sample.

Test Area North/Technical Support Facility Sewage Treatment Plant

Description - The TAN/TSF Sewage Treatment Plant (TAN 623) was constructed in 1956. It was designed to treat raw wastewater by biologically digesting the majority of the organic waste and other major contaminants, then applying it to the land surface for infiltration and evaporation. The Sewage Treatment Plant consists of

- A wastewater-collection manhole;
- An Imhoff tank;
- Sludge drying beds;
- A trickle filter and settling tank;
- A contact basin; and
- An infiltration disposal pond.

The TAN/TSF Disposal Pond was constructed in 1971. It consists of a primary disposal area and an overflow section, both of which are located within an unlined, fenced 14.2-ha (35-acre) area. The overflow pond is used only when wastewater is diverted to it for brief periods of cleanup and maintenance of the primary pond. In addition to receiving treated sewage wastewater, the TAN/TSF Disposal Pond also receives process wastewater, which enters the facility at the TAN-655 lift station.

The TSF sewage primarily consists of spent water containing wastes from restrooms, sinks, and showers. The sanitary wastewater goes to the TAN 623 Sewage Treatment Plant, and then to the TAN 655 lift station, which pumps to the TAN/TSF Disposal Pond.

The process drain system collects wastewater from process drains and building sources originating from various TAN facilities. The process wastewater consists of liquid effluent, such as steam condensate; water softener and demineralizer discharges; cooling water; heating, ventilating, and air conditioning; and air scrubber discharges. The process wastewater is transported directly to the TAN-655 lift station, where it is mixed with sanitary wastewater before being pumped to the TAN/TSF Disposal Pond.

WLAP Wastewater Monitoring Results - The permit flow limit is 129 million L/yr (34 million gal/yr) discharged to the TAN/TSF Disposal Pond. Total effluent to the TAN/TSF Disposal Pond for calendar year 2002 was approximately 30 million L (7.8 million gal). The permit for the TAN/TSF Sewage Treatment Plant also sets concentration limits for total suspended solids and total nitrogen measured in the effluent to the TAN/TSF Disposal Pond and requires that the effluent be sampled and analyzed monthly for several parameters. During 2002, 24-hour composite samples (except fecal and total coliform, which were grab samples) were collected from the TAN-655 lift station effluent monthly.

Table 5-13 summarizes the effluent monitoring results for calendar year 2002. Monthly concentrations of total suspended solids were well below the permit limit (100 mg/L) throughout

Table 5-13. TAN/TSF Sewage Treatment Plant effluent annual monitoring results (2002).[a,b]

Parameter	Minimum	Maximum	Average[c]	Permit Limit[d]
Biological Oxygen Demand (5-day)	2.85	15.2	7.2	NA
Chloride	14.2	323.0	82.6	NA
Fluoride	0.1[e]	0.294	0.217	NA
Nitrogen, as Ammonia	0.0325	2.550	0.819	NA
Nitrogen, Nitrate + Nitrite (mg-N/L)	0.005[e]	4.07	2.14	NA
Total Phosphorus	0.0941	2.22	0.664	NA
Sulfate	32	45.3	37.5	NA
Total Dissolved Solids	271	798	388	NA
Nitrogen, Total Kjeldahl	0.168	3.49	1.325	NA
Total Suspended Solids	2[e]	13.6	4.1	100
Arsenic	0.00125[e]	0.0039	0.0024	NA
Barium	0.0842	0.1220	0.983	NA
Chromium	0.00125[e]	0.0040	0.0028	NA
Iron	0.00625[e]	0.3940	0.0724	NA
Lead	0.0001[e]	0.0026	0.0010	NA
Manganese	0.00125[e]	0.0148	0.0042	NA
Mercury[f]	7.97	0.0001	0.0001	NA
Selenium	0.00075[e]	0.0027	0.0016	NA
Sodium	0.00084[e]	177.0	51.1	NA
Zinc	0.0161	0.0759	0.0358	NA
Fecal Coliform (colonies/100 mL)	500	130,000	27,364	NA
Total Coliform (colonies/100 mL)	100	90,000	16,897	NA
Total Nitrogen[g] (mg/L)	0.78[e]	7.36	3.47	20

a. All values are in milligrams per liter unless otherwise noted.

b. Duplicate samples were collected in February and December of 2002 for all parameters, excluding fecal and total coliform. Data from duplicate sample were used in calculating the annual summary.

c. Annual average is determined from the average of the monthly values. Half the reported detection limit was used in the yearly average calculation for those data reported as below the detection limit.

d. Effluent limit specified in Section I, Schedule A, Paragraph 1 of the WLAP.

e. Sample result was less than the detection limit; value shown is half the detection limit.

f. All data were reported as below the detection limit. Half of the highest reported detection limit for a particular parameter is used for the annual maximum concentration.

g. Total nitrogen is calculated as the sum of total Kjeldahl nitrogen and nitrate + nitrite.

the entire year, with an annual average of 4.1 mg/L. All monthly total nitrogen (TKN + nitrite/nitrate nitrogen) concentrations were well below the permit limit of 20 mg/L, with the maximum monthly concentration of 7.4 mg/L reported in November.

WLAP Groundwater Monitoring Results - To measure potential TAN/TSF Disposal Pond impacts to groundwater, the WLAP for the TAN/TSF Sewage Treatment Plant requires collecting groundwater samples semiannually from four monitoring wells:

- One background aquifer well (TANT-MON-A-001) upgradient of the TAN/TSF Disposal Pond; and

- Three aquifer wells (TAN-10A, TAN-13A, and TANT-MON-A-002) that serve as permit points of compliance.

The permit limits contaminant concentrations in TAN-10A, TAN-13A, and TANT-MON-A-002 to the Idaho primary and secondary groundwater standards. Table 5-14 presents the monitoring results for 2002.

Iron concentrations exceeded the permit standard of 0.3 mg/L in TANT-MON-A-001 (the background well) and TAN-13A in April and in TAN-10A in April and October. These concentrations are consistent with results of the past few years; elevated iron concentrations historically have been detected in the TAN WLAP monitoring wells.

The older galvanized steel riser pipes were replaced with stainless steel riser pipes in all four TAN WLAP monitoring wells during August 2001. Video log information gathered during the well maintenance showed that the stainless steel well casings in wells TAN-13A, TANT-MON-A-001, and TAN-MON-A-002 appeared relatively free of rust to the water table. Iron concentrations have decreased in all three of these wells when compared to samples collected before the maintenance (April 2001) and those collected after the maintenance. The iron concentrations in these three wells continued to decrease between the April and October 2002 sampling events.

Video log information gathered on TAN-10A showed that the carbon steel well casing appeared to be rusted most of the way to the water table. During 2001, the iron concentrations in TAN-10A increased after maintenance, and iron concentrations for TAN-10A were the highest of the four wells. The condition of the well casing, coupled with the residual effects relating to the replacement of the galvanized riser pipe, may have resulted in the increased iron concentrations in TAN-10A in 2002.

All samples and duplicate samples collected from well TAN-10A in April and October exceeded the permit limit (SCS) for TDS of 500 mg/L (Table 5-14). The TDS increased from 509 and 540 mg/L in the April samples to 568 and 627 mg/L in the October samples. The condition of the well casing and the residual effects from replacing the riser pipe may also be contributing to the increase of the TDS in well TAN-10A.

Fecal coliform was absent in all samples and wells during the 2002 permit year. However, total coliform was present in TANT-MON-A-001 (background well) and TANT-MON-A-002

Table 5-14. TAN/TSF Sewage Treatment Plant groundwater monitoring results (2002).

	TANT-MON-A-001 (GW-015301)		TANT-MON-A-002 (GW-015304)		TAN-10A (GW-015303)				TAN-13A (GW-015302)		PCS/SCS[a]
Depth to Water Table m (ft)	62.34 (204.52)	63.54 (208.45)	63.63 (208.76)	64.53 (211.72)	62.68 (205.65)	62.68 (205.65)	63.58 (208.60)	63.58 (208.60)	63.11 (207.04)	63.70 (209.00)	
Sample Date Parameter	4/3/2002	10/9/2002	4/3/2002	10/9/2002	4/1/2002	4/1/2002[b]	10/2/2002	10/2/2002[b]	4/2/2002	10/2/2002	
TKN	1.0[c] U[d]	2.2	1.0 U	1.0 U	1.0 U	1.0 U	3.9	1.7	1.0 U	1.0 U	NA[e]
BOD	8.0 U	10.7	8.0 U	15.2	7.7	10	2.7	2.6	10.2	12.0	NA
Chloride	12.0	11.4	4.1	3.8	107	108	103	103	3.7	3.1	250
TDS	209	224	181	170	509	540	568	627	167	297	500
Total Phosphorus	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	NA
Sodium	7.94	8.26	6.46	6.64	49.1	48.8	50.7	51.9	6.14	6.14	NA
NO_3-N	0.967	1.02	0.581	0.61	1.78	1.77	1.47	1.48	0.432	0.43	10
NO_2-N	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	1
NO_2-N +NO_3-N	0.9	0.93	0.53	0.56	1.73	1.73	1.26	1.22	0.39	0.43	10
NH_4-N	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.15	0.10 U	0.10 U	0.13	NA
Arsenic	0.0179	0.0039	0.0048	0.0036	0.0063	0.0029 U	0.0029	0.0029	0.0029	0.0028	0.05
Barium	0.0845	0.0836	0.0847	0.0776	0.246	0.251	0.235	0.243	0.0776	0.0747	2
Chromium	0.0056	0.0045	0.0066	0.006	0.0040	0.0009 U	0.0008 U	0.0008 U	0.0054	0.0046	0.1
Mercury	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.002
Selenium	0.0033 U	0.0026 U	0.0033 U	0.0026 U	0.0033 U	0.0033 U	0.0026 U	0.0026 U	0.0033 U	0.0026 U	0.05
Fluoride	0.3	0.20	0.3	0.20	0.2	0.2	0.10	0.10	0.2	0.2	4
Iron	1.990	0.027 U	0.229	0.0981	1.160	0.603	3.03	3.22	0.411	0.027 U	0.3
Lead	0.0034	0.0028 U	0.003 U	0.0028 U	0.003 U	0.003 U	0.0028 U	0.0028 U	0.003 U	0.0028 U	0.015
Manganese	0.0027	0.0004 U	0.0109	0.0034	0.0167	0.0126	0.0146	0.013	0.0053	0.0042	0.05
Sulfate	32.9	28.7	15.6	16.8	42	43.5	43.8	43.2	20.8	16.2	250
Zinc	0.405	0.0453	0.383	0.157	0.103	0.0798	0.201	0.195	0.366	0.280	5
Total Coliform	Absent	1[f]	Absent	700[g]	Absent	Absent	Absent	Absent	Absent	Absent	1 colony/ 100 mL
Fecal Coliform	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	NA

a. Primary constituent standards (PCS) and secondary constituent standards (SCS) in groundwater referenced in IDAPA 58.01.11.200.01.a and b.

b. Duplicate sample.

c. All concentrations are in milligrams per liter, except total and fecal coliform, which are colonies per 100 mL.

d. U flag indicates that the result was reported as below the detection limit.

e. NA = Not applicable.

f. *Enterobacter agglomerans* was speciated in this sample.

g. *Enterbacter sakazakii* was speciated in this sample.

(compliance well) in the October samples. The PCS for total coliform is 1 colony/100 mL. The total coliform in wells TANT-MON-A-001 and TANT-MON-A-002 was 1 colony/100 mL and 700 colonies/100 mL, respectively. The coliform species identified by the laboratory was *Enterobacter agglomerans* in well TANT-MON-A-001 and *Enterobacter sakazakii* in well TANT-MON-A-002. The TAN/TSF Disposal Pond effluent contains total coliform bacteria; however, it is unlikely the coliform detected in these two wells was the result of the Disposal Pond effluent. TANT-MON-A-001 is the background well and is not influenced by the Disposal Pond. TANT-MON-A-002 is northwest of the Disposal Pond, and groundwater flows at TAN are primarily to the south or southeast; therefore, it is unlikely that bacteria could be transported into the well without significant transverse dispersivity in the vadose zone. A possible source of the bacteria in TANT-MON-A-002 could be the formation of a biofilm due to long periods of inactivity.

No other parameters exceeded groundwater quality standards during calendar year 2002.

Test Reactor Area Cold Waste Pond

Description - The TRA Cold Waste Pond was constructed in 1982. The majority of wastewater received by the Cold Waste Pond is secondary cooling water from the Advanced Test Reactor when it is in operation. Chemicals used in the cooling water are primarily commercial corrosion inhibitors and sulfuric acid to control pH. Other wastewater discharges to the Cold Waste Pond are nonhazardous and nonradioactive and include, but are not limited to, maintenance cleaning waste, floor drains, and yard drains

The cold waste effluents collect at the cold well sump and sampling station (TRA-764) before being pumped to the Cold Waste Pond. The cooling tower system has a radiation monitor with an alarm that prevents accidental discharges of radiologically contaminated cooling water.

WLAP Wastewater Monitoring Results - A letter from the Idaho DEQ issued in 2001, authorized the continued operation of the Cold Waste Pond under the terms and conditions of the WLAP regulations (Johnston 2001). As a result, total nitrogen (TKN + nitrite/nitrate nitrogen) and total suspended solids analyses were added in August 2001 to the list of parameters analyzed quarterly at the Cold Waste Pond. These are the only parameters required for compliance. Other parameters are sampled for surveillance purposes.

Automated samplers are used to collect quarterly 24-hour time-proportional composite samples from TRA-764. Total suspended solids and total nitrogen results are summarized in Table 5-15. Additional monitoring for surveillance parameters is discussed in the next section. Total suspended solids were undetected in all samples collected during 2002. The detection level of 4.0 mg/L is well below the regulatory limit of 100 mg/L. The maximum total nitrogen concentration during 2002 was 3.3 mg/L, and it was also significantly less then the regulatory limit of 20 mg/L.

WLAP Groundwater Monitoring Results - Currently, there are no groundwater monitoring requirements associated with the TRA Cold Waste Pond. However, groundwater monitoring is expected to be required when a permit is issued.

Table 5-15. TRA Cold Waste Pond effluent monitoring results (2002).[a,b]

Parameter	Minimum	Maximum	Average	Permit Limit[c]
Total Suspended Solids	2.0 U[d]	2.0 U	2.0 U	100
Total Nitrogen[e]	1.546	3.3	2.8	20

a. All values are in milligrams per liter.

b. For results below the detection limits, half the detection limit was used in calculating the summaries.

c. Effluent limit specified in IDAPA 58.01.17.600.06.B, Wastewater Land Application Permit Rules.

d. U-flag indicates that the result was reported as below the detection limit.

e. Total nitrogen is calculated as the sum of total Kjeldahl nitrogen and nitrate + nitrite.

5.3 Liquid Effluent Surveillance Monitoring

As stated in Section 5.2, additional parameters specified in the Idaho groundwater quality standards are also monitored. The results of this additional monitoring are discussed by individual facility in the following sections. This additional monitoring is performed in support of surveillance activities.

Argonne National Laboratory-West

During 2002, the Industrial Waste Pond and Secondary Sanitary Lagoon at ANL-W were monitored monthly for iron, sodium, chloride, fluoride, sulfate, pH, conductivity, total dissolved solids, turbidity, biological oxygen demand, gross alpha, gross beta, gamma spectrometry, and tritium. Additionally, the Secondary Sanitary Lagoon was also monitored monthly for total coliform. All parameters for both ponds were well below applicable Idaho groundwater standards (Table 5-16).

Central Facilities Area

The influent and effluent to the CFA Sewage Treatment Plant are both monitored according to the WLAP issued for the plant. The results of the permit-related monitoring are discussed in detail in Section 5.2. Table 5-17 summarizes the additional monitoring conducted during 2002 at the CFA Sewage Treatment Plant and shows those parameters with at least one detected result during the year. Additional monitoring is performed quarterly from the floor drains and vehicle maintenance areas of the Transportation Complex at CFA 696. During 2002, no corresponding limits were exceeded for any of the additional parameters monitored, and all additional parameters were within historical concentration levels.

Table 5-16. ANL-W Industrial and Sanitary Waste Pond monitoring results (2002).

Parameter	Industrial Waste Pond			Industrial Waste Ditch			Sanitary Waste Pond		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Iron[a]	0.1	1.6	0.6	0.1	7.8	1.19	0.1	0.84	0.27
Mercury	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
Sodium	26.9	65.1	46.5	19.9	221	45.5	115	216	160.7
Chloride	15	97	51	14	118	51.6	117	264	190.3
Fluoride	1.0	1.8	1.1	1.0	1.0	1.0	1.0	1.0	1.0
Phosphate	1.0	1.0	1.0	1.0	1.0	1.0	1.0	33	6.51
Sulfate	10	47	26	9	65	27.6	22	163	102.5
Gross alpha[b]	5.2	7.3	6.05	5.2	6.0	5.57	5.2	6.0	5.57
Gross beta	15	20	18.1	15	20	18.8	4.8	7.3	5.84
Gross gamma	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tritium	3200	3200	3200	3200	3600	3300	3200	3600	3300
pH[c]	7.24	8.76	8.00	7.24	8.27	7.73	6.48	7.30	7.02

a. Values of iron through sulfate are in milligrams per liter.

b. Radiological values are in picocuries per liter.

c. pH values are in standard units.

Idaho Nuclear Technology and Engineering Center

Wastewater Land Application permits exists for the Sewage Treatment Plant and the New and Existing Percolation Ponds at the INTEC. The results of permit-related monitoring are discussed in detail in Section 5.2. Table 5-18 summarizes the additional monitoring conducted during 2002 at INTEC and shows those parameters with at least one detected result during the year.

For the INTEC Existing Percolation Ponds, all results were well within the applicable limits and historical concentration levels. For the INTEC Sewage Treatment Plant, none of the additional parameters exceeded applicable limits. Although the pH level exceeded the historical high concentration limit at both the influent to and effluent from the INTEC Sewage Treatment Plant, it did not exceed applicable limits.

Naval Reactors Facility

Liquid effluent monitoring confirmed all discharges to the industrial waste ditch in 2002 were controlled in accordance with applicable federal and State laws. No detections above these limits were seen. Specifics regarding this monitoring are published in the *2002 Environmental Monitoring Report for the Naval Reactors Facility* (Bechtel Bettis 2002).

Table 5-17. CFA liquid effluent surveillance monitoring results (2002).[a,b]

Parameter	Minimum	Maximum	Average[c]
Influent to CFA Sewage Treatment Plant Pond 1			
Conductivity (µS)	834	2,477	1,250
Total Phosphorus	0.817	5.62	2.50
Effluent from CFA Sewage Treatment Plant to Pivot Irrigation System			
Conductivity (µS)	1,268	1,448	1,390
Chloride	310	310	310
Fluoride	0.346	0.346	0.346
Sulfate	50.6	50.6	50.6
Total Dissolved Solids	772	772	772
Total Suspended Solids	2[d]	34	12
Aluminum	0.0106	0.0106	0.0106
Barium	0.0893	0.0893	0.0893
Copper	0.0029	0.0029	0.0029
Manganese	0.0032	0.0032	0.0032
Sodium	130	130	130
Selenium	0.00063	0.00063	0.00063
Zinc	0.0142	0.0142	0.0142
Gross Beta[e]	3.78±0.65	3.78±0.65	3.78±0.65
Transportation Complex, CFA-696			
pH (standard units) (grab)	734	9.73	8.43
Conductivity (µS)	7.62	1,115	927
Total Oil and Grease	5[d]	78.6	31.2

a. Only parameters with at least one detected result are shown.
b. All values are in milligrams per liter unless otherwise noted.
c. Radiological average calculations are weighted by uncertainty.
d. Sample result was less than the detection limit; value shown is half the detection limit.
e. Gross beta values are in picocuries per liter, plus or minus the uncertainty (two standard deviations).

Table 5-18. INTEC liquid effluent surveillance monitoring results (2002).[a,b]

Parameter	Minimum	Maximum	Average[c]
INTEC Existing Percolation Ponds			
Sulfate	24.9	53.1	40.5
Barium	0.0557	0.1290	0.0841
Influent to INTEC Sewage Treatment Plant			
Conductivity (µS)	704.2	936.2	830.7
Alkalinity	239	291	270
Bicarbonate	239	291	270
Nitrogen, as Ammonia	12.3	36.7	30.4
pH (standard units)	8.15	10.68	9.35
Effluent from INTEC Sewage Treatment Plant			
pH (standard units) (composite)	7.87	9.76	8.92
Alkalinity	153	240	200
Carbonate	1[d]	62.4	25.8
Fluoride	0.1	0.1	0.1
Bicarbonate	113	240	175
Nitrogen, as Ammonia	0.722	20.6	7.7
Sulfate	43.2	43.2	43.2
Barium	0.0539	0.0539	0.0539
Copper	0.0027	0.0027	0.0027
Iron	0.0538	0.0538	0.0538
Manganese	0.0091	0.0091	0.0091
Sodium	102	102	102
Selenium	0.0008	0.0008	0.0008
Zinc	0.0057	0.0057	0.0057
Potassium-40[e]	12.60 ± 43.80 U[f]	48.30 ± 25.40	27.58 ± 15.49
Gross Beta[e]	7.29 ± 0.45	13.70 ± 0.91	10.42 ± 0.28

a. Only parameters with at least one detected result are shown.
b. All values are in milligrams per liter unless otherwise noted.
c. Radiological average calculations are weighted by uncertainty.
d. Sample result was less than the detection limit; value shown is half the detection limit.
e. Radiological values are in picocuries per liter, plus or minus the uncertainty (two standard deviations).
f. U – result was a statistical nondetect.

Test Area North

The effluent to the TAN/TSF Disposal Pond receives a combination of process water from various TAN facilities and treated sewage waste. The effluent is monitored monthly, and the results are discussed in Section 5.2. Additional monitoring for surveillance purposes is conducted monthly for metal parameters and quarterly for radiological parameters. Table 5-19 summarizes the results of this additional monitoring for those parameters with at least one detected result. During 2002, the concentrations of the additional parameters were within historical levels and applicable limits.

Table 5-19. TAN liquid effluent surveillance monitoring results (2002).[a,b]

Parameter	Minimum	Maximum	Average[c]
Conductivity (µS) (grab)	394.9	1,408.0	644.5
pH (standard units) (grab)	7.66	9.50	8.15
Aluminum	0.0092[d]	0.443	0.055
Copper	0.00125	0.0176	0.0069
Gross Alpha[e]	0.77 ± 0.42	3.97 ± 1.64	0.96 ± 0.41
Gross Beta[e]	3.06 ± 0.60	20.90 ± 0.87	6.89 ± 0.39
Strontium-90[e]	8.08 ± 2.26	8.08 ± 2.26	8.08 ± 2.26

a. Only parameters with at least one detected result are shown.
b. All values are in milligrams per liter unless otherwise noted.
c. Radiological average calculations are weighted by uncertainty.
d. Sample result was less than the detection limit; value shown is half the detection limit.
e. Radionuclide values are in picocuries per liter plus, or minus the uncertainty (two standard deviations).

Test Reactor Area

The effluent to the Cold Waste Pond receives a combination of process water from various TRA facilities. The effluent is monitored quarterly, with the results of monitoring discussed in Section 5.2. Additional monitoring for surveillance purposes is conducted quarterly for metal parameters and for radiological parameters. Table 5-20 summarizes the results of this additional monitoring for those parameters with at least one detected result. During 2002, the concentrations of the additional parameters were within historical levels and applicable limits. Both the sulfate and TDS levels were above the historical high concentration limits.

The largest volume of wastewater received by the TRA Cold Waste Pond is secondary cooling water from the Advanced Test Reactor when it is in operation. During 2002, concentrations of sulfate and TDS were elevated in samples collected during reactor operation. These differences are due to the normal raw water hardness, as well as corrosion inhibitors and sulfuric acid added to control the cooling water pH. Concentrations of sulfate and TDS exceeded the risk-based release levels specific for the TRA Cold Waste Pond during reactor operation but not during reactor outages. The annual average was also slightly above the risk-based release limit, which is the concentration predicted to degrade groundwater quality to above drinking water standards.

Table 5-20. TRA effluent surveillance monitoring results (2002).[a,b]

Parameter	Minimum	Maximum	Average[c]
Conductivity (µS) (grab)	499.2	1,180[d]	939
pH (standard units) (grab)	7.7	7.98	7.81
Chloride	15	32.2	28.1
Fluoride	0.1[d]	0.378	0.315
Nitrogen, Nitrate+Nitrite (mg-N/L)	1.25	3.06	2.48
Sulfate	15	463	352
Total Dissolved Solids	319	938	770
Nitrogen, Total Kjeldahl	0.05[d]	0.921	0.327
Arsenic	0.00125	0.005	0.004
Barium	0.056	0.136	0.116
Chromium	0.0037	0.0104	0.0086
Copper	0.00125[d]	0.0050	0.0040
Iron	0.00625	0.03680	0.01236
Sodium	9.81	30.9	24.5
Nickel	0.00125[d]	0.00250	0.00150
Antimony	0.0003[d]	0.0019	0.0009
Selenium	0.00125[d]	0.00380	0.00277
Zinc	0.00125[d]	0.0037	0.0017
Potassium-40[e]	22.80 ± 35.20 U[f]	34.70 ± 32.00	29.93 ± 12.72
Radium-226[e]	0.99 ± 4.74 U	8.75 ± 6.98	3.77 ± 2.71
Gross Alpha[e]	1.47 ± 1.63 U	5.52 ± 2.22	2.61 ± 0.93
Gross Beta[e]	1.93 ± 0.43	15.50 ± 1.38	4.63 ± 0.32

a. Only parameters with at least one detected result are shown.
b. All values are in milligrams per liter unless otherwise noted.
c. Radiological average calculations are weighted by uncertainty.
d. Sample result was less than the detection limit; value shown is half the detection limit.
e. Radiological values are in picocuries per liter, plus or minus the uncertainty (two standard deviations).
f. U – result was a statistical nondetect.

5.4 Drinking Water Monitoring

In 1988, a centralized drinking water program was established for most INEEL facilities. ANL-W and the NRF are the only two facilities that are not included in the M&O contractor Drinking Water Program. ANL-W is managed by DOE Chicago, and the NRF is operated for the DOE-Pittsburgh Naval reactors, Idaho Branch Office by Bechtel Bettis, Inc.

The Drinking Water Program was established to monitor drinking water and production wells, which are multiple use wells for industrial use, fire safety, and drinking water. According to the "Idaho Regulations for Public Drinking Water Systems" (IDAPA 58.01.08), INEEL drinking water systems are classified as either nontransient or transient, noncommunity water systems. The M&O contractor transient, noncommunity water systems are at the Experimental Breeder Reactor No. 1 (EBR-I), the Gun Range, and the Main Gate. The rest of the M&O contractor water systems are classified as nontransient, noncommunity water systems, which have more stringent requirements than transient, noncommunity water systems.

The Drinking Water Program monitors drinking water to ensure it is safe for consumption and to demonstrate that it meets federal and State regulations (that MCLs are not exceeded). The Safe Drinking Water Act establishes the overall requirements for the Drinking Water Program.

Because groundwater supplies the drinking water at the INEEL, information on groundwater quality was used to help develop the Drinking Water Program. The USGS and the M&O contractor monitor and characterize groundwater quality at the INEEL. Three groundwater contaminants have impacted M&O contractor drinking water systems: tritium at CFA, carbon tetrachloride at the Radioactive Waste Management Complex (RWMC), and trichloroethylene at TAN/TSF.

As required by the state of Idaho, the Drinking Water Program uses U.S. EPA-approved (or equivalent) analytical methods to analyze drinking water in compliance with IDAPA 58.01.08 and 40 Code of Federal Regulations (CFR) 141-143 (2002).

Currently, the Drinking Water Program monitors ten water systems, which include 17 wells. Drinking water parameters are regulated by the state of Idaho under authority of the Safe Drinking Water Act. Parameters with primary maximum contaminant levels must be monitored at least once during every three-year compliance period. Parameters with secondary maximum contaminant levels are monitored every three years based on a recommendation by the EPA. The three-year compliance periods for the Drinking Water Program are 1999-2001, 2002-2004, and so on. Many parameters require more frequent sampling during an initial period to establish a baseline, and subsequent monitoring frequency is determined from the baseline.

Because of known contaminants, the Drinking Water Program monitors certain parameters more frequently than required. For example, the program monitors for bacteriological analyses more frequently because of historical problems with bacteriological contaminants. These detections were possibly caused by biofilm on older water lines and stagnant water, and resampling results were normally in compliance with the MCL.

Onsite Drinking Water Monitoring Results

During 2002, 254 routine samples and 24 quality control samples were collected and analyzed from CFA, EBR-I, Gun Range, INTEC, Main Gate, Power Burst Facility (PBF), RWMC, TAN/Contained Test Facility (CTF) and TAN/TSF, and TRA. In addition to the routine sampling, the Drinking Water Program also collects nonroutine samples. For example, a nonroutine sample is one collected after a water main breaks and is repaired to determine if the water is acceptable for use before the main is put back into service. The Drinking Water Program received 23 requests for nonroutine sampling during 2002.

Analytical results of interest, exceedances, nitrate (required to be monitored annually) results, and lead/copper results in 2002 are presented in Tables 5-21 through 5-24, respectively, and are discussed in the following subsections. EBR-I, Gun Range, INTEC, Main Gate, PBF, TAN/CTF, and TRA were well below drinking water limits for all regulatory parameters and are, therefore, not discussed further in this report.

In addition to the listed parameters monitored in 2002, the M&O contractor also sampled for arsenic, lead, and copper. The MCL for arsenic is 10 µg/L. All M&O contractor water systems monitored were less than the reporting limit of 5 µg/L.

Table 5-21. Monitored parameters of interest in 2002.

Parameter[a]	Location	Results[b] (four-quarter average)	MCL[b]
Trichloroethylene	TSF #2 Well	2.93[c]	NA[d]
	TSF Distribution	1.38	5
	RWMC Well	1.98[c]	NA
	RWMC Distribution	1.43	5
Carbon Tetrachloride	RWMC Well	4.3	NA
	RWMC Distribution	2.88	5
Tritium	CFA Distribution	10,234 pCi/L	20,000 pCi/L
	CFA #1 Well	10,347 pCi/L	NA
	CFA #2 Well	9607 pCi/L[e]	NA

a. The parameters shown are known contaminants that the Drinking Water Program is tracking.

b. Results and maximum contaminant level are in micrograms per liter, unless otherwise noted.

c. Sampled for surveillance purposes (not required by regulations to be sampled). The compliance point is after the sparger system (air stripping process); the compliance result is 1.38 µg/L for the four-quarter average.

d. NA = Maximum contaminant level is not applicable to the well concentration.

e. Result is based on a three-quarter average.

Table 5-22. Monitored parameters exceedences in 2002.

Parameter[a]	Location	Results	MCL
Total Coliform	RWMC	Present	Absent

a. Total coliform was detected in the RWMC drinking water system in August and September.

Table 5-23. Nitrate results for ANL-W and M&O contractor water systems in 2002.

Water System	PWS Number	Parameter	Concentration[a]	MCL[a]
ANL-W	6060036	Nitrate as nitrogen	1.7	10
CFA	6120008	Nitrate as nitrogen	3.2	10
INTEC	6120012	Nitrate as nitrogen	1.4	10
CTF	6120013	Nitrate as nitrogen	1.4	10
EBR-I	6120009	Nitrate as nitrogen	0.9	10
Gun Range	6120025	Nitrate as nitrogen	1.0	10
Main Gate	6120015	Nitrate as nitrogen	1.2	10
PBF	6120019	Nitrate as nitrogen	1.5	10
RWMC	6120018	Nitrate as nitrogen	1.3	10
TRA	6120020	Nitrate as nitrogen	1.4	10
TSF	6120021	Nitrate as nitrogen	1.4	10

a. Concentration and MCL are in milligrams per liter.

Table 5-24. Lead and copper results for ANL-W and M&O contractor water systems in 2002.[a]

Sampling Location	Maximum Concentration	Next Highest Concentration	Average of Two Highest Concentrations	MCL
Copper				
ANL-W Distribution System	340	270	305	1,300
CFA Distribution System	150	85	117.5	1,300
CPP Distribution System	570	190	380	1,300
PBF Distribution System	52	24	38	1,300
RWMC Distribution System	160	120	140	1,300
TAN/CTF Distribution System	160	130	145	1,300
TAN/TSF Distribution System	27	16	21.5	1,300
TRA Distribution System	230	200	215	1,300
Lead				
ANL-W Distribution System	58	44	51	15
CFA Distribution System	3.6	1.5	2.55	15
CPP Distribution System	2.6	2.1	2.35	15
PBF Distribution System	2.6	1 U[b]	1.55[c]	15
RWMC Distribution System	1 U	1 U	1 U[d]	15
TAN/CTF Distribution System	13	1.2	7.1	15
TAN/TSF Distribution System	9.3	2.3	5.8	15
TRA Distribution System	5.9	1.3	3.6	15

a. All concentrations are in micrograms per liter.

b. U-flag indicates that the result was below the detection limit.

c. One-half of the reported detection limit was used in the average calculation.

d. Because both results were below detection, the average shown is the reported detection limit.

Lead and copper is required to be monitored once every three years for all INEEL water systems, except for the transient noncommunity water systems at the Gun Range, Main Gate, and EBR-I. The MCL is calculated by taking the two highest concentrations and averaging the results. All samples were below the MCL for lead (15 µg/L) and copper (1300 µg/L).

Central Facilities Area - The CFA water system serves approximately 850 people daily. Since the early 1950s, wastewater containing tritium was disposed to the SRPA at TRA and INTEC through injection wells and infiltration ponds. These wastewaters migrated south southwest and are the suspected source of tritium contamination in the CFA water supply wells. The practice of disposing of wastewater through injection wells has been discontinued for many years.

In 2002, water samples were collected quarterly from CFA #1 Well (at CFA-651), CFA #2 Well (at CFA-642), and CFA-1603 (point of entry to the distribution system) for compliance purposes. Since December 1991, the mean tritium concentration has been below the MCL at all three locations. In general, tritium concentrations in groundwater have been decreasing (Figure 5-3) because of changes in disposal rates, disposal techniques, recharge conditions, and radioactive decay.

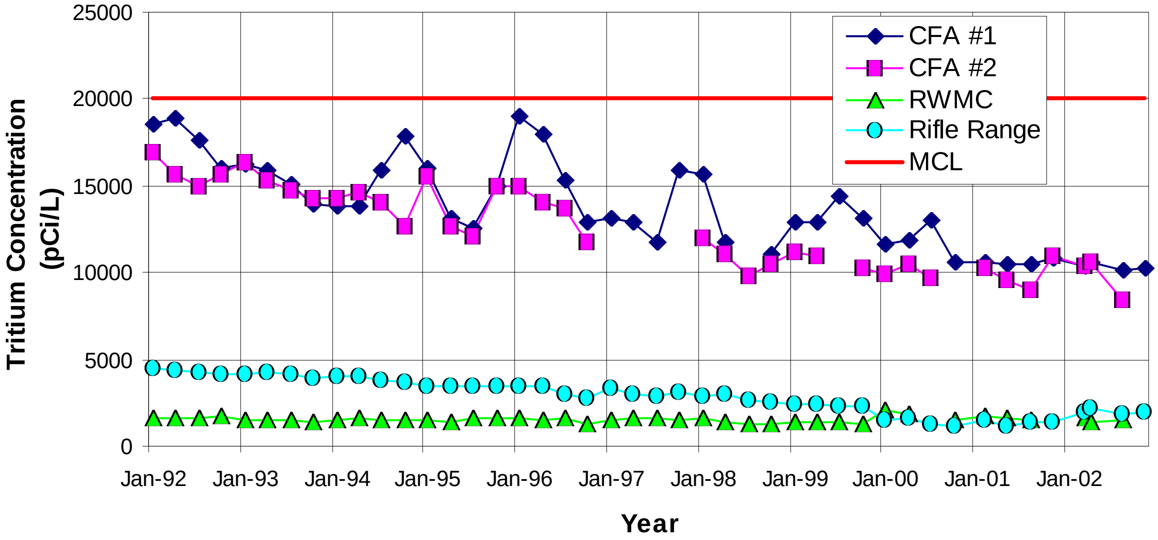


Figure 5-3. Tritium concentrations in two wells and two distribution systems at the INEEL (1992-2002).

CFA Worker Dose - Because of the potential impacts to downgradient workers at CFA from radionuclides in the SRPA, the potential effective dose equivalent from radioactivity in water was calculated. CFA was selected because tritium concentrations found in these wells were the highest of any drinking water wells. The 2002 calculation was based on

- Mean tritium concentration for the CFA distribution system in 2002;
- Water usage information for 2002 showing CFA #1 was used for approximately 50 percent of the drinking water and CFA #2 for 50 percent of the drinking water; and
- Data from a 1990-1991 USGS study for iodine-129 (^{129}I) using the accelerator mass spectrographic analytical technique that indicated water from both CFA #1 and CFA #2 had measurable concentrations of ^{129}I. The average (four samples) concentration for ^{129}I for the CFA distribution system was 0.28 ± 0.03 pCi/L for 2002. For perspective, the proposed EPA drinking water standard for ^{129}I is 1 pCi/L.

For the 2002 dose calculation, the assumption was made that each worker's total water intake came from the CFA drinking water distribution system. This assumption overestimates the dose because workers typically consume only about half their total intake during working hours and typically work only 240 days rather than 365 days per year. The estimated effective dose equivalent to a worker from consuming all their drinking water at CFA during 2002 was 0.98 mrem (9.8 µSv), below the EPA standard of 4 mrem/yr for public drinking water systems.

Radioactive Waste Management Complex - Various solid and liquid radioactive and chemical wastes, including transuranic wastes, have been disposed at the RWMC. The RWMC contains pits, trenches, and vaults where radioactive and organic wastes were disposed below grade, as well as placed above grade on a large pad and covered. During an INEEL-wide characterization program conducted by USGS, carbon tetrachloride and other volatile organic compounds were detected in groundwater samples taken at the RWMC (Lewis and Jensen 1984). Review of waste disposal records indicated an estimated 334,630 L (88,400 gal) of organic chemical wastes (including carbon tetrachloride, trichloroethylene, tetrachloroethylene, toluene, benzene, 1,1,1 trichloroethane, and lubricating oil) were disposed at the RWMC before 1970. High vapor-phase concentrations (up to 2700 parts per million vapor phase) of volatile organic compounds were measured in the zone above the water table. Groundwater models predict that volatile organic compound concentrations will continue to increase in the groundwater at the RWMC.

The RWMC production well is located in WMF-603 and supplies all of the drinking water for over 300 people at the RWMC. The well was put into service in 1974. Water samples were collected at the wellhead and from the point of entry to the distribution system, which is the point of compliance, at WMF-604.

Since monitoring began at RWMC in 1988, there had been an upward trend in carbon tetrachloride concentrations until 1999 (Figure 5-4). Since 1999, carbon tetrachloride concentrations have remained fairly constant. In October 1995, the carbon tetrachloride concentrations increased to 5.48 µg/L at the well. This was the first time the concentrations exceeded the maximum contaminant level of 5.0 µg/L. However, the maximum contaminant level for carbon tetrachloride is based on a four-quarter average and applies to the distribution system. The distribution system is the point from which water is first consumed at RWMC and is the compliance point. Table 5-25 summarizes the carbon tetrachloride concentrations at the RWMC drinking water well and distribution system for 2002. The mean concentration at the well for 2002 was 4.3 µg/L, and the maximum concentration was 4.8 µg/L. The mean concentration at the distribution system was 2.88 µg/L, and the maximum concentration was 2.9 µg/L.

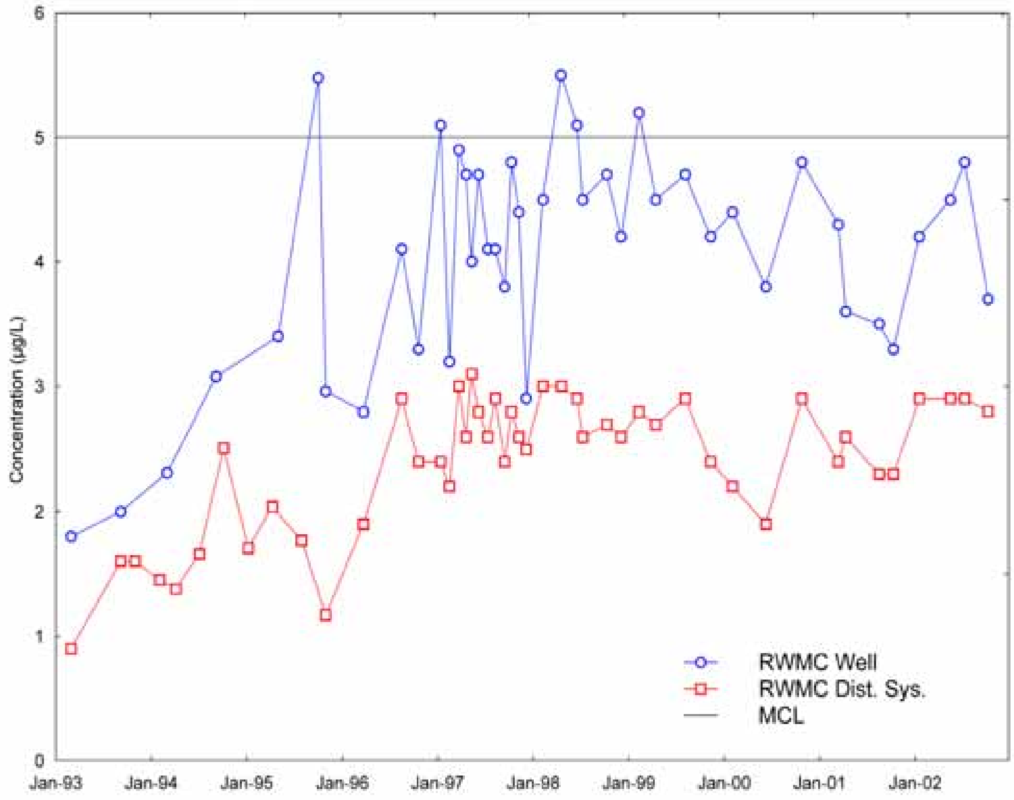


Figure 5-4. Carbon tetrachloride concentrations in the RWMC drinking water well and distribution system.

Table 5-25. Carbon tetrachloride concentrations in the RWMC drinking water well and distribution system (2002).

Location	Number of Samples	Carbon Tetrachloride Concentration [a]			
		Minimum	Maximum	Mean	MCL
RWMC WMF-603 Well	4	3.7	4.8	4.30	NA[b]
RWMC WMF-604 Distribution	4	2.8	2.9	2.88	5.0

a. All concentrations are in micrograms per liter.

b. NA = Not applicable. MCL applies to the distribution system only.

In addition to the carbon tetrachloride detections, total coliform bacteria were detected in the RWMC water system for the months of August and September. Through an onsite investigation, resampling, and inspection of the water system, it was determined that the coliform bacteria detection was caused by older water lines and stagnant water. Since that time, a temporary chlorination system has been installed, and no coliform bacteria have been detected. When funding is provided, a permanent chlorination system will be installed.

Test Area North/Technical Support Facility - In 1987, trichloroethylene was detected at both TSF #1 and #2 Wells, which supply drinking water to approximately 100 employees at Technical Support Facility (TSF) daily. The inactive TSF injection well (TSF-05) is believed to be the principal source of trichloroethylene contamination at the TSF. Bottled water was provided until 1988 when a sparger system (air stripping process) was installed in the water storage tank to volatilize the trichloroethylene to levels below the MCL.

During the third quarter of 1997, TSF #1 Well was taken offline, and TSF #2 Well was put online as the main supply well because the trichloroethylene concentration of TSF #2 had fallen below the MCL of 5.0 µg/L. Therefore, by using TSF #2 Well, no treatment (sparger air stripping system) is currently required. TSF #1 Well is used as a backup to TSF #2 Well. If TSF #1 Well must be used, the sparger system must be activated to treat the water.

Figure 5-5 illustrates the concentrations of trichloroethylene in both TSF wells and the distribution system from 1993 through 2002. Past distribution system sample exceedances are attributed to preventive maintenance activities interrupting operation of the sparger system.

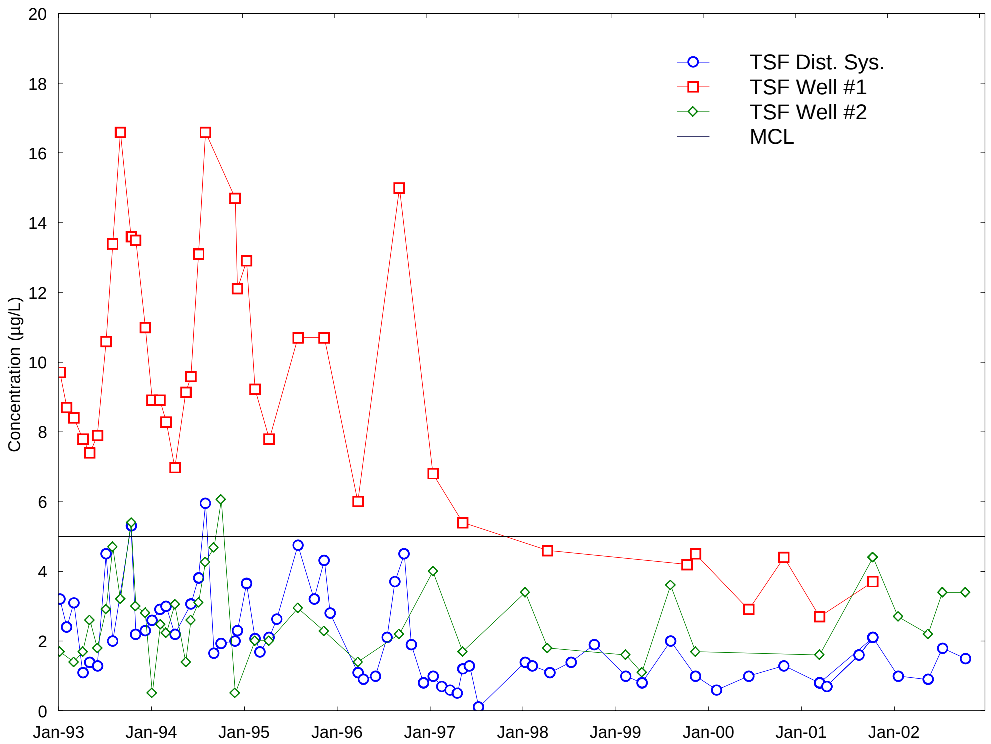


Figure 5-5. Trichloroethylene concentrations in TSF drinking water wells and distribution system (during 2002, sampling of Well #1 was not required).

Table 5-26 summarizes the trichloroethylene concentrations at TSF #2 Well and the distribution system. Regulations do not require sampling of TSF #2 Well; however, samples were collected to monitor trichloroethylene concentrations. The distribution system is the compliance point. TSF #1 Well was not sampled during 2002 because it was not required by the regulations. The mean concentration of trichloroethylene at the distribution system for 2002 was 1.30 µg/L, which is well below the MCL.

Table 5-26. Trichloroethylene concentrations at TSF #2 Well and distribution system (2002).

Location	Number of Samples	Trichloroethylene[a]			
		Minimum	Maximum	Mean	MCL
TSF #2 Well (612)[b]	4	2.2	3.4	2.93	NA[c]
TSF Distribution (610)	4	0.9	1.8	1.30	5.0

a. All concentrations are in micrograms per liter.

b. Regulations do not require sampling at this well.

c. NA = Not applicable. MCL applies to the distribution system only.

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During 2002, ANL-W analyzed quarterly samples for gross alpha, gross beta, and tritium from the entrance to the drinking water distribution system in accordance with the Safe Drinking Water Act. Values for both gross alpha concentration and gross beta concentration were well below MCLs. No detectable concentrations of tritium were reported.

ANL-W collected a nitrate sample as required by regulation. Results were below the EPA MCL (Table 5-23). A single sample was also collected for all primary and secondary drinking water organic and inorganic contaminants, including arsenic, in preparation for the next nine-year cycle of monitoring. No constituents were above their respective MCLs. ANL-W also collected 20 samples for lead and copper analysis again as part of the next cycle of testing required under Idaho drinking water regulations. The average of the two highest copper concentrations was below the MCL. However, as in the past, the average of the two highest concentrations (51 µg/L) for lead were well above the MCL of 15 µg/L (Table 5-24). ANL-W also tested their system quarterly for coliform bacteria with no positive results for the year.

Naval Reactors Facility

Drinking water samples were collected at a point before entering the distribution system. The samples were drawn from a sampling port immediately downstream from the NRF water softening treatment system. The water was monitored for volatile organic compounds, inorganic constituents, and water quality parameters. Radionuclides were sampled at each wellhead.

Drinking water monitoring at NRF did not detect any volatile organic compounds above minimum detection levels. No gross alpha, gross beta, programmatic gamma-emitters, or strontium-90 (^{90}Sr) were measured in excess of natural background concentrations in 2002.

Tritium values were generally comparable to background concentrations and showed no increase over levels reported in 2001. For more information see the *2002 Environmental Report for the Naval Reactors Facility* (Bechtel Bettis 2002).

Offsite Drinking Water Sampling

As part of the offsite monitoring performed by the ESER contractor, radiological analyses are performed on drinking water samples taken at offsite locations. In 2002, the ESER contractor collected a total of 30 drinking water samples from 14 offsite locations.

One drinking water sample collected in the fourth quarter of 2002 in Minidoka contained detectable levels of gross alpha activity (Table 5-27). The value (2.47 ± 0.76 pCi/L) is much lower than the EPA MCL of 15 pCi/L for drinking water.

As in years past, measurable gross beta activity was present in most offsite drinking water samples (26 of the 30 samples). Detectable concentrations ranged from 1.98 ± 0.94 to 8.74 ± 1.26 pCi/L (Table 5-27). The upper value of this range is below the EPA screening level for drinking water of 50 pCi/L. Concentrations in this range are normal and cannot be differentiated from the natural decay products of thorium and uranium that dissolve into water as the water passes through the basalt terrain of the Snake River Plain.

Tritium was measured in eight drinking water samples during 2002. Tritium concentrations ranged from 66.7 ± 30.1 to 349.9 ± 71.5 pCi/L, with the high result coming from Aberdeen (Table 5-27). The maximum level is still well below the DOE's DCG of 2.0×10^6 pCi/L and the EPA MCL of 20,000 pCi/L for tritium in water. Again, these levels can be explained by natural variability.

5.5 Aquifer Studies

The SRPA, which underlies the Eastern Snake River Plain and the INEEL, serves as the primary source for drinking water and crop irrigation in the Upper Snake River Basin. A brief description of the hydrogeology of the INEEL and the movement of water in the SRPA is given in Chapter 1. Further information may be found in numerous publications of the USGS. Copies of these publications can be requested from the USGS INEEL Project Office at 208-526-2438. During 2002, the USGS published eight documents covering hydrogeologic conditions at the INEEL or on the Eastern Snake River Plain. The abstracts to each of these reports are presented in Appendix C.

5.6 Radiological Groundwater Monitoring

Historic waste disposal practices have produced localized areas of radiochemical contamination in the SRPA beneath the INEEL. The INTEC facility used direct injection as a disposal method up to 1984. This wastewater contained high concentrations of both tritium and ^{90}Sr. Injection at the INTEC was discontinued in 1984 and the injection well sealed in 1990. When direct injection ceased wastewater from INTEC was directed to a pair of shallow

Table 5-27. ESER contractor offsite drinking water results (2002).

Location	Sample Results[a]		Limits for Comparison[a]	
	Result ± 2s	MDC[b]	EPA MCL[b]	DOE DCG[b]
Gross Alpha				
Minidoka	2.47 ± 0.76	1.83	15	30
Gross Beta				
May 2002				
Aberdeen[c]	2.80 ± 2.05	3.24	50	100
Duplicate[c]	4.54 ± 2.02	3.01	50	100
Fort Hall	3.67 ± 2.09	3.25	50	100
Idaho Falls	3.58 ± 1.82	2.73	50	100
Minidoka	8.74 ± 2.52	3.50	50	100
Monteview[c]	2.20 ± 1.92	3.09	50	100
Moreland	7.25 ± 2.46	3.49	50	100
Mud Lake	3.38 ± 1.61	2.41	50	100
Roberts	4.28 ± 1.82	2.69	50	100
Shoshone[c]	1.98 ± 1.89	3.04	50	100
Tabor	4.71 ± 1.93	2.83	50	100
November 2002				
Aberdeen	8.04 ± 1.05	2.78	50	100
Arco[c]	2.22 ± 0.84	2.66	50	100
Atomic City	3.69 ± 0.89	2.65	50	100
Duplicate[c]	2.59 ± 0.89	2.81	50	100
Carey	3.02 ± 0.87	2.64	50	100
Fort Hall	8.31 ± 1.05	2.78	50	100
Howe[c]	2.19 ± 0.84	2.64	50	100
Idaho Falls	2.80 ± 0.88	2.74	50	100
Minidoka	8.15 ± 1.20	3.30	50	100
Monteview	4.33 ± 0.91	2.70	50	100
Moreland	3.69 ± 1.04	3.19	50	100
Mud Lake	4.00 ± 0.86	2.53	50	100
Roberts	3.10 ± 0.88	2.71	50	100
Shoshone[c]	2.07 ± 0.81	2.54	50	100
Tabor	4.51 ± 0.96	2.80	50	100
Tritium				
May 2002				
Aberdeen	349.90 ± 71.54	128.46	20,000	2×10^6
Howe	316.54 ± 71.08	128.46	20,000	2×10^6
November 2002				
Fort Hall	118.0 ± 107.0	107.6	20,000	2×10^6

a. All values shown are in picocuries per liter.

b. MDC = minimum detectable concentration, EPA MCL = maximum contaminant level, DOE DCG = derived concentration guide.

c. Result does not exceed the MDC and is, therefore, considered to be undetected.

percolation ponds, where the water infiltrates into the subsurface. Disposal of low- and intermediate-level radioactive waste solutions to the percolation ponds ceased in 1993 with the installation of the Liquid Effluent Treatment and Disposal Facility (LET&D). TRA also discharged contaminated wastewater, but to a shallow percolation pond. The TRA pond was replaced in 1993 by a flexible plastic (hypalon) lined evaporative pond, which stopped the input of tritium to groundwater, and the new INTEC percolation ponds went into operation in August 2002.

The average combined rate of tritium wastewater disposal at the TRA and INTEC during 1952-1983 was 910 Ci/yr; during 1984-1991, 280 Ci/yr; and during 1992-1995, 107 Ci/yr. From 1952-1998, the INEEL disposed about 93 Ci of ^{90}Sr at TRA and about 57 Ci at INTEC. Wastewater containing ^{90}Sr was never directly discharged to the SRPA at TRA, but at INTEC a portion of the ^{90}Sr was injected directly to the SRPA. From 1996 to 1998, the INEEL disposed about 0.03 Ci of ^{90}Sr to the INTEC infiltration ponds (Bartholomay et al. 2000).

Presently only ^{90}Sr continues to be detected by the M&O contractor and the USGS at levels above the MCL value in some wells between INTEC and CFA.

U.S. Geological Survey

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. The configuration and extent of the tritium contamination area, based on the 1998 data, are shown in Figure 5-6 (Bartholomay et al. 2000). The area of contamination within the 0.5-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.

Concentrations of tritium in the area of contamination have continued to decrease. The area of elevated concentrations near CFA likely represents water originating at INTEC some years earlier when larger amounts of tritium were disposed. This is further supported by the fact that there are no known sources of tritium contamination to groundwater at CFA.

Two monitoring wells downgradient of TRA (Well 65) and INTEC (Well 77) (see Figure 5-2) have continually shown the highest tritium concentrations in the aquifer over time. For this reason, these two wells are considered representative of maximum concentration trends in the rest of the aquifer. The average tritium concentration in Well 65 near TRA decreased from (1.30 ± 0.18) x 10^4 pCi/L in 2001 to (0.96 ± 0.11) x 10^4 pCi/L in 2002; the tritium concentration in Well 77 south of INTEC decreased from (1.38 ± 0.16) x 10^4 pCi/L in 2001 to (1.35 ± 0.14) x 10^4 pCi/L in 2002.

The EPA MCL for tritium in drinking water is 20,000 pCi/L. The values in both Well 65 and Well 77 have remained below this limit in recent years as a result of radioactive decay (tritium has a half-life of 12.3 years), a decrease in tritium disposal rates, and dilution within the SRPA.

Strontium-90 - The configuration and extent of ^{90}Sr in groundwater, based on the latest published data, are shown in Figure 5-7 (Bartholomay et al. 2000). The contamination originates from INTEC as a remnant of the earlier injection of wastewater. No ^{90}Sr in groundwater has been

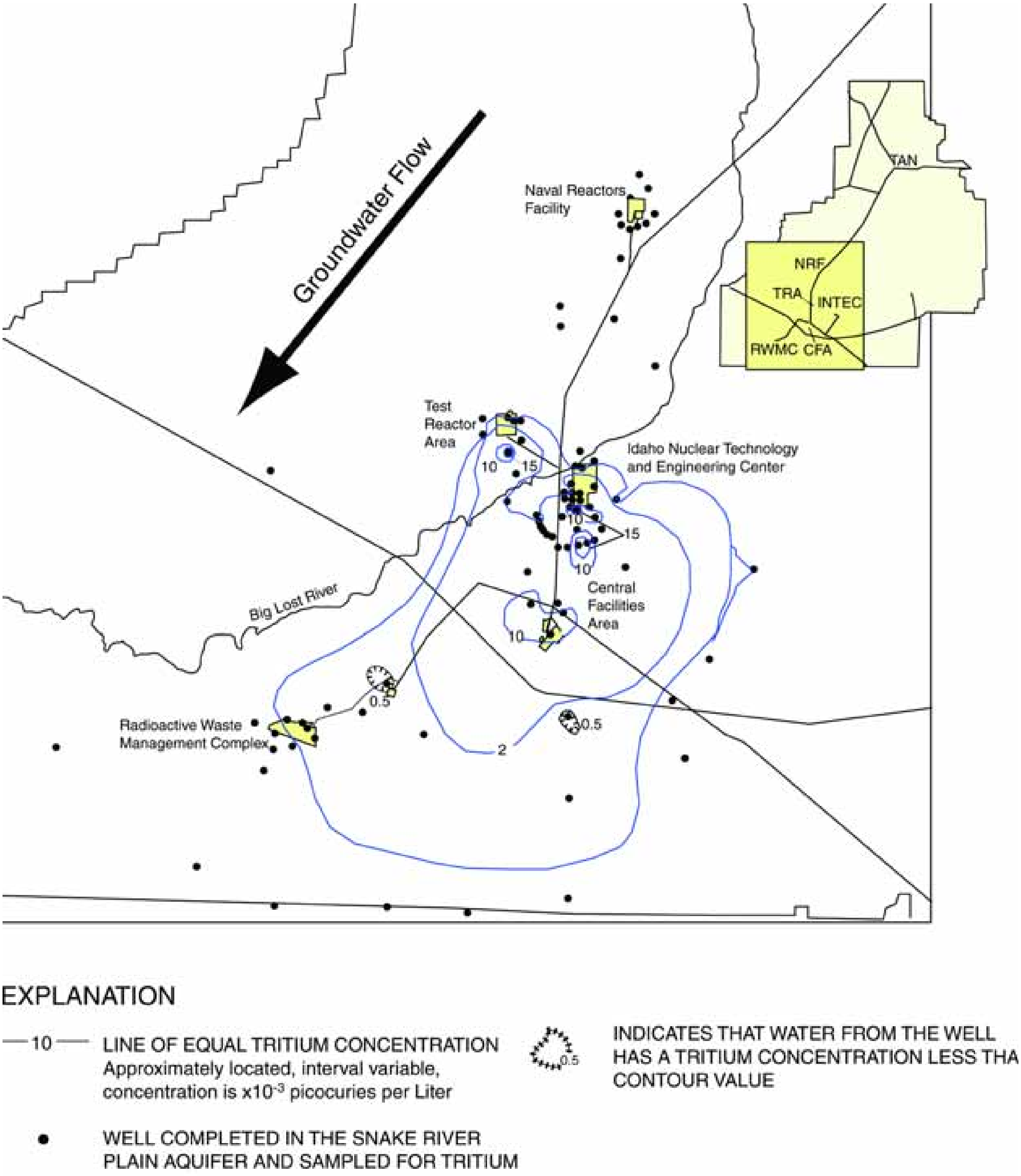

Figure 5-6. Distribution of tritium in the Snake River Plain Aquifer on the INEEL (1998) (Bartholomay et al. 2000).

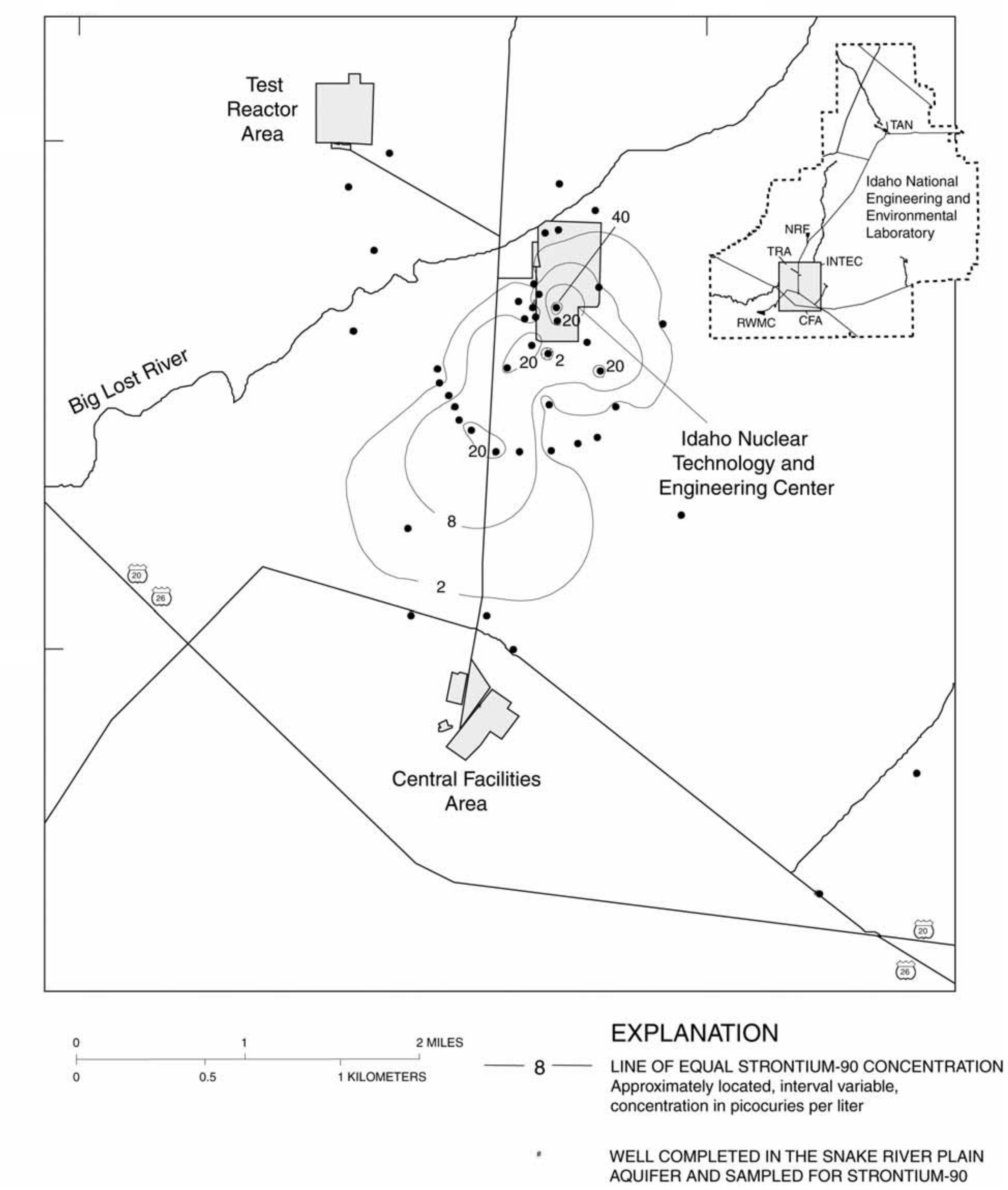

Figure 5-7. Distribution of strontium-90 in the Snake River Plain Aquifer on the INEEL (1998) (Bartholomay et al. 2000).

detected in the vicinity of TRA. All ^{90}Sr at TRA was disposed to infiltration ponds in contrast to the direct injection that occurred at the INTEC. At TRA, ^{90}Sr is retained in surficial sedimentary deposits, interbeds, and in the perched groundwater zones. The area of the ^{90}Sr contamination from INTEC is approximately the same as it was in 1991.

Concentrations of ^{90}Sr in wells have remained relatively constant since 1989. The concentration in Well 65 remained essentially unchanged between 2001 (0.95 ± 2.39 pCi/L) and 2002 (0.96 ± 0.11 pCi/L). Concentrations in Well 77 decreased from 2.00 ± 1.98 pCi/L in 2001 to1.35 ± 0.14 pCi/L in 2002. The MCL for ^{90}Sr in drinking water is 8 pCi/L.

Before 1989, ^{90}Sr concentrations had been decreasing because of changes in waste disposal practices, radioactive decay, diffusion, dispersion, and dilution from natural groundwater recharge. The relatively constant ^{90}Sr concentrations in the wells sampled from 1992 to 1998 are thought to be due, in part, to a lack of recharge from the Big Lost River that would act to dilute the ^{90}Sr. Also, an increase in the disposal of other chemicals into the INTEC percolation ponds may have changed the affinity of ^{90}Sr on soil and rock surfaces, causing it to become more mobile (Bartholomay et al. 2000).

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ANL-W samples five wells (four monitoring and one production) (Figure 5-8) twice a year for radionuclides, metals, total organic carbon, total organic halogens, and water quality parameters. Gross alpha, gross beta, and certain uranium isotopes were measured in groundwater during 2002. Uranium isotopes (i.e., natural uranium, ^{235}U, ^{238}U), and gross alpha and gross beta

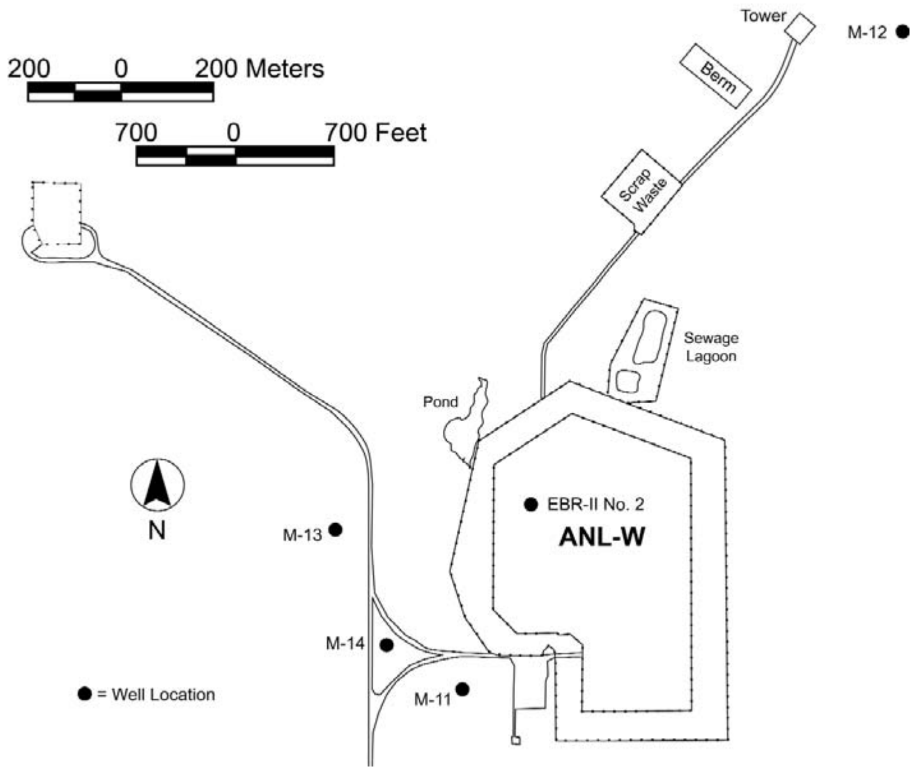

Figure 5-8. ANL-W monitoring well locations.

activity have been measured in these wells in the past. The concentrations are consistent with concentrations attributable to natural sources of uranium- and thorium-series radionuclides and the concentrations are the same for both upgradient and downgradient wells, implying a natural source for this radioactivity. Table 5-28 gives the values for the measured radionuclides.

Naval Reactors Facility

Groundwater samples around NRF are collected by the USGS under a memorandum of agreement. Groundwater monitoring did not detect any gross alpha or gross beta activity in excess of natural background concentrations. Measurements of tritium were at least a factor of one hundred below EPA MCL values. No ^{90}Sr or programmatic gamma-emitters were detected. For more information, see the *2002 Environmental Monitoring Report for the Naval Reactors Facility* (Bechtel Bettis 2002).

5.7 Nonradiological Groundwater Monitoring

U.S. Geological Survey

Sampling for purgeable (volatile) organic compounds in groundwater was conducted by the USGS at the INEEL during 2002. Water samples from an onsite production well and 11 groundwater monitoring wells were collected and submitted to the USGS National Water Quality Laboratory in Lakewood, Colorado, for analysis of 61 purgeable organic compounds. A USGS report describes the methods used to collect the water samples and ensure sampling and analytical quality (Mann 1996). Eleven purgeable organic compounds were detected at concentrations above the laboratory reporting level of 0.2 µg/L in at least one well on the INEEL (Table 5-29).

The RWMC production well contained detectable concentrations of five of these purgeable organic compounds. Annual average concentrations of these compounds in this well were slightly higher than those observed in 2001. Although the carbon tetrachloride concentrations were above the MCL of 5 µg/L at the end of 2002, EPA requirements apply to the distribution system (Table 5-29).

Argonne National Laboratory-West

ANL-W samples five wells (four monitoring and one production) twice a year for radionuclides, metals, total organic carbon, total organic halogens, and water quality parameters. The common metals aluminum, calcium, iron, magnesium, potassium, and sodium were all detected at levels consistent with past years. Barium, chromium, copper, manganese, vanadium, and zinc were also measured. Concentrations of these metals during the first half of the year were qualified by the laboratory as estimated. Concentrations during the second half were not qualified, but the laboratory used a different procedure than in the first round samples. Table 5-28 gives the values for all constituents measured. Water quality parameters were within ranges of past values.

Table 5-28. Summary of metals and water quality parameters in ANL-W monitoring wells (2002).

Well	M-11		M-12		M-13		M-14		EBR-II No. 2		MCL
Sample Date	05/09	10/24	05/08	10/22	05/08	10/22	05/08	10/22	05/08	10/22	
Parameter	**Radionuclides[a]**										
Gross Alpha		1.86 ± 0.81[b]					3.00 ± 0.75		2.10 ± 0.70		15
Gross Beta	2.60 ± 0.75	2.98 ± 0.59	3.70 ± 0.80	0.00 ± 0.00	0.00 ± 0.00	3.93 ± 0.54	4.80 ± 0.85		2.20 ± 0.75	3.21 ± 0.57	50[c]
U-234	1.28 ± 0.16		1.36 ± 0.17				1.55 ± 0.18		1.22 ± 0.15		[d]
U-233/234		2.86 ± 0.76				1.26 ± 0.51		1.50 ± 0.34			
U-238	0.45 ± 0.09	0.92 ± 0.41	0.63 ± 0.20			0.82 ± 0.40	0.57 ± 0.10	0.74 ± 0.22	0.66 ± 0.11		
Metals[e]											
Aluminum	26.40	11.40/ 4.43	17.70		21.50	8.55	29.90	3.56/ 3.54	19.70	18.30	50–200
Barium	36.20	34.6/ 34.6	41.30		32.80	33.90	37.10	34.70/ 34.70	36.30	8.47	2,000
Calcium	3.67	4.03/ 4.02	3.74		3.50	3.96	2.68	3.97/ 3.98	3.75	3.97	NE[f]
Chromium		3.69/ 4.17				5.44		4.78/ 4.82		2.67	100
Copper		3.28/ 3.40				1.57		1.91		4.67	NE
Iron	86.10	110.0/126.0	17.60		169.00	247.00	375.00	155/ 191	22.90	131	300
Lead								2.67			NE
Magnesium	1.22	1.28/ 1.20	1.24		1.16	1.19	1.22	1.14/ 1.19	1.23	1.22	NE
Manganese						2.78		0.98/ 1.22			50
Potassium	3.88	3.51/ 3.51	3.88		3.68	3.52	3.41	3.45/ 3.46	2.95	3.42	NE
Sodium	1.74	1.86/ 1.86	1.75		1.70	1.87	1.76	1.87/ 1.86	1.87	1.97	NE
Thallium						0.25					2
Vanadium	5.80	5.61/ 5.63	5.30		4.80	6.22	5.60	5.89/ 5.73	5.30	6.46	NE
Zinc								11.7/ 9.76	18.30	13.30	5,000
Anions[g]											
Chloride	19.00	19.30	17.40	0.79/ 0.65	17.60	18.40	19.00	19.20/ 19.20	18.70	19.20	250
Nitrate	2.10	1.55	2.00/ 1.90		2.00	1.40	2.00	1.60	2.00	1.50	10
Sulfate	18.80	15.90	16.60		18.90	16.10	19.40	16.30/ 16.20	18.90	16.40	250

Table 5-28. Summary of metals and water quality parameters in ANL-W monitoring wells (2002) (cont.).

Well	M-11		M-12		M-13		M-14		EBR-II No. 2		MCL
Sample Date	05/09	10/24	05/08	10/22	05/08	10/22	05/08	10/22	05/08	10/22	
Water Quality Parameters[g]											
Bicarbonate Alkalinity		170				164		165/ 174		155	NE
Carbonate Alkalinity						1.44		1.48/ 1.49			NE
Total Alkalinity	134	172	144		138	165	136	166/ 176	142	156	NE
Total Dissolved Solids	222	222	229		226	233	235	233/ 229	232	238	500
Total Organic Carbon	1.40	1.54	0.86/ 0.88	0.92	1.10/ 1.10	1.35/ 1.45	1.50/ 1.40	1.36/ 0.93	1.10	0.91	NE
Total Organic Halogen			9.20						8.30		NE
Conductivity (µS)[h]	376	324	358		375	325	376	331/ 329	379	337	NE

a. All radionuclide values are in picocuries per liter plus or minus one standard deviation.
b. Shaded cells denote values that have been qualified as estimated, either by the analytical laboratory or during data validation.
c. The MCL for gross beta activity is four mrem/yr. A value of 50 pCi/L has been established as a screening level concentration.
d. The MCL for total uranium is a concentration (30 µg/L) instead of an activity (pCi/L).
e. All metal values are in micrograms per liter.
f. NE = not established. The EPA has not yet established an MCL for this constituent.
g. All anions and water quality parameter values are in milligrams per liter, unless otherwise noted.
h. µS = microsiemens.

Table 5-29. Concentrations of purgeable organic compounds in USGS well samples (2002).[a]

Well ID	Date	Carbon Tetra-chloride	Chloroform	Toluene	Methylene Chloride	Tetrachloro ethylene	1,1-Dichloro-ethane	1,1-Dichloro-ethylene	1,1,1-Trichloroet hane	1,2-Dichloro-propane	Dichloro-difluoro-methane	Trichloro-ethylene
34	04/24	ND (>0.2)[b]	ND (>0.2)	ND (>0.2)	ND (>0.2)	ND (>0.2)	ND (>0.2)	ND (>0.2)	0.1742	ND (>0.2)	0.1494	ND (>0.2)
(SW of INTEC)	10/01	ND	ND	ND	ND	ND	ND	ND	0.1508	ND	0.1214	ND
38	04/16	ND	ND	ND	ND	ND	ND	ND	0.1446	ND	0.1867	ND
(SW of INTEC)	10/17	ND	ND	0.6847	ND	ND	ND	ND	ND (>0.2)	ND	0.1573	ND
65	04/05	ND	ND	ND	ND	ND	ND	ND	0.2245	ND	0.1078	ND
(S of TRA)	10/23	ND	ND	ND	ND	ND	ND	ND	0.2111	ND	0.6747	ND
77	04/24	ND	ND	ND	ND	ND	ND	0.1328	0.1938	ND	0.1318	ND
(S of TRA)	10/03	ND	ND	ND	ND	ND	ND	0.1414	0.2100	ND	0.1091	ND
87	04/11	2.648	0.1238	ND	ND	ND	ND	ND	0.1896	ND	0.2183	0.6054
(N of RWMC)	10/10	2.850	0.1433	ND	ND	0.1022	ND	ND	0.1943	ND	0.2086	0.6632
88	04/02	1.488	0.4391	ND	ND	ND	ND	ND	0.1356	ND	ND (>0.2)	0.5987
(S of RWMC)	10/01	1.337	0.4037	ND	ND	ND	ND	ND	0.1184	ND	ND	0.5734
92 (SDA at RWMC)	04/17	149.6	235.6	ND	4.716	29.72	3.281	ND	22.38	1.859	ND	198.1
119	04/04	0.3051	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
(S of RWMC)	10/03	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
120	04/11	2.364	0.3604	ND	ND	ND	ND	ND	0.2161	ND	ND	0.7072
(SW of RWMC)	10/10	3.361	0.5575	ND	ND	0.1164	ND	ND	0.2958	ND	ND	1.056
ANP 9	08/05	ND	0.1479	ND	ND	ND	ND	ND	ND	ND	ND	ND
Highway 3	07/15	ND	0.1671	ND	ND	ND	ND	ND	ND	ND	ND	ND
No Name 1	08/05	ND	0.1388	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 5-29. Concentrations of purgeable organic compounds in USGS well samples (2002) (cont).[a]

Well ID	Date	Carbon Tetra-chloride	Chloroform	Toluene	Methylene Chloride	Tetrachloro-ethylene	1,1-Dichloro-ethane	1,1-Dichloro-ethylene	1,1,1-Trichloro-ethane	1,2-Dichloro propane	Dichloro-difluoro-methane	Trichloro-ethylene
PSTF Test	08/05	ND	0.1978	ND	ND	ND	ND	ND	ND	ND	ND	ND
RWMC PROD	01/10	6.431	1.091	ND	ND	0.2580	ND	ND	0.5870	ND	ND	2.815
	02/14	4.320	0.8548	ND	ND	0.1921	ND	ND	0.4414	ND	ND	2.066
	03/14	5.286	1.104	ND	ND	0.2567	ND	ND	0.6820	ND	ND	2.676
	04/11	5.038	0.9296	ND	ND	0.2343	ND	ND	0.4841	ND	ND	2.389
	05/09	7.150	0.8927	ND	ND	0.2796	ND	ND	0.6396	ND	ND	2.813
	06/13	4.826	0.8523	ND	ND	0.2112	ND	ND	0.4726	ND	ND	2.268
	07/18	4.585	0.8329	ND	ND	0.2081	ND	ND	0.4125	ND	ND	2.104
	08/08	5.009	0.7830	ND	ND	0.1880	ND	ND	0.4470	ND	ND	1.980
	09/12	4.181	0.6957	ND	ND	0.1786	ND	ND	0.3643	ND	ND	1.934
	10/10	4.777	0.8553	ND	ND	0.2124	ND	ND	0.4494	ND	ND	2.096
	11/14	4.938	1.718	ND	ND	0.1997	ND	ND	0.4780	ND	ND	2.247
	12/12	5.484	1.019	ND	ND	0.1786	ND	ND	0.5236	ND	ND	2.391
MCL		5.0	NE			5.0		7.0	NE[c]		NE	5.0

a. All values are in microgram per liter.

b. ND = not detected. The concentration is less than the reporting limit for the analysis shown in the parenthesis.

c. NE = not established. EPA has not established an MCL for this constituent.

Naval Reactors Facility

Groundwater samples around NRF are collected by the USGS under a memorandum of agreement. Most volatile organic compounds, inorganic analytes, and water quality parameters were below the minimum detection levels. None of the monitored nonradiological constituent concentrations averaged above primary drinking water standards. For more information, see the *2002 Environmental Monitoring Report for the Naval Reactors Facility* (Bechtel Bettis 2002).

5.8 Storm Water Monitoring

The EPA NPDES regulations for the point source discharges of storm water to waters of the United States require permits for discharges from industrial activities (40 CFR 122.26 2002). Following these regulations, waters of the United States at the INEEL have been defined as the

- Big Lost River;
- Little Lost River;
- Birch Creek and Birch Creek Playa;
- Spreading areas;
- Big Lost River sinks; and
- Tributaries.

Together, the above locations compose the Big Lost River System (Figure 5-9).

A Storm Water Monitoring Program was implemented in 1993 when storm water permits initially applied to the INEEL facilities. The program was modified as permit requirements changed, data were evaluated, and needs were identified. On September 30, 1998, the EPA issued the "Final Modification of the NPDES Storm Water Multi-Sector General Permit for Industrial Activities" (63 FR 189 1998) (referred to as the General Permit). The INEEL M&O contractor implemented the analytical monitoring requirements of the 1998 General Permit starting January 1, 1999. Visual monitoring was implemented starting October 1, 1998, and continues to be performed quarterly.

The General Permit was reissued in October 2000. The *Idaho National Engineering and Environmental Laboratory Storm Water Pollution Prevention Plan for Industrial Activities* was revised in 2001 to meet the requirements of the reissued General Permit (DOE-ID 2001). The Storm Water Monitoring Program meets the General Permit requirements by conducting permit-required monitoring. The General Permit requires visual monitoring during the first, third, and fifth years of the permit's duration and both analytical and visual monitoring on the second and fourth years. The General Permit requires that samples be collected and visually examined from rainstorms that accumulated at least 0.25 cm (0.1 in.) of precipitation preceded by at least 72 hours without measurable precipitation (< 0.25 cm [< 0.1 in.]) to allow pollutants to build up

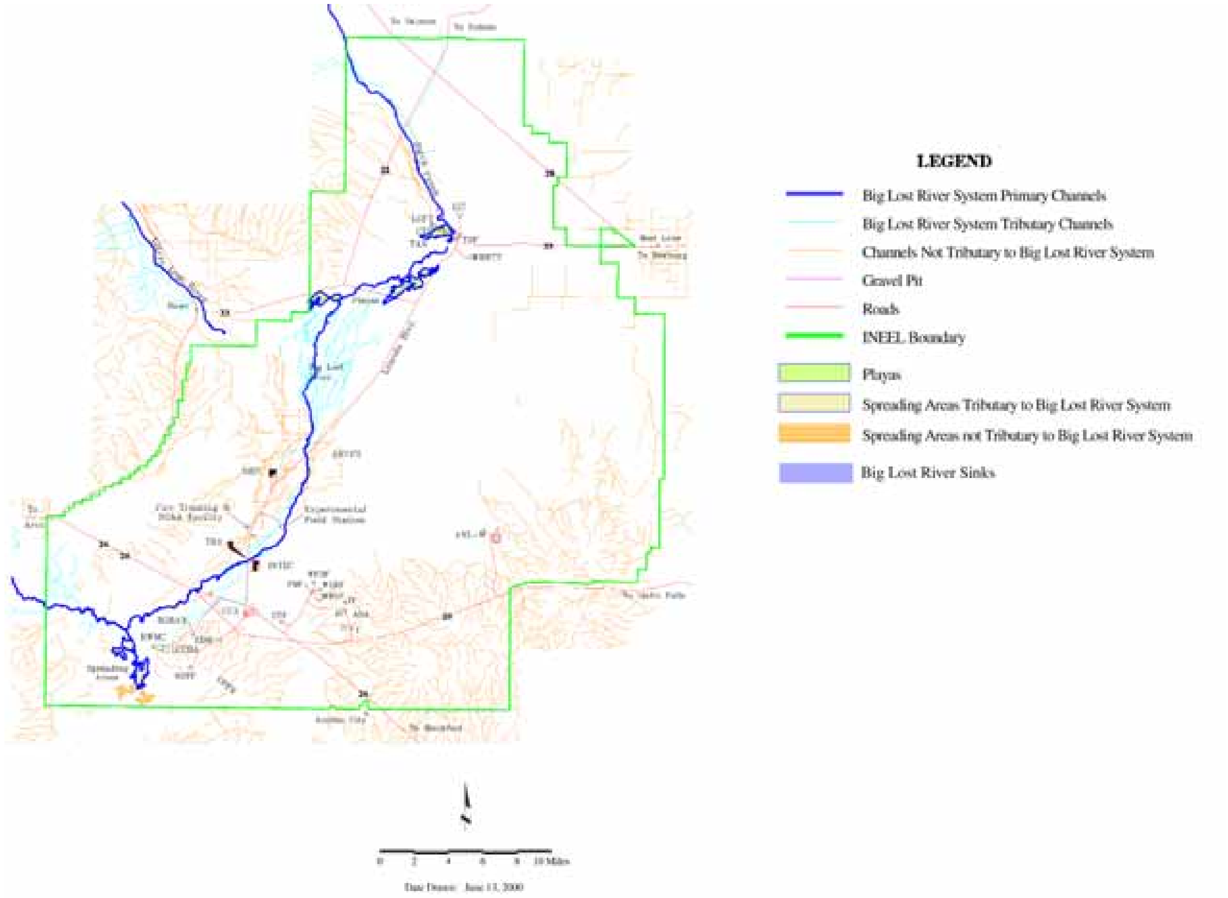

Figure 5-9. Big Lost River System.

and then be flushed from the drainage basin. The Storm Water Monitoring Program monitors the following facilities or activities

- Borrow sources (nonmetallic mineral mining, Sector J);
- INTEC (hazardous waste treatment, storage, and disposal, Sector K);
- Landfills I, II, and III Extension at the CFA (Landfills, Sector L);
- RWMC (Sector K and Sector L); and
- Specific Manufacturing Capability (transportation equipment manufacturing, Sector AB).

In addition to the above discussed NPDES permit-required monitoring, the program monitors storm water to deep injection wells to comply with state of Idaho injection well permits. In 1997, responsibility for monitoring of storm water entering deep injection wells was transferred from the USGS to the M&O Storm Water Monitoring Program. Storm water data are reported as analytical data submitted to the EPA in a discharge monitoring report; as General Permit visual data and analytical data included in the annual revisions of the plan; or data for storm water discharged to deep injection wells reported to the Idaho Department of Water Resources.

Thirty-four sites at five INEEL areas are designated as storm water monitoring locations based upon drainage patterns and proximity to potential sources of pollutants. Twenty-seven of these locations met the conditions for quarterly visual monitoring required by the General Permit when discharges occur to the Big Lost River System. The General Permit requires visual examinations of storm water for obvious indications of storm water pollution. In addition, visual examinations were conducted for surveillance purposes at some locations whether or not storm water discharged to the Big Lost River System.

The General Permit does not contain numeric limitations for analytical parameters, except for pH limitations from runoff from coal piles such as the one at INTEC. Other parameters are compared to benchmark concentrations to help evaluate the quality of storm water discharges.

Storm Water Monitoring Results

During 2002, 77 visual storm water examinations were performed at 20 locations. No rainfall, snowmelt, or discharge down injection wells was observed at 15 monitoring points; therefore, no visual examinations were performed or analytical samples collected at those locations.

The visual examinations performed in 2002 showed satisfactory implementation of the *INEEL Storm Water Pollution Prevention Plan for Industrial Activities* (DOE-ID 2001), and no corrective actions were required or performed during the year.

Analytical samples were collected for qualifying rain events that potentially discharged to waters of the United States at applicable monitoring locations. Potential discharges to waters of the United States from a qualifying storm occurred at only two locations both at the RWMC (RWMC-MP-1/2 and RWMC-MP-4/1). Although the potential for discharge to waters of the United States exist, there was no indication that such a discharge occurred for these events. Although the potential for these discharges to reach the waters of the United States exist, there is no indication that a discharge actually occurred. Tables 5-30 and 5-31 summarize the 2002 results and permit benchmark concentrations for these two locations.

The measured concentrations for total suspended solids, iron, and magnesium exceeded the benchmark concentration levels at both locations for all three samples collected. Chemical oxygen demand exceeded the benchmark concentration for two of the three samples collected at RWMC-MP-4/1 and for all three samples collected at RWMC-MP-1/2. These parameters have been above benchmark concentrations at these locations in the past. No deficiencies in pollution prevention practices have been identified in these areas that would lead to high concentrations for these parameters, and no definite cause has been identified. However, iron and magnesium are common soil-forming minerals and may be attributed to suspended sediment, deposited onsite from high winds and landfill operations, in the storm water discharge. Storm drain filters for petroleum and sediment are in place and maintained regularly to provide additional pollution prevention.

Table 5-30. RWMC-MP-1/2 storm water results (2002).

Parameter	Maximum	Average	# Samples	# Detections[a]	Benchmark
Cyanide	0.09[b]	0.04	3	3	0.0636
Chemical Oxygen Demand	528	358	3	3	120[c]
Nitrogen, as Ammonia	1.7	1.0	3	2	NA
Total Suspended Solids	954	449	3	3	100[c]
Silver	0.0022	0.0012	3	1	0.0318
Arsenic	0.0072	0.0066	3	3	0.16854
Cadmium	0.0017	0.0010	3	2	0.0159
Iron	11.60	6.76	3	3	1[c]
Mercury	0.0001	0.0001	3	1	0.0024
Magnesium	24.0	18.1	3	3	0.0636[c]
Lead	0.0107	0.0072	3	2	0.0816
Selenium	0.0025	0.0018	3	0	0.2385
Conductivity (µS)	21,120	7,444	3	3	NA
pH (standard units)	8.36	7.85	3	3	6.0–9.0

a. # detections indicate the number of samples with results greater than the minimum detectable limit for that constituent.

b. All values are in milligrams per liter unless otherwise noted.

c. Benchmarks exceeded.

Table 5-31. RWMC-MP-4/1 storm water results (2002).

Parameter	Maximum	Average	# Samples	# Detections[a]	Benchmark
Cyanide	0.008[b]	0.004	3	1	0.0636
Chemical Oxygen Demand	350	197	3	3	120[c]
Nitrogen, as Ammonia	2.5	1.2	3	1	NA
Total Suspended Solids	558	320	3	3	100[c]
Silver	0.0063	0.0026	3	1	0.0318
Arsenic	0.0173	0.0100	3	3	0.16854
Cadmium	0.0019	0.0009	3	1	0.0159
Iron	29.6	15.5	3	3	1[c]
Mercury	0.00005	0.00005	3	0	0.0024
Magnesium	16.3	10.5	3	3	0.0636[c]
Lead	0.0225	0.0130	3	3	0.0816
Selenium	0.0017	0.0014	3	0	0.2385
Conductivity (µS)	419.7[b]	355.3	3	3	NA
pH (standard units)	8.49	8.07	3	3	6.0–9.0

a. # Detections indicate the number of samples with results greater than the minimum detectable limit for that constituent.

b. All values are in milligrams per liter unless otherwise noted.

c. Benchmarks exceeded.

5.9 Offsite Surface Water Sampling

As part of the offsite monitoring performed by the ESER contractor, radiological analyses are performed on surface water samples taken at offsite locations (Table 5-32). Locations outside of the INEEL boundary are sampled twice a year for gross alpha, gross beta, and tritium. In 2002, the ESER contractor collected 12 surface water samples from five offsite locations.

No measurable gross alpha activity was found in surface water samples during 2002. Tritium was measured in two offsite surface water samples during 2002. The surface water sample and duplicate collected in the Twin Falls area had concentrations ranging from 37 ± 67 to 173 ± 10^{6} pCi/L (Table 5-32). The maximum level detected was lower than the EPA MCL of

Table 5-32. ESER contractor offsite surface water results (2002).

Location	Sample Results[a]		Limits for Comparison[b]	
	Result ± 2s[c]	MDC[d]	EPA MCL[e]	DOE DCG[f]
Tritium				
November 2002				
Twin Falls (Alpheus Spring)	143 ± 106	106.7	20,000	2.0 x 10^6
Twin Falls (Alpheus Spring duplicate)	173.0 ± 107.0	106.7	20,000	2.0 x 10^6
Gross Beta				
May 2002				
Bliss (Bliss Boat Dock)	3.40 ± 1.90	2.94	15	100
Buhl (Clear Spring)	3.48 ± 1.90	2.92	15	100
Twin Falls (Alpheus Spring)	7.05 ± 2.15	3.02	15	100
November 2002				
Bliss (Bliss Boat Dock)	5.75 ± 1.01	2.92	50	100
Buhl (Clear Spring)	3.95 ± 0.95	2.79	50	100
Hagerman (Bill Jones Fish Farm)	2.25 ± 0.88	2.81	50	100
Duplicate	3.63 ± 0.93	2.90	50	100
Idaho Falls (John Hole Dock)	1.85 ± 0.86	2.88	50	100
Twin Falls (Alpheus Spring)	6.26 ± 1.03	2.78	50	100

a All values shown are in picocuries per liter.

b. Values shown are in picocuries per liter. These limits are shown for comparison purposes only and do not apply to the individual sample locations.

c. ± 2s = plus or minus two standard deviations.

d. MDC = minimum detectable concentration.

e. EPA MCL = maximum contaminant level.

f. DOE DCG = Derived Concentration Guide.

20,000 pCi/L and the DOE's DCG of 2.0 x 10^6 pCi/L for tritium in water. The EPA MCL and DOE DCG values for tritium and gross beta activity are given for comparison purposes only and do not apply to the individual sample locations. These levels can be attributed to natural variability.

Gross beta activity was measured in nine of the 12 offsite surface water samples. Detectable concentrations ranged from 1.85 ± 1.72 to 7.05 ± 2.15 pCi/L at Idaho Falls and Twin Falls, respectively (Table 5-32). The maximum concentration is well below the EPA screening level for gross beta in drinking water of 50 pCi/L. Concentrations in this range are consistent with those measured in the past and cannot be differentiated from natural decay products of thorium and uranium that dissolve into water as the water passes through the surrounding basalts of the Snake River Plain.

5.10 Waste Management Surveillance

Onsite Surface Water Sampling

In compliance with DOE Order 435.1, the M&O contractor collects surface water, as surface runoff, at the Waste Experimental Reduction Facility (WERF) and the RWMC from the locations shown on Figures 5-10 and 5-11, respectively. Two control locations approximately 2 km (1.24 mi) north of the RWMC are sampled. The control location for the RWMC Transuranic Storage Area (TSA) and WERF is on the west side of the restrooms at the Big Lost River Rest Area. The control location for the RMWC Subsurface Disposal Area (SDA) is 1.5 km (0.93 mi) west from the Van Buren Boulevard intersection on U.S. Highway 20/26 and 10 m (33 ft) north on the T-12 road.

Surface water is collected to determine if radionuclide concentrations exceed alert levels or if concentrations have increased significantly compared to historical data. Since 1994, quarterly surface water runoff samples have been collected at the WERF seepage basins to determine if contamination has been released from stored waste.

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

Surface water runoff samples were collected during the first, second, and third quarters of 2002 at the RWMC and WERF. Table 5-33 summarizes the results of human-made radionuclides. All sample results were comparable to historical results.

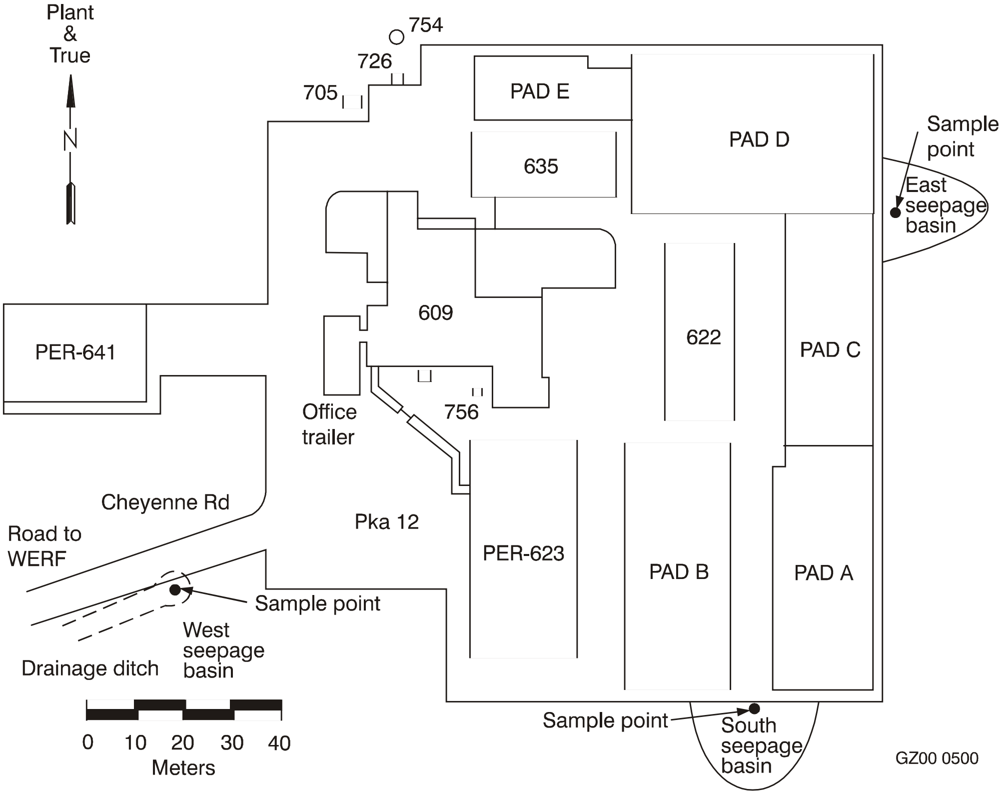

Figure 5-10. WERF surface water sampling locations.

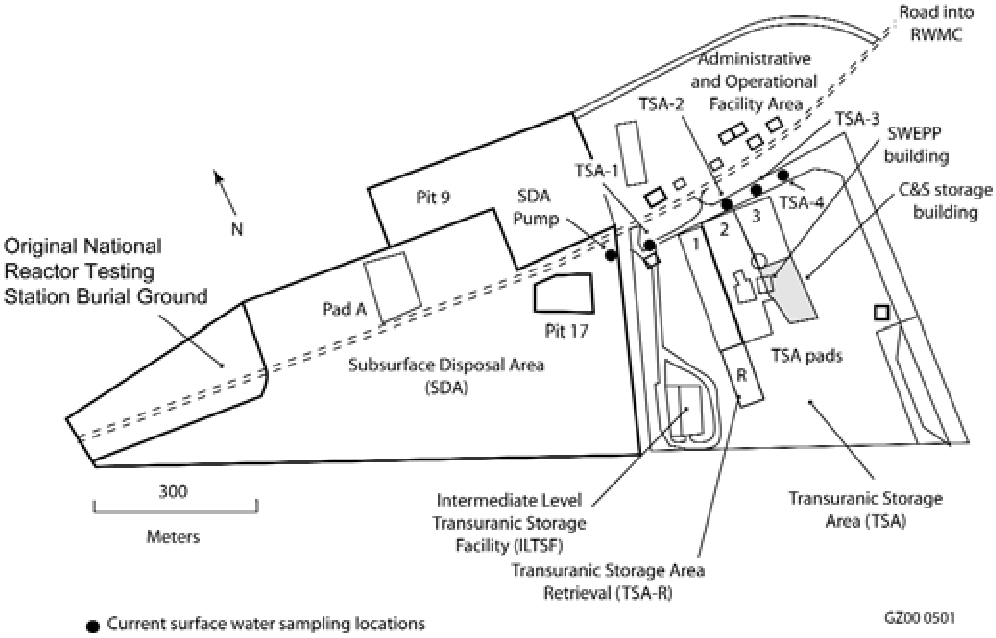

Figure 5-11. RWMC surface water sampling locations.

Table 5-33. Surface water runoff results of human-made radionuclides (2002).

Location	Parameter	Maximum Concentration[a]	% DCG	Comment
RWMC				
TSA-2	Cesium-137	0.32 ± 0.13	0.01	Comparable to historical concentrations
TSA-2	Plutonium-239/240	0.0089 ± 0.0040	0.03	Comparable to historical concentrations
WERF				
East, South Seepage Basins	Cesium-137	3.2 ± 0.3	0.11	Comparable to historical concentrations

a. All values are in picocuries per liter.

5.11 Summary

All monitoring required for wastewater land applications permit compliance and drinking water regulations was performed in 2002. The only limit exceeded for those sampled parameters was lead in drinking water at ANL-W. All other parameters were below permit or regulatory limits. Surveillance monitoring of groundwater, storm water, and surface water were also conducted in 2002. Although some storm water samples exceeded benchmark levels, they were still within the range of historical values. All measured parameters were below regulatory limits.

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Chapter 6 - Environmental Monitoring Programs - Agricultural Products, Wildlife, Soil, and Direct Radiation

Chapter Highlights

To help assess the impact of contaminants released to the environment by operations at the Idaho National Engineering and Environmental Laboratory (INEEL), agricultural products (milk, lettuce, wheat, potatoes, and sheep); wildlife; and soil were sampled and analyzed for radionuclides. In addition, direct radiation was measured on and off the INEEL in 2002.

Some anthropogenic (human-made) radionuclides were detected in agricultural product, wildlife, and soil samples. For the most part, the results could not be directly linked to operations at the INEEL. With the exception of americium-241 concentrations in soils collected at the Waste Experimental Reduction Facility (WERF), concentrations of radionuclides detected in soil samples were consistent with fallout levels from atmospheric weapons testing. The maximum levels for these radionuclides were all well below regulatory health-based limits for protection of human health and the environment.

Americium-241 was detected above background levels in soil samples collected around WERF. However, the concentrations were consistent with those measured historically and are attributable to past WERF operations and fallout.

Direct radiation measurements made at offsite, boundary, and onsite (except Radioactive Waste Management Complex [RWMC]) locations were consistent with background levels. The measured annual dose equivalent from external exposure was 123 mrem. Direct radiation measurements made at the (RWMC) were greater than background levels but consistent with those made historically at that location.

6. ENVIRONMENTAL MONITORING PROGRAMS - AGRICULTURAL PRODUCTS, WILDLIFE, SOIL, AND DIRECT RADIATION

6.1 Organization of Monitoring Programs

This chapter provides a summary of the various environmental monitoring activities that relate to agricultural products, wildlife, soil, and direct radiation currently being conducted on and around the INEEL (Table 6-1). These media are potential pathways for transport of INEEL contaminants to nearby populations.

The Management and Operating (M&O) contractor monitored soil, vegetation, and direct radiation on the INEEL to comply with applicable U.S. Department of Energy (DOE) orders and other requirements. The M&O contractor collected approximately 500 soil, vegetation, and direct radiation samples for analysis in 2002.

Argonne National Laboratory-West (ANL-W) and the Naval Reactors Facility (NRF) also conduct monitoring of soil, vegetation, and direct radiation. These programs are to show compliance with DOE orders but are limited in scope to their specific facilities.

The Environmental Surveillance, Education and Research (ESER) contractor conducted offsite environmental surveillance and collected samples from an area of approximately 23,308 km^2 (9000 mi^2) of southeastern Idaho at locations on, around, and distant to the INEEL. The ESER contractor collected approximately 450 agricultural products, wildlife, soil, and direct radiation samples for analysis in 2002.

Section 6.2 presents the agricultural products and wildlife surveillance results sampled under the ESER Program. Section 6.3 presents the results of soil sampling by both the ESER contractor and the M&O contractor. The direct radiation surveillance results are presented in Section 6.4. Results of the waste management surveillance activities are discussed in Section 6.5. Section 6.6 summarizes the findings presented in this chapter.

The analytical results reported in the following surveillance sections are those that are greater than two times the analytical uncertainty (see Appendix B for information on statistical methods). Analytical uncertainties reported in text and tables are plus or minus two standard deviations (± 2s) uncertainty for the radiological analysis.

6.2 Agricultural Products and Wildlife Sampling

Milk

During 2002, 184 milk samples were collected under the ESER Program. All of the samples were analyzed for gamma-emitting radionuclides including iodine-131 (^{131}I). During the first and third quarters, selected samples were analyzed for tritium. During the second and fourth quarters, selected samples were analyzed for strontium-90 (^{90}Sr).

Table 6-1. Other environmental surveillance activities at the INEEL.

	Media				
Area/Facility[a]	Agricultural Products	Wildlife	Soil	Vegetation	Direct Radiation
Argonne National Laboratory-West					
ANL-W			◆	◆	
Management and Operating Contractor					
CFA			◆		
RWMC			◆	◆	◆
PBF/WROC				◆	◆
Sitewide[b]			◆	◆	◆
Naval Reactors Facility					
NRF			◆	◆	◆
Environmental Surveillance, Education and Research Program					
INEEL/Regional	◆	◆	◆	◆	◆
INEEL Oversight Program[c]					
INEEL/Regional	◆[d]		◆		◆

a. ANL-W = Argonne National Laboratory-West, CFA = Central Facilities Area, RWMC = Radioactive Waste Management Complex, PBF/WROC = Power Burst Facility/Waste Reduction Operations Complex, and NRF = Naval Reactors Facility.

b. Sitewide includes thermoluminescent dosimeters located at major facilities (e.g., CFA, NRF, and ANL-W).

c. The INEEL Oversight Program results are presented in annual reports prepared by that organization and are therefore not reported here.

d. The only agricultural product collected by the INEEL Oversight Program is milk.

Iodine-131 (^{131}I) was detected in one milk sample from Roberts at a level of 5.26 ± 3.02 pCi/L. This value is well below the DOE derived concentration guide (DCG) for ^{131}I in water of 3000 pCi/L. Cesium-137 (^{137}Cs) was also detected in one milk sample from Idaho Falls at a level of 1.57 ± 1.49 pCi/L. This value is below the DCG for ingested ^{137}Cs in water of 3000 pCi/L. Tritium was not detected in any milk sample in 2002.

Strontium-90 (^{90}Sr) was detected in 11 out of 13 samples ranging from 0.49 ± 0.38 pCi/L at Rupert to 5.89 ± 4.60 pCi/L in a sample from Blackfoot. All levels of ^{90}Sr in milk were consistent with those data previously reported by the U.S. Environmental Protection Agency (EPA) as resulting from worldwide fallout deposited on soil, then taken up by ingestion of grass by cows (EPA 1995). The maximum value is lower than the DOE DCG for ^{90}Sr in water of 1,000 pCi/L.

Lettuce

Sixteen lettuce samples, including one duplicate, were collected from regional private gardens. Strontium-90 above the ± 2s uncertainty was detected in seven of the lettuce samples ranging from 0.065 ± 0.056 pCi/g at Howe to 0.36 ± 0.24 pCi/g in the duplicate from Arco (Table 6-2). Strontium-90 is present in lettuce through plant uptake of ^{90}Sr in soil. Strontium-90 is present in soil as a residual of fallout from aboveground nuclear weapons testing, which took place between 1945 and 1980. The quantities detected in 2002 are similar to those identified in past years. Therefore, these detections were most likely from weapons testing fallout. No other radionuclides were detected in lettuce in 2002.

Wheat

One of the 32 wheat samples (including one duplicate) collected during 2002 contained a measurable concentration of ^{90}Sr. This sample, from Monteview, measured 0.22 ± 0.20 pCi/g. One wheat sample from Aberdeen contained a measurable concentration of ^{137}Cs at a level of (4.0 ± 2.7) x 10^{-3} pCi/g. The concentrations of ^{90}Sr and ^{137}Cs were similar to those detected in recent years (Table 6-3), and are attributed to historic aboveground nuclear weapons testing.

Potatoes

Fourteen potato samples, including one duplicate, were collected during 2002: one sample each from five distant locations, four boundary locations, and four and a duplicate from out-of-state locations (Figure 6-1). Idaho samples were collected from Blackfoot, Howe, Idaho Falls, Monteview, Moore, Mud Lake, Rupert, and Taber. Out-of-state samples were received from Oregon, Colorado, New Jersey, and Wyoming. Cesium-137 was detected in one of the samples from the Mud Lake boundary location, at a level of (3.4 ± 3.3) × 10^{-3} pCi/g. Cesium-137 is present in soil as a result of fallout from aboveground nuclear weapons testing between 1945 and 1980, and this detection was most likely from that fallout. No other radionuclides were detected in potatoes.

Table 6-2. Strontium-90 concentrations in garden lettuce (1997-2002).[a,b]

Location	1997	1998	1999	2000	2001	2002[c]
Distant Group						
Blackfoot	NS[d]	NS	NS	NS	NS	120 ± 160
Carey	70 ± 50	200 ± 50	120 ± 80	295 ± 140	144 ± 110	280 ± 160
Idaho Falls	50 ± 30	70 ± 40	60 ± 40	61 ± 50	114 ± 110	25 ± 50
Grand Mean[e]	**95 ± 30**	**135 ± 32**	**90 ± 45**	**330 ± 74**	**201 ± 78**	**150 ± 77**
Boundary Group						
Arco	70 ± 70	200 ± 100	120 ± 40	81 ± 41	88 ± 110	93 ± 45
Duplicate						36 ± 24
Howe	80 ± 80	100 ± 90	60 ± 70	88 ± 48	21 ± 110	65 ± 56
Split						78 ± 60
Monteview	90 ± 40	100 ± 50	225 ± 200	NS	74 ± 110	85 ± 44
Mud Lake	170 ± 80	100 ± 80	160 ± 80	51 ± 51	40 ± 110	110 ± 52
Grand Mean[e]	**100 ± 35**	**125 ± 41**	**140 ± 58**	**73 ± 27**	**56 ± 55**	**78 ± 20**

a. Concentrations are times 10^{-3} picocuries per gram.

b. Analytical results are for dry weight, plus or minus two standard deviations (± 2s).

c. Approximate minimum detectable concentration (MDC) of ^{90}Sr in lettuce is 2 x 10^{-4} pCi/g dry weight.

d. NS = no sample collected.

e. Uncertainty calculated as $2\left(\sqrt{\sum_{i=1}^{n} s_i^2}\right)\Big/ n$ where s_i is the standard deviation of sample i and n is the number of samples within the group.

Table 6-3. Strontium-90 concentrations in wheat (1997-2002).[a,b]

Location	1997	1998	1999	2000	2001[c]	2002
			Distant Group			
Aberdeen	NS[d]	NS	NS	NS	NS	36 ± 260
Blackfoot	14 ± 6	8 ± 4	5 ± 5	6 ± 6	60 ± 99	69 ± 130
Blackfoot[e]						81 ± 270
Carey	5 ± 4	NS	8 ± 3	NS	49 ± 180	28 ± 130
Idaho Falls	4 ± 4	7 ± 3	8 ± 6	5 ± 3	-37 ± 88	50 ± 160
Split						240 ± 270
Minidoka	5 ± 4	6 ± 3	4 ± 3	6 ± 4	218 ± 290	0.78 ± 190
Roberts (Menan)	NS	NS	NS	NS	NS	19 ± 130
Rockford	NS	NS	NS	NS	NS	-220 ± 260
Rupert	NS	NS	NS	NS	NS	90 ± 270
Tabor	NS	NS	NS	NS	NS	110 ± 300
Grand Mean[f]	**7 ± 3**	**6 ± 2**	**6 ± 2**	**6 ± 3**	**73 ± 92**	**46 ± 68**
			Boundary Group			
Arco	4 ± 3	6 ± 3	5 ± 3	6 ± 4	95 ± 260	41 ± 380
Duplicate					59 ± 87[g]	120 ± 360
Howe	NS	NS	NS	NS	NS	18 ± 150
Monteview	5 ± 5	9 ± 4	6 ± 5	2 ± 2	50 ± 97	220 ± 200
Mud Lake	4 ± 4	8 ± 4	3 ± 3	5 ± 4	19 ± 74	54 ± 170
Terreton	6 ± 4	7 ± 3	5 ± 4	3 ± 3	63 ± 130	86 ± 200
Grand Mean[f]	**5 ± 2**	**8 ± 2**	**5 ± 2**	**4 ± 2**	**57 ± 65**	**90 ± 106**

a. Concentrations are times 10^{-3} picocuries per gram.

b. Analytical results are for dry weight, plus or minus two standard deviations (± 2s).

c. Approximate MDC of ^{90}Sr in wheat through 2000 was 4 x 10^{-3} pCi/g dry weight. After 2001, the MDC decreased to 20 x 10^{-3} pCi/g dry weight.

d. NS = no sample collected.

e. Samples were collected from two Blackfoot locations in 2002.

f. Uncertainty calculated as $2\left(\sqrt{\sum_{i=1}^{n} s_i^2}\right)/n$, where s is the standard deviation of sample i and n is the number of samples in the group.

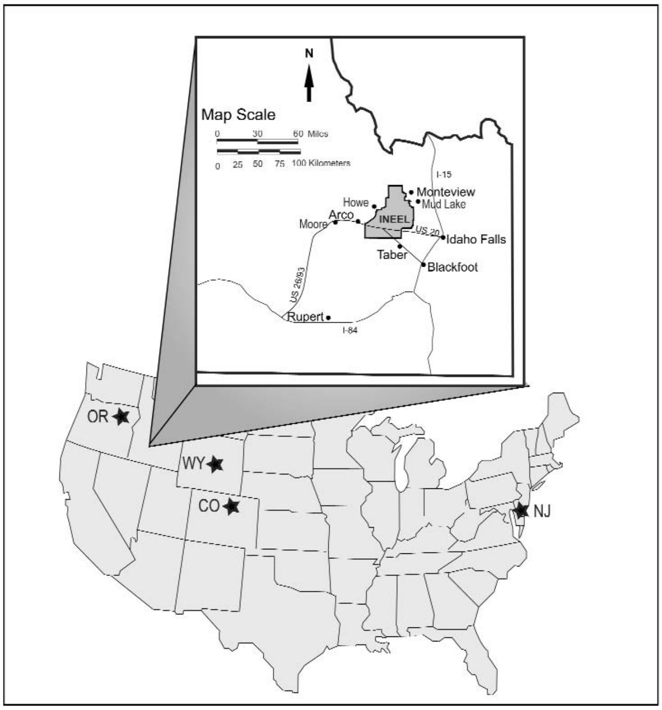

Figure 6-1. Locations of potato samples taken during 2002.

Sheep

Certain areas of the INEEL are open to grazing under lease agreements managed by the Bureau of Land Management. Every year, during the second quarter, ESER personnel collect samples from sheep grazed in these areas, either just before or shortly after they leave the INEEL. For the calendar year 2002, six sheep were sampled. Four were from INEEL land, and two were from Dubois to serve as control samples. Cesium-137 was detected in the muscle tissue of two onsite samples (ranging from [6.9 ± 2.9] x 10^{-3} to [7.3 ± 2.1] x 10^{-3} pCi/g) and in one liver tissue sample from an onsite animal ([5.0 ± 2.7] x 10^{-3} pCi/g). Although ^{137}Cs was not measured above the 2s uncertainty in the control sheep in 2002, all ^{137}Cs concentrations were similar to those found in both onsite and offsite sheep samples. Figure 6-2 shows that ^{137}Cs concentrations in both sheep liver and muscle have been essentially the same (error bars overlap) since 1996. Iodine-131 did not exceed the 2s uncertainty in any of the sheep.

Game Animals

Muscle, liver, and thyroid samples were collected from 11 mule deer, nine pronghorn, and one elk, which had been accidentally killed on INEEL roads. There was detectable ^{137}Cs radioactivity in the liver of one elk; the liver, muscle and thyroid of one mule deer; and the liver and muscle of three different pronghorn taken on or near the INEEL (Table 6-4). No other radionuclides were detected.

In 1998 and 1999, four pronghorn, five elk, and eight mule deer muscle samples were collected as background samples from hunters across the Western United States: three from

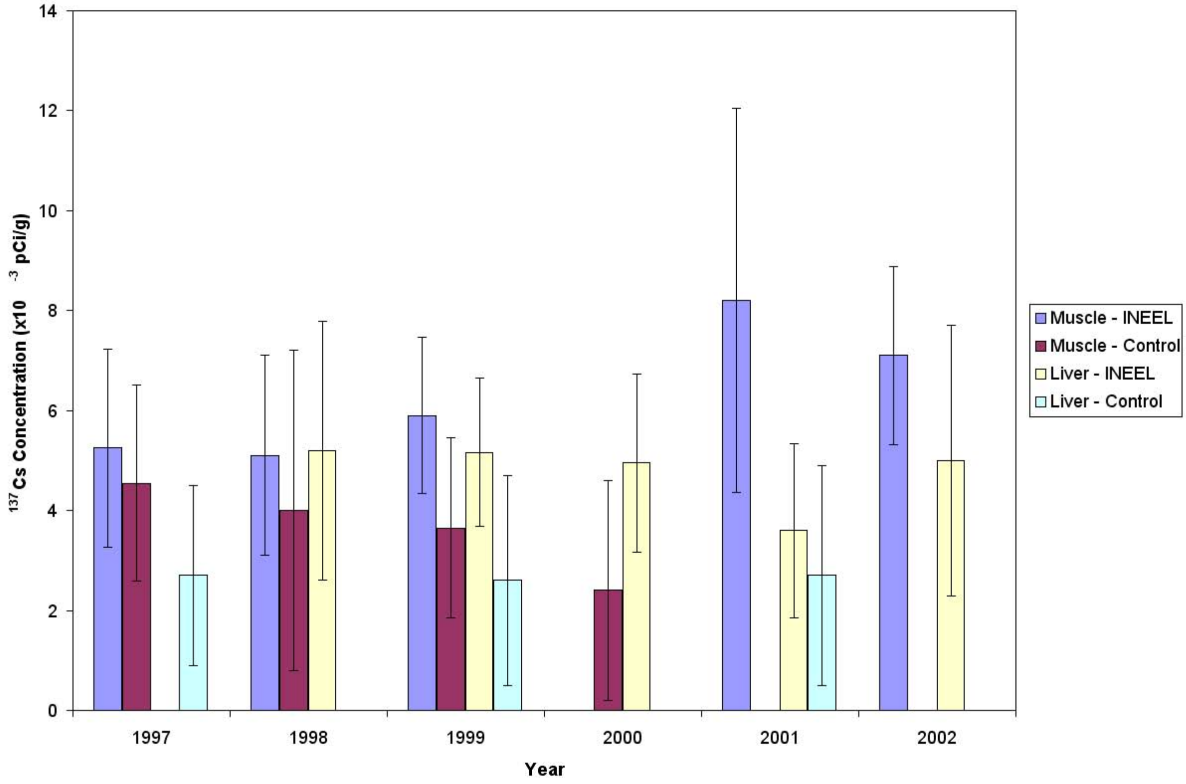

Figure 6-2. Cesium-137 concentrations in muscle and liver of sheep collected from on the INEEL and from control areas.

Tissue	Number of Samples	Minimum	Maximum	Mean
		Pronghorn		
Muscle	3	$(3.0 \pm 2.9) \times 10^{-3}$	$(3.2 \pm 2.9) \times 10^{-3}$	$(3.1 \pm 1.6) \times 10^{-3}$
Liver	1		$(5.1 \pm 3.6) \times 10^{-3}$	
		Elk		
Liver	1		$(3.5 \pm 2.6) \times 10^{-3}$	
		Mule deer[b]		
Muscle	1		$(13 \pm 9.8) \times 10^{-3}$	
Liver	1		$(11 \pm 3.4) \times 10^{-3}$	
Thyroid	1		$(4.1 \pm 3.2) \times 10^{-1}$	

a. All concentrations are in picocuries per gram.

b. These samples were all taken from a single, road -killed animal.

central Idaho; three from Wyoming; three from Montana; four from Utah; and one each from New Mexico, Colorado, Nevada, and Oregon. Each background sample had small, but detectable, ^{137}Cs concentrations in their muscle ranging from $(1.5 \pm 0.2) \times 10^{-3}$ to $(200 \pm 200) \times 10^{-3}$ pCi/g. Muscle results from animals sampled in 2002 are within this range, from $(3.0 \pm 2.9) \times 10^{-3}$ to $(13 \pm 9.8) \times 10^{-3}$ pCi/g. The 2002 values are also within the range of historical values. The highest value for ^{137}Cs was recorded in the liver of a mule deer at $(10.5 \pm 3.4) \times 10^{-3}$ pCi/g collected on the INEEL near CFA. These values can be attributed to the ingestion of radionuclides in plants from worldwide fallout associated with aboveground nuclear weapons testing. No ^{131}I was detected in any of the thyroid glands.

Marmots are hunted and consumed by the Shoshone-Bannock Tribes. During 2002, three marmots were collected from the RWMC and two from the Pocatello Zoo, which was used as the control area. Muscle, viscera, and hair-skin/bone samples were collected from each and analyzed for americium-241 (^{241}Am), plutonium-238 (^{238}Pu), plutonium-239/240 ($^{239/240}$Pu), ^{90}Sr, and gamma-emitting radionuclides.

All analytes were below detectable levels in all tissues from control animals (Table 6-5). This compares to data from control marmot samples collected in 2000 (three animals) in which no detections were made (DOE-ID 2002). There were also no detections of anthropogenic radionuclides in the three animals collected from the RWMC in 2000 (DOE-ID 2002).

One marmot collected from the RWMC contained low levels of ^{137}Cs in all three tissue-types (Table 6-5). The ^{137}Cs concentrations were about an order of magnitude higher than those detected in marmots collected around the RWMC in 1998 (DOE-ID 2000). This individual was captured in a trap location near the Subsurface Disposal Area (SDA) and Pit 9, which may explain the detection of ^{137}Cs in this sample as compared to no detections in 1998 (DOE-ID 2000). However, the ^{137}Cs concentrations observed in this animal are below those observed in other wildlife species collected previously at the SDA as well as in control animals collected for that study (Arthur and Janke 1986).

A second marmot had ^{90}Sr detected in the muscle and hair-skin/bone tissues (Table 6-5). Before being taken as a sample, this animal had been captured in Pit 9 as well as outside the SDA on the south side indicating it traversed the SDA. Again, this concentration was well below ^{90}Sr levels detected in animals in previous studies at the SDA (Arthur and Janke 1986). Potential dose from consuming these marmots is discussed in Chapter 7.

Eleven ducks were collected during 2002: two control samples from Heise and Mud Lake, three from the Test Reactor Area (TRA) Northeast Cold Pond, and four from Test Area North (TAN). Samples of the exterior, edible portions, and the remainder (33 samples total plus three duplicates) of all these waterfowl were analyzed for gamma-emitting radionuclides with a subset analyzed for ^{90}Sr, ^{241}Am, ^{238}Pu, and $^{239/240}$Pu. All 11 ducks had positive detections for one or more radionuclides in at least one tissue. Total radionuclide concentrations for those samples are summarized in Table 6-6. The potential dose from consuming these ducks is discussed in Chapter 7.

No mourning doves were collected in 2002.

Table 6-5. Human-made radionuclides detected in yellow-bellied marmots (2002).

Location	Media	Number of Samples Collected (No. of samples with detections)	Radionuclides Detected Above Minimum Detection Limits	Maximum Concentration[a]	Effective Dose Equivalent[b]
	Muscle	2 (0)	BD[c]	BD	BD
	Viscera	2 (0)	BD	BD	BD
	Skin/Bone	2 (0)	BD	BD	BD
	Muscle	3 (1)[d]	^{137}Cs	0.27 ± 0.03	0.003[e]
	Viscera	3 (1)[d]	^{137}Cs	0.13 ± 0.02	0.001[e]
	Hair- Skin/Bone	3 (1)[d]	^{137}Cs	0.18 ± 0.02	0.031[f]
	Muscle	3 (1)	^{90}Sr	0.02 ± 0.01	0.0005[e]
	Viscera	3 (1)	^{90}Sr	0.04 ± 0.01	0.001[e]
	Hair-Skin/Bone	3 (3)	^{90}Sr	2.64 ± 0.54	1.844[f]

Concentrations are in picocuries per gram ± 2 standard deviations.
Effective dose equivalents are in millirem.
BD = all analytes were below minimum detection limits.
These detections of ^{137}Cs are from a single animal.
Ingestion dose based on consuming 225 g of meat.
Inhalation dose.

6.3 Soil Sampling

Soils are sampled to determine if long-term deposition of airborne materials released from the INEEL have resulted in a buildup of radionuclides in the environment. The ESER contractor collects offsite soil samples every two years. Samples were collected during the third quarter of 2002. Sample locations include boundary and distant localities (Figure 6-3). Five points were sampled at each location within a 10 x 10-m (32.8 x 32.8-ft) grid. At each point two discrete depth intervals, 0-5 cm (0-2 in.) and 5-10 cm (2-4 in.), were sampled. Samples from each depth at all five points were combined to make two composite samples: one for the 0-5 cm (0-2 in.) depth interval and one for the 5-10 cm (2-4 in.) depth interval, for each location.

Samples were analyzed for gamma-emitting radionuclides, ^{90}Sr, and certain actinides. Aboveground nuclear weapons testing resulted in many radionuclides being distributed throughout the world. Of these, ^{137}Cs, ^{90}Sr, ^{238}Pu, $^{239/240}$Pu, and ^{241}Am, all of which could potentially be released from INEEL operations, are of particular interest because of their abundance from nuclear fission events (e.g., ^{137}Cs and ^{90}Sr) or from their persistence in the environment because of long half-lives (e.g., $^{239/240}$Pu with a half-life of 24,390 years). All of these radionuclides, as well as ^{60}Co, were detected in one or more soil samples collected during 2002 (Figure 6-4). However,

Table 6-6. Radionuclide concentrations in 11 ducks using INEEL wastewater disposal ponds (2002).[a]

	Waterfowl Species and Location										
Nuclide	Coot TRA	Coot TRA	Coot TRA	Gadwall Mud Lake	Gadwall Mud Lake	Mallard Heise	Mallard Heise	Common Goldeneye TAN	Common Goldeneye TAN	Common Goldeneye TAN	Common Goldeneye TAN
Edible											
Cerium-141	—[b]	936 ± 770	—	—	1170 ± 700	—	—	—	—	463 ± 440	—
Cesium-137	—	—	—	—	—	—	—	—	—	44.6 ± 31.0	—
Cobalt-60	—	—	—	—	—	—	—	—	—	—	—
Niobium-95	—	—	—	—	—	—	—	—	—	—	676 ± 410
Plutonium-239/240	—	—	—	—	2.18 ± 1.80	—	—	—	—	—	—
Strontium-90	—	9.80 ± 7.60	—	—	7.55 ± 7.50	—	—	—	—	—	—
Exterior											
Amercium-241	—	—	—	—	—	—	—	—	10.60 ± 9.60	—	—
Cerium-141	—	—	—	—	192 ± 140	—	—	—	—	—	—
Cesium-134	—	—	—	—	—	11.8 ± 11.0	—	—	—	—	—
Cesium-137	8.56 ± 7.80	—	—	—	—	—	—	—	—	27.00 ± 7.00	—
Cobalt-60	—	—	—	—	13.10 ± 8.50	—	—	7.86 ± 5.40	—	—	7.06 ± 5.70
Strontium-90	—	145 ± 140	—	—	—	—	—	138 ± 100	134 ± 110	164 ± 110	135 ± 100
Remainder											
Antimony-124	—	—	—	—	—	—	—	—	48.5 ± 40.0	—	—
Cesium-134	—	—	—	—	10.10 ± 9.80	—	—	—	—	—	—
Cesium-137	—	—	—	—	—	—	—	—	—	42.9 ± 18.0	—
Cobalt-60	15.9 ± 13.0	9.06 ± 9.00	—	—	—	17.0 ± 11.0	—	18.8 ± 11.0	—	—	—
Hafnium-181	—	—	—	—	—	—	—	—	79.3 ± 74.0	—	—
Manganese-54	—	19.9 ± 16.0	—	—	—	—	—	—	—	—	—
Niobium-95	—	—	—	0.131 ± 0.130	—	—	274 ± 170	—	—	—	—
Plutonium-239/240	—	—	15.6 ± 10.0	—	—	—	—	—	—	—	—
Strontium-90	—	144 ± 130	169 ± 150	—	—	—	120 ± 110	—	—	172 ± 130	—
Zirconium-95	136 ± 100	—	—	—	—	—	—	—	—	—	—

a. Concentrations shown are $\times 10^{-3}$ picocuries per gram ± 2 standard deviations.

b. A double dash (--) indicates the radionuclide was not detected in that sample.

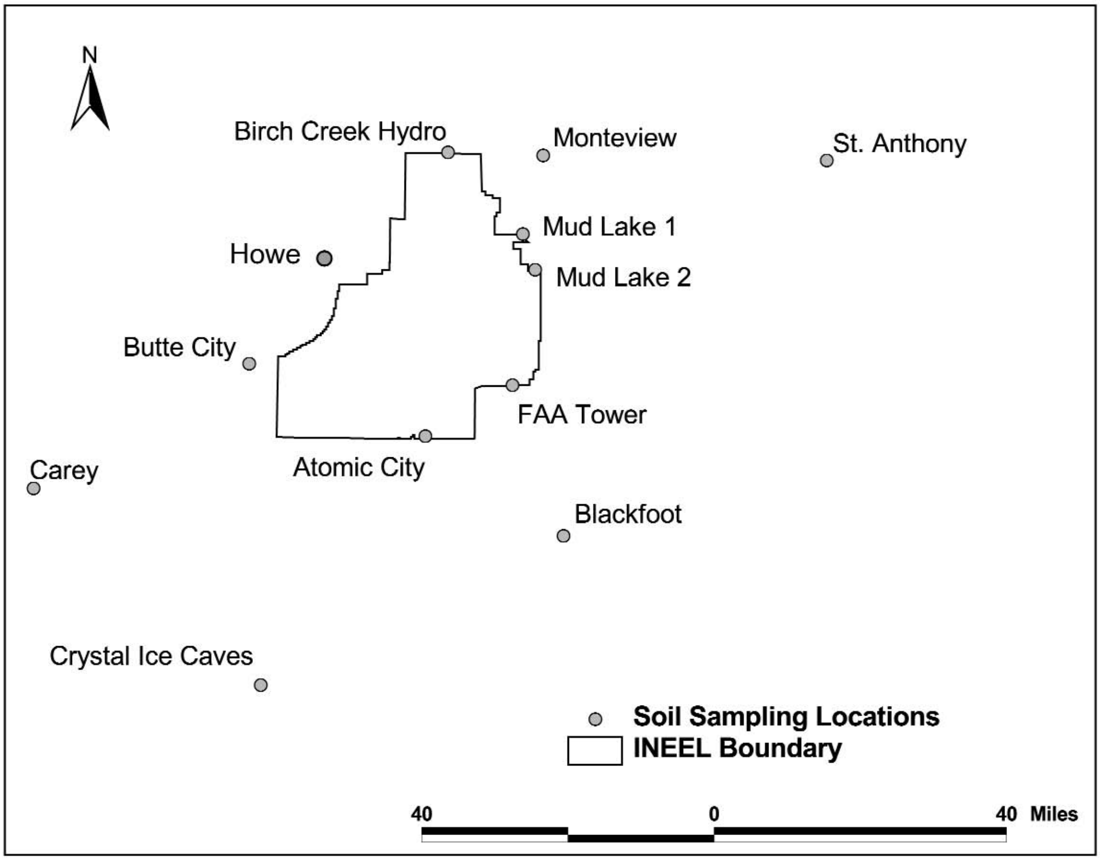

Figure 6-3. Offsite soil sample locations.

if INEEL inputs had contributed significantly to these concentrations, it would be expected that boundary concentrations would be higher than distant locations. There were no differences (using independent sample t-tests and $\alpha = 0.05$) between boundary and distant group concentrations for any of these radionuclides.

Figure 6-5 displays the geometric mean areal activity of specific radionuclides in offsite soils from 1975 to present. The geometric means were used because the data were lognormally skewed. The shorter-lived radionuclides (^{90}Sr and ^{137}Cs) show overall decreases through time.

Radionuclide levels in soils at 101 site surveillance locations near major INEEL facilities were measured by the M&O contractor in 2002 using insitu gamma spectrometry with additional grab samples at 0-5 cm (0-2 in.) at selected locations. The surface soils were analyzed insitu for gamma-emitting radionuclides and ^{90}Sr. No ^{90}Sr was detected during insitu measurements. Table 6-7 summarizes the insitu gamma results.

Table 6-8 presents results of selected samples collected by the M&O contractor and analyzed for alpha-emitting transuranics. Based on the 2002 and historical data, it was concluded that the anthropogenic radionuclides detected are a result of worldwide fallout from atmospheric testing of nuclear weapons and past INEEL facility operations.

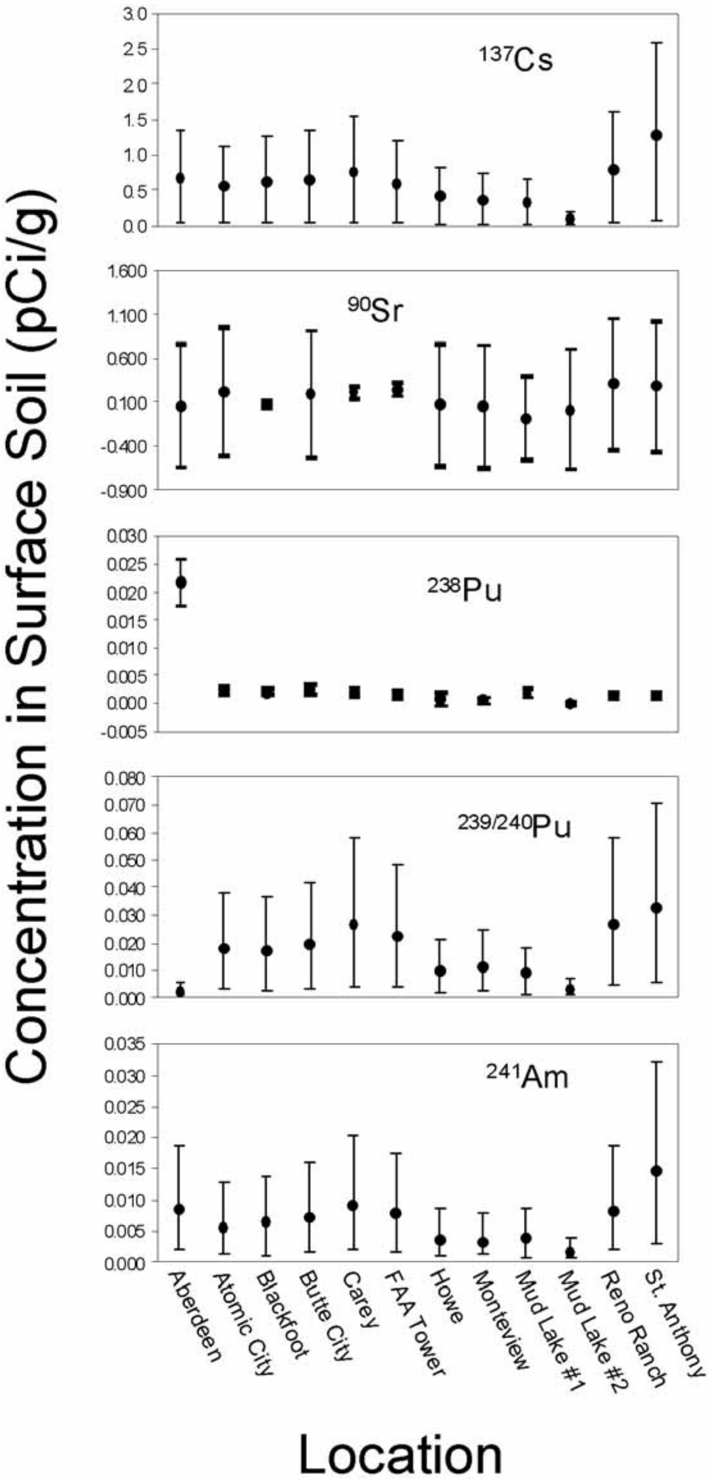

Figure 6-4. Concentrations of selected radionuclides in soil sampled in 2002 (values with error bars [error bars equal 2 standard deviations] that overlap zero are not considered detected).

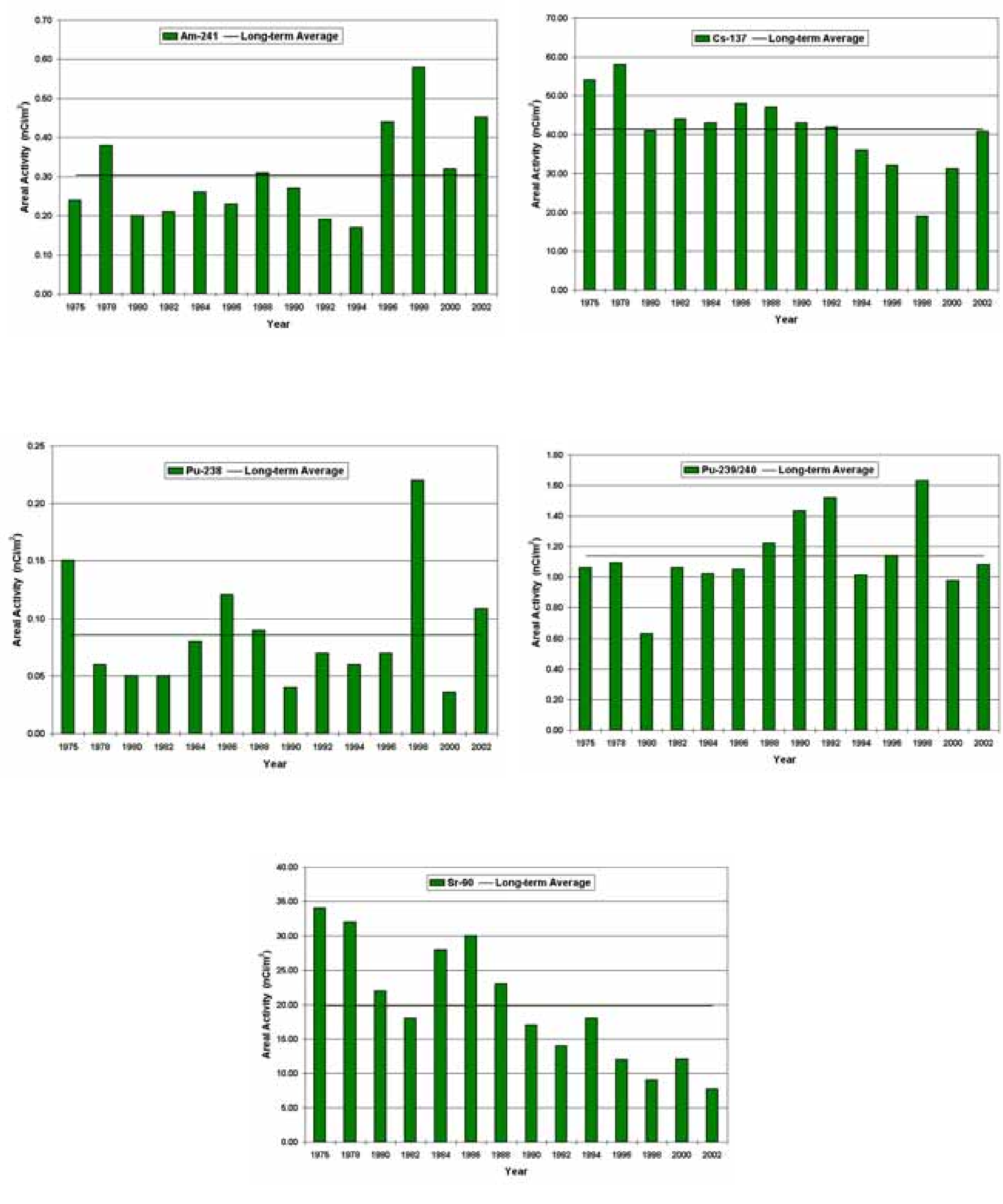

Figure 6-5. Geometric mean areal activity in offsite surface (0-5 cm [0-2 in.]) soils (1975-2002).

Table 6-7. Insitu soil gamma results measured by the M&O contractor (2002).

		Concentration[a]			
Location	Radionuclide	Minimum	Maximum	Mean	Comment
PBF	Cesium-137	0.40 ± 0.03	0.67 ± 0.13	0.57	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout.
RWMC	Cesium-137	< MDC[b]	1.23 ± 0.07	0.63	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout.
TAN	Cesium-137	0.30 ± 0.03	2.60 ± 0.20	0.64	Concentrations above background for the INEEL, but consistent with historical concentrations at INTEC[c].
TRA	Cesium-137	0.1± 0.02	2.2 ± 0.04	1.13	Concentrations above background for the INEEL, but consistent with historical concentrations at TRA.

a. Concentrations are in picocuries per gram ± 2 standard deviations.

b. < MDC = less than minimum detectable concentration.

c. INTEC = Idaho Nuclear Technology and Engineering Center.

Table 6-8. Soil radiochemistry results reported by the M&O contractor (2002).

		Concentrations[a]			
Location	Radionuclide	Minimum	Maximum	Mean	Comment
RWMC	Americium-241	0.0526 ± 0.0108	0.889 ± 0.133	0.336	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout.
	Plutonium-239/240	0.0326 ± 0.0105	0.231 ± 0.048	0.1060	
	Strontium-90	0.121 ± 0.068	0.310 ± 0.066	0.229	
PBF	Americium-241	<MDC[b]	0.00362 ± 0.00266	—	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout.
	Plutonium-239/240	0.00976 ± 0.00380	0.0180 ± 0.0088	0.0139	
	Strontium-90	0.178 ± 0.078	0.223 ± 0.074	0.201	
TAN	Americium-241	—	0.00551 ± 0.00298	—	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout.
	Plutonium-239/240	—	0.0240 ± 0.0096	—	
	Strontium-90	—	0.201 ± 0.066	—	
TRA	Americium-241	0.00444 ± 0.00286	0.0140 ± 0.0046	0.0079	Concentrations within the background range for the INEEL and surrounding areas and attributable to past fallout.
	Plutonium-239/240	0.0109 ± 0.0056	0.0321 ± 0.0090	0.0182	
	Strontium-90	0.148 ± 0.062	0.220 ± 0.060	0.196	

a. Concentrations are in picocuries per gram ± 2 standard deviations.

b. < MDC = less than minimum detectable concentration.

ANL-W collects four soil samples annually, two from the predominant wind direction and two from the crosswind directions. Sufficient material to fill a 500 mL (16 oz.) wide mouth jar is collected from 0-5 cm (0-2 in.) depth within an approximately 1 m^2 (~10 ft^2) area. Samples are analyzed for low-level gamma-emitting radionuclides, and uranium, plutonium, and thorium isotopes. Table 6-9 presents the results of the 2002 sampling effort.

Table 6-9. Soil radiochemistry results reported by ANL-W (2002).

Radionuclide	Concentrations[a] Minimum	Maximum	Mean	Location of Maximum
Human-Made				
Cesium-137	0.13 ± 0.02	7.77 ± 0.44	1.68 ± 0.46	Industrial Waste Pond
Plutonium-239/240	0.02 ± 0.01	0.07 ± 0.01	0.04 ± 0.02	Air Monitor #1
Naturally Occurring				
Actinium-228	0.91 ± 0.10	1.34 ± 0.13	1.19 ± 0.34	Air Monitor #1
Bismuth-214	0.77 ± 0.06	1.07 ± 0.08	0.95 ± 0.21	Air Monitor #4
Lead-214	0.87 ± 0.08	1.22 ± 0.08	1.05 ± 0.22	Air Monitor #3
Potassium-40	15.90 ± 1.08	20.20 ± 1.28	18.65 ± 3.26	Air Monitor #1
Thorium-228	0.82 ± 0.08	1.47 ± 0.14	1.24 ± 0.34	Air Monitor #2
Thorium-230	1.03 ± 0.10	1.31 ± 0.13	1.15 ± 0.31	Air Monitor #1
Thorium-232	0.93 ± 0.08	1.33 ± 0.12	1.11 ± 0.37	Air Monitor #4
Uranium-233/234	0.58 ± 0.05	1.17 ± 0.90	0.84 ± 0.20	Industrial Waste Pond
Uranium-235	0.026 ± 0.007	0.07 ± 0.01	0.054 ± 0.028	Air Monitor #3
Uranium-238	0.70 ± 0.60	0.97 ± 0.08	0.83 ± 0.19	Industrial Waste Outfall

a. Concentrations are in picocuries per gram.

Wastewater Land Application Permit Soil Sampling at CFA

The Wastewater Land Application Permit (WLAP) for the CFA Sewage Treatment Plant allows for nonradioactive wastewater to be pumped from the treatment lagoons to the ground surface (DOE-ID 1999, IDEQ 2000). Soils are sampled from the CFA land application area following each application season. Subsamples are taken from 0-30 cm (0-12 in.) and 30-61 cm (12-24 in.) at each location and composited, yielding two composite samples, one from each depth. These samples are analyzed for pH, salinity, sodium absorption ratio, and nitrogen, in accordance with the WLAP, to determine whether wastewater application is resulting in detrimental changes in soil quality. These results are presented in Table 6-10. Baseline data collected by Cascade Earth Sciences, Ltd. in 1993 are presented for comparison purposes in Table 6-10.

Soil pH has remained fairly constant during the application period (Table 6-10). However, the pH level at both the 0-30 cm (0-12 in.) and the 30-61 cm (12-24 in.) intervals during 2002 represent the application period minimum, indicating that soil pH may be decreasing. Percent organic matter has varied around baseline concentrations; however, it is expected to take several years for decomposed vegetation to be incorporated into the soil profile.

The soil salinity levels are within acceptable ranges based on electrical conductivity results (Bohn et al. 1985). Soil salinity levels between 0-2 mmhos/cm are generally accepted to have

Table 6-10. CFA Sewage Treatment Plant land application area soil monitoring results (2002).

Parameter[a]	Baseline Data[b] Depth (in.)	1993	Application Period 1995 through 2001 Depth (in.)	Minimum	Maximum	Average	2002
pH[c] (standard units)	0–6	7.6	0–12	8.0	8.4	8.2	7.6
	6–16	8.0	12–24	7.9	8.6	8.3	7.6
	16–30	8.1	–	–	–	–	–
Electrical Conductivity (mmhos/cm)	0–6	0.6	0–12	0.36	1.20	0.74	1.01
	6–16	0.7	12–24	0.20	1.64	0.69	0.80
	16–30	0.6	–	–	–	–	–
Organic Matter (%)[c]	0–6	2.2	0–12	0.63	3.09	1.85	0.44
	6–16	1.6	12–24	0.56	2.29	1.16	0.84
	16–30	1.4	–	–	–	–	–
Nitrate-Nitrogen	0–6	16	0–12	1.81[d]	6.00	3.45[e]	0.676
	6–16	6	12–24	0.43[d]	5.20	1.80[e]	4.17
	16–30	3	–	–	–	–	–
Ammonium-Nitrogen	0–6	7.9	0–12	1 U[f]	6.10	3.50[e]	0.81
	6–16	7.6	12–24	1 U	6.00	3.09[e]	0.81
	16–30	7.4	–	–	–	–	–
Phosphorus[g]	0–6	29	0–12	4.9	12.0	8.5	3.69
	6–16	18	12–24	2 U	10.2	4.2[e]	1.39
	16–30	12	–	–	–	–	–
Sodium Adsorption Ratio	0–6	1.0	0–12	0.35	6.72	2.64	3.23
	6–16	1.4	12–24	0.31	4.03	1.55	1.82
	16–30	2.6	–	–	–	–	–

a. All values are in milligrams per liter unless otherwise noted.

b. Baseline sample results were based on a composite of three representative samples taken at each depth. Baseline soil depths and locations differ from permit samples.

c. The minimum, maximum, and average shown do not reflect a result from 1995. While samples were collected in 1995, the analytical laboratory failed to analyze them.

d. Only includes values that were greater than the detection limit.

e. Where applicable, half the reported detection limit was used to calculate the average.

f. U = that the reported result is below the detection limit.

g. Available phosphorus was analyzed rather than the total phosphorus.

negligible effects on plant growth. During 2002, the electrical conductivity in both the 0-30 cm (0-12 in.) and the 30-61 cm (12-24 in.) intervals increased slightly over historical levels but remained well below the recommended 2 mmhos/cm maximum.

Soils with sodium adsorption ratios below 15 and electrical conductivity levels below 2 mmhos/cm are generally classified as not having sodium or salinity problems (Bohn et al. 1985). While 2002 sodium adsorption ratios were elevated at both depths relative to baseline levels and to historical average levels, they remain well below the ratio generally indicating a sodium or salinity problem in soil.

Nitrogen data suggest negligible nitrogen accumulation from wastewater application. The low soil available nitrogen (ammonium-nitrogen [NH_4N] and nitrate-nitrogen [NO_3N]) concentrations suggest that the native sagebrush and grass vegetation use all of the plant available nitrogen and that the total nitrogen application is low. Increased nutrients and water from wastewater application may be stimulating plant growth, which in turn rapidly utilizes plant available nitrogen. The ammonium and nitrate nitrogen concentrations are comparable to those of unfertilized, background agricultural soils.

In 2002, available phosphorus concentrations remained below baseline concentrations and less than that considered adequate for range and pasture crop growth (EPA 1981).

Based on these results, the application of wastewater at the CFA does not appear to adversely affect soil chemistry. However, analysis continue, as required by the WLAP, to evaluate potential long-term effects.

Naval Reactors Facility

Naval Reactors Facility personnel also sample soil and vegetation annually for programmatic radionuclides. For detailed information see the *2002 Environmental Monitoring Report for the Naval Reactors Facility* (Bechtel Bettis 2002).

6.4 Direct Radiation

Thermoluminescent dosimeters (TLDs) measure cumulative exposures to ambient ionizing radiation. The TLDs detect changes in ambient exposures attributed to handling, processing, transporting, or disposing of radioactive materials. The TLDs are sensitive to beta energies greater than 200 kilo-electron volts (keV) and to gamma energies greater than 10 keV. The TLD packets contain four lithium fluoride chips and are placed about 1 m (~3 ft) above the ground at specified locations. The four chips provide replicate measurements at each location. The TLD packets are replaced in May and November of each year. The sampling periods for 2002 were from November 2001 through April 2002 (spring) and from May through October 2002 (fall).

The measured cumulative environmental radiation exposure for offsite locations from November 2001 through October 2002 is shown in Table 6-11 for two adjacent sets of dosimeters maintained by the ESER and M&O contractors. For purposes of comparison, annual exposures from 1998-2002 are also included for each location.

Table 6-11. Annual environmental radiation exposures (1998-2002).[a]

	1998		1999		2000		2001		2002	
	ESER	M&O	ESER	M&O	ESER	M&O	ESER	M&O	ESER	M&O
Distant Group										
Aberdeen	128 ± 8	157 ± 18	130 ± 9	124 ± 7	144 ± 28	133 ± 18	152 ± 21	137 ± 19	141 ± 20	126 ± 17
Blackfoot	130 ± 6	134 ± 7	111 ± 4	111 ± 6	138 ± 27	126 ± 18	145 ± 20	136 ± 18	125 ± 17	119 ± 17
Blackfoot (CMS)[b]	113 ± 4	–	113 ±14	–	114 ± 22	–	134 ±13	–	113 ± 16	–
Blue Dome[c]	–	–	–	–	–	–	–	–	106 ± 15	–
Craters of the Moon	122 ± 6	121 ± 8	115 ± 12	120 ± 13	126 ± 25	121 ± 17	137 ± 19	136 ± 18	121 ± 17	124 ± 17
Dubois[c]	–	–	–	–	–	–	–	–	109 ± 15	–
Idaho Falls	124 ± 6	115 ± 6	124 ± 13	108 ± 10	129 ± 25	123 ± 17	147 ± 20	127 ± 17	126 ± 18	112 ± 16
Jackson[c]	–	–	–	–	–	–	–	–	97 ± 13	–
Minidoka	116 ± 7	113 ± 6	112 ± 7	113 ± 12	118 ± 23	111 ± 16	131 ± 18	122 ± 17	111 ± 15	107 ± 15
Rexburg	144 ± 7	116 ± 4	129 ± 5	110 ± 11	148 ± 29	120 ± 16	155 ± 22	131 ± 18	144 ± 20	115 ± 16
Roberts	130 ± 6	137 ± 8	131 ± 9	129 ± 10	137 ± 27	139 ± 19	157 ± 22	144 ± 21	134 ± 26	132 ± 18
Mean	**126 ± 2**	**128 ± 3**	**121 ± 3**	**116 ± 4**	**132 ± 9**	**125 ± 7**	**146 ± 7**	**133 ± 7**	**120 ± 5**	**119 ± 6**
Boundary Group										
Arco	128 ± 7	117 ± 6	128 ± 12	124 ± 7	128 ± 25	121 ± 17	143 ± 20	134 ± 18	126 ± 17	120 ± 17
Atomic City	132 ± 6	124 ± 5	124 ± 8	133 ± 6	131 ± 26	128 ± 18	147 ± 20	137 ± 18	130 ± 18	124 ± 17
Howe	125 ± 5	116 ± 7	118 ± 6	116 ± 10	118 ± 23	114 ± 16	133 ± 18	130 ± 18	121 ± 17	NS[d]
Monteview	124 ± 4	113 ± 8	114 ± 6	108 ± 14	122 ± 24	116 ± 16	134 ± 19	120 ± 16	118 ± 16	115 ± 16
Mud Lake	137 ± 7	130 ± 4	129 ± 9	128 ± 13	140 ± 27	126 ± 18	151 ± 21	140 ± 20	136 ± 19	129 ± 18
Birch Creek/Reno Ranch	117 ± 6	105 ± 6	113 ± 10	113 ± 18	118 ± 23	108 ± 16	114 ± 16	107 ± 15	110 ± 15	104 ± 14
Mean	**127 ± 2**	**118 ± 3**	**121 ± 4**	**120 ± 5**	**126 ± 10**	**119 ± 7**	**137 ± 8**	**128 ± 7**	**124 ± 7**	**118 ± 7**

a. All values are in milliroentgens ± 2 standard deviations.

b. The M&O contractor does not sample at the Blackfoot Community Monitoring Station (CMS).

c. These stations were added by the ESER contractor in 2001.

d. The TLD was missing for the fall reading and no annual reading could be calculated.

The mean annual exposures from distant locations in 2002 were 120 ± 5.2 milliroentgens (mR) as measured by ESER contractor dosimeters and 119 ± 6.3 mR, as measured by the M&O contractor's dosimeters. For boundary locations, the mean annual exposures were 124 ± 7.0 mR as measured by ESER contractor dosimeters and 118 ± 7.4 mR as measured by M&O contractor dosimeters. Using both ESER and M&O data, the average dose equivalent of the distant group was 123 millirem (mrem), when a dose equivalent conversion factor of 1.03 was used to convert from milliroentgens to millirem in tissue (NRC 1997). The average dose equivalent for the boundary group was 125 mrem.

In addition to TLDs, the M&O contractor uses a global positioning radiometric scanner system to conduct gamma radiation surveys. The global positioning radiometric scanner is mounted on a four-wheel drive vehicle. The two plastic scintillation detectors of the radiometric scanner measure gross gamma in counts per second with no coincidence corrections or energy compensation. Elevated count rates suggest possible areas of contamination or elevated

background areas. Both global positioning system and radiometric data are continuously recorded. The vehicle is driven at approximately 8 km/hr (5 mph) to collect survey data (see Subsection 6.5, Direct Radiation).

Onsite TLDs maintained by the M&O contractor representing the same exposure period as the offsite dosimeters are shown in Appendix D, Figures D-1 through D-10. The results are expressed in milliroentgens ± 2 standard deviations. Onsite dosimeters were placed on facility perimeters, concentrated in areas likely to show the highest gamma radiation readings. Other onsite dosimeters are located in the vicinity of radioactive materials storage areas. At some facilities, elevated exposures result from areas of soil contamination around the perimeter of these facilities.

The maximum exposure onsite recorded during 2002 was 784 ± 110 mR at location TRA 3. This location is the closest to a radioactive storage area, which is inside the facility fence line. Locations TRA 2, 3, and 4 are also adjacent to the former radioactive disposal ponds, which have been drained and covered with clean soil and large rocks.

The Idaho Chemical Processing Plant (ICPP) 20 TLD is located near a radioactive material storage area. Exposures at ICPP 20, INTEC Tree Farm 1, and INTEC Tree Farm 4 for 2002 were all comparable to historical exposures.

Table 6-12 summarizes the calculated effective dose equivalent an individual receives on the Snake River Plain from various background radiation sources.

The terrestrial portion of natural background radiation exposure is based on concentrations of naturally occurring radionuclides found in soil samples collected in 1976, the last time a comprehensive background study was completed. Concentrations of naturally occurring radionuclides in soil are not expected to change significantly over this relatively short time period. Data indicated the average concentrations of uranium-238 (^{238}U), thorium-232 (^{232}Th), and potassium-40 (^{40}K) were 1.5, 1.3, and 19 pCi/g, respectively. The calculated external dose equivalent 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. Because snow cover can reduce the effective dose equivalent Idaho residents receive from the soil, a correction factor must be made each year to the above estimate of 76 mrem/yr. For 2002, this resulted in a corrected dose of 64 mrem/yr because of snow cover, which ranged from 2.54 to 33.0 cm (1 to 13 in.) in depth with an average of 24.4 cm (9.6 in.) over 83 days with recorded snow cover.

The cosmic component varies primarily with altitude increasing from about 26 mrem at sea level to about 48 mrem at the elevation of the INEEL at approximately 1500 m (4900 ft) (NCRP 1987). Cosmic radiation may vary slightly because of solar cycle fluctuations and other factors.

The estimated sum of the terrestrial and cosmic components of dose to a person residing on the Snake River Plain in 2002 was 112 mrem. This is below the 123 mrem measured at distant locations by TLDs after conversion from milliroentgens to millirem in tissue. These values are very close and within normal variability (Table 6-11). Therefore, it is unlikely that INEEL operations contribute to background radiation levels at distant locations.

The component of background dose that varies the most is inhaled radionuclides. According to the National Council on Radiation Protection and Measurements, the major contributor of external dose equivalent received by a member of the public from ^{238}U plus decay products are short-lived decay products of radon (NCRP 1987). The amount of radon in buildings and groundwater depends, in part, upon the natural radionuclide content of the soil and rock of the area. This also varies between buildings of a given geographic area depending upon the materials each contains, the amount of ventilation and air movement, and other factors. The United States average of 200 mrem was used in Table 6-12 for this component of the total background dose because no specific estimate for southeastern Idaho has been made, and few specific measurements have been made of radon in homes in this area. Therefore, the effective dose equivalent from natural background radiation for residents in the INEEL vicinity may actually be higher or lower than the total estimated background dose of about 352 mrem shown in Table 6-12 and will vary from one location to another.

Table 6-12. Calculated effective dose equivalent from background sources (2002).

Source of Radiation Dose Equivalent	Total Average Annual Dose[a] Calculated	Measured
External		
Terrestrial	64	NA[b]
Cosmic	48	NA
Subtotal	112	123
Internal		
Cosmogenic	1	
Inhaled Radionuclides	200	
^{40}K and others[c]	39	
Subtotal	240	
Total	**352**	

a. All values are in millirem.

b. NA = terrestrial and cosmic radiation parameters were not measured individually.

c. ^{40}K = potassium-40, others are natural isotopes and decay products of uranium and thorium.

Naval Reactors Facility

The NRF also has TLDs placed around the perimeter fence of the facility and at distant locations to measure cumulative exposure. For detailed information see the *2002 Environmental Monitoring Report for the Naval Reactors Facility* (Bechtel Bettis 2002).

6.5 Waste Management Surveillance Sampling

Vegetation, soil, and direct radiation sampling is performed at waste management facilities (the RWMC and the WERF) in compliance with DOE Order 435.1, Radioactive Waste Management.

Vegetation Sampling

At the RWMC, vegetation is collected from the five major areas shown on Figure 6-6. Russian thistle is collected in even-numbered years. Vegetation has been collected every three years from WERF (Figure 6-7) beginning in 1984 and was collected in 2002.

Samples of perennial plants were collected from WERF in 2002. Control samples were collected near Tractor Flats (Figure 6-8). Because of recontouring and construction activities at the RWMC, no Russian thistle was available for sampling in 2002. The vegetation samples were analyzed for gamma-emitting radionuclides, ^{90}Sr, and alpha-emitting transuranics. No gamma-emitting radionuclides were detected. Plutonium-239/240 and ^{90}Sr were detected as shown in

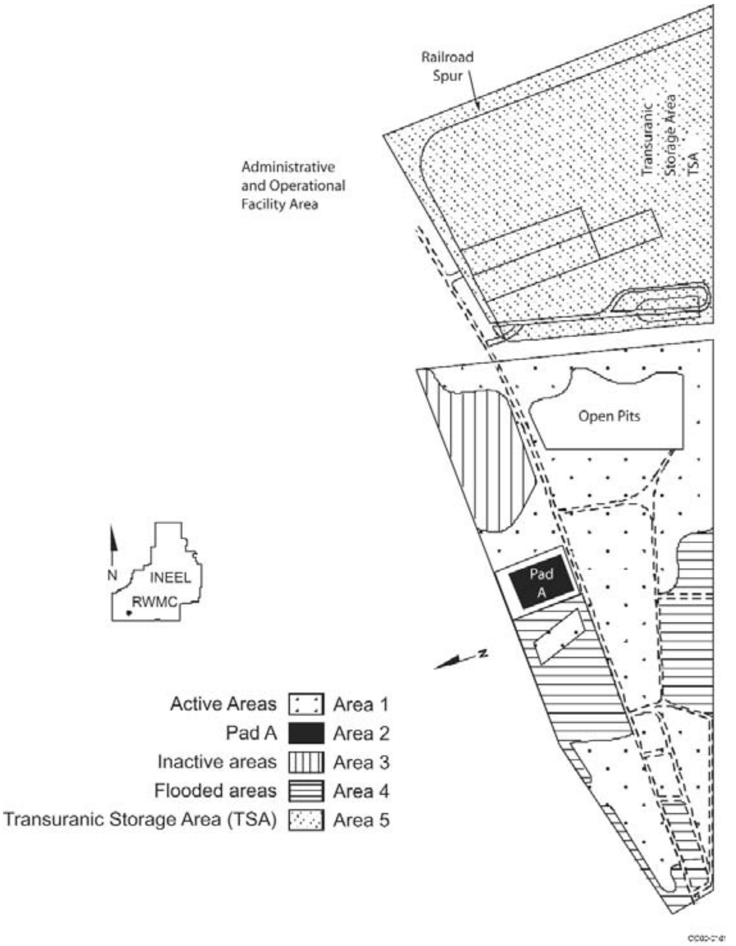

Figure 6-6. Five major areas of the RWMC used for M&O Waste Management vegetation collection.

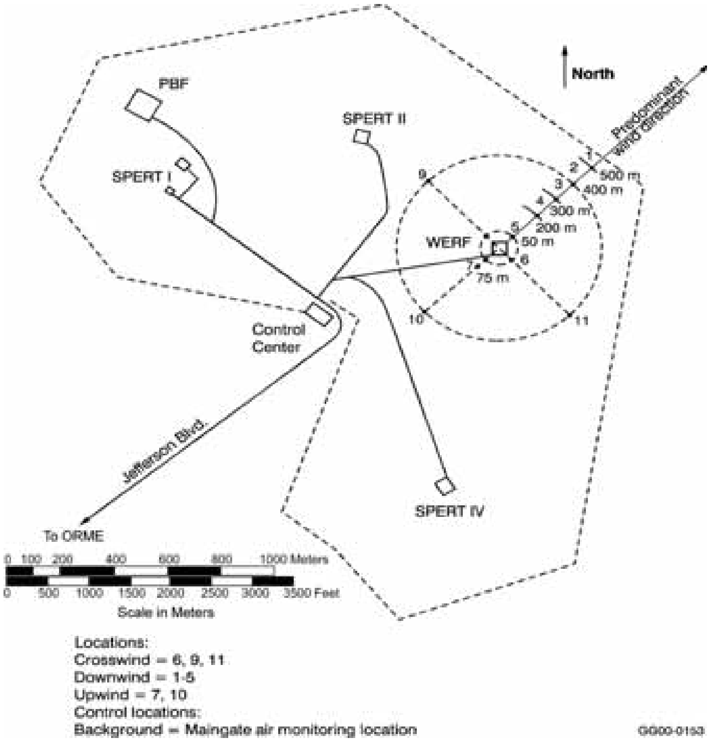

Figure 6-7. WERF vegetation sampling locations.

Table 6-13. The concentrations were all within the background range for the INEEL and surrounding areas and are attributable to past fallout.

ANL-W collects random vegetation samples from predominant wind directions and other areas of concern. Vegetation is sampled at the same locations as soil samples. Approximately one kg (2.2 lb) of mixed vegetation is collected and dried. The dried material is then powdered and analyzed for various radionuclides. Table 6-14 presents the 2002 vegetation results.

Soil Sampling

Biennial soil sampling was conducted during 2002. Soil samples were collected at the WERF locations shown in Figure 6-9, at 0-5 cm (0-2 in.). The soils were analyzed for gamma-emitting radionuclides and ^{90}Sr. Selected samples were analyzed for alpha-emitting transuranics.

Cesium-137, $^{239/240}$Pu, and ^{90}Sr were detected in all soil samples (Table 6-15). The concentrations are within the background range for the INEEL and surrounding areas and are attributable to past fallout. Americium-241 concentrations are above background for the INEEL but are consistent with historical concentrations at WERF and are attributable to past operational activities and fallout.

Direct Radiation

The radiometric scanner system was used to conduct soil surface radiation (gross gamma) surveys at the RWMC to complement soil sampling. The global positioning radiometric scanner is mounted on a four-wheel drive vehicle. The system includes two plastic scintillators that

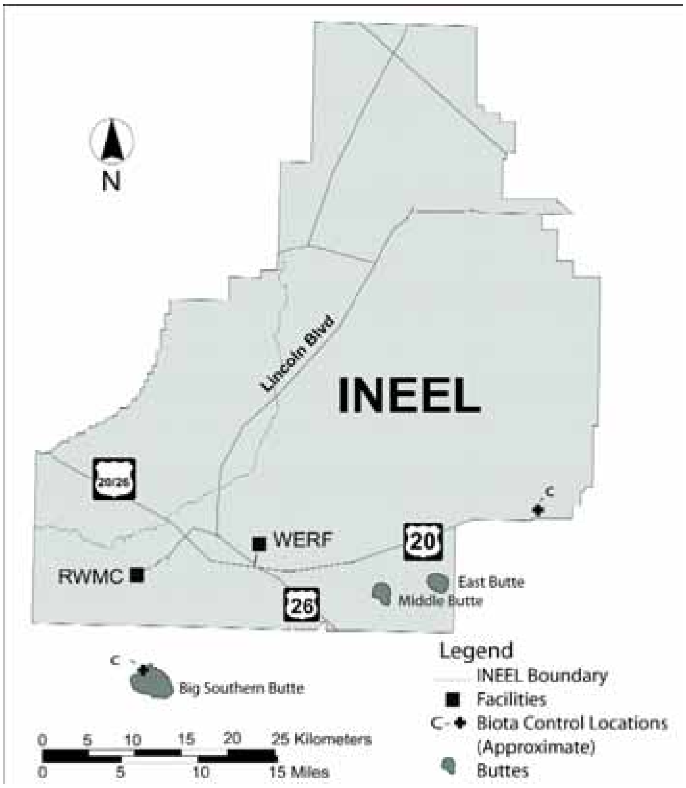

Figure 6-8. Vegetation control sample locations (RWMC-Frenchman's Cabin, WERF - Tractor Flats).

Table 6-13. Perennial sample results (2002).

Parameter	Minimum Concentration[a]	Maximum Concentration[a]
Plutonium-239/240	$3.93 \times 10^{-4} \pm 3.64 \times 10^{-4}$	$1.13 \times 10^{-3} \pm 0.58 \times 10^{-3}$
Strontium-90	$3.92 \times 10^{-2} \pm 0.92 \times 10^{-2}$	$1.04 \times 10^{-1} \pm 0.13 \times 10^{-1}$

a. Concentrations are in picocuries per gram ± 2 standard deviations.

Table 6-14. Vegetation radiochemistry results reported by ANL-W (2002).[a]

Radionuclide	Concentrations[b]			Location of Maximum
	Minimum	Maximum	Mean	
		Human-Made		
Cesium-137	0.13 ± 0.04	0.14 ± 0.04	0.13 ± 0.05	Air Monitor #2
		Naturally Occurring		
Actinium-228	0.30 ± 0.13	11.70 ± 3.66	6.00 ± 3.66	768B Lab
Beryllium-7	2.60 ± 0.94	5.55 ± 0.62	3.98 ± 2.21	Air Monitor #4
Bismuth-214	0.18 ± 0.06	1.02 ± 0.30	0.46 ± 0.36	Industrial Waste Pond
Lead-214	0.37 ± 0.17	5.74 ± 2.03	2.25 ± 2.05	768B Lab
Potassium-40	7.98 ± 2.43	26.00 ± 11.10	14.69 ± 12.62	768B Lab
Radium-226	0.18 ± 0.06	1.02 ± 0.30	0.46 ± 0.36	Industrial Waste Pond
Thorium-228	0.02 ± 0.01	0.27 ± 0.03	0.08 ± 0.04	Industrial Waste Pond -North
Thorium-230	0.025 ± 0.007	0.47 ± 0.18	0.122 ± 0.187	768B Lab
Thorium-232	0.030 ± 0.004	0.501 ± 0.25	0.121 ± 0.031	Air Monitor #1
Uranium-233/234	0.013 ± 0.005	0.144 ± 0.017	0.051 ± 0.025	Industrial Waste Pond -North
Uranium-235	0.011 ± 0.003	0.021 ± 0.006	0.013 ± 0.008	Industrial Waste Pond -North
Uranium-238	0.020 ± 0.005	0.144 ± 0.016	0.053 ± 0.023	Industrial Waste Pond-North

a. Only values greater than 2s uncertainty are reported. All radionuclides had at least one sample below the minimum detectable concentration.

b. Concentrations are in picocuries per gram.

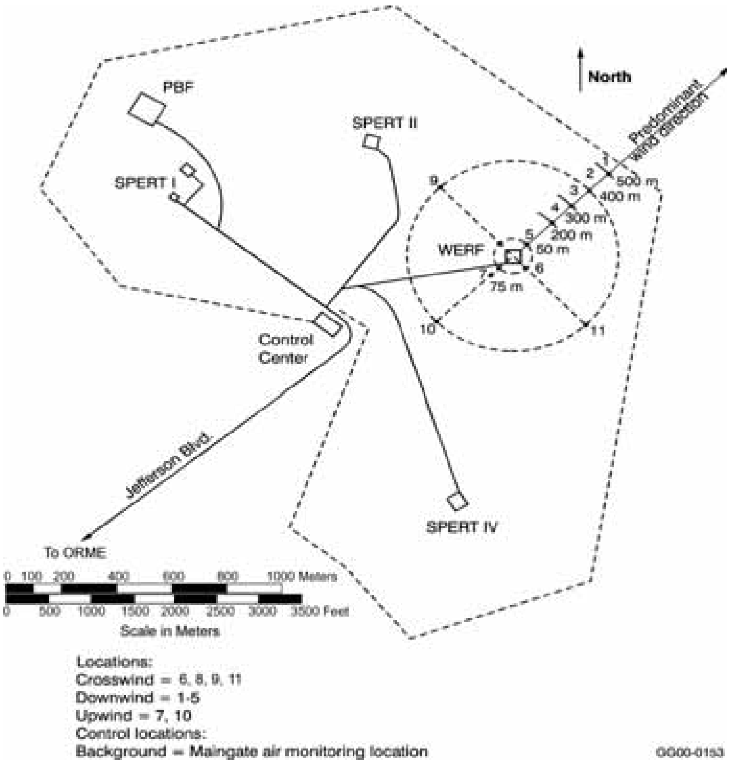

Figure 6-9. WERF soil sampling locations.

Table 6-15. WERF soil sampling results (2002).

Parameter	Minimum Concentration[a]	Maximum Concentration[a]	% ECG[b]
Cesium-137	0.30 ± 0.08	0.67 ± 0.12	11.2
Americium-241	0.00486 ± 0.00476	0.00665 ± 0.00540	0.0002
Plutonium-239/240	0.00947 ± 0.00436	0.0187 ± 0.0094	0.0002
Strontium-90	0.133 ± 0.078	0.221 ± 0.084	0.0368

a. Concentrations are in picocuries per gram ± 2 standard deviations.

b. ECG = Environmental Concentration Guide (EG&G 1986) in picocuries per gram.

measure gross gamma in counts per second with no coincidence corrections or energy compensation (elevated count rates indicate possible areas of contamination or elevated background). Both the global positioning system and radiometric data are continuously recorded.

Figures 6-10 and 6-11 show the radiation readings from the 2002 RWMC spring and fall surveys, respectively. The spring and fall surveys around the active low-level waste pit were comparable to or lower than historical measurements for that area. No new elevated readings were identified during either survey. Table 6-16 compares the maximum results of the spring and fall surveys. Although readings varied slightly from year to year, the results are comparable to previous years' measurements taken at the same locations.

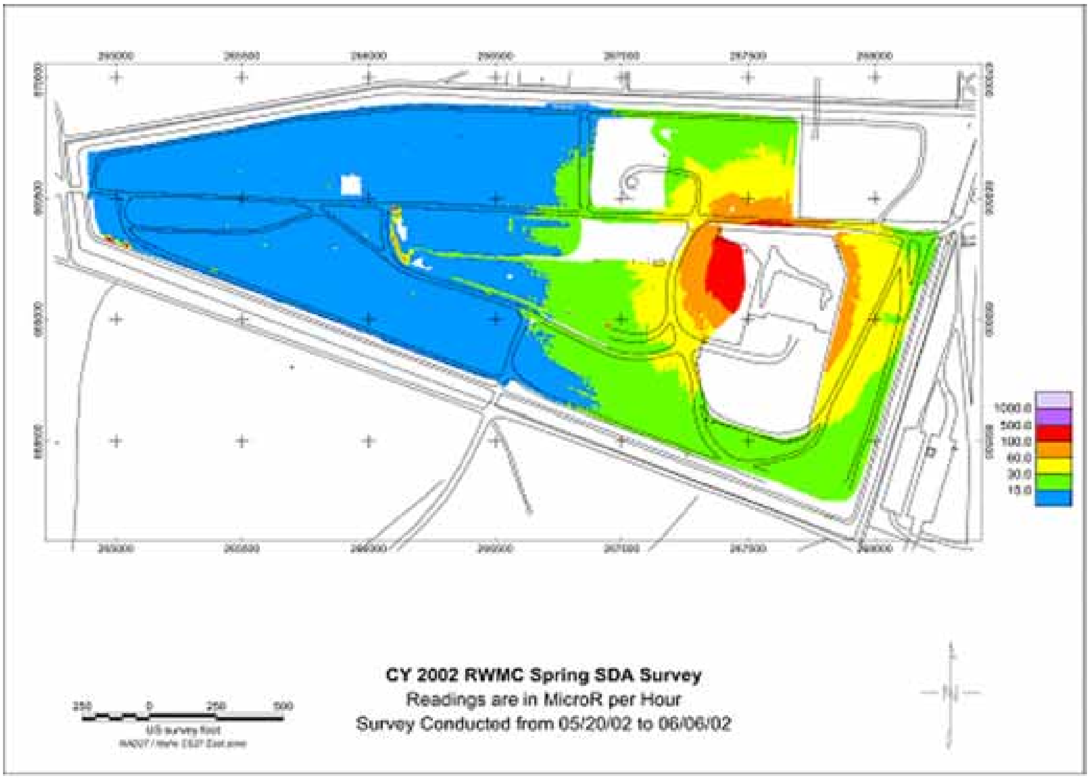

Figure 6-10. RWMC surface radiation spring 2002.

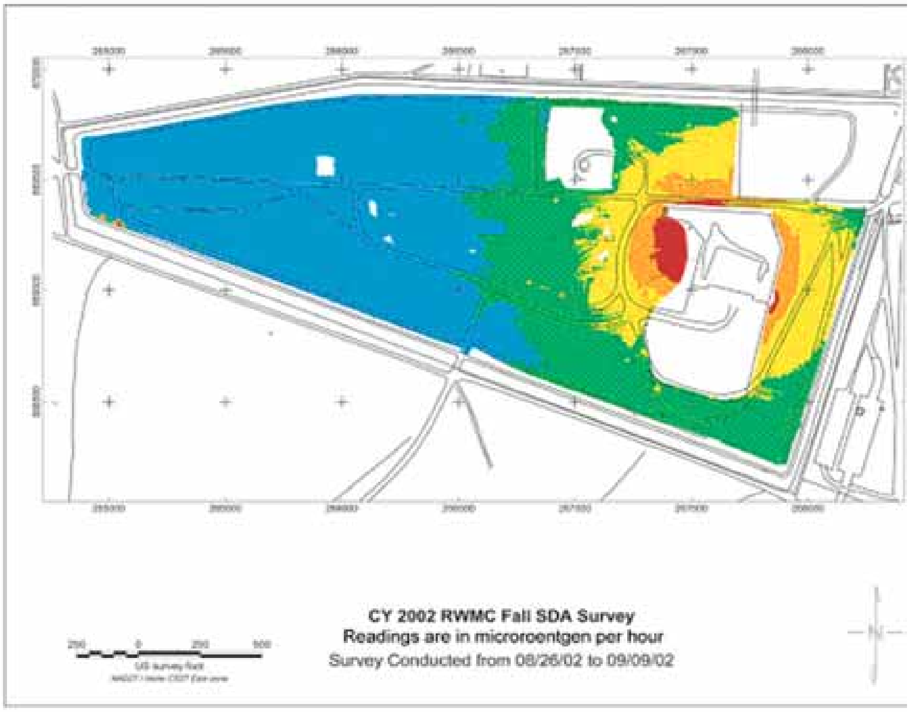

Figure 6-11. RWMC surface radiation fall 2002.

Pad A cannot be surveyed via the global positioning radiometric scanner because of driving restrictions. Therefore, it was traversed with a hand-held detector. No elevated readings were identified on Pad A during either the spring or fall survey.

6.6 Summary

The M&O and ESER contractors sampled a variety of media in 2002, including agricultural products, wildlife, soil, and direct radiation to assess if operations at the INEEL are releasing contaminants to the environment in significant levels. Assessment of the 2002 data indicates that although some contaminants were detected, they could not be directly linked to operations at the INEEL. Concentrations of radionuclides detected were consistent with levels attributed to fallout from atmospheric weapons testing. Furthermore, the maximum levels for the contaminants found were all well below regulatory health-based limits for protection of human health and the environment.

Table 6-16. Comparison of spring and fall global positioning radiometric survey.

	Spring		Fall	
	2002	**2001**	**2002**	**2001**
Maximum[a]	460	353	410	502
Location of Maximum Value[b]	West End of Trench #58	Soil Vault Row #18	West End of Trench #58	Soil Vault Row #18

a. All values are in microroentgens per hour.

b. Excludes operating low-level waste pit.

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Chapter 7 - Dose to the Public and to Biota

Chapter Highlights

Potential radiological doses to the public from Idaho National Engineering and Environmental Laboratory (INEEL) operations were evaluated to determine compliance with pertinent regulations and limits. Two different computer models were used to estimate doses: CAP-88 and the mesoscale diffusion (MDIFF) air dispersion model. CAP-88 is required by U.S. Environmental Protection Agency to demonstrate compliance with the Clean Air Act. The National Oceanic and Atmospheric Administration Air Resources Laboratory-Field Research Division developed MDIFF to evaluate dispersion of pollutants in arid environments such as those found at the INEEL. The maximum calculated dose to an individual by either of the methods was well below the applicable radiation protection standard of 10 mrem/yr. The dose to the maximally exposed individual, as determined by the CAP-88 program, was 0.055 mrem (0.55 µSv). The dose calculated using the MDIFF dispersion coefficients was 0.04 mrem (0.4 µSv). The maximum potential population dose to the approximately 268,218 people residing within a 80-km (50-mi) radius of any INEEL facility was 0.93 person-rem, well below that expected from exposure to background radiation.

Using the maximum radionuclide concentrations in collected waterfowl, game animals, and marmots, a maximum potential dose from ingestion was calculated. The maximum potential dose for each was estimated to be 0.004 mrem (0.04 µSv) for waterfowl, 1.34 mrem (13.4 µSv) for game animals, and 0.003 mrem (0.03 µSv) for marmots.

The potential dose to aquatic and terrestrial biota from contaminated soil and water was also evaluated, using a graded approach. Based on this approach there is no evidence that INEEL-related contamination is having an adverse impact on populations of plants and animals.

7. DOSE TO THE PUBLIC AND TO BIOTA

It is the policy of the U.S. Department of Energy (DOE) "to conduct its operations in an environmentally safe and sound manner. Protection of the environment and the public are responsibilities of paramount importance and concern to DOE" (DOE 1993a). DOE Order 5400.5 further states, "It is also a DOE objective that potential exposures to members of the public be as far below the limits as is reasonably achievable..." (DOE 1993b). This chapter describes the dose to members of the public and to the environment based on the 2002 radionuclide concentrations from operations at the INEEL.

7.1 General Information

Individual radiological impacts to the public surrounding the INEEL remain too small to be measured by available monitoring techniques. To show compliance with federal regulations established to ensure public safety, the dose from INEEL operations was calculated using the reported amounts of radionuclides released during the year from INEEL facilities (see Chapter 4) and appropriate air dispersion computer codes. During 2002, this was accomplished for the radionuclides summarized in Table 4-2.

The following estimates were calculated:

- The effective dose equivalent to the hypothetical maximally exposed individual (MEI), as defined by the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations, using the CAP-88 computer code as required by the regulation (Cahki and Parks 2000);
- The effective dose equivalent to the MEI residing offsite using dispersion values from the mesoscale diffusion (MDIFF) model (Sagendorf et al. 2001) to comply with DOE Order 5400.1; and
- The collective effective dose equivalent (population dose) for the population within 80 km (50 mi) of an INEEL facility to comply with DOE Order 5400.1. The estimated population dose was based on the effective dose equivalent calculated from the MDIFF air dispersion model for the MEI.

In this chapter, the term dose refers to effective dose equivalent unless another term is specifically stated. Dose was calculated by summing the effective dose equivalents from each exposure pathway. Effective dose equivalent includes doses received from both external and internal sources and represents the same risk as if an individual's body were uniformly irradiated. DOE dose conversion factors and a 50-yr integration period was used in calculations in combination with the MDIFF air dispersion model for internally deposited radionuclides (Kocher 1988) and for radionuclides deposited on the ground surface (DOE 1988). The CAP-88 computer code uses dose and risk tables developed by the U.S. Environmental Protection Agency (EPA). No allowance is made in the dose calculations using MDIFF for shielding by housing materials, which is estimated to reduce the dose by about 30 percent, or less than year-round occupancy time in the community. The CAP 88 computer code does not include shielding by housing materials, but it does include a factor to allow for shielding by surface soil contours from radioactivity on the ground surface.

Of the potential exposure pathways by which radioactive materials from INEEL operations could be transported offsite (see Figure 3-1, page 3.4), atmospheric transport is the principal potential pathway for exposure to the surrounding population. This is because winds can carry airborne radioactive material rapidly and some distance from its source. The water pathways are not considered major contributors to dose because no surface water flows off the INEEL and no radionuclides from the INEEL have been found in drinking water wells offsite. Because of these factors, the MEI dose is determined through the use of computer codes of atmospheric dispersion of airborne materials.

7.2 Maximum Individual Dose - Airborne Emissions Pathway

Summary of Computer Codes

The NESHAP, as outlined in the Code of Federal Regulations, Title 40, Part 61 (40 CFR Part 61), Subpart H, requires the demonstration that radionuclides other than radon released to air from any DOE nuclear facility do not result in a dose to the public of greater than 10 mrem/yr (40 CFR 61 2001). This includes releases from stacks and diffuse sources. The EPA requires the use of an approved computer code to demonstrate compliance with 40 CFR Part 61. The INEEL uses the code CAP-88 as recommended in 40 CFR 61 to demonstrate NESHAP compliance.

The National Oceanic and Atmospheric Administration Air Resources Laboratory-Field Research Division (NOAA ARL-FRD) developed a mesoscale air dispersion model called MDIFF (formerly known as MESODIF) (Sagendorf et al. 2001). The MDIFF diffusion curves were developed by the NOAA ARL-FRD from tests in desert environments (e.g., the INEEL and the Hanford Site in eastern Washington). The MDIFF curves are more appropriate for estimating dose to the public due to INEEL emissions than those used by the CAP-88 code. The MDIFF code is a dispersion model only and does not account for plume depletion and radioactive decay.

The MDIFF model has been in use for almost 40 years to calculate dispersion coefficients that are then used to calculate the dose to members of the public residing near the INEEL. In previous years, doses calculated using the MDIFF air dispersion coefficients have been somewhat higher than doses calculated using CAP-88. Differences between the two computer codes were discussed in detail in the 1986 annual report (Hoff et al. 1987). The offsite concentrations calculated using both computer codes were compared to actual monitoring results at offsite locations in 1986, 1987, and 1988 (Hoff et al. 1987, Chew and Mitchell 1988, Hoff et al. 1989). Concentrations calculated for several locations using the MDIFF dispersion coefficients showed good agreement with concentrations from actual measurements, with the model calculations generally predicting concentrations higher than those measured.

The primary difference is the atmospheric dispersion portion of the codes. CAP-88 makes its calculations based on the joint frequency of wind conditions from a single wind station located near the source in a straight line from that source and ignores recirculation. MDIFF calculates the trajectories of a puff using wind information from 36 towers in the Upper Snake River Plain. This allows for more accurate and site-specific modeling of the movement of a release using prevailing wind conditions between time of the release and the time that the plume leaves the INEEL region. For this reason, the two computer codes may not agree on the location of the MEI or the magnitude of the maximum dose.

CAP-88 Computer Code

The dose from INEEL airborne releases of radionuclides calculated to demonstrate compliance with NESHAP are published in the *National Emissions Standards for Hazardous Air Pollutants-Calendar Year 2002 INEEL Report for Radionuclides* (DOE-ID 2003). For these calculations, 63 potential maximum locations were evaluated. The CAP-88 computer code predicted the highest dose to be at Frenchman's Cabin, located at the southern boundary of the INEEL. This location is only inhabited during portions of the year, but it must be considered as a potential MEI location according to the NESHAP. At Frenchman's Cabin, an effective dose equivalent of 0.055 mrem (0.55 μSv) was calculated. The facilities making the largest contributions to this dose were the Idaho Nuclear Technology and Engineering Center (INTEC) at 87 percent, the Test Reactor Area (TRA) at nine percent, and the Radioactive Waste Management Complex (RWMC) at four percent. The dose of 0.055 mrem (0.55 μSv) is well below the whole body dose limit of 10 mrem (100 μSv) for airborne releases of radionuclides established by 40 CFR 61.

MDIFF Model

Using data gathered continuously at meteorological stations on and around the INEEL and the MDIFF model, the NOAA ARL-FRD prepares a mesoscale map (Figure 7-1) showing the calculated 2002 total integrated concentration (TIC). These TICs are based on a unit release rate weighted by percent contribution for each of eight INEEL facilities (Argonne National Laboratory-West [ANL-W], Central Facilities Area [CFA], INTEC, Naval Reactors Facility [NRF], Power Burst Facility [PBF], RWMC, TRA, Test Area North [TAN]). To create the isopleths shown in Figure 7-1, the TIC values are contoured. Average air concentrations (in curies per cubic meter) for a radionuclide released from a facility are estimated from a TIC isopleth (line of equal air concentration) in Figure 7-1. To calculate the average air concentration, the dispersion coefficient is multiplied by the quantity of the radionuclide released (in curies) during the year and divided by the number of hours in a year squared (8760 hr^2 or 7.70×10^7). This does not account for plume depletion, radioactive decay, or in-growth or decay of radioactive progeny. In 2000, a revision to the methods and values used for the calculation of the MEI dose from the MDIFF dispersion values was undertaken. Values for the deposition and plant uptake rates of radionuclides, most noticeably radioiodines, were modified to reflect present operations and current values in use. The most notable change, mathematically, is the increase of the iodine-129 (^{129}I) deposition velocity from 0.01 m/sec to 0.035 m/sec, as the emitted radionuclides went from predominantly organic in nature to elemental. These changes resulted in a mathematical increase in the amount of radionuclides deposited on the ground and available for plant uptake. This resulted in a net increase in the ingestion dose.

The MDIFF model predicted that the highest TIC for radionuclides in air at a location with a year-round resident during 2002 would have occurred approximately 8.9 km

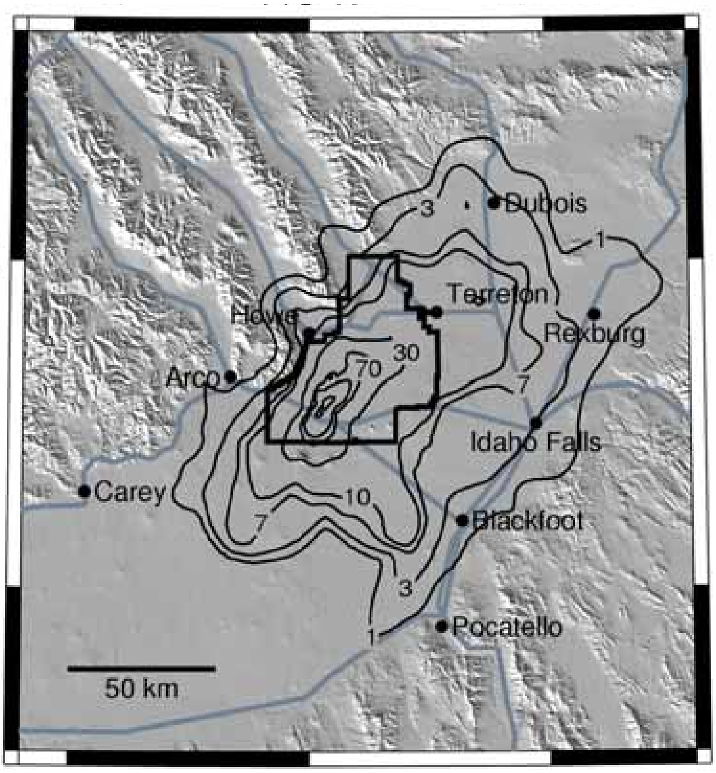

Figure 7-1. Average mesoscale isopleths of total integrated concentrations at ground level normalized to unit release rate from all INEEL facilities (Concentrations are times 10^{-9} hours squared per meter cubed).

(5.5 mi) west-northwest of Mud Lake, Idaho. The maximum hypothetical dose was calculated for an adult resident at that location from inhalation of air, submersion in air, ingestion of radioactivity on leafy vegetables, and exposure because of deposition of radioactive particles on the ground. The calculation was based on data presented in Table 4-2 and the grid used to produce Figure 7-1.

Using the largest calculated TIC for each facility (Table 7-1) at the location inhabited by a full-time resident and allowing for radioactive decay and plume depletion during the transit of the radionuclides from each facility to the location of the MEI, west-northwest of Mud Lake, the potential annual effective dose equivalent from all radionuclides released was calculated to be 0.04 mrem (4.0 x 10^{-4} mSv) (Table 7-2). This dose is well below the whole body dose limit of 10 mrem set in the 40 CFR 61 for airborne releases of radionuclides.

The ingestion pathway remained the primary route of exposure and accounted for 92 percent of the total dose, followed by inhalation at six percent, and immersion at two percent. For 2002, ^{129}I contributed approximately 72 percent of the total dose, followed by strontium-90 (^{90}Sr) with 13 percent; plutonium-239 (^{239}Pu) at 4 percent; cesium-137 (^{137}Cs) at 3 percent; and

Table 7-1. Dispersion coefficient, travel time, and distance from each facility to the MEI location.

Facility	Dispersion Coefficient (hr^2/m^3)	Travel Time hours	Distance km (miles)
ANL-W	2.28×10^{-8}	1.92	29.9 (18.58)
CFA	2.27×10^{-8}	2.75	46.9 (29.13)
INTEC	2.19×10^{-8}	3.28	42.9 (26.64)
NRF	3.98×10^{-8}	2.45	35.8 (22.28)
PBF	2.53×10^{-8}	2.96	41.5 (25.78)
RWMC	1.82×10^{-8}	2.96	54.7 (33.99)
TAN	2.34×10^{-7}	0.85	10.3 (6.39)
TRA	2.15×10^{-8}	2.66	43.4 (26.94)

Table 7-2. Maximum individual effective dose equivalent as calculated from MDIFF model results (2002).

Radionuclide[a]	Radionuclide Concentration in Air at Maximum Offsite Location[b] (Ci/m^3)	Maximum Effective Dose Equivalent mrem	mSv
^{129}I[c]	1.47×10^{-17}	2.88×10^{-2}	2.88×10^{-4}
^{90}Sr + D[d]	3.11×10^{-17}	5.17×10^{-3}	5.17×10^{-5}
^{239}Pu	2.31×10^{-19}	1.50×10^{-3}	1.50×10^{-5}
^{137}Cs + D[c,d]	3.11×10^{-17}	1.29×10^{-3}	1.29×10^{-5}
^{241}Pu	6.57×10^{-18}	8.18×10^{-4}	8.18×10^{-6}
^{240}Pu	1.26×10^{-19}	8.15×10^{-4}	8.15×10^{-6}
^{41}Ar	1.08×10^{-13}	7.14×10^{-4}	7.14×10^{-6}
^{238}Pu	5.52×10^{-20}	3.25×10^{-4}	3.25×10^{-6}
^{244}Cm	6.82×10^{-20}	2.53×10^{-4}	2.53×10^{-6}
^{131}I	1.28×10^{-18}	1.24×10^{-4}	1.24×10^{-6}
^{241}Am	5.88×10^{-21}	3.93×10^{-5}	3.93×10^{-7}
^{151}Sm	1.77×10^{-19}	2.66×10^{-5}	2.66×10^{-7}
^{85}Kr	2.34×10^{-12}	2.62×10^{-5}	2.62×10^{-7}
All Others	NA	5.17×10^{-3}	5.17×10^{-5}
Total		**0.040**	**4.0×10^{-4}**

a. Table includes only radionuclides that contribute a dose of 1.0×10^{-5} mrem or more.
b. Estimate of radioactive decay is based on a transport time from each facility using the distance to MEI location and the average wind speed in that direction from each facility.
c. Concentration adjusted for plume depletion.
d. When indicated (+D), the contribution of progeny decay products was also included in the dose calculations.

plutonium-240 (^{240}Pu), plutonium-241 (^{241}Pu), and argon-41 (^{41}Ar) at 2 percent each. All others contributed less than one percent each (Figure 7-2). The respective contributions to the overall dose by facility is as follows: INTEC (96.5 percent), TRA (3.3 percent), NRF (0.09 percent). (The percent contribution shown for NRF assumes all gross alpha is ^{239}Pu and gross beta is ^{90}Sr.) TAN (0.05 percent), and RWMC (0.03 percent). The Power Burst Facility (PBF), ANL-W, and

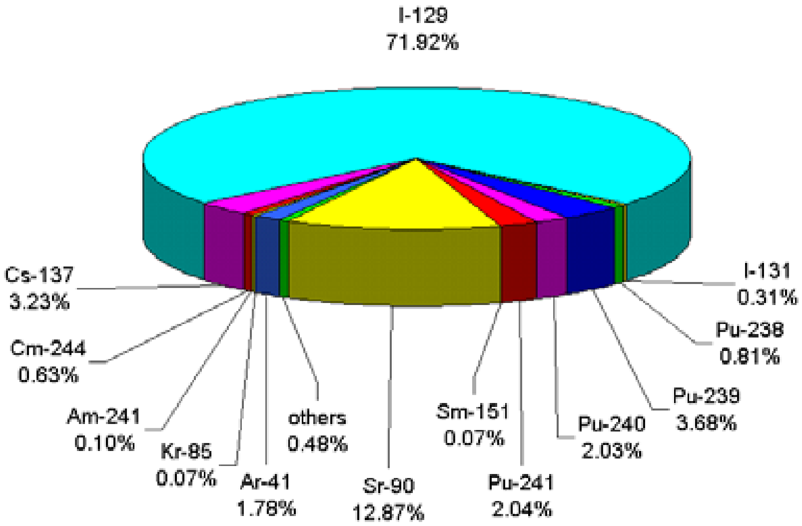

Figure 7-2. Radionuclides contributing to maximum individual dose (as calculated using the MDIFF air dispersion model) (2002).

CFA each contributed approximately 0.01 percent of the 2002 total dose.

The calculated maximum dose resulting from INEEL operations is still a small fraction of the average dose received by individuals in southeastern Idaho from cosmic and terrestrial sources of naturally occurring radiation found in the environment. The total annual dose from all natural sources is estimated at approximately 352 mrem (Table 6-11).

7.3 80-Kilometer (50-Mile) Population Dose

As with the calculation of the maximum individual dose, the determination of the population dose, also underwent changes in 2000. Using the power of a geographical information system (ArcView), annual population no longer needs to be distributed using growth estimations and a specialized computer code. In addition to this simplification, the population dose is now calculated for the population within an 80-km (50-mi) radius of any INEEL facility. This takes into account the changes in facility operations, in that the INTEC is no longer the single largest contributor of radionuclides released.

An estimate was made of the collective effective dose equivalent, or population dose, from inhalation, submersion, ingestion, and deposition resulting from airborne releases of radionuclides from the INEEL. This collective dose included all members of the public within 80 km (50 mi) of an INEEL facility. The population dose was calculated in a spreadsheet program that multiplies the average dispersion coefficient for the county census division (in hours squared per cubic meter) by the population in each census division within that county division and the normalized dose received at the location of the MEI (in rem per year per hour squared per meter cubed). This gives an approximation of the dose received by the entire population in a given county division (Table 7-3).

The dose received per person is obtained by dividing the collective effective dose equivalent by the population in that particular census division. This calculation overestimates dose because the model conservatively does not account for radioactive decay of the isotopes during transport over distances greater than the distance from each facility to the residence of the MEI located near Mud Lake. Idaho Falls, for example, is about 50 km (31 mi) from the nearest facility (ANL-W) and 80 km (50 mi) from the farthest. Neither residence time nor shielding by housing was considered when calculating the MEI dose on which the collective effective dose equivalent is based. The calculation also tends to overestimate the population doses because they are extrapolated from the dose computed for the location of the potential MEI. This individual is potentially exposed through ingestion of contaminated leafy garden vegetables grown at that location.

The 2002 MDIFF dispersion coefficient used for calculation of the population dose within each county division was obtained by averaging the results from appropriate census divisions contained within those county divisions. The total population dose is the sum of the population doses for the various county divisions (Table 7-3). The estimated potential population dose was 0.93 person-rem (0.0093 person-Sv) to a population of approximately 268,218. When compared with an approximate population dose of 94,400 person-rem (944 person-Sv) from natural background radiation, this represents an increase of only about 0.001 percent. The dose of 0.93 person-rem can also be compared to the following estimated population doses for the same size population: 32,200 person-rem for medical diagnostic procedures, about 940 person-rem from exposure to highway and road construction materials, or 2.7 person-rem from nuclear power generation. The largest collective doses are found in the Idaho Falls and Moreland census divisions. The Idaho Falls census division received the highest population dose because of its largest population. In 2001, the second highest population dose was estimated the the Hamer census division. In 2002, the Moreland census division has the second large estimated population dose due to differences in the dispersion values provided by NOAA (Figure 7-1). In 2001, Monteview, Mud Lake and Terreton (which are within the Hamer census division) were encompassed by the 30 x 10^{-9} hr^2/m^3 contour. In 2002, these towns lay within the same 10 x 10^{-9} hr^2/m^3 contour that Moreland did. Because Moreland has a higher population than Hamer, the resulting population dose was estimated to be greater for the Moreland census division.

7.4 Individual Dose - Game Ingestion Pathway

The potential dose an individual may receive from the occasional ingestion of meat from game animals continues to be investigated at the INEEL. Such studies include the potential dose to individuals who may eat (a) waterfowl that reside briefly at waste disposal ponds at TRA, INTEC, and ANL-W used for the disposal of low-level radioactive wastes and (b) game birds and game animals that may reside on or migrate across the INEEL.

Table 7-3. Dose to population within 80 kilometers (50 miles) of INEEL facilities (2002).

Census Division[a,b]	Population[c]	Population Dose	
		Person-rem	Person-Sv
Aberdeen	3,294	4.66×10^{-3}	4.66×10^{-5}
Alridge	584	1.10×10^{-4}	1.10×10^{-6}
American Falls	2,951	9.99×10^{-4}	9.99×10^{-6}
Arbon (part)	28	3.63×10^{-6}	3.63×10^{-8}
Arco	2,378	4.65×10^{-2}	4.65×10^{-4}
Atomic City (city)	25	–	–
Atomic City (division)	2,794	4.87×10^{-2}	4.87×10^{-4}
Blackfoot	13,202	3.35×10^{-2}	3.35×10^{-4}
Carey (part)	935	2.59×10^{-3}	2.59×10^{-5}
East Clark	72	9.66×10^{-5}	9.66×10^{-7}
Firth	3,275	8.02×10^{-3}	8.02×10^{-5}
Fort Hall (part)	2,014	2.32×10^{-3}	2.32×10^{-5}
Hailey-Bellevue (part)	4	2.24×10^{-11}	2.24×10^{-13}
Hamer[d]	2,317	7.29×10^{-2}	7.29×10^{-4}
Howe	323	1.09×10^{-2}	1.09×10^{-4}
Idaho Falls	76,383	2.57×10^{-1}	2.57×10^{-3}
Idaho Falls, west	1,809	2.08×10^{-2}	2.08×10^{-4}
Inkom (part)	567	9.23×10^{-5}	9.23×10^{-7}
Island Park (part)	81	1.06×10^{-4}	1.06×10^{-6}
Leadore (part)	6	1.89×10^{-7}	1.89×10^{-9}
Lewisville-Menan	3,835	4.21×10^{-2}	4.21×10^{-4}
Mackay (part)	1,129	5.57×10^{-6}	5.57×10^{-8}
Moody (part)	4,469	4.70×10^{-3}	4.70×10^{-5}
Moreland	9,378	7.34×10^{-2}	7.34×10^{-4}
Pocatello (part)	77,332	5.25×10^{-2}	5.25×10^{-4}
Rigby	10,789	5.38×10^{-2}	5.38×10^{-4}
Ririe	1,447	1.18×10^{-3}	1.18×10^{-5}
Roberts	1,663	2.50×10^{-2}	2.50×10^{-4}
Shelley	7,199	3.10×10^{-2}	3.10×10^{-4}
South Bannock (part)	288	8.10×10^{-6}	8.10×10^{-8}
St Anthony (part)	2,223	7.61×10^{-3}	7.61×10^{-5}
Sugar City	5,056	2.44×10^{-2}	2.44×10^{-4}
Swan Valley (part)	4,978	3.22×10^{-4}	3.22×10^{-6}
Thornton	18,910	7.25×10^{-2}	7.25×10^{-4}
Ucon	5,441	2.65×10^{-2}	2.65×10^{-4}
West Clark	1,039	3.20×10^{-3}	3.20×10^{-5}
Totals	**268,218**	**0.93**	**9.3×10^{-3}**

a. Census divisions are statistical entities established for census purposes. The boundaries may encompass population centers and surrounding areas: e.g., the Idaho Falls division includes Ammon, Ucon, and most of Bonneville County.

b. (Part) means only a part of the county census division lies within the 80-km (50-mi) radius of a major INEEL facility.

c. Population based on 2000 Census Report for Idaho and updated to 2002 based on county population growth from 1960 to 2000.

d. The Hamer division includes Monteview, Mud Lake, and Terreton.

Waterfowl

A study was initiated in 1994 to obtain data on the potential doses from waterfowl using INEEL waste disposal ponds. This study focused on the two hypalon-lined evaporation ponds at TRA that replaced the percolation ponds formerly used for disposal of wastes at that facility (Warren et al. 2001).

In the fall of 2002, seven ducks were collected from waste ponds on the INEEL and four were collected from offsite locations (two each from Heise and Mud Lake, Idaho) as controls. Of the waterfowl collected from the INEEL, three were collected from waste ponds containing radionuclides at the TRA and four from the waste pond at TAN. The maximum potential dose from eating 225 g (8 oz) of meat from ducks collected in 2002 is presented in Table 7-4. Radionuclide concentrations driving these doses are reported in Table 6-6. Doses from consuming waterfowl are based on the assumption that ducks are killed and eaten immediately after leaving the ponds.

The maximum potential dose of 0.004 mrem (0.04 µSv) from these waterfowl samples is substantially below the 0.89 mrem (8.9 µSv) committed effective dose equivalent estimated from the most contaminated ducks taken from the evaporation ponds between 1993 and 1998 (Warren et al. 2001).

Mourning Doves

No mourning doves were collected in 2002.

Table 7-4. Maximum potential dose from ingestion of edible tissue of waterfowl using INEEL waste disposal ponds in 2002.[a]

Radionuclide	Dose[b] (mrem)
Cerium-141	6.84×10^{-4}
Cesium-137	5.02×10^{-4}
Cobalt-60	2.75×10^{-5}
Niobium-95	3.35×10^{-4}
Plutonium-239/240	2.11×10^{-3}
Strontium-90	4.12×10^{-4}
Total Dose	**4.07×10^{-3}**

a. Committed (50-yr) effective dose equivalent from consuming 225 g (8 oz) based on DOE dose conversion factors.

b. These are the maximum doses from the highest radionuclide concentrations in seven different ducks.

Big Game Animals

A conservative estimate of the potential whole-body dose that could be received from an individual eating the entire muscle and liver mass of an antelope with the highest levels of radioactivity found in these animals was estimated at 2.7 mrem in a study on the INEEL from 1976-1986 (Markham et al. 1982). Game animals collected at the INEEL during the past few years have shown much lower concentrations of radionuclides. Based on the highest concentration of radionuclides found in a game animal during 2002, the potential dose was approximately 1.34 mrem (13.4 µSv).

Yellow-bellied Marmots

During the third quarter of 2002, three marmots were collected from the Subsurface Disposal Area (SDA) of the RWMC. Two marmots were also collected, as controls, from the Pocatello Zoo. Each marmot was dissected into three samples, the edible portion (muscle tissue), viscera, and the remainder (skin, fur, bones). The potential dose from eating 225 g (8 oz.) of the most contaminated edible portions of the marmots collected in 2002 is 0.003 mrem (0.03 µSv).

7.5 Biota Dose Assessment

Introduction

The impact of environmental radioactivity at the INEEL on nonhuman biota was assessed using the graded approach procedure detailed in *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002) and the associated spreadsheet (RadBCG Calculator). The graded approach evaluates the impacts of a given set of radionuclides on aquatic and terrestrial ecosystems by comparing available concentration data in soils and water with biota concentration guides (BCGs). A BCG is defined as the environmental concentration of a given radionuclide in soil or water that, under the assumptions of the model, would result in a dose rate less than 1 rad/d to aquatic animals or terrestrial plants or 0.1 rad/d (1 mGy/d) to terrestrial animals. If the sum of the measured environmental concentrations divided by the BCGs (the combined sum of fractions) is less than one, no negative impact to populations of plants or animals is expected. No doses are calculated unless the screening process indicates a more detailed analysis is necessary.

The approach is graded because it begins the evaluation using conservative default assumptions and maximum values for all currently available data. Failure at this general screening step does not necessarily imply harm to organisms. Instead, it is an indication that more realistic model assumptions may be necessary. Several specific steps for adding progressively more realistic model assumptions are recommended. After applying the recommended changes at each step, if the combined sum of fractions is still greater than one, the graded approach recommends evaluating the next step. The steps can be summarized as:

1. Consider using mean concentrations of radionuclides rather than maxima;

2. Consider refining the evaluation area;

3. Consider using site-specific information for lumped parameters, if available;

4. Consider using a correction factor other than 100 percent for residence time and spatial usage in favor of more realistic assumptions;

5. Consider developing and applying more site-specific information about food sources, uptake, and intake; and

6. Conduct a complete site-specific dose analysis. This is may be a large study, measuring or calculating doses to individual organisms, estimating population level impacts, and, if doses in excess of the limits are present, culminating in recommendations for mitigation.

Each step of this graded approach requires appropriate justification before it can be applied. For example, before using the mean concentration, assessors must discuss why the maximum concentration is not representative of the radionuclide concentration to which most members of the plant or animal population are exposed.

Evaluations beyond the initial general screening require assessors to make decisions about assessment areas, organisms of interest, and other things. Much of this work has been completed and is currently in the publication process (Morris 2003). Of particular importance for the terrestrial evaluation portion of the 2002 biota dose assessment is the division of the INEEL into evaluation areas based on potential soil contamination and habitat types (Figure 7-3). Details and justification will be provided in Morris (2003).

The graded approach and the RadBCG Calculator (DOE 2002) are designed to evaluate certain common radionuclides. Thus, this biota dose assessment evaluated potential doses from radionuclides detected in soil or water on the INEEL that are also included in the graded approach (Table 7-5).

Aquatic Evaluation

For this analysis, maximum effluent data were used because actual pond water samples were not available. These data are assumed to overestimate actual pond water concentrations because of dilution in the larger volume of the pond. In the absence of measured pond sediment concentrations, the spreadsheet calculates sediment concentrations based on a conservative sediment distribution coefficient. The only available radionuclide specific concentrations were for radium-226 (^{226}Ra) in TRA effluents and ^{90}Sr in TAN effluents (Table 7-6) (see DOE 2002 for a detailed description of the assessment procedure). These data were combined in a Site-wide general screening analysis that failed because of the high concentration of ^{226}Ra in TRA effluents (Table 7-6, First Screening). The ^{90}Sr in the TAN pond was low enough to pass the screen and did not contribute significantly to this failure. Assuming dilution in the pond, the aquatic dose was reevaluated using an average concentration of ^{226}Ra in the TRA effluent rather than a maximum. This value also failed the screen (Table 7-6, Second Screening). The RadBCG Calculator identified the riparian animal as the critical organism. The TRA pond is lined, enclosed with a maintained gravel berm, and a chain-link fence, and is not attractive to riparian organisms. No riparian animals have been documented to use the pond. Therefore, a still-conservative assumption was made that organisms would only have access to, and use, the pond

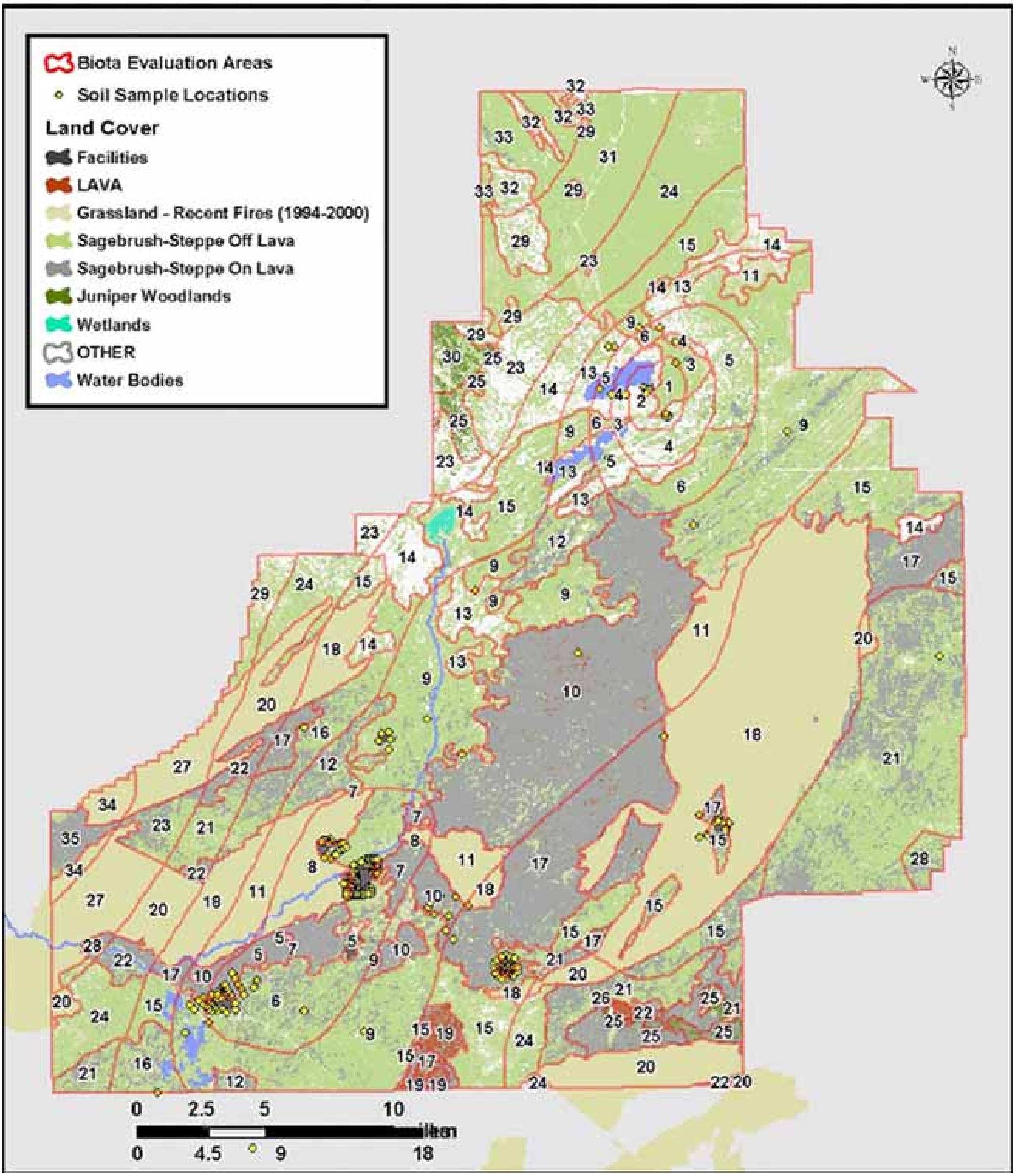

Figure 7-3. Evaluation areas and current soil sampling locations on the INEEL.

Table 7-5. Radionuclides that can currently be evaluated using the graded approach (DOE 2002) compared to those detected in soil or water on the INEEL in 2002.

Graded Approach	Detected
^{241}Am[a]	**^{241}Am**
^{144}Ce	**^{137}Cs**
^{135}Cs	**^{60}Co**
^{137}Cs	^{152}Eu
^{60}Co	^{40}K
^{154}Eu	^{238}Pu
^{155}Eu	**$^{239/240}$Pu**[b]
^{3}H	**^{90}Sr**
^{129}I	**$^{233/234}$U**[c]
^{131}I	**^{235}U**
^{239}Pu	
^{226}Ra	
^{228}Ra	
^{125}Sb	
^{90}Sr	
^{99}Tc	
^{232}Th	
^{233}U	
^{234}U	
^{235}U	
^{238}U	
^{65}Zn	--
^{95}Zr	--

a. Radionuclides in **bold type** are present in both lists and were included in this assessment.
b. Analyzed as ^{239}Pu.
c. Analyzed as ^{233}U.

Table 7-6. Biota dose assessment of aquatic ecosystems on the INEEL.

Nuclide	Water BCG[a] (pCi/L)	Effluent Concentration (pCi/L)	Partial Fraction[b]	Sediment BCG (pCi/g)	Calculated Sediment Concentration[c] (pCi/g)	Partial Fraction[d]	Sum of Fractions[e]
			First Screening[f]				
^{226}Ra	0.2	8.75	0.5	4	0.6	0.1	50
^{90}Sr	300	8.08	0.03	60	0.2	0.0004	0.03
						Combined Sum of Fractions[g]	**50**
			Second Screening[f]				
^{226}Ra	0.2	3.77	20	4	0.3	0.06	20
^{90}Sr	300	8.08	0.03	60	0.2	0.0004	0.03
						Combined Sum of Fractions[g]	**20**
			Third Screening[f]				
^{226}Ra	5	3.77	0.8	100	0.3	0.003	0.8
^{90}Sr	700	8.08	0.001	2000	0.2	2×10^{-5}	0.001
						Combined Sum of Fractions[g]	**0.8**

a. Biota concentration guide.
b. Effluent concentration/water BCG.
c. Calculated by the RadBCG spreadsheet based on the effluent concentration (DOE 2002).
d. Calculated sediment concentration/sediment BCG.
e. Sum of the partial fractions.
f. See the text for the rationale for the various screenings.
g. Sum of the sums of fractions. If the combined sum of fractions is less than one, the site passes the screening evaluation.

for two weeks out of the year and adjusted the correction factor from a value of one to a value of 0.038 (2 weeks/52 weeks). Using these assumptions, the combined sum of fractions was less than one and passed the screening test (Table 7-6, Third Screening).

Terrestrial Evaluation

For the initial terrestrial evaluation we used maximum concentrations from the management and operating (M&O) contractor 2002 soil sampling (Figure 7-3, Table 7-7) (see DOE 2002 for a detailed description of the assessment procedure). These concentrations failed the initial screen (Table 7-7, First Screening) because of a high ^{137}Cs concentration in a sample from evaluation area 6 (Figures 7-3 and 7-4). For this reason, area 6 was removed from the analysis and the remaining maximum soil concentrations used (Table 7-7, Second Screening). Evaluation of potential harm to nonhuman terrestrial biota from maximum detected soil and water concentrations over the entire INEEL, with the exception of evaluation Area 6, resulted in a combined sum of fractions less than one.

Area 6 was evaluated separately. Because it is a very large area (Figure 7-3) with wide variation in soil concentrations and few samples with high concentrations (Figure 7-4), it was determined that to use the average soil concentrations was appropriate in this assessment rather than maxima. The average soil concentrations resulted in combined sums of fractions less than one (Table 7-8) (see DOE 2002 for a detailed description of the assessment procedure).

Based on the results of the graded approach, there is no evidence that INEEL-related radioactivity in soil or water is harming populations of plants or animals.

7.6 Summary

Table 7-9 summarizes the calculated annual effective dose equivalents for 2002 from INEEL operations using both the CAP-88 and MDIFF air dispersion computer codes. A comparison is shown between these doses and the EPA airborne pathway standard and the estimated dose from natural background. The reasons for the disparity in the MDIFF and CAP-88 dose are a result of the changes made to the calculations in 2000 (see Section 7.3).

The contribution of game animal consumption to the population dose has not been calculated because only a limited percentage of the population hunts game, few of the animals killed have spent time on the INEEL, and most of the animals that do migrate from the INEEL would have reduced concentrations of radionuclides in their tissues by the time they were harvested (Halford et al. 1983). The total population dose contribution from these pathways would, realistically, be less than the sum of the population doses from inhalation of air, submersion in air, ingestion of vegetables, and deposition on soil.

A graded approach was used to evaluate the potential dose to aquatic and terrestrial biota as detailed in DOE (2002). Based on the results of this approach no adverse impact from contaminated soils and water on the INEEL are indicated to these biotic populations.

Table 7-7. Biota dose assessment of terrestrial ecosystems on the INEEL.

Nuclide	Water BCG[a] (pCi/L)	Effluent Concentration (pCi/L)	Partial Fraction[b]	Soil BCG (pCi/g)	Soil Concentration (pCi/g)	Partial Fraction[c]	Sum of Fractions[d]
				First Screening[e]			
^{241}Am	–	–	–	4000	0.0803	2×10^{-5}	2×10^{-5}
^{137}Cs	–	–	–	20	22.1	1	1
^{60}Co	–	–	–	700	1.01	0.001	0.001
^{239}Pu	–	–	–	6000	0.102	2×10^{-5}	2×10^{-5}
^{226}Ra	300	3.77	0.01	3	–	–	0.01
^{90}Sr	50,000	8.08	2×10^{-4}	20	8.47	0.4	0.4
$^{233/234}$U	–	–	–	5000	0.537	1×10^{-4}	1×10^{-4}
^{235}U	–	–	–	3000	0.0297	1×10^{-5}	1×10^{-5}
^{238}U	–	–	–	2,00	0.582	4×10^{-4}	4×10^{-4}
				Combined Sum of Fractions[f]			**1.5**
				Second Screening[e]			
^{241}Am	–	–	–	4000	0.0803	2×10^{-5}	2×10^{-5}
^{137}Cs	–	–	–	20	9.24	1	0.4×10^{-1}
^{60}Co	–	–	–	700	1.01	0.001	0.001
^{239}Pu	–	–	–	6000	0.102	2×10^{-5}	2×10^{-5}
^{226}Ra	300	3.77	0.01	3	–	–	0.01
^{90}Sr	50,000	8.08	2×10^{-4}	20	8.47	0.4	0.4
$^{233/234}$U	–	–	–	5000	0.537	1×10^{-4}	1×10^{-4}
^{235}U	–	–	–	3000	0.0297	1×10^{-5}	1×10^{-5}
^{238}U	–	–	–	2000	0.582	4×10^{-4}	4×10^{-4}
				Combined Sum of Fractions[f]			**0.8**

a. Biota concentration guide.

b. Effluent concentration/water BCG.

c. Calculated sediment concentration/sediment BCG.

d. Sum of the partial fractions.

e. See the text for the rationale for the various screenings.

f. Sum of the sums of fractions. If the combined sum of fractions is less than one, the site passes the screening evaluation.

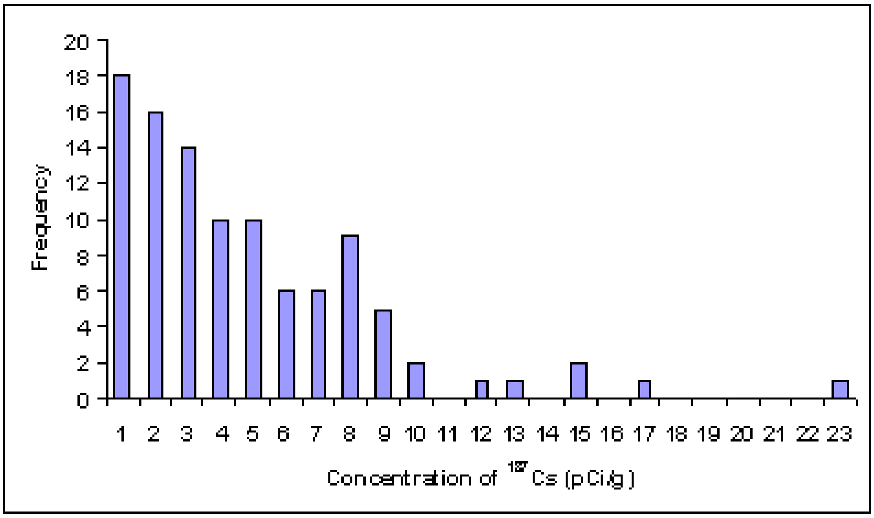

Figure 7-4. Histogram of ^{137}Cs concentration in soils in evaluation area 6 (Figure 7-3).

The histogram bars identify the number of samples with concentrations in specific ranges. For example, bar 1 represents the number of samples with concentrations between 0 and 1 pCi/g and the bar 2 represents the number of samples with concentrations between 1 and 2 pCi/g.

Table 7-8. Biota dose assessment of evaluation area 6 (Figure 7-3) on the INEEL using spatially averaged soil concentrations.

Nuclide	Water BCG[a] (pCi/L)	Effluent Concentration (pCi/L)	Partial Fraction[b]	Soil BCG (pCi/g)	Soil Concentration (pCi/g)	Partial Fraction[c]	Sum of Fractions[d]
^{241}Am	–	–	–	4000	0.034	9×10^{-6}	9×10^{-6}
^{137}Cs	–	–	–	20	4.3	0.2	0.2
^{60}Co	–	–	–	700	0.18	3×10^{-4}	3×10^{-4}
^{239}Pu	–	–	–	6000	0.0495	8×10^{-6}	8×10^{-6}
^{226}Ra	300	3.77	0.01	3	–	–	0.01
^{90}Sr	50,000	8.08	2×10^{-4}	20	3.67	0.2	0.2
$^{233/234}$U	–	–	–	5000	0.497	1×10^{-4}	1×10^{-4}
^{235}U	–	–	–	3000	0.0277	1×10^{-5}	1×10^{-5}
^{238}U	–	–	–	2000	0.519	3×10^{-4}	3×10^{-4}
					Combined Sum of Fractions[e]		**0.4**

a. Biota concentration guide.

b. Effluent concentration/water BCG.

c. Calculated sediment concentration/sediment BCG.

d. Sum of the partial fractions.

e. Sum of the sums of fractions. If the combined sum of fractions is less than one, the site passes the screening evaluation.

Table 7-9. Summary of annual effective dose equivalents because of INEEL operations (2002).

	Maximum Dose to an Individual [a]		Population Dose
	CAP-88[b]	MDIFF[c]	MDIFF
Dose	0.055 mrem 5.5×10^{-4} mSv	0.04 mrem 4.0×10^{-4} mSv	0.93 person-rem 9.3×10^{-3} person-Sv
Location	Frenchman's Cabin	8.7 km (5.5 mi) W-NW of Mud Lake	Area within 80 km (50 mi) of any INEEL facility
Applicable radiation protection standard [d]	10 mrem (0.1 mSv)	10 mrem (0.1 mSv)	No standard
Percentage of standard	0.55 percent	0.40 percent	No standard
Natural background	352 mrem (3.6 mSv)	352 mrem (3.6 mSv)	94.400 person-rem (944 person-Sv)
Percentage of background	0.02 percent	0.01 percent	0.001 percent

a. Hypothetical dose to a maximally exposed individual residing near the INEEL.

b. Effective dose equivalent calculated using the CAP -88 code.

c. Effective dose equivalent calcu lated using MDIFF air dispersion model. MDIFF calucations do not consider occupancy time or shielding by buildings.

d. Although the DOE standard for all exposure modes is 100 mrem/yr as given in DOE Order 5400.5, DOE guidance states that DOE facilities wi ll comply with the EPA standard for the airborne pathway of 10 mrem/yr.

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Chapter 8 - Ecological Research at the Idaho National Environmental Research Park

Chapter Highlights

The Idaho National Engineering and Environmental Laboratory (INEEL) was designated as a National Environmental Research Park (NERP) in 1975. The NERP program was established in the 1970s in response to recommendations from citizens, scientists, and members of Congress to set aside land for ecosystem preservation and study. In many cases, these protected lands became the last remaining refuges of what were once extensive natural ecosystems. The NERPs provide rich environments for training researchers and introducing the public to ecological sciences. They have been used to educate grade school and high school students and the general public about ecosystem interactions at U.S. Department of Energy (DOE) sites; train graduate and undergraduate students in research related to site-specific, regional, national, and global issues; and promote collaboration and coordination among local, regional, and national public organizations, schools, universities, and federal and state agencies.

Ecological research at the INEEL began in 1950 with the establishment of the long-term vegetation transect. This is perhaps DOE's oldest ecological data set and one of the oldest vegetation data sets in the West. Ecological research on the NERPs is leading to planning better land use, identifying sensitive areas on DOE sites so that restoration and other activities are compatible with ecosystem protection and management, and increasing contributions to ecological science in general.

The following ecological research activities took place at the Idaho NERP during 2002:

- Monitoring Amphibian and Reptile Populations on the INEEL;
- Behavior, Dispersal, and Survival of Captive-Raised Idaho Pygmy Rabbits Released onto the INEEL in Idaho;
- Alternative Container Design for Large Acreage Revegetation;
- Ecological Impacts of Irrigating Native Vegetation with Treated Sewage Wastewater;
- Natural and Assisted Recovery of Sagebrush in Idaho's Big Desert; and
- The Protective Cap/Biobarrier Experiment.

8. ECOLOGICAL RESEARCH AT THE IDAHO NATIONAL ENVIRONMENTAL RESEARCH PARK

The INEEL was designated as a NERP in 1975. The NERP program was established in the 1970s in response to recommendations from citizens, scientists and members of Congress to set aside land for ecosystem preservation and study. This has been one of the few formal efforts to protect land on a national scale for research and education. In many cases, these protected lands became the last remaining refuges of what were once extensive natural ecosystems.

There are five basic objectives guiding activities on the Research Parks. They are to

- Develop methods for assessing and documenting the environmental consequences of human actions related to energy development.
- Develop methods for predicting the environmental consequences of ongoing and proposed energy development.
- Explore methods for eliminating or minimizing predicted adverse effects from various energy development activities on the environment.
- Train people in ecological and environmental sciences.
- Use the NERPs for educating the public on environmental and ecological issues.

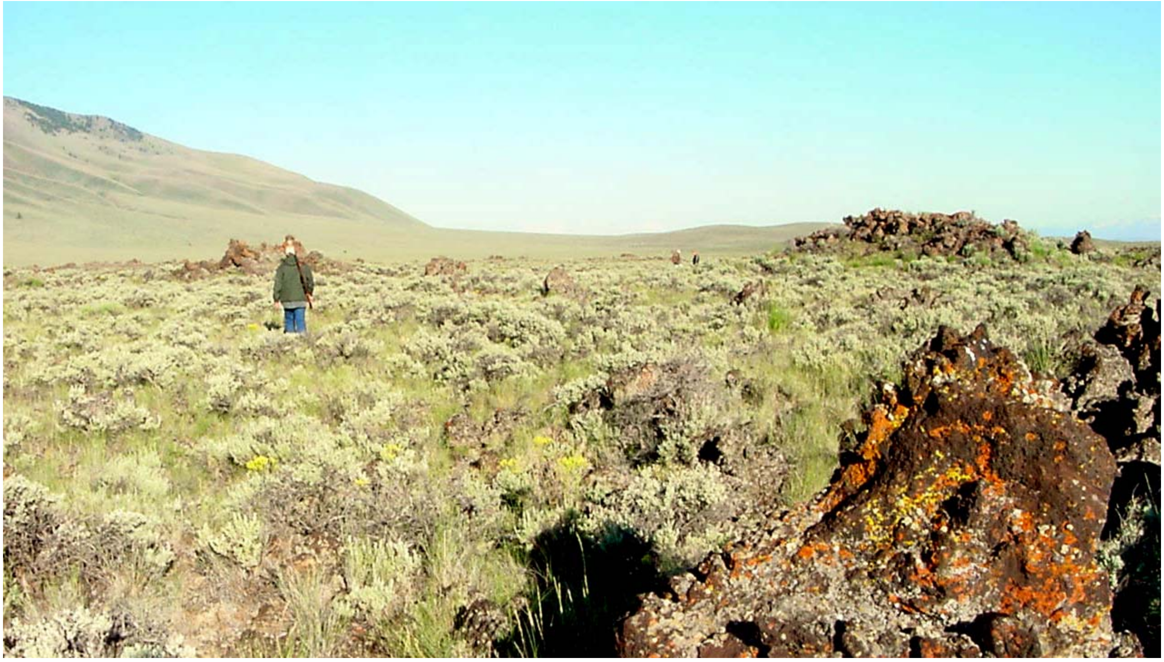
The NERPs provide rich environments for training researchers and introducing the public to ecological sciences. They have been used to educate grade school and high school students and the general public about ecosystem interactions at U.S. Department of Energy (DOE) sites; train graduate and undergraduate students in research related to site-specific, regional, national, and global issues; and promote collaboration and coordination among local, regional, and national public organizations, schools, universities, and federal and state agencies.

Establishment of NERPs was not the beginning of ecological research at federal laboratories. Ecological research at the INEEL began in 1950 with the establishment of the long-term vegetation transect. This is perhaps DOE's oldest ecological data set and one of the oldest vegetation data sets in the West. Other long-term studies conducted on the Idaho NERP include the reptile monitoring study initiated in 1989 and is the longest continuous study of its kind in the world as well as the protective cap biobarrier experiment initiated in 1993, which evaluates the long-term performance of evapotranspiration caps and biological intrusion barriers.

Ecological research on the NERPs is leading to planning better land-use, identifying sensitive areas on DOE sites so that restoration and other activities are compatible with ecosystem protection and management, and increasing contributions to ecological science in general.

The Idaho NERP provides a coordinating structure for ecological research and information exchange at the INEEL. The Idaho NERP facilitates ecological research on the INEEL by attracting new researchers, providing background data to support new research project development, and providing logistical support for assisting researcher access to the INEEL. The

Idaho NERP provides infrastructure support to ecological researchers through the Experimental Field Station and museum reference collections. The Idaho NERP tries to foster cooperation and research integration by encouraging researchers using the INEEL to collaborate, develop interdisciplinary teams to address more complex problems, and encourage data sharing, and by leveraging funding across projects to provide more efficient use of resources. The Idaho NERP has begun to develop a centralized ecological database to provide an archive for ecological data and facilitate retrieval of data to support new research projects and land management decisions. The Idaho NERP can also be a point of synthesis for research results that integrates results from many projects and disciplines and provides analysis of ecosystem-level responses. The Idaho NERP also provides interpretation of research results to land and facility managers to support the National Environmental Policy Act (NEPA) process, natural resources management, radionuclide pathway analysis, and ecological risk assessment.



The following sections describe ecological research activities that took place at the Idaho NERP during 2002.

8.1 Monitoring Amphibian and Reptile Populations on the INEEL: Indicators of Environmental Health and Change

Investigators and Affiliations

Charles R. Peterson, Professor, Herpetology Laboratory, Department of Biological Sciences, Idaho State University, Pocatello, ID

Christopher L. Jenkins, Graduate Student, Herpetology Laboratory, Department of Biological Sciences, Idaho State University, Pocatello, ID

Funding Sources

U.S. Department of Energy Idaho Operations Office

Background

Many amphibian and reptile species have characteristics that make them sensitive environmental indicators. The main research goal is to provide indicators of environmental health and change by monitoring the distribution and population trends of amphibians and reptiles on the INEEL.

Information from this project is important to the DOE for several reasons: (1) as an indicator of environmental health and change, (2) for management of specific populations of sensitive species, (3) for meeting NEPA requirements regarding the siting of future developments, (4) for avoiding potentially dangerous snake-human interactions, and (5) for providing a basis for future research into the ecological importance of these species. Additionally, this project provides venomous snake safety training to INEEL employees and summer assistants. This training provides key information on how to avoid and treat bites from venomous snakes. It also helps workers place the relatively low risk of snakebite in perspective and fosters an appreciation of the ecological role of snakes on the INEEL. Finally, this project assists in the training and support of undergraduate and graduate students in environmental research.

Objectives

The overall goal of this project is to determine amphibian and reptile distribution on the INEEL and monitor populations in select areas. Specific objectives for 2002 included the following:

- Continue monitoring snake and lizard populations;
- Provide herpetological expertise as needed; and
- Provide snake safety workshops.

Accomplishments through 2002

Specific accomplishments for 2002 include the following:

- Snake monitoring efforts continued at three den sites, allowing more accurate estimates of specific populations of reptiles on the INEEL to be made. These estimates will allow examination of population trends over time. Population size and survival estimates for snake communities on the INEEL are currently being evaluated.

- The INEEL herpetological database was updated using the observations gained from this research (Figure 8-1).

- Herpetological expertise was provided to numerous groups on the INEEL in 2002, including snake safety training sessions and field safety consultations.

- Three new communal snake dens were discovered in the southeastern portion of the INEEL.

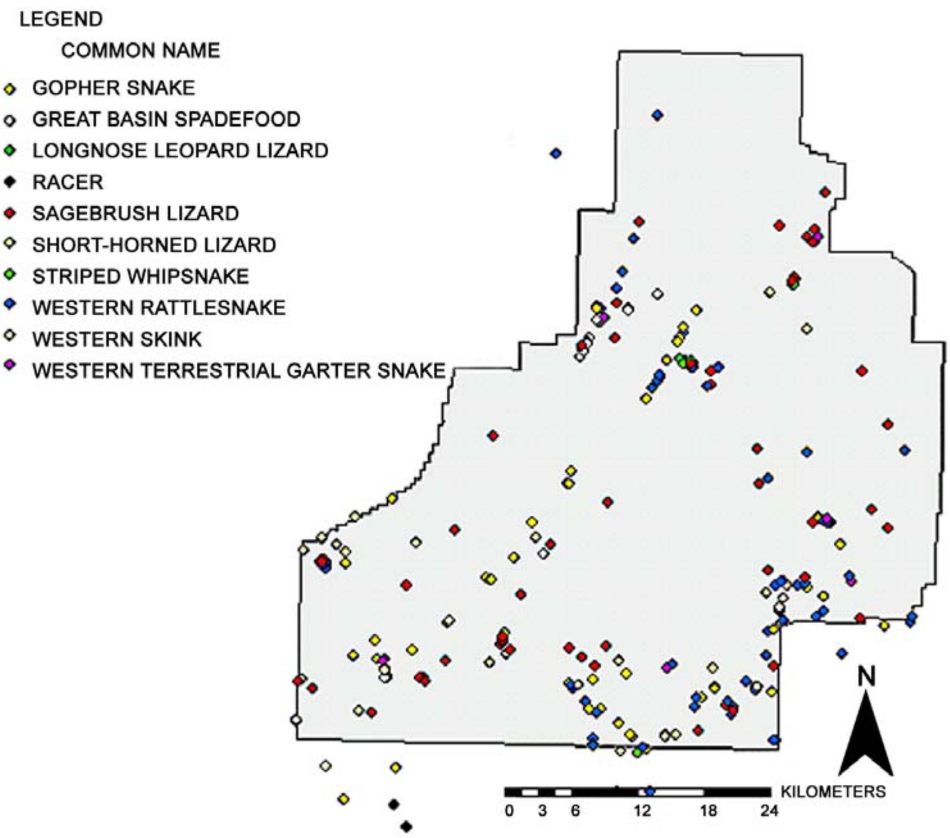


Figure 8-1. Updated herpetological database for the INEEL. Reptile and amphibian observations are a combination of museum records, survey records, and contributed observations.

Results

Important results this year included confirming the continued presence of leopard lizards (*Crotaphytus wislizenii*) through observation at Circular Butte, finding new snake hibernacula, beginning radiotelemetry studies, and providing specific herpetological expertise to several groups on the INEEL.

1. The number of marked snakes on the INEEL increased in 2002 to 3086, including all snakes PIT-tagged since 1994 and marking data collected at Cinder Butte from 1989-1994.

2. Two observations of a leopard lizard were made at Circular Butte in 2002. Many western skinks (*Eumeces skiltonianus*) and sagebrush lizards (*Sceloporus graciosus*) were sighted across the entire INEEL, and short-horned lizards (*Phrynosoma douglassii*) were observed across the southeastern end of the Site.

3. Breeding activity by spadefoot toads was not observed on the INEEL in 2002.

4. Radiotelemetry work began in the southeastern portion of the INEEL as part of Mr. Jenkins' Ph.D. research, to look at the effects of landscape characteristics on dispersal and mating systems.

5. Three additional communal dens sites were found in the southeastern portion of the INEEL. Snake communities at Twin Buttes Crater were comprised of gopher snakes (*Pituophis catenifer*), western rattlesnakes (*Crotalus viridis*), and terrestrial garter snakes (*Thamnophis gans*); at North Tower Cave they were comprised of gopher snakes and western rattlesnakes; and at Amazon Butte they were comprised of western rattlesnakes and terrestrial garter snakes.

6. Herpetological expertise was provided in the form of seven snake safety training sessions, disseminating herpetological data for the site, and conducting field safety consultations. The snake safety-sessions have all generated positive feedback from the employees, and many also yield invitations for additional presentations, both on the INEEL and in local communities.

7. Data on road-killed reptiles are being used to develop a research project for an Idaho State University graduate student on the effects of roads on snake populations.

8.2 Behavior, Dispersal, and Survival of Captive-Raised Idaho Pygmy Rabbits (*Brachylagus idahoensis*) Released onto the INEEL in Idaho

Investigators and Affiliations

Rodney D. Sayler, Associate Professor, Department of Natural Resource Sciences, Washington State University, Pullman, WA

Lisa A. Shipley, Associate Professor, Department of Natural Resource Sciences, Washington State University, Pullman, WA

Robert Westra, Graduate Student, Department of Natural Resource Sciences, Washington State University, Pullman, WA

Funding Sources

Washington Department of Fish and Wildlife

Background

The pygmy rabbit (*Brachylagus idahoensis*) is the smallest rabbit in North America, a sagebrush foraging specialist, and one of only two North American rabbits to dig its own burrow. The Columbia Basin pygmy rabbit (*Brachylagus idahoensis*) is a distinct population of native rabbit that once occupied Douglas, Grant, Lincoln, Adams, and Benton Counties in central Washington. Pygmy rabbits occur in other areas of the West, but the Columbia Basin population is genetically unique, has been isolated from other populations for thousands of years, and occupies an unusual ecological setting. The long-isolated and genetically unique population of Columbia Basin pygmy rabbits located in Washington State has declined precipitously to dangerously low levels. Therefore, the U.S. Fish and Wildlife Service recently listed the Columbia Basin pygmy rabbits as an endangered population segment. Since little is known about successful captive rearing and methods for restoring pygmy rabbits back into vacant natural habitats, reintroduction techniques are being tested in southeastern Idaho to develop protocols for the eventual restoration of endangered pygmy rabbits in Washington State. Idaho pygmy rabbits are propagated in captivity at Washington State University and elsewhere and released into the wild in southeastern Idaho to determine whether selected captive rearing and release methods influence the behavior, dispersal, and survival of pygmy rabbits reintroduced into suitable sagebrush habitat.

Objectives

Specific objectives of this research include:

- Develop techniques to enhance the survival of captive-bred Idaho pygmy rabbits released into natural habitats for the purpose of establishing new local populations of pygmy rabbits;
- Test the effects of captive-rearing and release methods on the resulting behavior, dispersal, and survival of reintroduced pygmy rabbits; and
- Develop recommended protocols for restoring Columbia Basin pygmy rabbits in areas of vacant, suitable sagebrush habitat and model the numbers of captive-bred animals and

survival rates needed to establish new local breeding populations.

Accomplishments through 2002

The first two experimental releases of captive-reared Idaho pygmy rabbits were conducted in August and September 2002, at the INEEL west of Idaho Falls, Idaho. An initial group of 13 and a second group of seven animals from Washington State University were fitted with radio collars and released into temporary, weld-wire containment pens surrounding the two openings of a 3-4 m (10-15 ft) long plastic drainage tube burrow dug into the soil about 0.8-1.1 m (2.5-3.5 ft) deep in the center. The plastic-tubing burrows were intended to partially replicate a natural pygmy rabbit burrow system and provide both thermal buffering and some protection against digging predators. Another goal of the artificial burrow system was to reduce premature dispersal of rabbits away from the release site selected in good sagebrush habitat. Released animals were monitored almost daily to record behavior, dispersal, habitat use, and survival during late summer and early fall and approximately weekly during November and December 2002.

Results

All released rabbits readily adapted to the small, temporary holding cages surrounding their burrow openings and continued normal feeding on provided foods (i.e., sagebrush tips, spinach, lettuce, and pellet food). All containment pens were removed from the burrows by the fourth day, allowing free movement and dispersal of the animals.

Eleven of the 20 released animals made dispersal movements away from their release burrow ranging from about 36 m (120 ft) to 1.1 km (0.7 mi). All but one of the dispersing animals selected other appropriate habitat consisting of relatively tall, dense big sagebrush with relatively good grass and forb availability. Released animals appeared to adapt to natural local forage quickly and also appeared to use a high proportion of grass and forbs until colder weather began in October, which prompted greater use of sagebrush.

Nondispersing animals continued to use the artificial burrows provided on the release site, sometimes using their own and two or more burrows of adjacent released animals. Despite dispersal by some animals, the two release groups created a local cluster or loose colony of interacting individuals going into Fall 2002.

By November 2002, only five of the original 20 released rabbits were still alive. However, mortality appeared to be higher during late summer while raptors were observed on the study area and declined later in the fall after the fall raptor migration had ended. All known mortalities were attributed to either raptors or coyotes. Over winter mortality was low and four rabbits survived until the spring breeding season in April 2003. Thus, despite default expectations of high mortality in captive-reared and released pygmy rabbits, surprisingly, the first release of pygmy rabbits ever attempted was successful in carrying surviving animals through to the next breeding season.

Plans for Continuation

Idaho pygmy rabbits are currently being bred at a propagation facility at Washington State

University to provide 30+ animals for conducting a second test of release methods for pygmy rabbits in summer and fall 2003. A second release site near the original release site has been selected and will be prepared with another series of 12-15 artificial burrows so that two separate release populations can be studied on the same general INEEL study area.

During the summer of 2003, the effects of reduced human contact on initial behavior and survival of released pygmy rabbits will be evaluated. In addition, a cohort of about six adult rabbits will be compared with the 30+ juvenile rabbits intended for release.

Based upon the first field season of observations in 2002, several aspects of the release techniques are being improved for summer 2003. In addition, year 2002 data on behavior, dispersal, and survival are being analyzed and a short publication based on these initial, but important results, is being prepared.

This study on the INEEL is a major component of the recovery program for the endangered Columbia Basin pygmy rabbit, but will also provide valuable information in the event that local reintroductions are ever warranted for Idaho pygmy rabbits. A more detailed progress report is available from the Investigators upon request.

8.3 Alternative Container Design for Large Acreage Revegetation

Investigators and Affiliations

Tim Meikle, Director of Research and Development, Bitterroot Restoration, Inc., Corvallis, MT

Funding Sources

U.S. Department of Agriculture Small Business Initiative Research Grant

Background

Revegetation of arid lands disturbed by fire, or by cropping, mining, and other activities, represent a continuous and substantial expenditure by the responsible entities. Federal legislation such as the Surface Mining Control and Reclamation Act, the Conservation Reserve Program, and Comprehensive Environmental Response, Compensation, and Liability Act require the planting of native seed/seedlings and the expenditure of millions of dollars annually on sites that are highly disturbed or contaminated from activities such as mining, agriculture, industrial activities, and forest fires.

With regards to arid land shrubs, mechanical seeding and transplanting of nursery-grown plant materials compete directly for revegetation dollars but are not equal in their efficacy. Mechanical seeding is an inexpensive, but highly ineffective means of restoring arid land shrubs to disturbed sites. Mechanical seeding of arid land shrubs has proven largely ineffective for several reasons, including low seed efficiency, low seed availability, inability to effectively produce large quantities of seed from appropriate genotypes, and the increased hazard of noxious weeds introduction either naturally or from wildland seed collections. Transplanting of nursery propagated arid land shrubs, in contrast, negates many of these concerns and is highly successful but can be prohibitively expensive. If the cost of effective arid land planting stock can be substantially reduced, however, transplanting will likely become the revegetation method of choice on millions of acres of lands damaged by fire, mining, agricultural activities, and other disturbances.

The primary cause for this failure to produce cost-effective arid land planting stock is the lack of a container system designed specifically for arid land plant species. Current container systems have been designed for horticultural and forestry applications. In general, plant species grown for these applications are ecologically, morphologically, and physiologically different than arid land plant species grown for restoration projects. When these factors are taken into account, it is possible to design a short duration, high-density plant container system that will minimize nursery inputs without sacrificing infield survival. The benefit to be realized by clients is an inexpensive, highly adaptable source of arid lands planting stock that provides successful field establishment. A substantial potential market exists for a container plant system that produces low cost seedlings for arid lands restoration projects.

Bitterroot Restoration, Inc. in collaboration with U.S. Department of Agriculture, Agricultural Research Services received a Phase I U.S. Department of Agriculture Small Business Initiative Research grant to develop a low cost alternative container design for use in large-scale transplanting projects in arid lands. This project is being conducted at a number of locations across the western United States including the Idaho National Environmental Research Park at the INEEL.

Objectives

The technical objective addressed with fieldwork at the INEEL was to determine the percentage survival of sagebrush established in Booth Tubes versus other currently used forestry containers.

Accomplishments through 2002

Nine field study sites were established throughout the Western United States. The various sites represented different potential client types (i.e., mine industry, federal agency), different initial site conditions, and a broad geographic area. All sites experienced the continuing Western drought.

Each study site consisted of a completely randomized block of 200 replicates per treatment. Treatments were (1) 8 x 1 Booth Tube, (2) 164 cm^3 (10 in^3) Ray Leach Cone-tainer, (3) 65 cm^3 (4 in^3) Ray Leach Cone-tainer, (4) Ecopot-PS-315, (5) PaperPot-FS-315, and (6) Zipset Plant Band 1.25 x 6 in. Plant materials in all container types were produced under greenhouse conditions. Shipping and packing times for each container type were recorded. Field planting with hand planting tools occurred from mid-March through early May. Field planting times for each container type were recorded at each site. Field data (survival and height) collection occurred in August and September with one exception. The La Plata, New Mexico, site was dropped from the study because of complete mortality resulting from severe drought as reported by the project cooperator.

Analysis for the study consisted of calculating means for survival data at individual study sites. Planting rate and shipping rate data were compiled, averaged, and times normalized on a per thousand plant basis. Based upon this, estimated shipping and planting labor cost rates were applied to estimate cost efficiencies associated with each container type.

Results

Plant survival varied widely between sites and was highly dependent upon site moisture conditions. In general, the Bingham Canyon, Utah site was a dramatic success, while all other sites were judged as failures. Bingham Canyon received the highest precipitation amount (60 cm [19.7 in]) while La Plata Mine received the lowest precipitation (6.4 cm [2.5 in]). The Bingham Canyon Mine site experienced the most favorable moisture conditions resulting in excellent survival of Booth Tube containers (76 percent). At this site, the Booth Tube was equal to the Zipset for highest survival and exceeded all other containers. The high elevation of Bingham Canyon resulted in cooler temperatures, lower evapotranspiration, and higher rainfall than other sites. Areas with poor growing season precipitation and minimal subsoil moisture reserves fared much more poorly than Bingham Canyon Mine. Booth Tubes were marginally successful (<10 percent survival) on sites receiving less than 30-cm (12-in.) of precipitation. North Antelope Coal Mine (10 percent) and INEEL (9 percent) had the next highest Booth Tube survival while all other sites experienced two percent or less Booth Tube survival. In contrast, the commercially available containers with more mature plant material experienced generally high survival on all sites with the exception of Hanford Reach National Wildlife Refuge and the Bureau of Land Management (BLM) Worland site. Both of these sites experienced less than 13-cm (5-in.) of precipitation during the October 2001 to September 2002 period.

Late frosts impacted Booth Tube seedlings at some sites. During the planting of the Caballo, North Antelope, and Worland-BLM sites, snow and freezing temperatures occurred for several days during and after planting. Black spots were noted on the dicots of Booth Tube seedlings, an indication of frost damage. In contrast, all of the commercial container material was dormant and immune to the effects of frost damage. Potential frost damage is a concern for the Booth Tube planting system. Previous research has indicated that winterfat (*Ceratoides lanata*), another dryland shrub, is highly tolerant of freezing temperatures during the dicot stage but damaged easily during the true leaf stage. An assumption for this study is that the same would be true of sagebrush. Further research to investigate frost tolerance of arid lands shrubs is proposed in Phase II.

Soil type may have also played a role in low survival of Booth Tube seedlings. Booth Tube containers removed from the INEEL site and the Natural Resource Conservation Service sites #1 and #2 were observed to have been plugged with fine soils. During hand-planting operations, planters tended to push Booth Tubes into the soils, thus creating a very dense plug of fine material at the lower end of the tube. This plug prevented root egress and likely contributed to the death of the seedling. In contrast, the Bingham Canyon site consisted of loose, highly drained gravels and consequently avoided the plugging problem. The plugging problem could easily be resolved by shortening the tube configuration to a 15-cm (6-in.) length that would allow for easier planting.

Despite overall poor survival, conditions at all sites were severely drought impacted and some success was achieved. The Bingham Canyon site represents what may be possible under more moderate growing conditions typical of the areas in which the seedlings were planted. The investigators do concede, however, that this container type may not be suitable for areas in which the mean average precipitation is less than 25-cm (10-in.) annually and sub-soil moisture is absent.

Plans for Continuation

Data on survivorship and growth rates will be collected again in the fall of 2003.

8.4 Ecological Impacts of Irrigating Native Vegetation with Treated Sewage Wastewater

Investigators

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Funding Sources

Department of Energy Idaho Operations Office

Background

In 1995, the INEEL began disposing of treated wastewater at the Central Facilities Area (CFA) by applying it to the surface of soils and native vegetation using a center pivot irrigation system. Research conducted on this disposal method at the INEEL provides an opportunity to determine the benefits and/or hazards of disposal of wastewater on native vegetation in arid and semi-arid regions. Results will be applicable to a wide range of municipal, industrial, and agricultural wastewater disposal needs. Because permits to dispose of agricultural and industrial wastewater may have restrictions on application to prevent deep percolation, this research may refine some of the models used to predict the maximum rate of wastewater application possible without percolation below the rooting zone.

The wastewater land application facility at CFA covers approximately 29.5 ha (73 acres). The permit for operating this system limits the application rate to 63.5 cm (25 in.) water per year, which must be applied such that no more than 7.6 cm (3 in.) of water leaches through the root zone toward groundwater. The 63.5-cm (25-in.) maximum application rate is more than two and one-half times the average annual precipitation, and plants may not be able to deplete this water in one growing season to prevent leaching. Most of the precipitation in this cool desert biome comes in the winter and spring. Soil moisture recharge occurs in the spring with snowmelt and rainfall. Wastewater application must be timed to avoid spring recharge to minimize deep percolation of wastewater. The wastewater also contains organic carbon, nitrogen, other nutrients, and trace metals that may have impacts on the proper functioning of native soil-plant systems.

Different plant species respond differently to the addition of water and nutrient elements, especially if those additions come at times of the year that are normally dry. These differences in response can result in some species being favored and others discouraged. Changes in plant community structure can be expected. For example, in arid and semiarid regions grasses are known to dominate where precipitation comes mostly in the summer and shrubs tend to dominate in areas where moisture comes as snow. Summer irrigation may lead to decreases in shrub dominance and increases in grasses.

Changes in plant community structure also mean changing habitats for other organisms such as small mammals, birds, insects, and big game animals. Because the area is relatively small, it is unlikely that decreased habitat quality would have significant impacts on wildlife populations on the INEEL. Increases in habitat quality, however, could have substantial impacts on wildlife use patterns in and near this small area.

Objectives

The primary objective of the research study was to determine the ecological benefits or hazards of applying wastewater on native vegetation in semiarid regions. Specific objectives were to determine the potential for impacts on rangeland quality, resident wildlife populations, and soil water balance.

Accomplishments through 2002

Accomplishments for 2002 include the following:

- Plant cover surveys were completed in the three distinct plant community types (sagebrush steppe, crested wheatgrass, and a transition type) on the study area;
- Soil moisture data were collected weekly at 20 sites in the wastewater application area and 20 control sites; and
- A breeding bird survey was conducted on the study site.

Results

Vegetation - Results from the 2002 vegetation data analyses confirm results from previous years. Sewage wastewater application affects crested wheatgrass communities the least. Similar cover values and similar species composition, as evidenced by high Simplified Morisita's Similarity Index values, support this conclusion. This index returns a value of one for two plant communities that are identical and a value of zero for two communities that have no similar community elements. Crested wheatgrass communities at the INEEL tend to occur as monocultures; thus, crested wheatgrass communities are very homogenous and unlikely to exhibit much spatial variation, even when disturbed.

The vegetation type that represents a transitional zone between the crested wheatgrass community and the sagebrush steppe community was slightly more affected by the irrigation treatment than the crested wheatgrass community. The difference between the irrigated and control transition plots was particularly apparent in the difference in grass cover values between the two treatments. However, the Simplified Morisita's Index value returned for the transitional vegetation type indicates that the species composition between the irrigated and control plots was quite similar.

The greatest differences between the irrigated and control treatments were found in the sagebrush steppe community. Total cover values were substantially different between irrigated and control plots, largely due to very low sagebrush cover in the irrigated treatment. In addition, the Simplified Morisita's index value comparing species composition between the treatments suggests that sewage wastewater application affects sagebrush steppe communities to a greater degree than it affects the other two vegetation types studied here. Sagebrush steppe community vegetation is more likely to fluctuate in response to disturbance or changing environmental conditions because sagebrush steppe communities are much more heterogeneous, and therefore are more likely to vary in space and time. Additionally, a higher species richness value for the sagebrush steppe plots suggests greater potential for niche separation, which increases the potential for vegetation composition change in response to disturbance.

Animals - Breeding bird surveys were conducted on the wastewater application area during June of 2002 following U. S. Geological Survey, Breeding Bird Survey guidelines. A breeding bird survey route stop was established on the application area in 1997 and surveys have been conducted yearly since that time. In 2002, Western meadowlark (*Sturnella neglecta*) remained the most abundant species. Other common species included brown-headed cowbird (*Imolothrus ater*), Brewer's Sparrow (*Spizella breweri*), Brewer's blackbird (*Euphagus cyanocelphalus*), and horned lark (*Eremophila alpestris*). One species, sage sparrow (*Amphispiza belli*), which has been common in the past, was not observed during the 2002 survey. Otherwise, results from the 2002 survey were comparable to previous years and similar to that found on the CFA breeding bird survey route.

Soil Moisture - During the 2002 growing season, soil moisture dynamics were similar between irrigated and control soil profiles within the crested wheatgrass community. Both the irrigated and control soil profiles demonstrated a spring infiltration event in which the soil moisture wetting front reached approximately one meter (3.2 ft). Water redistribution throughout the soil profile was evident through the end of April. Subsequent to this, soil moisture decreased steadily throughout the wetted profile through the summer as a result of evapotranspiration. Soils began to approach the lower limit of extraction by August in 2002.

The soil moisture profiles do not indicate an increase in soil moisture at 20 cm (7.9 in.) or deeper due to wastewater application. If irrigation were to affect soil moisture, we would expect to see either small wetting fronts in the profile throughout the summer (in the case of pulses in application), or we would expect soil moisture in at least some portion of the top of the soil profile to remain elevated (in the case of relatively steady application of water). Neither of these patterns is apparent in the irrigated crested wheatgrass soil profiles. In fact, those profiles dry down throughout the summer in a manner very similar to that of the control soil profiles. Thus, most of the additional water received by a soil profile through wastewater application is evaporated or transpired before it percolates to a depth of 20 cm (7.9 in.) within the soil profile. It should be noted that it is possible for a small amount of water to move downward through the soil profile, without detectable changes in soil moisture content, because of unsaturated flow. In addition, soil moisture did not change at the bottom of the soil profiles throughout the season at many of the hydroprobe access tube locations, suggesting that any flux through the bottom of the soil profiles would result from unsaturated flow.

As with soil moisture dynamics in the crested wheatgrass vegetation type, no differences in soil moisture profiles between irrigated and control locations are apparent in either the transition or the sagebrush steppe vegetation type. In both transition and sagebrush steppe vegetation, soil moisture profiles in the irrigated locations do not indicate soil moisture increases at the top of the soil profile in response to irrigation, nor does water content at the bottom of the profiles at most access tube locations change. Thus, although changes in vegetation cover and composition between irrigated and control locations vary among vegetation type (i.e., control and irrigated plots within the sagebrush steppe community are more different than control and irrigated plots within the crested wheatgrass community), no such pattern is obvious in soil moisture dynamics. In fact, soil moisture dynamics in irrigated locations do not differ substantially from those in control locations for any of the vegetation types. Therefore, the probability of water percolating through the rooting zone and continuing to move downward was essentially the same for the wastewater application area and control locations during the 2002 growing season.

Plans for Continuation

We plan to continue this as a long-term study with similar data collected annually. We also hope to be able to consider adding data collection to address some ecosystem processes (nutrient cycling and decomposition) that may be changing on a faster time scale and may allow predictions of changes that may occur over longer time periods.

8.5 Natural and Assisted Recovery of Sagebrush (*Artemisia tridentata*) in Idaho's Big Desert: Effects of Seeding Treatments and Livestock Grazing on Successional Trajectories of Sagebrush Communities

Investigators

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Funding Sources

Bureau of Land Management

U.S. Department of Energy Idaho Operations Office

The Nature Conservancy

Background

Averaged over the last ten years, approximately 95,000 ha (235,000 acres) of lands managed by the Bureau of Land Management (BLM) in Idaho have burned annually. The BLM and other managers of Idaho rangelands, including the INEEL, must decide whether the burned areas need stabilization and rehabilitation treatments to prevent soil erosion and inhibit the invasion of exotic species such as cheatgrass (*Bromus tectorum*). Most of these rangelands have historically been dominated by big sagebrush (*Artemisia tridentata*), which does not resprout after fire. Sagebrush provides critical food and habitat for sage grouse, a species proposed for listing under the Endangered Species Act. With the accelerating loss of native sagebrush communities and habitat for sage grouse and other sagebrush-obligate species, sagebrush reseeding following fire has become an important consideration, as has the issue of livestock grazing impacts on recovering native vegetation and seeded areas. In the last three years approximately 70 percent of the sage grouse habitat in eastern Idaho's Big Desert has been burned by wildfire. Fire suppression and rehabilitation costs are rising, and the threats to human life and property are increasing in eastern Idaho.

This study has been divided into three components to address management concerns relative to: (1) native plant recovery in good ecological condition rangeland, (2) success of aerial seeding sagebrush, and (3) whether livestock grazing affects recovery on sagebrush steppe rangelands. These three components will provide new scientific information that addresses current management concerns relative to wildfire impacts and rehabilitation treatments on the eastern Snake River Plain. These studies are designed to establish long-term, replicated monitoring sites that can be reread in the future to provide additional information to managers about post-fire recovery and rehabilitation success. These studies will also provide insight into restoring sagebrush and understory herbaceous species for sage grouse and other sagebrush obligate wildlife species and domestic livestock in the Great Basin.

Objectives

The overall objectives of the proposed research are to examine some of the key factors that influence trajectories of community diversity and structure following wildfire in sagebrush-steppe ecosystems. Specifically, the factors that influence the recovery of these systems following fire and the replacement of native plant communities with vegetation dominated by cheatgrass (*Bromus tectorum*) will be examined. In 2002, research began to examine three basic research objectives:

- Describe post-wildfire trajectories in community composition and structure in areas in good ecological condition;
- Compare sagebrush recruitment on areas that have been aerially seeded to areas relying on natural recruitment processes; and
- Determine whether trajectories of community composition and structure differ between areas returned to grazing after fire and areas where grazing is excluded.

Accomplishments through 2002

To address the second objective, surveys for sagebrush seedlings were conducted along transects 1000-m (3281-ft) in length. Surveys were conducted May 9 and 10, 2002.

To address the first and third objectives, paired research plots were established in a portion of the area burned by the 2000 Tin Cup Fire. Grazing enclosure fences were constructed around one plot from each pair. The enclosed plot will be used to address questions related to recovery of vegetation in ungrazed sagebrush steppe rangeland. The unfenced plot will be used to examine the role of livestock grazing on that recovery. In all of these plots, plant cover, species richness and diversity were measured. Permanent photoplots and photopoints were established and photographed.

Results

Seedling Survey - Investigators found a total of 12 individual seedlings in three groups. All three groups were on one of the planted lines in the ungrazed area. However, all three groups were near (1, 20, and 65 m [3.2, 66 and 213 ft]) and downwind of surviving mature sagebrush plants. Because of the proximity to surviving sagebrush plants, we could not unequivocally conclude that they resulted from the February 2001 aerial planting.

Species Richness, Density and Frequency - A total of 78 plant species were encountered in the ten pairs of plots (20 plots). Eleven of those were nonnative species. Three of the ten pairs of plots contained no nonnative species. Species richness ranged from 23 to 49 species per plot. Indian rice grass (*Achnatherum hymenoides*), green rabbitbrush (*Chrysothamnus viscidiflorus*), tapertip hawksbeard (*Crepis acuminata*), squirreltail (*Elymus elymoides*), and Hood's phlox (*Phlox hoodii*) were found in all of the plots. Narrowleaf goosefoot (*Chenopodium *leptophyllum*), shaggy fleabane (*Erigeron pumilus*), desert biscuit root (*Lomatium foeniculaceum*), and hoary aster (*Machaeranthera canescens*) occurred in 19 of the 20 plots. Douglas' dusty maiden (*Cheanactis douglasii*), Wilcox's woolystar (*Eriastrum wilcoxii*), and blue bunch wheatgrass (*Pseudoroegneria spicata*) were found in 18 of the 20 plots. Twenty-one species occurred in 15 or more of the 20 plots.

Coefficient of Community is the percentage of total species that the two communities have in common. It was calculated here as to compare the two plots of each pair for similarity in terms of the species present. Coefficient of Community varied from 0.69 to 0.86. These results suggest that most pairs of plots share many of the same species.

Plant Cover - Total plant cover on the paired plots was 11 percent. Shrubs and grass cover were 4.6 and 1.5 percent, respectively. Perennial forb (wildflower) cover was 3.6 percent. Cover by introduced species (weeds) was 0.7 percent.

Plans for Continuation

For 2003 a plan to begin the grazing treatments with cattle and sheep in the area of the paired plots and continuation of collecting the plant diversity and cover data as was done in 2002. There are plans for continuing the seedling surveys on the same transects and adding some additional transects in an area that burned in 1994 but was planted with sagebrush at the same time as the 2000 fire. We also plan to conduct surveys for species richness and diversity on some of the older fire scars on the INEEL. The project will continue with similar data collection through 2004.

8.6 The Protective Cap/Biobarrier Experiment: A Study of Alternative Evapotranspiration Landfill Caps for the INEEL

Investigator

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Funding Sources

U.S. Department of Energy Idaho Operations Office

Background

Shallow land burial is the most common method for disposing of industrial, municipal, and low-level radioactive waste, but in recent decades it has become apparent that conventional landfill practices are often inadequate to prevent movement of hazardous materials into groundwater or biota (Suter et al. 1993, Daniel and Gross 1995, Bowerman and Redente 1998). Most waste repository problems result from hydrologic processes. When wastes are not adequately isolated, water received as precipitation can move through the landfill cover and into the wastes (Nyhan et al. 1990, Nativ 1991). The presence of water may cause plant roots to grow into the waste zone and transport toxic materials to aboveground foliage (Arthur 1982, Hakonson et al. 1992, Bowerman and Redente 1998). Likewise, percolation of water through the waste zone may transport contaminants into groundwater (Fisher 1986, Bengtsson et al. 1994).

In semiarid regions, where potential evapotranspiration greatly exceeds precipitation, it is theoretically possible to preclude water from reaching interred wastes by (1) providing a sufficient cap of soil to store precipitation that falls while plants are dormant and (2) establishing sufficient plant cover to deplete soil moisture during the growing season, thereby emptying the water storage reservoir of the soil.

The Protective Cap/Biobarrier Experiment (PCBE) was established in 1993 at the Experimental Field Station on the INEEL to test the efficacy of four protective landfill cap designs. The ultimate goal of the PCBE is to design a low maintenance, cost effective cap that uses local and readily available materials and natural ecosystem processes to isolate interred wastes from water received as precipitation. Four evapotranspiration (ET) cap designs, planted in two vegetation types, under three precipitation regimes have been monitored for soil moisture dynamics, changes in vegetative cover, and plant rooting depth in this replicated field experiment.

Objectives

From the time it constructed, the PCBE has had four primary objectives:

- Compare the performance of caps having biobarriers (capillary breaks) with that of soil only caps and that of caps based on U.S. Environmental Protection Agency recommendations for Resource Conservation and Recovery Act caps;
- Examine the effects of biobarriers as capillary breaks placed at different depths on water percolation, water storage capacity, plant rooting depths, and water extraction patterns;
- Evaluate the performance of caps receiving higher precipitation than expected under either the present climate or that anticipated in the foreseeable future; and
- Compare the performance of a community of native species on ET caps to that of caps vegetated with a monoculture of crested wheatgrass.

Specific tasks within the PCBE for 2002 were twofold. The first was to summarize results from the first seven years of data collection (1993-2000) and present those results in a short, concise report to provide guidance to managers, planners, and private contractors involved with the design and construction of protective caps for burial of hazardous waste at the INEEL. The report includes a brief summary of the theory of evapotranspiration caps, a summary of research results on the PCBE and previous capping experiments, and specific recommendations for constructing and maintaining evapotranspiration caps at the INEEL. This report is intended to update the report by Anderson et al. (1991).

The second task of the PCBE in 2002 was to continue irrigation treatments and to continue soil moisture and plant community data collection. These data will be analyzed according to the four major objectives listed above; however, the focus of the project will shift from short-term cap function to longer-term performance issues. For example, emphasis on plant community structure will change from vegetation establishment to long-term changes in community composition as plant communities on the caps continue to develop. The PCBE has one of the most complete, long-term data sets for experimental ET caps, which makes it a model system for studying ET cap longevity.

Accomplishments through 2002

A draft of the short report entitled Evapotranspiration Caps for the Idaho National Engineering and Environmental Laboratory: A Summary of Research and Recommendations was completed in 2002 (Forman 2003). Additionally, the report was sent out for review, and comments were addressed at the end of the year. The report was formatted and printed early in 2003.

Three irrigation treatments were completed on schedule in 2002. The fall/spring irrigated plots were irrigated in April and then again in October. The summer irrigated plots were irrigated once every two weeks from the end of June through the beginning of August. Soil moisture measurements were collected on the PCBE once every two weeks from the middle of March through the middle of October. Vegetation cover data were collected throughout the month of July.

Soil moisture and vegetation data for 2002 were archived. Some initial data analyses on soil moisture data were conducted in the fall of 2002.

Results

Results summarized in the short report indicate that the soil only cap and the biobarrier caps generally performed similarly throughout the study period (1993-2000) under ambient precipitation, and all moisture received as precipitation was returned to the atmosphere annually via evapotranspiration. The Resource Conservation and Recovery Act cap occasionally drained, even under ambient precipitation, as a result of water infiltrating to and running off the flexible membrane liner.

Water extraction patterns were similar between vegetation types under ambient precipitation. However, in many years the amount of water in the soil profile at the end of the growing season did significantly differ in response to vegetation type under augmented precipitation treatments.

For example, from 1996-2000, there was more water in the caps planted in crested wheatgrass versus caps planted in native vegetation under augmented summer precipitation. Nevertheless, cap failure on the PCBE has been a rare occurrence under any cap design, vegetation type, and precipitation regime combination.

The initial results of the PCBE from 1993-2000 have indicated that low maintenance; cost-effective ET caps can be used to effectively isolate buried waste at the INEEL. To date, this project has also generated a large amount of data useful for making decisions related to specific capping projects at the INEEL. Longer term data will be used to assess longevity of these caps.

Initial data analyses from the 2002 soil moisture data indicate that the spring wetting front extended to the bottom of the soil profile on several of the plots receiving spring irrigation. A few of those plots likely drained. Those same plots received fall irrigation in October; however, the wetting fronts resulting from that irrigation treatment did not reach the bottom of the soil profile on any of the plots. Thus, a combination of spring infiltration from snowmelt and infiltration from the spring irrigation treatment caused many plots to reach or nearly reach storage capacity. Water in the soil profile was quickly transpired and cap performance was not affected later in the season.

Wetting fronts on ambient and summer irrigated plots never exceeded 1 m (3.2 ft) throughout the year. Thus, all of the water received through precipitation and irrigation on ambient and summer irrigated plots was returned to the atmosphere. These results confirm that a global climate change scenario that includes large increases in winter precipitation (especially precipitation received in late winter or early spring) pose the greatest threat to these cap designs. However, plots at or near storage capacity in the spring are able to recover that storage capacity within one growing season.

Vegetation data from the PCBE in 2002 have not yet been analyzed.

Plans for Continuation

Plant community composition and related soil moisture dynamics were still undergoing directional changes through 2000. For example, soil moisture at the bottom of the soil profile in crested wheatgrass plots increased as plant cover decreased from 1995 through 2000. The PCBE should continue to be monitored at least until these parameters begin to stabilize and natural long-term fluctuations can be characterized. The long-term performance of these four cap designs can best be assessed through continued monitoring.

Additional recommended research for the PCBE includes studies pertaining to long-term cap maintenance such as response to fire, invasive plant species, erosion, and the role of soil microbiota in cap function.

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Chapter 9 - Quality Assurance

Chapter Highlights

Quality assurance and quality control programs are maintained by contractors conducting environmental monitoring and by laboratories performing environmental analyses to ensure precise, accurate, representative, and reliable results and maximize data completeness. Data reported in this document were obtained from several commercial, university, government, and government contractor laboratories. To assure quality results, these laboratories participate in a number of laboratory quality check programs.

Laboratories used by the Environmental Surveillance, Education and Research (ESER) Program met their quality assurance goals in 2002.

Quality issues that arose with laboratories used by the Management and Operating contractor were addressed with the laboratory and resolved.

9. QUALITY ASSURANCE

Quality assurance and quality control programs are maintained by contractors conducting environmental monitoring and by laboratories performing environmental analyses.

9.1 Quality Assurance Programs

The purpose of a quality assurance and quality control program is to ensure precise, accurate, representative, and reliable results and maximize data completeness. Another key issue of a quality program is to ensure that data collected at different times is comparable to previously collected data. Elements of typical quality assurance programs include the following

- Adherence to peer-reviewed written procedures for sample collection and analytical methods;
- Documentation of program changes;

- Periodic calibration of instruments with standards traceable to the National Institute of Standards and Technology;
- Chain of custody procedures;
- Equipment performance checks;
- Routine yield determinations of radiochemical procedures;
- Replicate samples to determine precision;
- Analysis of blind, duplicate, and split samples;
- Analysis of quality control standards in appropriate matrices to test accuracy;
- Analysis of reagent and laboratory blanks to measure possible contamination occurring during analysis;
- Analysis of blind spike samples (samples containing an amount of a constituent known to the sampling organization, but not the analytical laboratory) to verify the accuracy of a measurement;
- Internal and external surveillance to verify quality elements; and
- Data verification and validation programs.

9.2 Laboratory Intercomparison Programs

Data reported in this document were obtained from several commercial, university, government, and government contractor laboratories. In 2002, the Management and Operating (M&O) contractor used the Idaho National Engineering and Environmental Laboratory (INEEL) Radiological Measurements Laboratory (RML) and General Engineering Laboratories for radiological analyses and Southwest Research Institute of Oklahoma for inorganic analyses. The M&O Drinking Water Program used the INEEL Environmental Hygiene Laboratory for bacteriological analyses, Paragon for radiological analysis, and Environmental Health Labs for inorganic and organic analyses.

The ESER contractor used the Environmental Assessments Laboratory (EAL) located at Idaho State University (ISU) for gross radionuclide analyses (gross alpha, gross beta, and gamma spectrometry) and Severn-Trent of Richland, Washington, for specific radionuclide analyses (e.g., strontium-90 [^{90}Sr], americium-241 [^{241}Am], plutonium-238 [^{238}Pu], and plutonium-239/240 [$^{239/240}$Pu]). The U.S. Department of Energy's (DOE's) Radiological and Environmental Sciences Laboratory (RESL) performed radiological analyses for the U.S. Geological Survey (USGS). The USGS National Water Quality Laboratory (NWQL) conducted nonradiological analyses. For 2002 samples from the Naval Reactors Facility were sent to Severn-Trent of Richland Washington for radiological analyses and the University of Georgia for tritium analyses. All these laboratories participated in a variety of programs to ensure the quality of their analytical data. Some of these programs are described below.

Quality Assessment Program

The Quality Assessment Program, administered by the DOE Environmental Measurements Laboratory (EML) in Brookhaven, New York, is a performance evaluation program that tests the quality of DOE contractor and subcontractor laboratories in performing environmental radiological analyses. EML prepares samples containing known amounts of up to 15 radionuclides in four media: simulated air filters, soil, vegetation, and water. These are distributed to participating laboratories in March and September. Participants can use any method for the analysis, and they are required to report their results within 90 days. EML issues quality assessment reports twice per year in which the identities of participating laboratories, their results, and comparison to EML results are presented. These reports are now available, along with a searchable database of results, on the Internet at http://www.eml.doe.gov/qap/reports/ (DOE 2003).

2002 Quality Assurance Program Results

Comparisons of the air, water, and soil results for the laboratories used by environmental monitoring organizations in 2002 are presented in Figures 9-1, 9-2, and 9-3. For the June air, only the gross beta results from General Engineering Labs were qualified as acceptable with warning. For December, the ISU EAL received an acceptable with warning on their gross beta analysis, and both General Engineering Labs and the INEEL RML received acceptable with warning evaluations on their ^{238}Pu results. Severn-Trent received a not acceptable rating on their December plutonium analyses (^{238}Pu and ^{239}Pu).

Water results were qualified, with the General Engineering Labs receiving an acceptable with warning for gross alpha and tritium in June. The NWQL received a not acceptable for their June gross alpha results. General Engineering Labs, Severn-Trent, and Paragon received a not acceptable for their gross alpha analysis in December. Severn-Trent also received a not acceptable for the December gross beta analysis. The NWQL gross alpha analysis improved in December to acceptable with warning. The INEEL RML also received an acceptable with warning for their December plutonium analyses.

Comparisons are also presented for soils since all parties collected soil samples in 2002. The transuranic elements along with cesium-137 (^{137}Cs) and ^{90}Sr are of interest in the 2002 soils data. For the June ^{239}Pu analysis, the INEEL RML, Severn-Trent, and Southwest Research Institute of Oklahoma were all qualified as acceptable with warning. Severn-Trent also received an acceptable with warning for their December ^{137}Cs analysis.

National Institute of Standards and Technology

RESL participates in a traceability program administered through the National Institute of Standards and Technology (NIST). NIST prepares several alpha-, beta-, and gamma-emitting standards, generally in liquid media, for analysis by RESL.

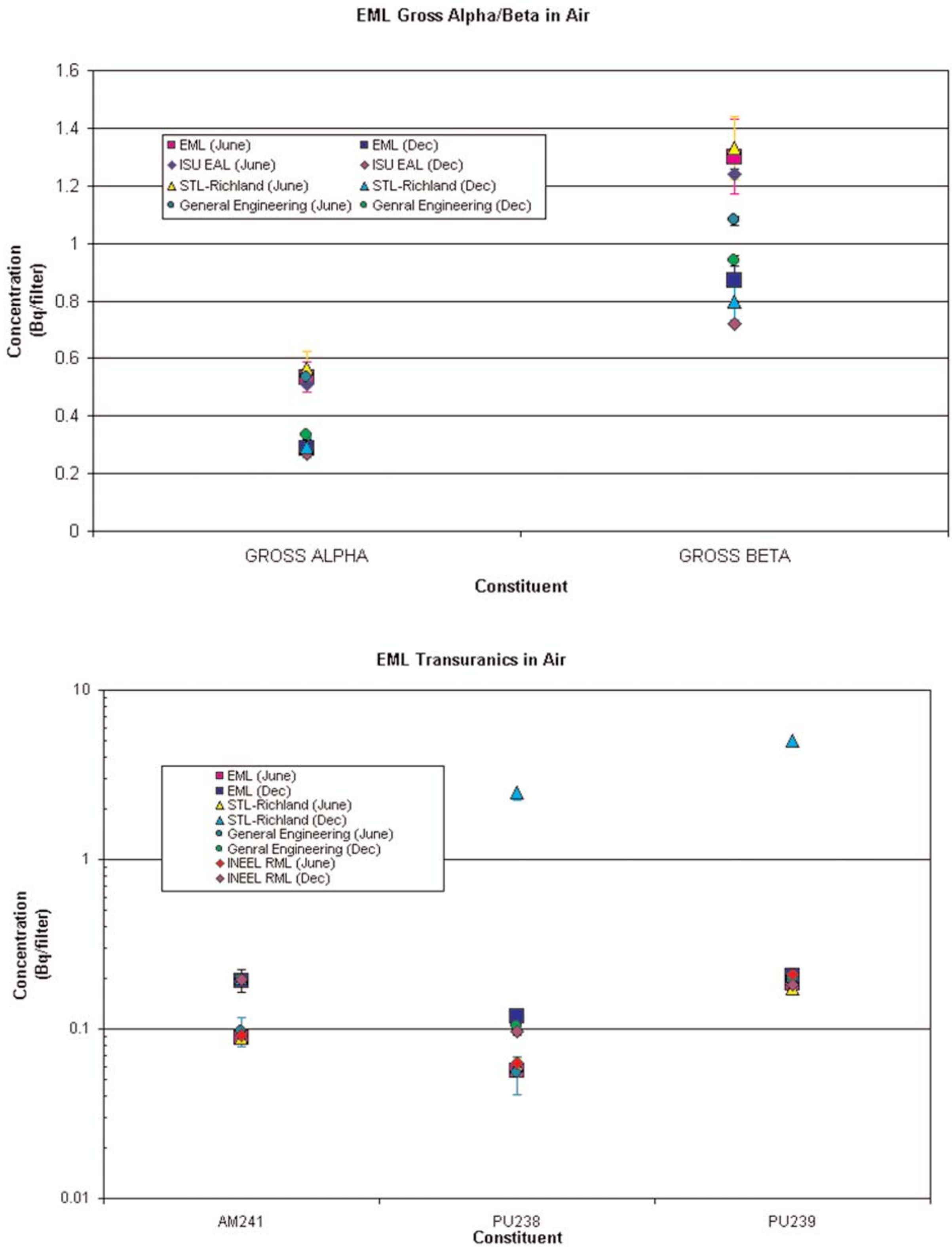


Figure 9-1. Surveillance contractor laboratory air sampling results from the EML intercomparison (2002).

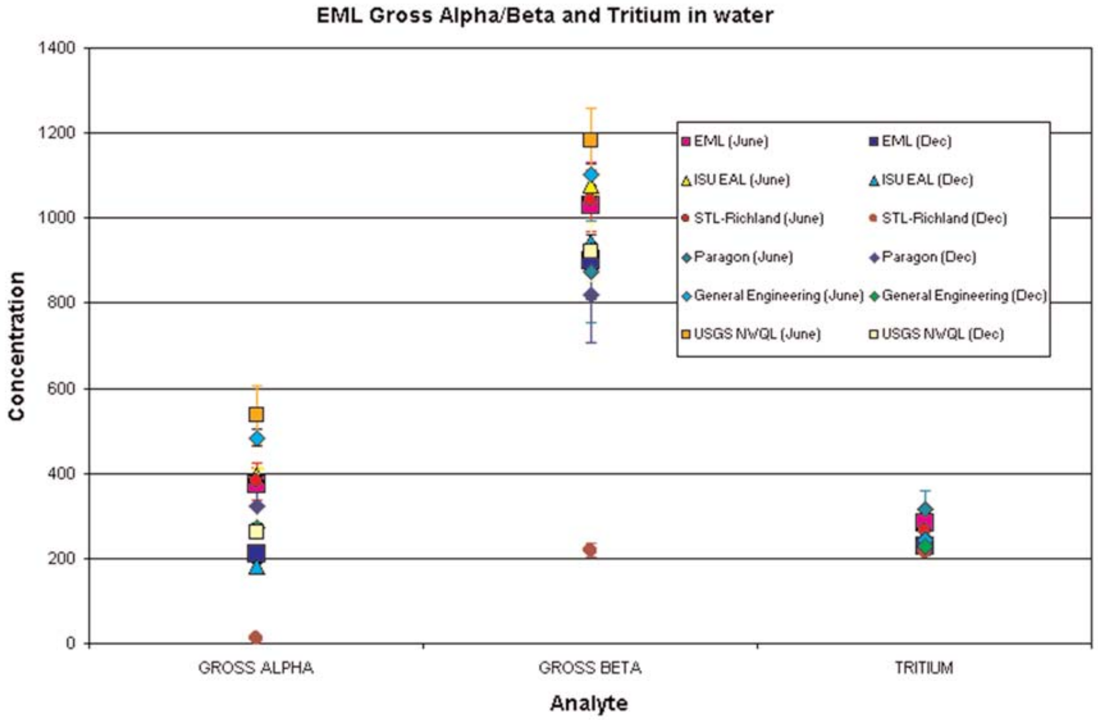


Figure 9-2. Surveillance contractor laboratory water sampling results from the EML intercomparison (2002).

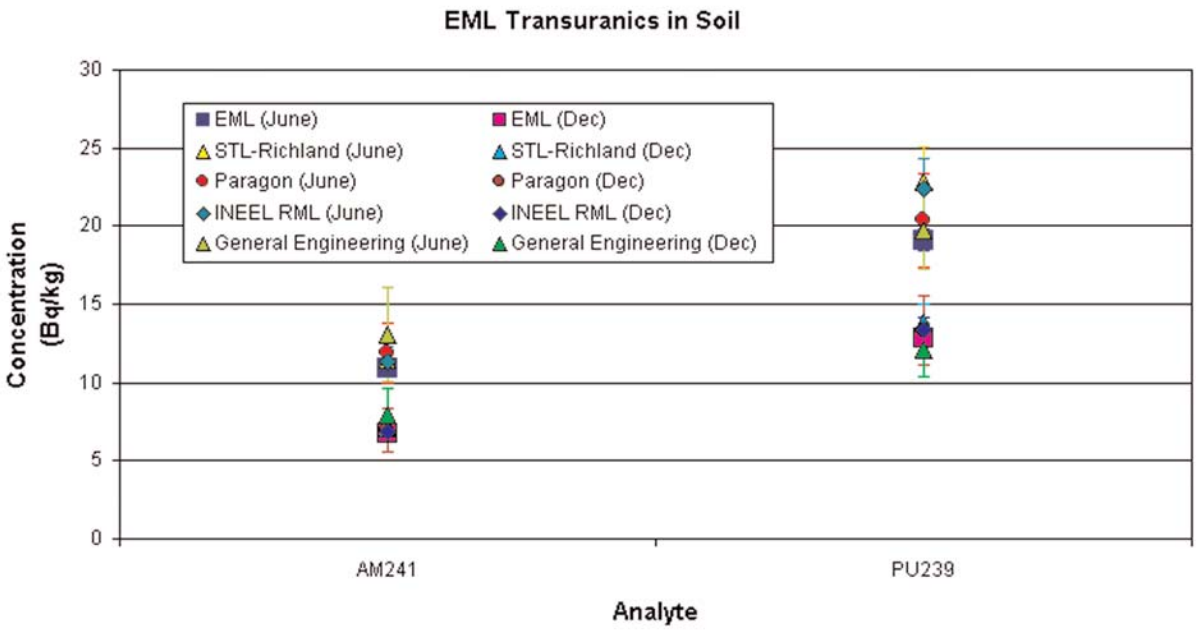


Figure 9-3. Surveillance contractor laboratory soil sampling results from the EML intercomparison (2002).

Dosimetry

To verify the quality of the environmental dosimetry program conducted by the M&O contractor, the Operational Dosimetry Unit participates in International Environmental Dosimeter Intercomparison Studies. The Operational Dosimetry Unit's results have been within ± 30 percent of the test exposure values on all intercomparisons. Quality control of the environmental dosimetry program is maintained through internal check measurements every month.

Other Programs

INEEL contractors participate in additional performance evaluation programs, including those administered by the International Atomic Energy Agency, the U.S. Environmental Protection Agency (EPA), and the American Society for Testing and Materials. Where possible, contractors use laboratories that are certified by the state of Idaho or certified by another state whose certification is recognized by the state of Idaho.

9.3 Data Precision and Verification

As a measure of the quality of data collected, the ESER contractor, the M&O contractor, the USGS, and other contractors performing monitoring use a variety of quality control samples of different media. Quality control samples include blind spike samples, duplicate samples, and split samples.

Blind Spikes

Groups performing environmental sampling use blind spikes to assess the accuracy of the laboratories used for analysis. Contractors purchase samples spiked with known amounts of radionuclides or nonradioactive substances from suppliers who are traceable to the NIST. These samples are then submitted to the laboratories with regular field samples, with the same labeling and sample numbering system. The analytical results are expected to compare to the known value within a set of performance limits.

Duplicate Sampling within Organizations

Monitoring organizations also collect a variety of quality control samples as a measure of the precision of sampling and analysis activities. One type is a duplicate sample, where two samples are taken from a single location at the same time. A second type is a split sample, where a single sample is taken and later divided into two portions that are analyzed separately. Contractors specify in quality assurance plans relative differences expected to be achieved in reported results for both types of quality assurance samples.

Both the ESER contractor and the M&O contractor maintained duplicate air samplers at two locations during 2002. The ESER contractor operated duplicate samplers at the locations in Arco and Howe. The M&O contractor duplicate samplers were located at Argonne National Laboratory-West (ANL-W) and at the Van Buren Boulevard Gate. Filters from these samplers were collected and analyzed in the same manner as filters from regular air samplers. Graphs of gross beta activity for the duplicate samplers are shown in Figures 9-4 and 9-5.

Duplicate Sampling between Organizations

Another measure of data quality can be made by comparing data collected simultaneously by different organizations. The ESER contractor, the M&O contractor, and the state of Idaho's INEEL Oversight Program collected air monitoring data throughout 2002 at four sampling locations: the distant locations of Craters of the Moon National Monument, Idaho Falls, on the INEEL at the Experimental Field Station, and Van Buren Boulevard Gate. Data from these sampling locations for gross beta are shown in Figure 9-6.

The ESER contractor also collects semiannual samples of drinking and surface water jointly with the INEEL Oversight Program at five locations in the Magic Valley area. Table 9-1 contains results of the gross alpha, gross beta, and tritium analyses for the 2002 samples taken from these locations.

The USGS also collects groundwater samples simultaneously with the INEEL Oversight Program routinely. Results from this sampling are regularly documented in reports prepared by the two organizations.

9.4 Program Quality Assurance

Liquid Effluent Program Quality Assurance/Quality Control

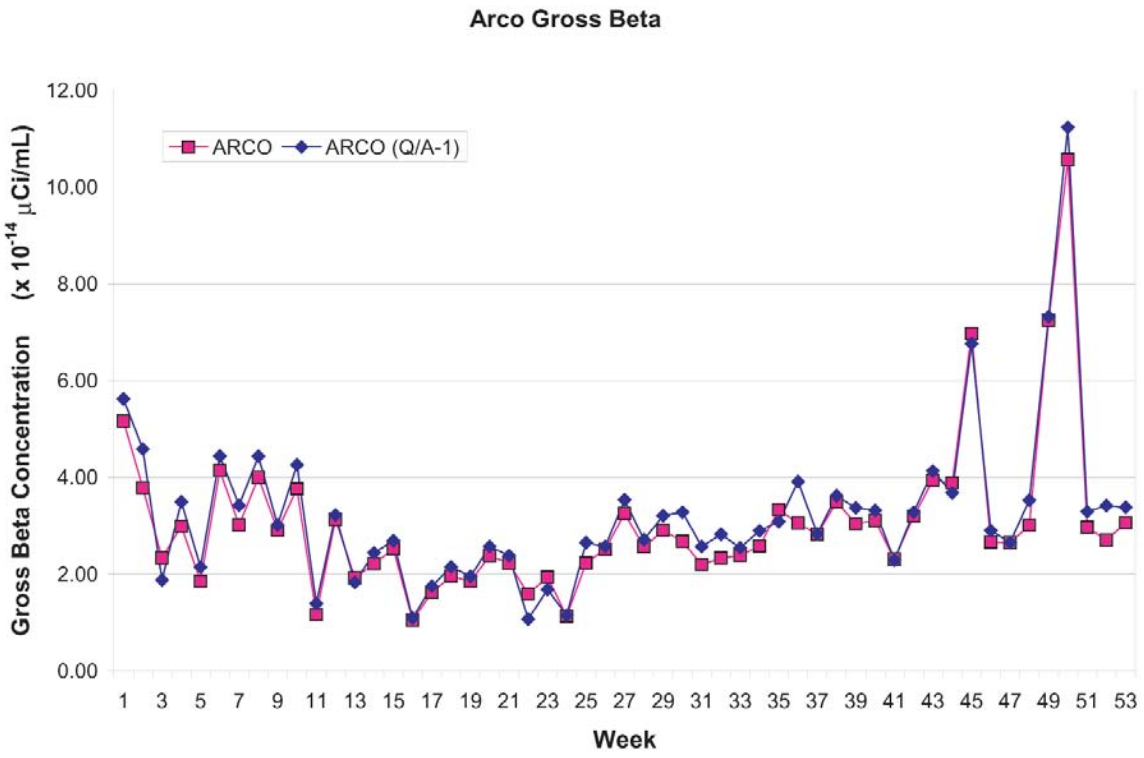
The M&O contractor's Liquid Effluent Monitoring Program has specific quality assurance/ quality control objectives for monitoring data. Goals are established for accuracy, precision, and completeness, and all analytical results are validated following standard EPA protocols. This section applies to all surveillance groundwater and effluent monitoring.

Performance evaluation samples (submitted as field blind spikes) are required to assess analytical data accuracy. At a minimum, performance evaluation samples are required quarterly.

During 2002, four quarterly sets of performance evaluation samples were submitted to the laboratory along with routine monitoring samples. No blind spike parameters routinely missed the performance acceptance limits. For blind spike results that fall below the performance acceptance limit, the concern is that all the associated reported concentrations could be biased in the same direction as the blind spike results and could result in an exceedance of a permit limit. A review of the reported concentrations for all blind spike parameters that fell below the performance acceptance limit showed that there were no impacts to regulatory limits.

Relative percent difference between the duplicate samples is used to assess data precision. Table 9-2 shows the results for 2002.

The goal for completeness is to collect 100 percent of all required compliance samples. During the 2002 year, this goal was met.



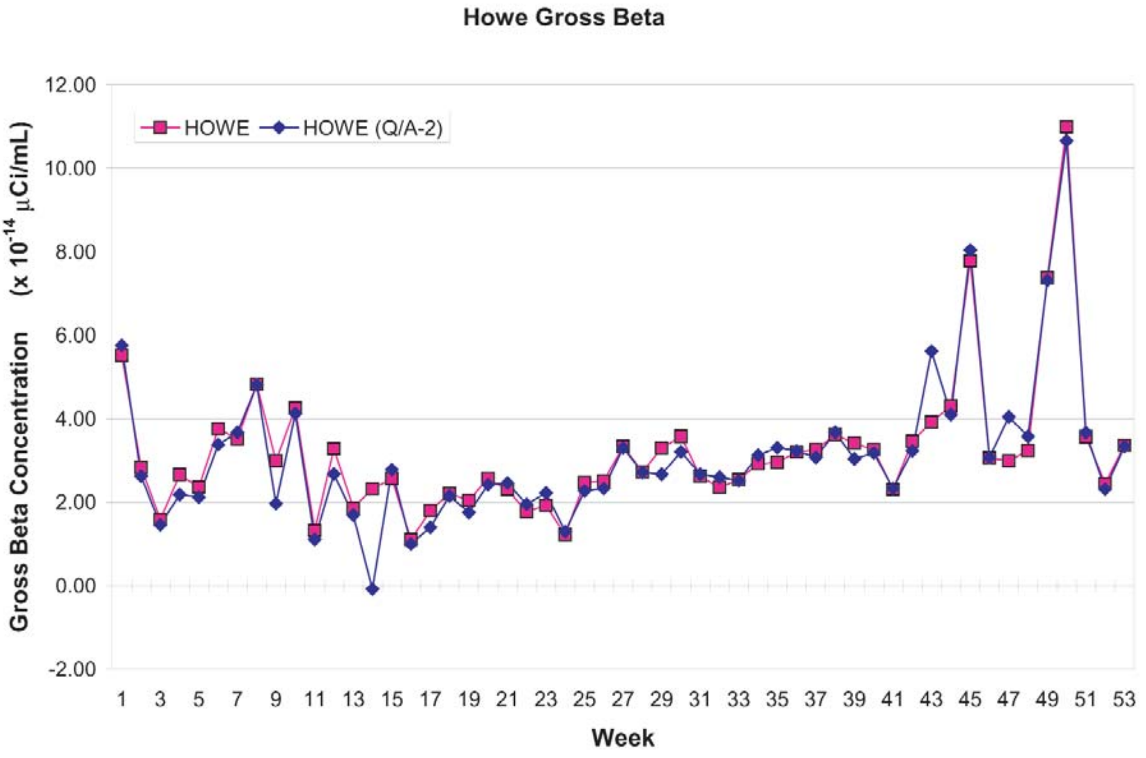
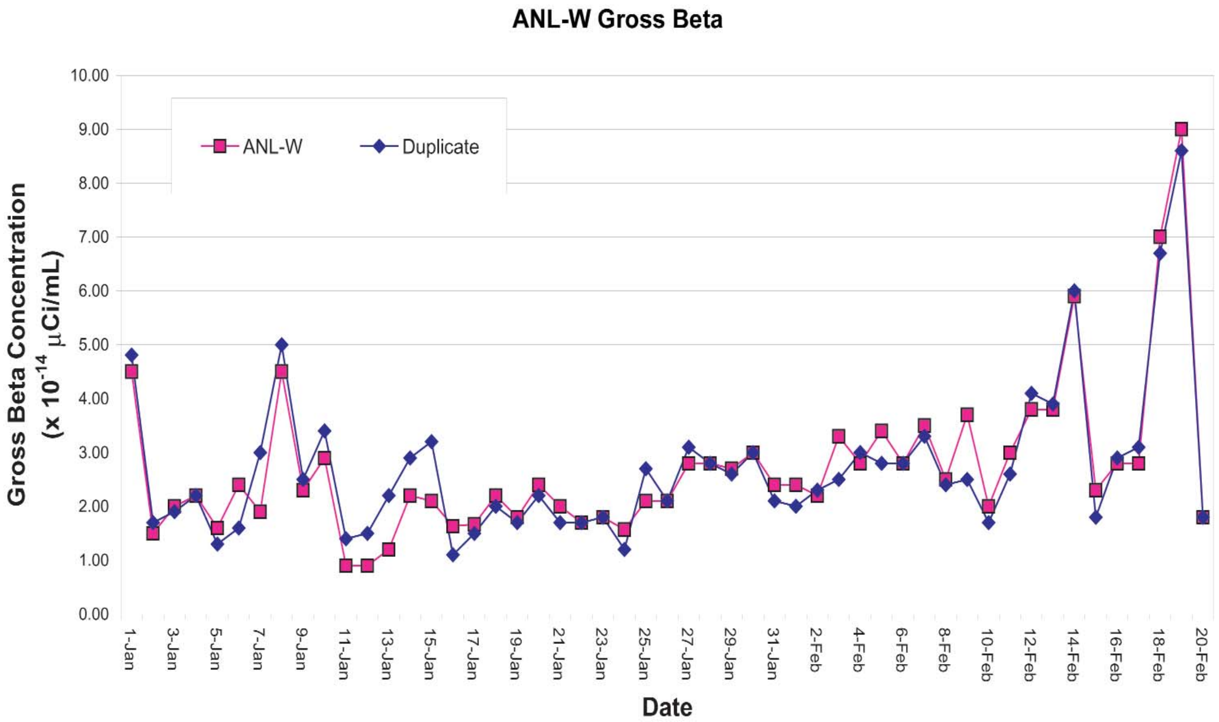


Figure 9-4. ESER contractor duplicate air sampling gross beta results (2002).



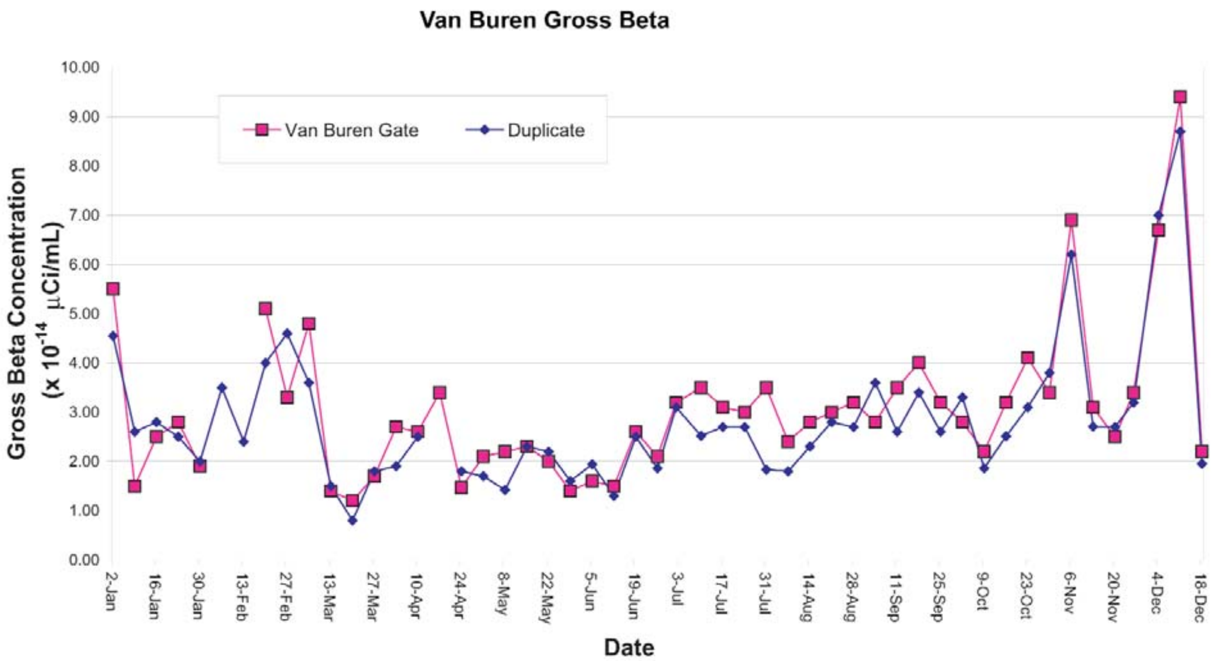
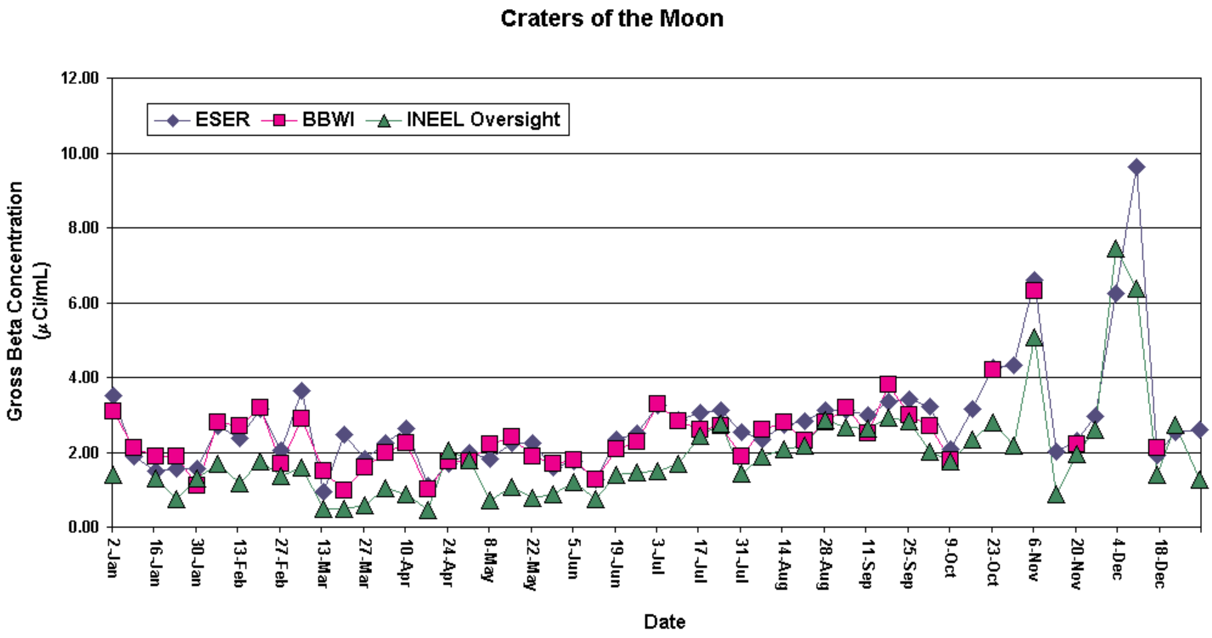


Figure 9-5. M&O contractor duplicate air sampling gross beta results (2002).



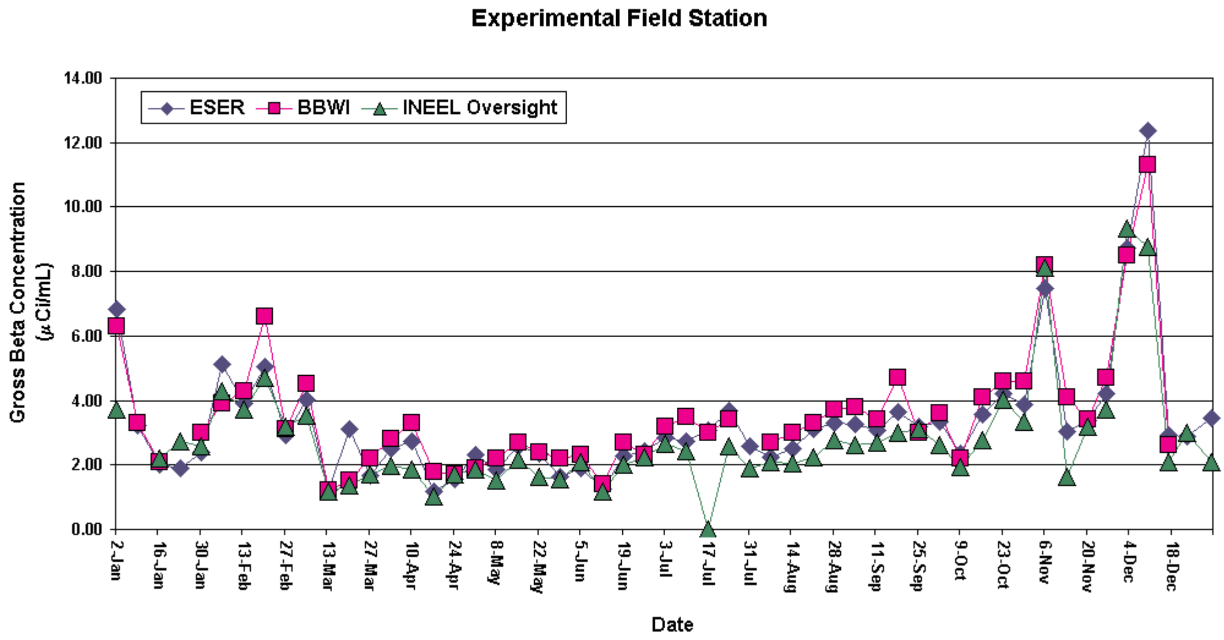


Figure 9-6. Comparison of gross beta concentrations measured by ESER contractor, M&O contractor, and state of Idaho (2002).

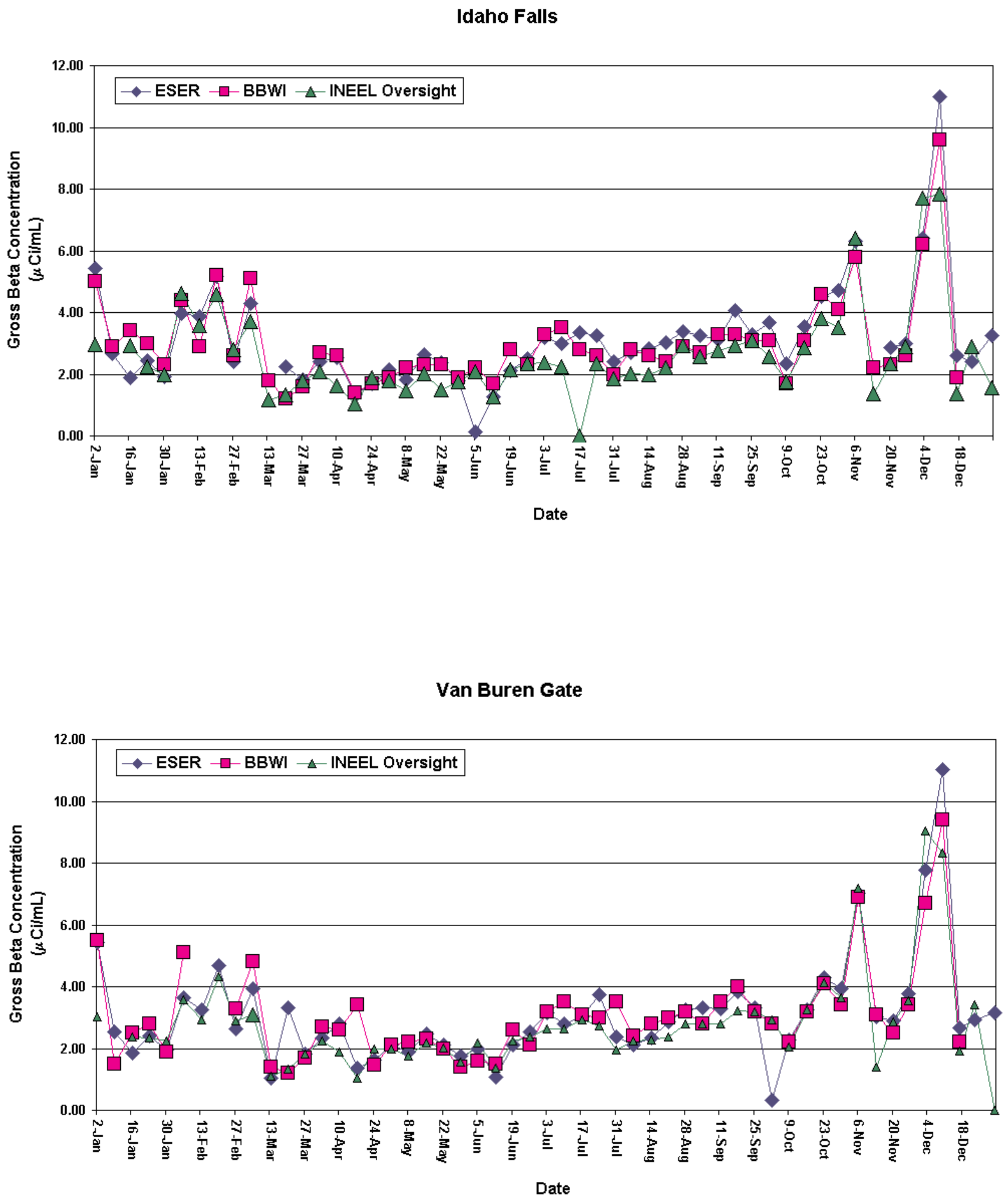


Figure 9-6. Comparison of gross beta concentrations measured by ESER contractor, M&O contractor, and state of Idaho (2002) (continued).

Table 9-1. Comparison of ESER and INEEL Oversight Program water monitoring results (2002).[a]

Location	Date	Gross Alpha (pCi/L) ESER	Gross Alpha (pCi/L) State	Gross Beta (pCi/L) ESER	Gross Beta (pCi/L) State	Tritium (pCi/L) ESER	Tritium (pCi/L) State
Drinking Water							
Atomic City	05/08	-0.34 ± 1.0	-1.5 ± 1.2	1.80 ± 1.83	1.8 ± 0.6	-83.25 ± 60	10 ± 90
	11/06	0.41 ± 0.79	2.7 ± 1.7	3.69 ± 1.79	2.9 ± 0.9	118 ± 107	-35 ± 64
Minidoka	05/08	0.21 ± 1.6	1.6 ± 1.6	8.74 ± 2.53	3.3 ± 0.8	-39.64 ± 60.59	-10 ± 90
	11/11	2.47 ± 1.51	0.7 ± 1.8	8.15 ± 2.14	2.1 ± 0.9	0.0 ± 0.0	-50 ± 64
Mud Lake	05/08	0.1 ± 0.6	0.0 ± 1.0	3.38 ± 1.61	3.6 ± 0.8	-518.24 ± 68.88	-70 ± 90
	11/06	0.02 ± 0.55	0.7 ± 1.0	4.0 ± 1.72	2.8 ± 0.8	0.0 ± 0.0	-30 ± 90
Shoshone	05/07	-0.21 ± 1.11	1.9 ± 1.2	1.98 ± 1.89	2.1 ± 0.8	-257.64 ± 68.37	-40 ± 90
	11/04	0.4 ± 0.64	4.2 ± 1.9	2.07 ± 1.61	1.8 ± 0.9	0.0 ± 0.0	70 ± 90
Surface Water							
Bill Jones Hatchery	05/07	0.56 ± 1.03	1.2 ± 1.2	1.62 ± 1.72	2.5 ± 0.8	-74.75 ± 61.27	-20 ± 90
	11/04	0.39 ± 0.78	2.1 ± 1.5	3.63 ± 1.85	2.5 ± 0.7	0.0 ± 0.0	90 ± 90
Clear Springs	05/07	-0.65 ± 0.99	1.3 ± 1.4	3.48 ± 1.90	2.6 ± 1.0	-120.20 ± 61.36	20 ± 64
	11/04	0.03 ± 0.79	1.8 ± 1.4	3.95 ± 1.90	3.7 ± 1.0	0.0 ± 0.0	-10 ± 90
Alpheus Spring	05/07	-0.22 ± 1.19	0.5 ± 1.7	7.05 ± 2.15	2.3 ± 0.8	-100.31 ± 60.74	30 ± 90
	11/04	0.24 ± 0.89	3.3 ± 2.2	6.26 ± 2.06	2.4 ± 0.9	173 ± 107	0 ± 90

a. Values are shown as the result ± 2 standard deviations, where the standard deviation is the total uncertainty.

Table 9-2. Relative percent difference results.

Parameter	RPD Result
Inorganic and metals	90 percent within the program goal of less than or equal to 35 percent.
Radiological parameters	Two of 23 duplicates had detectable quantities, one of two met the program goal of less than or equal to 35 percent.

Validation performed on analytical results from the 2002 sampling efforts resulted in two rejected samples:

- The January composite pH result for CPP-797 was rejected for exceeding the hold time; and
- The May total suspended solids result for CFA-689 was rejected for exceeding the hold time.

No other sampling or validation issues were identified during calendar year 2002.

Wastewater Land Application Permit Groundwater Monitoring Quality Assurance/Quality Control

The groundwater sampling activities associated with Wastewater Land Application Permit compliance sampling follow established procedures and analytical methodologies.

During 2002, groundwater samples were collected from all of the Idaho Nuclear Technology and Engineering Center (INTEC) and Test Area North (TAN) Wastewater Land Application Permit monitoring wells with the exception of perched wells ICPP MON-V-191 and ICPP-MON-V-212. Well ICPP-MON-V-191 was dry, and well ICPP MON-V-212 did not have a sufficient volume of water to collect a sample. All but one of the samples required for permit compliance were collected. A field pH sample analysis was not performed because the field pH meter failed during sample collection. Of the samples collected and submitted to the laboratory, only six parameter results were rejected as unusable during data validation because of laboratory errors.

Field quality control samples were collected or prepared during the sampling activity in addition to regular groundwater samples. Laboratories qualified by the INEEL Sample Management Office performed all M&O wastewater and groundwater analyses during 2002. Because TAN and INTEC are regarded as separate sites, quality control samples (duplicate samples, field blanks, and equipment blanks) were prepared for each site.

Duplicate samples are collected to assess the potential for any bias introduced by analytical laboratories. One duplicate groundwater sample was collected for every 20 samples collected or, at a minimum, five percent of the total number of samples collected. Duplicates were collected using the same sampling techniques and preservation requirements as regular groundwater samples. Duplicates have precision goals within 35 percent as determined by the relative percent difference measured between the paired samples. In 2002, for the 36 duplicate pairs with detectable results, 94 percent had relative percent differences less than 35 percent. This high percentage of acceptable duplicate results indicates little problem with laboratory contamination and good overall precision.

Field blanks are collected to assess the potential introduction of contaminants during sampling activities. They were collected at the same frequency as the duplicate samples, and they were prepared by pouring analyte-free water (supplied by JT Baker) into the prepared bottles at the sampling site. For most chemical constituents, results above two times the method detection limit are identified as suspected contamination. Results from the field blanks did not indicate field contamination.

Equipment blanks (rinsates) are collected to assess the potential introduction of contaminants during decontamination activities. They were collected from the sample port manifold after decontamination and before subsequent use, also using deionized water. For most chemical constituents, results above two times the method detection limit are identified as suspected contamination. Results from the equipment blanks did not indicate improper decontamination procedures.

Results from the duplicate, field blank, and equipment blank (rinsate) samples indicate that field sampling procedures, decontamination procedures, and laboratory procedures were used effectively to produce high quality data.

Storm Water Monitoring Quality Assurance/Quality Control

The six samples at the Radioactive Waste Management Complex were collected as unfiltered grab samples. No trip blanks or duplicate samples were collected. Sample containers and preservation methods were used according to internal procedures. The data were reviewed according to internal procedures.

Visual examination reports were checked for accuracy against logbook entries before submittal to the industrial storm water coordinator.

Drinking Water Program Quality Assurance/Quality Control

The Drinking Water Program's completeness goal is to collect, analyze, and verify 100 percent of all compliance samples. This goal was met during 2002.

The Drinking Water Program requires that 10 percent of the samples (excluding batcteria) collected be quality assurance/quality control samples to include duplicates, field blanks, trip blanks, blind spikes, and splits. This goal was met in 2002 for all parameters.

The Drinking Water Program's precision goal states that the relative percent difference determined from duplicates must be 35 percent or less for 90 percent of all duplicates. That goal was met for 2002, with 90 percent of the relative percent differences calculated from a sample and its duplicate being less than the required 35 percent (for those with both results detected). Relative percent difference was not calculated if either the sample or its duplicate were reported as nondetects.

Waste Management Surveillance Program Quality Assurance/Quality Control

The M&O contractor analytical laboratories analyzed all Waste Management Surveillance Program samples as specified in the statements of work. These laboratories participate in a variety of intercomparison quality assurance programs, which verify all the methods used to analyze environmental samples. The programs include the DOE Environmental Measurements Laboratory Quality Assurance Program and the EPA Environmental Measurements Systems Laboratory Quality Assurance Program. The laboratories met the performance objectives specified by the EML and Environmental Measurements Systems Laboratory.

The Waste Management Surveillance Program met its completeness goals. Samples were collected and analyzed as planned from all available media. The Waste Management Surveillance Program submitted duplicate, blank, and control samples with routine samples for analyses. Quality assurance/quality control samples were also routinely submitted with program samples and demonstrated an acceptable agreement ratio with spiked values for all radionuclides.

REFERENCES

DOE, 2003, Environmental Measurements Laboratory, Quality Assurance Program, http://www.eml.doe.gov/qap/reports/.

Appendix A - Environmental Statutes and Regulations

The following environmental statutes and regulations are applicable, in whole or in part, on the Idaho National Engineering and Environmental Laboratory (INEEL) or at the INEEL boundary:

- U.S. Environmental Protection Agency (EPA), "National Primary and Secondary Ambient Air Quality Standards," 40 CFR 50, 2001;
- U.S. Environmental Protection Agency, "National Emission Standards for Hazardous Air Pollutants," 40 CFR 61, 2001;
- U.S. Environmental Protection Agency, "Oil Pollution Prevention," 40 CFR 112, 2001;
- U.S. Environmental Protection Agency, "National Pollutant Discharge Elimination System," 40 CFR 122, 2001;
- U.S. Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," 40 CFR 141, 2001;
- U.S. Environmental Protection Agency, "Hazardous Waste Management System: General," 40 CFR 260, 2001;
- U.S. Environmental Protection Agency, "Identifying and Listing of Hazardous Wastes," 40 CFR 261, 2001;
- U.S. Environmental Protection Agency, "Standards Applicable to Generators of Hazardous Waste," 40 CFR 262, 2001;
- U.S. Environmental Protection Agency, "Standards Applicable to Transporters of Hazardous Waste," 40 CFR 263, 2001;
- U.S. Environmental Protection Agency, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," 40 CFR 264, 2001;
- U.S. Department of Commerce, "Designated Critical Habitat," National Marine Fisheries Service, 50 CFR 226;

- U.S. Environmental Protection Agency, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," 40 CFR 265, 2001;
- U.S. Environmental Protection Agency, "Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities," 40 CFR 267, 2001;
- U.S. Department of Energy Order 5400.1, "General Environmental Protection Program," November 1988;
- U.S. Department of Energy Order 5400.5, "Radiation Protection of the Public and the Environment," January 1993;
- U.S. Department of Energy Order 435.1, "Radioactive Waste Management," August 2001;
- U.S. Department of the Interior, "Endangered and Threatened Wildlife and Plants," Fish and Wildlife Service, 50 CFR 17;
- U.S. Department of the Interior, "Listing Endangered and Threatened Species and Designating Critical Habitat," Fish and Wildlife Service, 50 CFR 424;
- U.S. Department of the Interior, "Endangered Species Exemption Process," Fish and Wildlife Service, 50 CFR 450-453;
- U.S. Department of the Interior, "Protection of Archeological Resources," National Park Service, 40 CFR 7;
- U.S. Department of the Interior, "Curation of Federally-Owned and Administered Archeological Collections," National Park Service, 43 CFR 79;
- Department of Environmental Quality, "Rules and Regulations for the Control of Air Pollution in Idaho," 1972, as amended through May 1990;
- Department of Environmental Quality, "Ground Water Quality Rules," 58.01.11, March 1997;
- Department of Environmental Quality, "Wastewater Land Application Permits," 58.01.17, November 1992;
- Department of Environmental Quality, "Idaho Regulations for Public Drinking Water Systems," 58.01.8000-58.01.8999, October 1993;
- Executive Order 11988, "Floodplain Management," May 1977;
- Executive Order 11990, "Protection of Wetlands," May 1977;
- Executive Order 12580, "Superfund Implementation," January 1987;
- Executive Order 12856, "Federal Compliance With Right-to-Know Laws and Pollution Prevention Requirements," August 1993;

- Executive Order 12873, “Federal Acquisition, Recycling, and Waste Prevention,” October 1993; and
- Executive Order 13101, “Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition,” September 1998.

The Derived Concentration Guides (DCGs) are based on the U.S. Department of Energy (DOE) standard (DOE 1993) and have been calculated using DOE models and parameters for internal (DOE 1988a) and external (DOE 1988b) exposure. These are shown in Table A-1. The most restrictive guide is listed when there is a difference between the soluble and insoluble chemical forms. The DCGs consider only the inhalation of air, the ingestion of water, and submersion in air. The principal standards and guides for release of radionuclides at the INEEL are those of DOE Order 5400.5, “Radiation Protection of the Public and the Environment.” The DOE standard is shown in Table A-2 along with the EPA statute for protection of the public, airborne pathway only.

Ambient air quality statutes are shown in Table A-3. Water quality statutes are dependent on the type of drinking water system sampled. Table A-4 is a partial list of maximum contaminant levels set by the EPA for public drinking water systems in 40 CFR 141 (2002).

Table A-1. Derived concentration guides for radiation protection.

Derived Concentration Guide[a,b]			Derived Concentration Guide		
Radionuclide	**In Air**	**In Water**	**Radionuclide**	**In Air**	**In Water**
Gross Alpha[c]	2×10^{-14}	3×10^{-8}	^{125}Sb	1×10^{-9}	5×10^{-5}
Gross Beta[d]	3×10^{-12}	1×10^{-7}	^{129}I	7×10^{-11}	5×10^{-7}
^{3}H (water)	1×10^{-7}	2×10^{-3}	^{131}I	4×10^{-10}	3×10^{-6}
^{14}C	5×10^{-7}	7×10^{-2}	^{132}I	4×10^{-8}	2×10^{-4}
^{24}Na[e]	4×10^{-9}	1×10^{-4}	^{133}I	2×10^{-9}	1×10^{-5}
^{41}Ar	1×10^{-8}	—	^{135}I	1×10^{-8}	7×10^{-5}
^{51}Cr	5×10^{-8}	1×10^{-3}	^{131m}Xe	2×10^{-6}	—
^{54}Mn	2×10^{-9}	5×10^{-5}	^{133}Xe	5×10^{-7}	—
^{58}Co	2×10^{-9}	4×10^{-5}	^{133m}Xe	6×10^{-7}	—
^{60}Co	8×10^{-11}	5×10^{-6}	^{135}Xe	8×10^{-8}	—
^{65}Zn	6×10^{-10}	9×10^{-6}	^{135m}Xe	5×10^{-8}	—
^{85}Kr	3×10^{-6}	—	^{138}Xe	2×10^{-8}	—
^{85m}Kr[f]	1×10^{-7}	—	^{134}Cs	2×10^{-10}	2×10^{-6}
^{87}Kr	2×10^{-8}	—	^{137}Cs	4×10^{-10}	3×10^{-6}
^{88}Kr	9×10^{-9}	—	^{138}Cs	1×10^{-7}	9×10^{-4}
^{88d}Rb	3×10^{-8}	8×10^{-4}	^{139}Ba	7×10^{-8}	3×10^{-4}
^{89}Rb	9×10^{-9}	2×10^{-3}	^{140}Ba	3×10^{-9}	2×10^{-5}
^{89}Sr	3×10^{-10}	2×10^{-5}	^{141}Ce	1×10^{-9}	5×10^{-5}
^{90}Sr	9×10^{-12}	1×10^{-6}	^{144}Ce	3×10^{-11}	7×10^{-6}
^{91m}Y	4×10^{-7}	4×10^{-3}	^{238}Pu	3×10^{-14}	4×10^{-8}
^{95}Zr	6×10^{-10}	4×10^{-5}	^{239}Pu	2×10^{-14}	3×10^{-8}
^{99m}Tc	4×10^{-7}	2×10^{-3}	^{240}Pu	2×10^{-14}	3×10^{-8}
^{103}Ru	2×10^{-9}	5×10^{-5}	^{241}Am	2×10^{-14}	3×10^{-8}
^{106}Ru	3×10^{-11}	6×10^{-6}			

a. Derived concentration guides (DCGs) are from DOE Order 5400.5 and are based on an effective dose equivalent of 100 mrem/yr.

b. All values are in microcuries per milliliter.

c. Based on the most restrictive alpha emitter (^{241}Am).

d. Based on the most restrictive beta emitter (^{228}Ra).

e. Submersion in a cloud of gas is more restrictive than the inhalation pathway.

f. An "m" after the number refers to a metastable form of the radionuclide.

Table A-2. Radiation standards for protection of the public in the vicinity of DOE facilities.

	Effective Dose Equivalent	
	mrem/yr	**mSv/yr**
DOE Standard for routine DOE activities (all pathways)	100[a]	1
EPA Standard for site operations (airborne pathway only)	10	0.1

a. The effective dose equivalent for any member of the public from all routine DOE operations, including remedial activities, and release of naturally occurring radionuclides shall not exceed this value. Routine operations refer to normal, planned operations and do not include accidental or unplanned releases.

Table A-3. EPA ambient air quality standards.

Pollutant	Type of Standard[a]	Sampling Period	EPA[b,c]
Sulfur Dioxide	Secondary	3-hour average	1300
	Primary	24-hour average	365
	Primary	Annual average	80
Nitrogen Dioxide	Primary and Secondary	Annual average	100
	Secondary	24-hour average	150
Total Particulates[d]	Primary and Secondary	Annual average	50

a. National primary ambient air quality standards define levels of air quality to protect the public health. Secondary ambient air quality standards define levels of air quality to protect the public welfare from any known or anticipated adverse effects of a pollutant.

b. The state of Idaho has adopted these same ambient air quality standards.

c. All values are in micrograms per cubic meter.

d. The primary and secondary standard to the annual average applies only to "particulates with an aerodynamic diameter less than or equal to a nominal 10 micrometers."

Table A-4. EPA maximum contaminant levels for public drinking water systems.

Constituent	Maximum Contaminant Levels[a]
Gross alpha	15 pCi/L
Gross beta[b]	50 pCi/L
Beta/gamma emitters	[c]
Nitrate (as N)	10
Fluoride	4
Trihalomethanes (Chloroform)	0.08
Carbon tetrachloride	0.005
Tetrachloroethylene	0.005
Toluene	1.0
1,1,1-trichloroethane	0.2
Trichloroethylene	0.005
Arsenic	0.01
Barium	2
Cadmium	0.005
Chromium	0.1
Copper	1.3
Lead	0.015
Mercury	0.002
Selenium	0.05

a. All values are in milligrams per liter unless otherwise noted.

b. The maximum contaminant level is established for gross beta as an exposure (4 mrem). The value shown is the screening level concentration.

c. Concentrations resulting in 4 mrem total body or organ dose equivalent.

REFERENCES

40 CFR 141, 2002, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, Office of the Federal Register.

DOE Order 5400.5, 1993, "Radiation Protection of the Public and the Environment," U.S. Department of Energy, January 7.

DOE (U.S. Department of Energy), 1988a, *Internal Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0071, July.

DOE, 1988b, *External Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0070, July.

Appendix B - Statistical Methods used in the Idaho National Engineering and Environmental Laboratory Annual Site Environmental Report

Relatively simple statistical procedures are used to analyze the data collected by the Idaho National Engineering and Environmental Laboratory (INEEL) Environmental Surveillance, Education and Research (ESER) program. ESER program personnel initially review field collection information and analytical results to determine whether there are clearly identifiable errors that would invalidate or limit the use of the results. Examples of these might be power outages at air sampler locations, torn membrane filters, or evidence of laboratory cross-contamination. Data that pass this initial screening are then evaluated for statistical significance with respect to laboratory analytical uncertainties, sample locations, reported releases from INEEL operations, meteorological data, and worldwide events that might conceivably have an effect on the regional environment.

Reporting Results

The results reported in the quarterly and annual reports are assessed in terms of data quality and statistical significance with respect to laboratory analytical uncertainties, sample locations, reported INEEL releases, meteorological data, and worldwide events that might conceivably have an effect on the INEEL environment. First, field collection and laboratory information are reviewed to determine identifiable errors that would invalidate or limit use of the data. Examples of these include insufficient sample volume, torn filters, evidence of laboratory cross-contamination, or quality control issues. Data that pass initial screening are further evaluated using statistical methods. Statistical tools are necessary for data evaluation particularly since environmental measurements typically involve the determination of minute concentrations, which are difficult to detect and even more difficult to distinguish from other measurements.

The term "measurable" as used for the discussion of results in this report does not imply any degree of risk to the public or environment but rather indicates that the radionuclide was detected at a concentration sufficient for the analytical instrument to record a value. The minimum detectable concentration (MDC) is used to assess measurement process capabilities. The MDC indicates the ability of the laboratory to detect an analyte in a sample at desired concentration levels. The ESER requires that the laboratory be able to detect radionuclides at levels below that normally expected in environmental samples, as observed historically in the region. These levels are typically well below regulatory limits. The MDC is instrument and analysis specific, and it is established by the analytical laboratory at the beginning of each analytical run. The MDC is an analytical/instrument value, determined by the laboratory before each analysis, above which there is a greater than 99.99 percent confidence that an analyte in a sample can be accurately measured.

It is the goal of the ESER program to minimize the error of saying something is not present when it actually is, to the extent that is reasonable and practicable. This is accomplished through the use of the uncertainty term, which is reported by the analytical laboratory with the sample result. For radiological data, individual analytical results are presented in this report with plus or minus two analytical standard deviations (± 2s). Where all analytical uncertainties have been estimated, "s" is an estimate of the population standard deviation "s," assuming a Guassian or normal distribution. The result plus or minus (±) the uncertainty term (2s) represents the 95 confidence interval for the measurement. That is, there is 95 percent confidence that the real concentration in the sample lies somewhere between the measured concentration minus the uncertainty term and the measured concentration plus the uncertainty term. By using a 2s value as a reporting level, the error rate for saying something is not there when it is, is kept to less than 5 percent. However, there may be a relatively high error rate for false detections (reporting something as present when it actually is not) for results near their 2s uncertainty levels. This is because the variability around the sample result may substantially overlap the variability around a net activity of zero for samples with no radioactivity. If the result lies in the range of two to three times its estimated analytical uncertainty (2s to 3s), and assuming that the result belongs to a Gaussian distribution (a bell-shaped curve), detection of the material by the analysis may be questionable because of statistical variations within the group of samples. Analyses with results in the questionable range (2s to 3s) are thus presented in this report with the understanding that the radionuclide may not actually be present in the sample. If the result exceeds 3s, there is higher confidence that the material was detected (or, that the radionuclide was indeed present in the sample). If a result is less than or equal to 2s there is little confidence that the radionuclide is present in the sample.

There are many factors that can influence the result to some degree. These factors are considered and included in the methods used to determine the estimated uncertainty of the measurement. Counting statistics primarily cause uncertainties in measurements near the MDC. For low concentrations near the MDC, the uncertainty in the measurement is nearly equal to the measurement itself, and the lower limit of the range of the measurement approaches "zero." As a result, such values might not be very reliable because the uncertainty is only an estimate and the actual probability distribution of the results is not usually known. In reality, the material being measured may not actually be present in the sample (termed a false positive). Therefore, when analytical results show a measurement very near the MDC, statistical tools, meteorological data, and INEEL release information are all considered when interpreting and evaluating the results.

Statistical Tests

An example set of data are presented here to illustrate the statistical tests used to assess data collected by the ESER contractor. The dataset used are the gross beta environmental surveillance data collected from January 8, 1997 through December 26, 2001. The data were collected weekly from several air monitoring stations located around the perimeter of the INEEL and air monitoring stations throughout the Snake River Plain. The perimeter locations are termed "boundary" and the plain locations are termed "distant." There are seven boundary locations (Arco, Atomic City, Birch Creek, Federal Aviation Administration [FAA] Tower, Howe, Monteview, and Mud Lake) and five distant locations (Blackfoot, Blackfoot Community Monitoring Station [CMS], Craters of the Moon, Idaho Falls, and Rexburg CMS). The gross beta data are of the magnitude 10^{-15}. To simplify the calculations and interpretation, these have been coded by multiplying each measurement by 10^{-15}.

Only portions of the complete gross beta data set are used. The purpose of this task is to evaluate and illustrate the various statistical procedures and not a complete analysis of the data.

Test of Normality

The first step in any analysis of data is a test for normality. Many standard statistical tests of significance require that the data be normally distributed. The most widely used test of normality is the Shapiro-Wilk W test (Shapiro and Wilk 1965). The Shapiro-Wilk W test is the preferred test of normality because of its good power properties as compared to a wide range of alternative tests (Shapiro et al. 1968). If the W statistic is significant ($p < 0.00001$), then the hypothesis that the respective distribution is normal should be rejected.

Graphical depictions of the data should be a part of any evaluation of normality. The following histogram (Figure B-1) presents such a graphical look along with the results of the Shapiro-Wilk W test. The data used for the illustration are the five years of weekly gross beta measurements for the Arco boundary location. The W statistic is highly significant ($p < 0.0001$), indicating that the data are not normally distributed. The histogram shows that the data are asymmetrical with right skewness. This suggests that the data may be lognormally distributed. The Shapiro-Wilk W test can be used to test this distribution by taking the natural logarithms of each measurement and calculating the W statistic. Figure B-2 presents this test of lognormality. The W statistic is not significant ($p = 0.80235$), indicating that the data are lognormal.

To perform parametric tests of significance, such as Student's t test or One-Way Analysis of Variance (ANOVA), it is required that all data be normally (or lognormally) distributed. Therefore, to compare gross beta results of each boundary location, tests of normality must be performed before such comparisons are made. Table B-1 presents the results of the Shapiro-Wilk W test for each of the seven boundary locations.

From Table B-1, none of the locations consist of data that are normally distributed and only some of the data sets are lognormally distributed. This is a typical result and a common problem when using a parametric test of significance. When many comparisons are to be made, attractive alternatives are nonparametric tests of significance.

Comparison of Two Groups

For comparison of two groups, the Mann-Whitney U test (Hollander and Wolfe 1973) is a powerful nonparametric alternative to the Student's t test. In fact, the U test is the most powerful

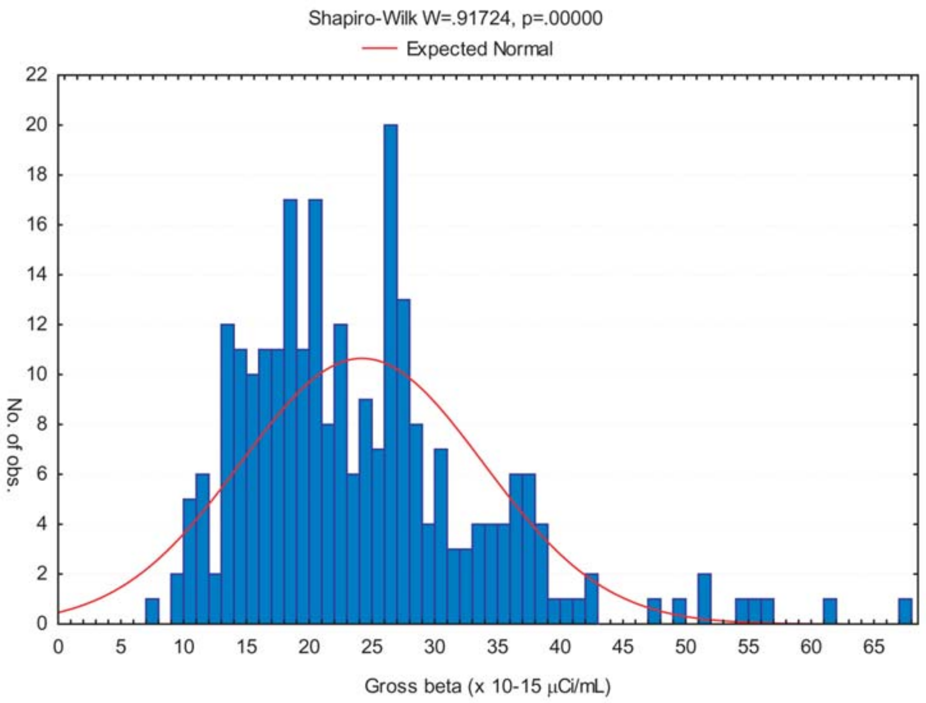


Figure B-1. Test of normality for Arco gross beta data.

(or sensitive) nonparametric alternative to the t test for independent samples; in some instances it may offer even greater power to reject the null hypothesis than the t test. The interpretation of the Mann-Whitney U test is essentially identical to the interpretation of the Student's t test for independent samples, except that the U test is computed based on rank sums rather than means. Because of this fact, outliers do not present the serious problem that they do when using parametric tests.

Table B-1. Tests of normality for boundary locations.

	Normal		Lognormal	
Location	**W statistic**	**p-value**	**W statistic**	**p-value**
Arco	0.9172	<0.0001	0.9963	0.8024
Atomic City	0.9174	<0.0001	0.9411	<0.0001
Birch Creek	0.8086	<0.0001	0.9882	0.0530
FAA Tower	0.9119	<0.0001	0.9915	0.1397
Howe	0.8702	<0.0001	0.9842	0.0056
Monteview	0.9118	<0.0001	0.9142	<0.0001
Mud Lake	0.6130	<0.0001	0.9704	<0.0001

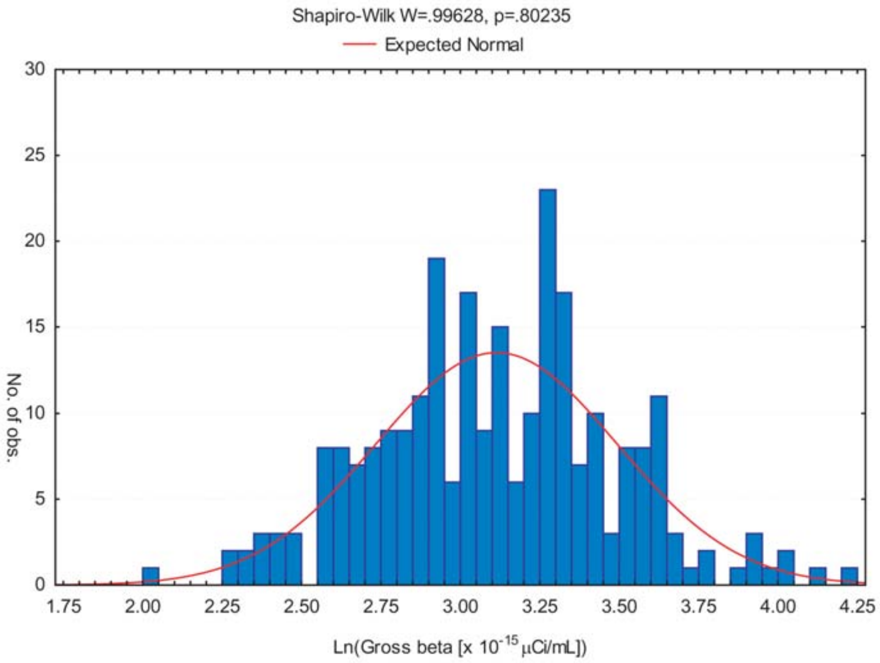


Figure B-2. Test of lognormality for Arco gross beta.

Suppose we wish to compare all boundary locations to all distant locations. Figure B-3 presents the box plots for the two groups. The median is the measure of central tendency most commonly used when there is no assumed distribution. It is the middle value when the data are ranked from smallest to largest. The 25th and 75th percentiles are the values such that 75 percent of the measurements in the data set are greater than the 25th percentile and 75 percent of the measurements are less than the 75th percentile. The large distance between the medians and the maximums seen in Figure B-3 indicate the presence of outliers. It is apparent that the medians are of the same magnitude, indicating graphically that there is probably not a significant difference between the two groups.

The Mann-Whitney U test compares the rank sums between the two groups. In other words, for both groups combined, it ranks the observations from smallest to largest. Then it calculates the sum of the ranks for each group and compares these rank sums. A significant p-value ($p < 0.05$) indicates a significant difference between the two groups. The p-value for the comparison of boundary and distant locations is not significant ($p = 0.0599$). Therefore, the conclusion is that there is not strong enough evidence to say that a significant difference exists between boundary and distant locations.

Comparison of Many Groups

Comparing the boundary locations amongst themselves in the parametric realm is done with a One-Way ANOVA. A nonparametric alternative to the One-Way ANOVA is the Kruskal-Wallis ANOVA (Hollander and Wolfe 1973). The test assesses the hypothesis that the different samples in the comparison were drawn from the same distribution or from distributions with the same median. Thus, the interpretation of the Kruskal-Wallis ANOVA is basically identical to that of the parametric One-Way ANOVA, except that it is based on ranks rather than means.

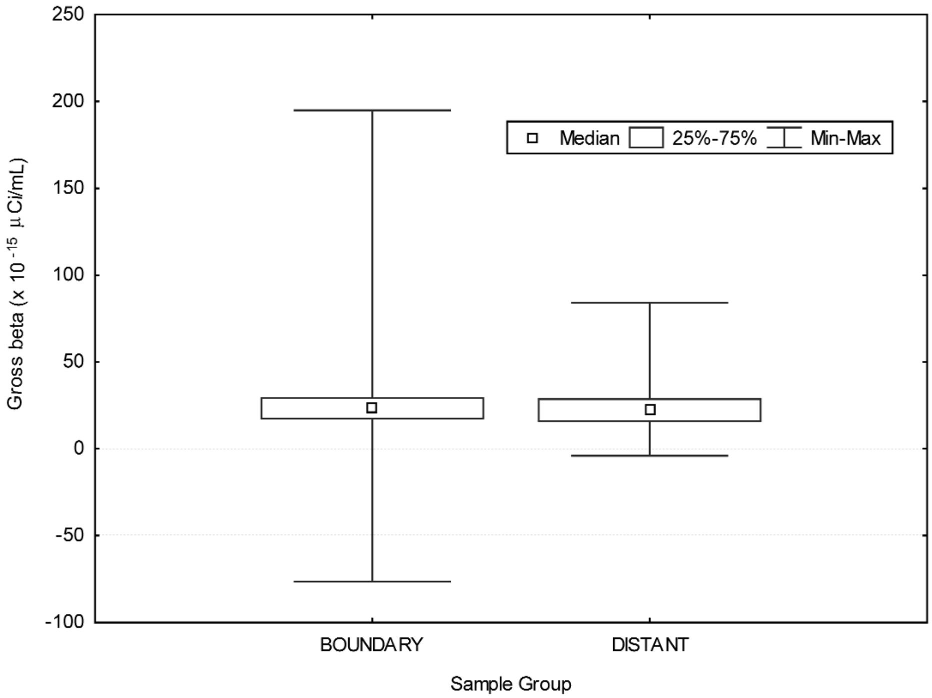


Figure B-3. Box plot of gross beta data from boundary and distant locations.

Figure B-4 presents the box plot for the boundary locations. The Kruskal-Wallis ANOVA test statistic is highly significant ($p < 0.0001$), indicating a significant difference amongst the seven boundary locations. Table B-2 gives the number of samples, medians, minimums, and maximums for each boundary location. The Kruskal-Wallis ANOVA only indicates that significant differences exist between the seven locations and not the individual occurrences of differences. If desired, the next step is to identify pairs of locations of interest and test those for significant differences using the Mann-Whitney U test. It is cautioned that all possible pairs should not be tested, only those of interest. As the number of pairs increases, the probability of a false conclusion also increases.

Suppose a comparison between Arco and Atomic City is of special interest because of their close proximity. A test of significance using the Mann-Whitney U test results in a p-value of 0.7288, indicating that a significant difference does not exist between gross beta results at Arco and Atomic City. Other pairs can similarly be tested but with the caution given above.

Tests for Trends Over Time

Regression analysis is used to test whether or not there is a significant positive or negative trend in gross beta concentrations over time. To illustrate the technique, the regression analysis is performed for the boundary locations as one group and the distant locations as another group. The tests of normality performed earlier indicated that the data were closer to lognormal than normal. For that reason, the natural logarithms of the original data are used in the regression analysis. Regression analysis assumes that the probability distributions of the dependent variable (gross beta) have the same variance regardless of the level of the independent variable (collection date). The natural logarithmic transformation helps in satisfying this assumption.

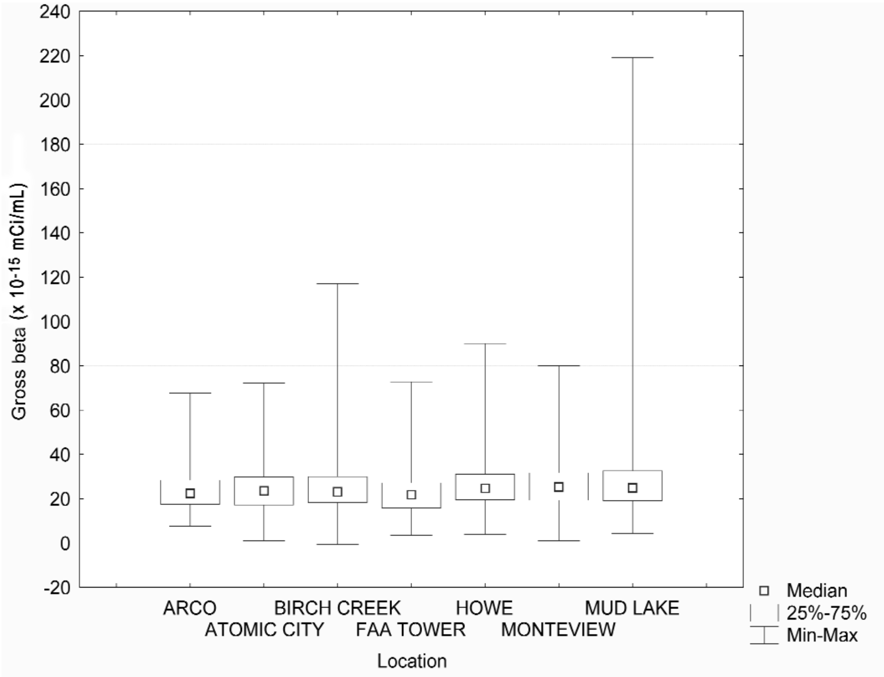


Figure B-4. Box plot of gross beta data for each boundary location.

Table B-2. Summary statistics for boundary locations.

Location	Number of Samples	Median[a]	Minimum[a]	Maximum[a]
Arco	258	22.49	7.53	67.66
Atomic City	260	23.61	1.13	72.20
Birch Creek	234	23.15	-0.52	117.00
FAA Tower	260	21.90	3.59	72.78
Howe	260	24.55	3.95	90.10
Monteview	260	25.30	1.03	80.10
Mud Lake	260	24.85	4.30	219.19

a. All values are × 10^{-15} microcuries per milliliter.

Figure B-5 presents a scatterplot of the boundary data with the fitted regression line superimposed. Figure B-6 presents the same for the distant data. Table B-3 gives the regression equation and associated statistics. There appears to be slightly increasing trends in gross beta over time for both the boundary and distant locations. A look at the regression equations and correlation coefficients in Table B-3 confirm this. Notice that the slope parameter of the regression equation and the correlation coefficient are equal. This is true for any linear regression fit. So, a test of significant correlation is also a test of significant trend. The p-value associated with testing, whether or not the correlation coefficient is different from zero, is the same as for testing if the slope of the regression line is different from zero. For both the boundary and distant locations, the slope is significantly different from zero and positive indicating an increasing trend in gross beta over time.

Another important point of note in Figures B-5 and B-6 is the obvious existence of a cyclical trend in gross beta. It appears as if the gross beta measurements are highest in the summer months and lowest in the winter months. Since the regression analysis performed above is over several years, we are still able to detect a positive trend over time even though it is confounded somewhat by the existence of a cyclical trend. This is important because a linear regression analysis performed over a shorter time period may erroneously conclude a significant trend, when in fact, it is just a portion of the cyclical trend.

Comparison of Slopes

A comparison of slopes between the regression lines for the boundary locations and distant locations will indicate if the rate of change in gross beta over time differs with location. The comparison of slopes can be performed by constructing 95 percent confidence intervals about the slope parameter (Neter and Wasserman 1974). If these intervals overlap, we can conclude that there is no evidence to suggest a difference in slopes for the two groups of locations.

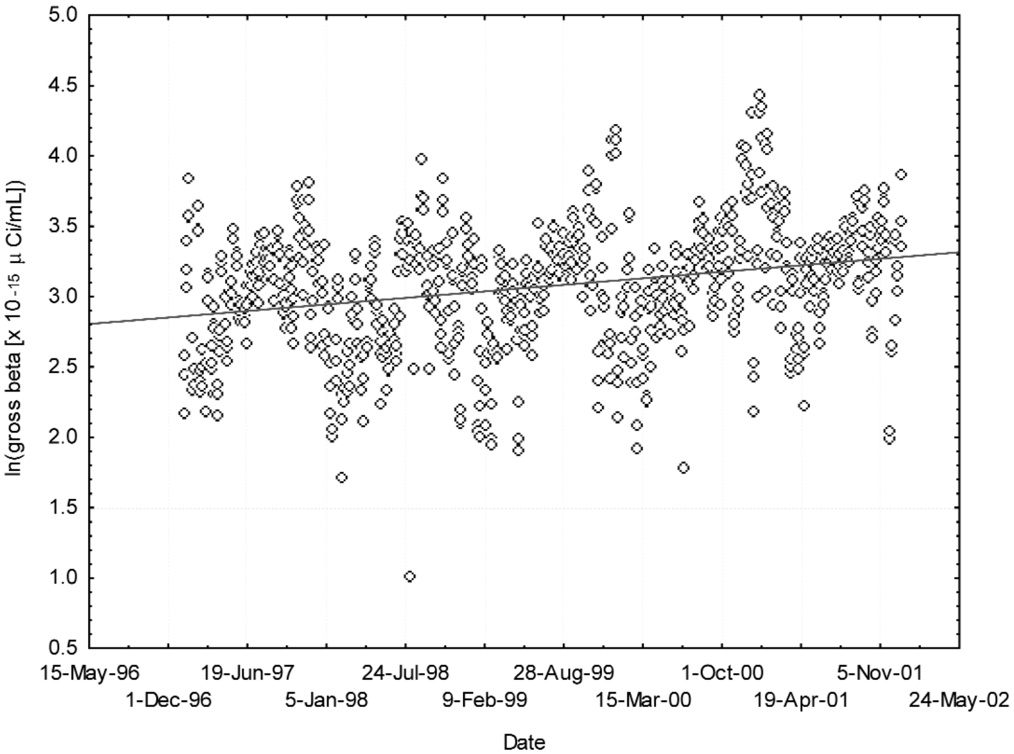


Figure B-5. Scatter plot and regression line for ln(gross beta) from boundary locations.

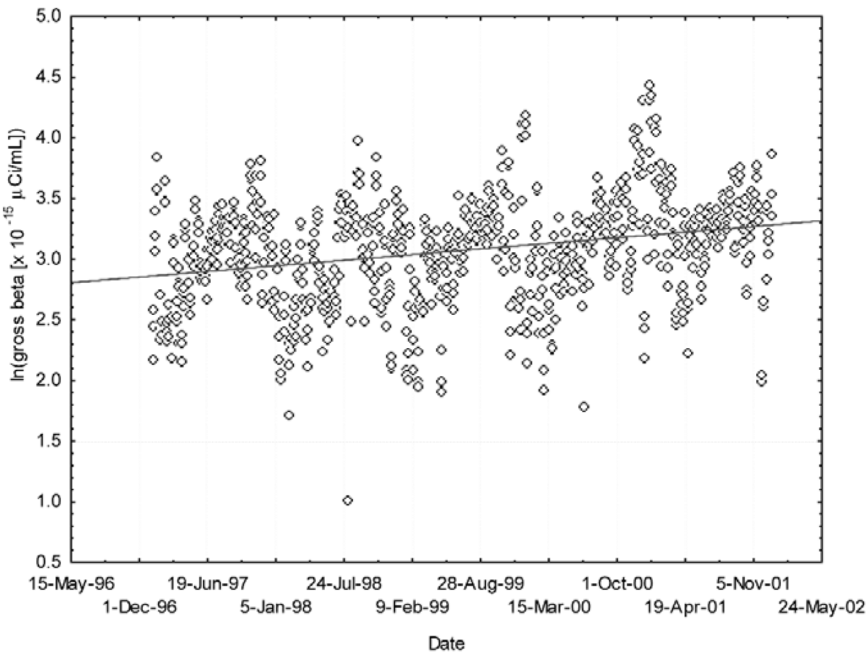


Figure B-6. Scatter plot and regression line for ln(gross beta) from distant locations.

Table B-3. Regression equations and associated statistics for boundary and distant locations.

Sample Group	Regression Equation	Correlation Coefficient	p-value
Boundary	ln(gross beta) = -38.7 + 0.245×(date)	0.245	<0.0001
Distant	ln(gross beta) = -39.4 + 0.253×(date)	0.253	<0.0001

A confidence interval for the slope is constructed as $b - t_{0.025,n-2} s_b \le \beta \le b + t_{0.025,n-2} s_b$ where:

b = point estimate of the slope;

$t_{0.025,n-2}$ = the Student's t-value associated with two-sided 95 percent confidence and *n-2* degrees of freedom;

s^b = the standard deviation of the slope estimate, *b*; and

ß = the true slope, which is unknown.

Table B-4 gives the values used in constructing of the confidence intervals and the resulting confidence intervals. From the fifth column of Table B-4 (the confidence intervals for the slope overlap), we can conclude that there is no difference in the rate of change in gross beta measurements for the two location groupings, boundary and distant.

Table B-4 . Ninety-five percent confidence intervals on the true slope.

Sample Group	b	z[a]	s_b	95 percent Confidence Interval
Boundary	0.245	1.96	0.0229	[0.200, 0.290]
Distant	0.253	1.96	0.0269	[0.200, 0.306]

a. For large sample sizes, the standard normal z-value is used instead of the Student’s t-value.

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Appendix C - U.S. Geological Survey 2002 INEEL Publication Abstracts

Estimated Age and Source of the Young Fraction of Ground Water at the Idaho National Engineering and Environmental Laboratory (Busenburg et al. 2001)

The U.S. Geological Survey, in cooperation with the U.S. Department of Energy, used concentrations of chlorofluorocarbons (CFCs), sulfur hexafluoride, helium (He), and tritium (^{3}H) to determine the estimated age of the young fraction of groundwater at and near the Idaho National Engineering and Environmental Laboratory (INEEL). These environmental tracers were introduced into the Snake River Plain Aquifer by natural recharge, return flow of irrigation water, and wastewater disposal at facilities at the INEEL. The source of the water and the fraction of young water in the samples also were used to date the groundwater. The data indicate that most groundwater samples are mixtures containing young fractions of water recharged after 1950 and older regional groundwater.

Data indicate that water in samples from wells in the southeastern part of the INEEL are a binary mixture of local recharge and very old regional ground water, and samples from most of the wells are about 20 to 50 percent young water that is about 14 to 21 years old. Two main mechanisms of recharge of the young fraction of groundwater were recognized in samples from the northern part of the INEEL: (1) water recharged by rapid focused recharge through the thick unsaturated zone and (2) water recharged by slow infiltration through the thick unsaturated zone. Some of the wells in the northern part of the INEEL contained all old regional water. Three wells in the northeastern part of the INEEL contained water that was strongly affected by agricultural practices and likely was recharged in the Terreton-Mud Lake area. This water was present in Wells 4, 27, and 29 and had estimated ages or 5, 10-13, and 24-28 years, respectively.

Water samples from wells that contained a young fraction of water that recharged in the central, western, and southwestern parts of the INEEL area complex contained mixtures of regional groundwater, agricultural return flow, natural recharge, and artificial recharge from infiltration ponds and injection wells at the various facilities at the INEEL. The chemistry and age or the young fraction of the samples varied greatly and could be correlated with distance from the source of recharge, depth of the open interval below the water table, length of the interval sampled, and location of the well with respect to the different sources of recharge. Age increased with distance from the source of recharge and increased with depth below the water table. The young recharge water comprises a very small fraction of the total volume of water in the Snake River Plain Aquifer, and this young water was sampled because most or the wells at and near the INEEL are completed in the upper 15 m of the aquifer.

Concentrations of fluoride (F), boron (B), lithium (Li), strontium (Sr), oxygen isotope ratios ($\delta^{18}O$), dissolved atmospheric gases, helium (He), and tritium (^{3}H), were used to determine the sources of water in the Snake River Plain Aquifer at and near the INEEL. Three natural groundwater types were identified from their He, Li, and F concentrations: (1) northeastern regional water with very high He, Li, and F concentrations, (2) recharge from the southeast with moderate He and high Li and F concentrations, and (3) recharge from mountain valleys in the western part of the INEEL with low concentrations of He and Li and high concentrations of Ca, Mg, and alkalinity. The water was modified locally by mixing with agricultural runoff and wastewater from INEEL facilities. The $\delta^{18}O$ ratios were used to calculate the fraction of young water in the samples from the western part of the INEEL. Terrigenic He and ^{3}H concentrations were used to calculate the fraction of infiltration recharge at the INEEL.

A preferential ground water flowpath that extends from the Little Lost River and Big Lost River Sinks southward through central INEEL past Big Southern Butte was identified. Flow velocities were estimated from tritium/helium ages and were about 3 m per day through the preferential flowpath. Flow velocities decreased to 1 m or less per day outside this preferential flowpath.

In areas where fractured basalts are exposed at the surface, both tritium and CFCs were present in the groundwater. The presence of these constituents indicates that focused recharge of post-1950s infiltration water occurred along preferential flowpaths through the unsaturated zone. This type of recharge was recognized in many areas at and near the INEEL.

Recharge temperatures were calculated from nitrogen and argon concentrations for many of the ground water samples and are useful indicators of the source of water in the Snake River Plain Aquifer at the INEEL. Recharge temperatures of about 6°C characterize underflow from Birch and Camas Creeks and Little Lost and Big Lost Rivers. Recharge temperatures of 9 to 13°C were calculated for the regional ground water of the Snake River Plain Aquifer at the INEEL.

Groundwater near the Radioactive Waste Management Complex, the Test Reactor Area, and the Idaho Nuclear Technology and Engineering Center contains concentrations of chlorofluorocarbans (CFCs) that are indicative of contamination. A large CFC-12 waste plume originating near the INTEC extends beyond the southern boundary of the INEEL.

Water in wells that are cased a few tens of meters below the water table contained no halocarbons, except for water in wells downgradient from injection wells. Greater-than-atmospheric concentrations of CFCs and other halocarbons were found in soil gases obtained from a depth of 1 m as far as 20 km south of the southwest corner of the INEEL. High concentrations of halocarbons also were found in unsaturated zone air blowing from the annulus of some wells in the southwestern part of the INEEL. The advective transport of CFCs and other halocarbons throughout the unsaturated zone probably occurs preferentially both vertically and horizontally along fractures associated with volcanic vent corridors. Barometric pumping appears to be the primary mechanism controlling the distribution of gases in the unsaturated zone in the southwestern part of the INEEL. Diffusion is the primary mechanism of gas transport of the northern and northeastern part of the INEEL in the areas that are covered by thick lacustrine and sedimentary playa deposits.

Introduction to the Hydrogeology of the Eastern Snake River Plain *(Bartholomay et al. 2002)*

This chapter gives a general overview of the hydrogeology of the eastern Snake River Plain and the INEEL and a description of the INEEL Lithologic Core Storage Library, a source of data for many of the chapters in this volume. It also summarizes definitions and lithostratigraphic terminology for the volume. This volume summarizes geoscience research on the INEEL site in the 1990s. The chapters are written by scientists from many organizations, including INEEL contractors, universities, the U.S. Geological Survey, the state of Idaho, and the Idaho Water Resources Research Institute.

Accumulation and Subsidence of Late Pleistocene Basaltic Lava Flows of the Eastern Snake River Plain, Idaho *(Champion et al. 2002)*

This chapter presents studies of cores from drill holes. It provides detailed petrographic descriptions, paleomagnetic characterization and correlation, and conventional K-Ar and $^{40}Ar/^{39}Ar$ dating, which allow examination of the process of accumulation of basaltic lava flows in a part of the eastern Snake River Plain, Idaho. Core holes at various locations in the INEEL demonstrate variable accumulation rates that can be fitted by linear regression lines with high correlation coefficients. Hiatuses of several hundred thousand years are represented in many of the core holes, but accumulation of flows resumed in most of the areas sampled by these core holes at rates nearly identical to previous rates. The studies show that an area of the eastern Snake River Plain north of its topographic axis, including the area of the INEEL, has undergone a hiatus in eruptive activity for the past ~200 thousand years. The data also allow enhanced interpretations of the volcanic hazard to the INEEL with regard to lava flow inundation, prediction of lava flow thickness, and assessment of eruption recurrence-time intervals.

A Hydrogen-based Subsurface-microbial Community Dominated by Methanogens *(Chapelle et al. 2002)*

The search for extraterrestrial life may be facilitated if ecosystems can be found on Earth that exist under conditions analogous to those present on other planets or moons. It has been proposed, on the basis of geochemical and thermodynamic considerations, that geologically derived hydrogen might support subsurface microbial communities on Mars and Europa in which methanogens form the base of the ecosystem. This article describes a unique subsurface microbial community in which hydrogen-consuming, methane-producing archaea far out number the bacteria. More than 90 percent of the 165 ribosomal DNA sequences recovered from hydrothermal waters circulating through deeply buried igneous rocks in Idaho are related to hydrogen-using methanogenic microorganisms. Geochemical characterization indicates that

geothermal hydrogen, not organic carbon, is the primary energy source for this methanogen-dominated microbial community. These results demonstrate that hydrogen-based methanogenic communities do occur in Earth's subsurface, providing an analogue for possible subsurface microbial ecosystems on other planets.

Tension Cracks, Eruptive Fissures, Dikes, and Faults Related to Late Pleistocene-Holocene Basaltic Volcanism and Implications for the Distribution of Hydraulic Conductivity in the Eastern Snake River Plain, Idaho *(Kuntz et al. 2002)*

Tension crack-eruptive fissure systems are a key characteristic of most late Pleistocene-Holocene basaltic lava fields in the eastern Snake River Plain, Idaho. Models based on elastic displacements that accompany dike intrusion and the dimensions of tension cracks and eruptive fissures give new perspectives on the size and shapes of dike systems in the eastern Snake River Plain. Elastic-displacement models predict faults related to dike intrusion, but these are absent at the late Pleistocenecene-Holocene lava fields. Numerous faults in the Box Canyon area of the Arco-Big Southern Butte volcanic rift zone can be misinterpreted as being related to dike-emplacement processes. Our data strongly suggest that these faults are tectonic in origin and related to the Lost River range-front fault.

Data about size and shapes of dike systems, in conjunction with detailed mapping and regional paleomagnetic studies, are used to interpret the style of volcanism in a part of the Idaho National Engineering and Environmental Laboratory and for the entire eastern Snake River Plain. The mapping-paleomagnetic studies suggest that sections of dike systems as long as ~40 km can be active simultaneously or within periods of time as short as a few hundred years.

The characteristics and locations of dikes, eruptive fissure systems, and tension cracks have implications for the movement of groundwater and migration of radioactive and chemical wastes in the Snake River Plain Aquifer at the INEEL. Buried zones of northwest-trending dikes, eruptive fissures, and tension cracks, referred to as vent corridors, are perpendicular to the regional direction of groundwater flow and probably control some of the lowest and highest estimates of hydraulic conductivity in the aquifer.

Kilometer-Scale Rapid Transport of Naphthalene Sulfonate Tracer in the Unsaturated Zone at the Idaho National Engineering and Environmental Laboratory *(Nimmo et al. 2002)*

To investigate possible long-range flow paths through the interbedded basalts and sediments of a 200-m-thick unsaturated zone, we applied a chemica1 tracer to seasonally filled infiltration ponds on the Snake River Plain in Idaho. This site is near the Subsurface Disposal Area for radioactive and other hazardous waste at the INEEL. Within 4 months we detected tracer in 1 of 13 sampled aquifer wells, and in 8 of 11 sampled perched-water wells as far as 1.3 km away. These detections show that (1) low-permeability layers in the unsaturated zone divert some flow horizontally, but do not prevent rapid transport to the aquifer, (2) horizontal convective transport rates within the unsaturated zone may exceed l4 m/d, perhaps through essentially saturated basalt fractures, tension cracks, lava tubes, or rubble zones; and (3) some perched water beneath the Subsurface Disposal Area derives from episodic surface water more than 1 km away. Such rapid and far-reaching flow may be common throughout the Snake River Plain and possibly occurs in other locations that have a geologically complex unsaturated zone and comparable sources of infiltrating water.

Geochemistry of the Little Lost River Drainage Basin, Idaho *(Swanson et al. 2002)*

The U.S. Geological Survey and Idaho State University, in cooperation with the U.S. Department of Energy, are conducting studies to describe the chemical character or groundwater that moves as underflow from drainage basins into the Snake River Plain Aquifer (SRPA) system at and near the INEEL and the effects or these recharge waters on the geochemistry of the SRPA system. Each of these recharge waters has a hydrochemical character related to geochemical processes, especially water-rock interactions, that occur during migration to the SRPA. Results of these studies will benefit ongoing and planned geochemical modeling of the SRPA at the INEEL by providing model input on the hydrochemical character of water from each drainage basin.

For this study, water samples were collected from six wells and two surface-water sites from the Little Lost River drainage basin during 2000 and analyzed for selected inorganic constituents, dissolved organic carbon, stable isotopes, tritium, and selected gross measurements of radioactivity. Four duplicate samples were collected for quality assurance. Results showed that most water from the Little Lost River drainage basin has a calcium-magnesium bicarbonate character. Water in two wells contained elevated chloride concentrations relative to water from the other sites. The computer code NETPATH was used to evaluate geochemical mass-balance reactions in the Little Lost River basin. Attempts to model water from the Little Lost River valley sites to that in the most downgradient wells, Mays and Ruby Farms, were unsuccessful. On closer inspection of these two wells, it was determined that they are much deeper than the other sample locations and the water could reflect the chemistry of the SRPA. Apparently another of the sample locations was contaminated as a result of local agricultural practices. Water in one well contained concentrations that mirrored Little Lost River water. Of all the sites sampled, only two upgradient wells contained water representative of the system. Mass-balance modeling of the system indicated that dissolution of dolomite is the major reaction taking place in the system. Nitrification of ammonium ion to nitrate and dissolution of inorganic fertilizers are chemical processes that also occur in the system. To better understand the geochemistry or the Little Lost River drainage basin, more samples that better represent the natural geochemistry or the basin need to be collected and evaluated.

Tritium in Flow from Selected Springs That Discharge to the Snake River, Twin Falls Hagerman Area, Idaho, 1994-99 *(Twining 2002)*

During 1994-1999, the U.S. Geological Survey, in cooperation with the U.S. Department of Energy, collected samples for tritium analyses from 19 springs along the north side of the Snake River near Twin Falls and Hagerman, Idaho, to address public concern over migration of approximately 31,000 Ci of tritium discharged in wastewater at the INEEL. Evaluating tritium for the Twin Falls-Hagerman area is part of a long-term project to monitor water quality of springs discharging from the Snake River Plain Aquifer downgradient from the INEEL. Routine and two quality assurance replicate samples have been collected annually since 1990 as part of the U.S. Geological Survey's quality assurance program.

The springs were characterized on the basis of their locations and tritium concentrations: Category I, II, and III. The differences in tritium concentrations in Category I, II, and III springs are a function of the groundwater flow regimes, land uses, and irrigation practices in and hydraulically upgradient from each category of springs. Tritium concentrations during the 1994-1999 water years ranged from a low 6.5 ± 0.6 pCi/L to a high of 65.0 ± 4.5 pCi/L. During 1999, tritium concentrations in the 19 springs ranged from 6.5 ± 0.6 to 46.1 ± 3.2 pCi/L. Mean annual tritium concentrations measured from 1990 to 1999 in selected spring's from each category show decreasing trends in tritium values, likely the result of natural isotope decay.

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Appendix D - Onsite Dosimeter Measurements and Locations

Table D-1. Environmental dosimeter measurements at Argonne National Laboratory-West (ANL-W) (2002).

Location	Exposure[a]
ANL 7	136 ± 19
ANL 8	135 ± 19
ANL 9	148 ± 21
ANL 10	179 ± 25
ANL 11	149 ± 21
ANL 12	132 ± 18
ANL 13	137 ± 19
ANL 14	131 ± 18
ANL 15	159 ± 22
ANL 16	153 ± 21
ANL 17	123 ± 17
ANL 18	139 ± 19

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

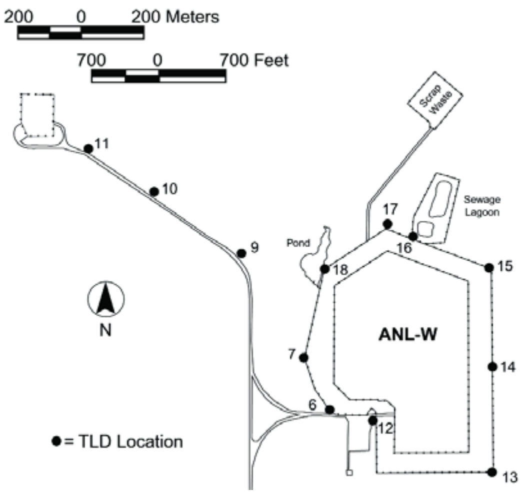

Figure D-1. Environmental dosimeter locations at ANL-W (2002).

Table D-2. Environmental dosimeter measurements at the Auxiliary Reactor Area (ARA) (2002).

Location	Exposure[a]
ARA 1	150 ± 21
ARA 2	172 ± 24
ARA 3	b
ARA 4	b

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

b. These thermoluminescent dosimeter (TLD) locations were eliminated due to decontamination and decommissioning activities.

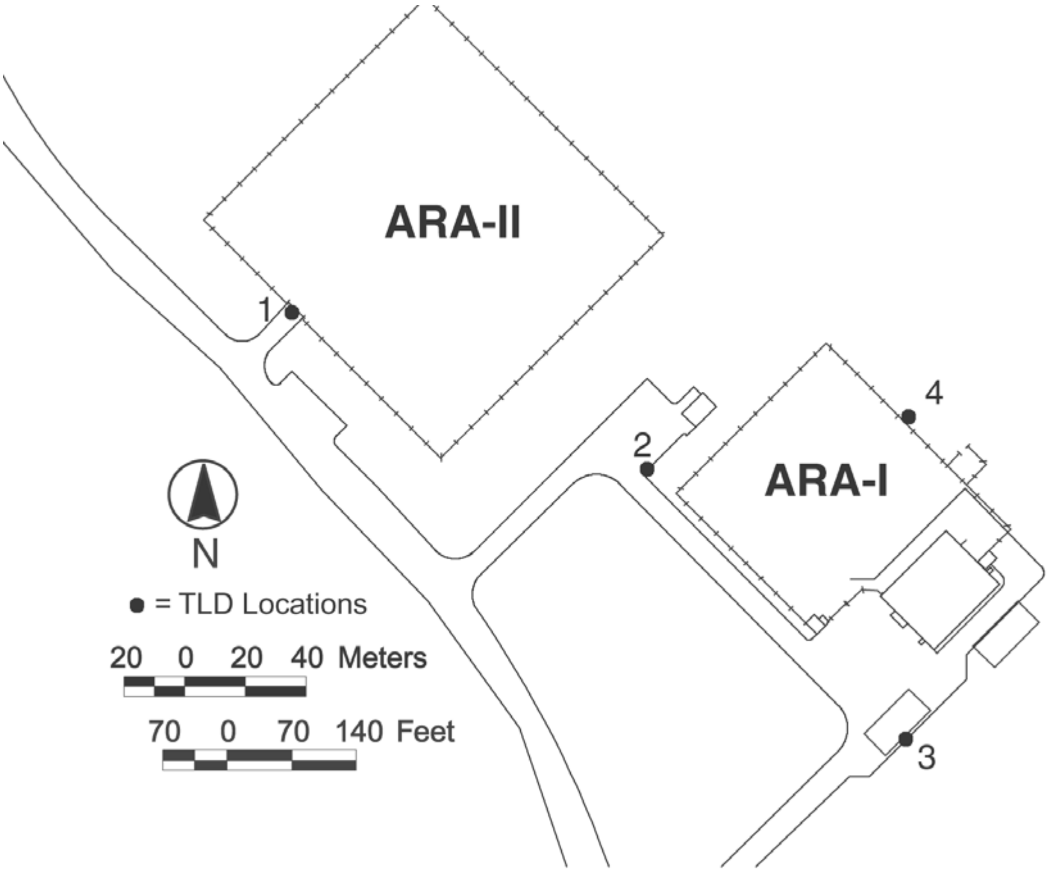

Figure D-2. Environmental dosimeter locations at ARA (2002).

Table D-3. Environmental dosimeter measurements at the Central Facilities Area (CFA) (2002).

Location	Exposure[a]
CFA 1	135 ± 19
CFA 2	120 ± 17
CFA 3	134 ± 19
CFA 4	126 ± 18

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

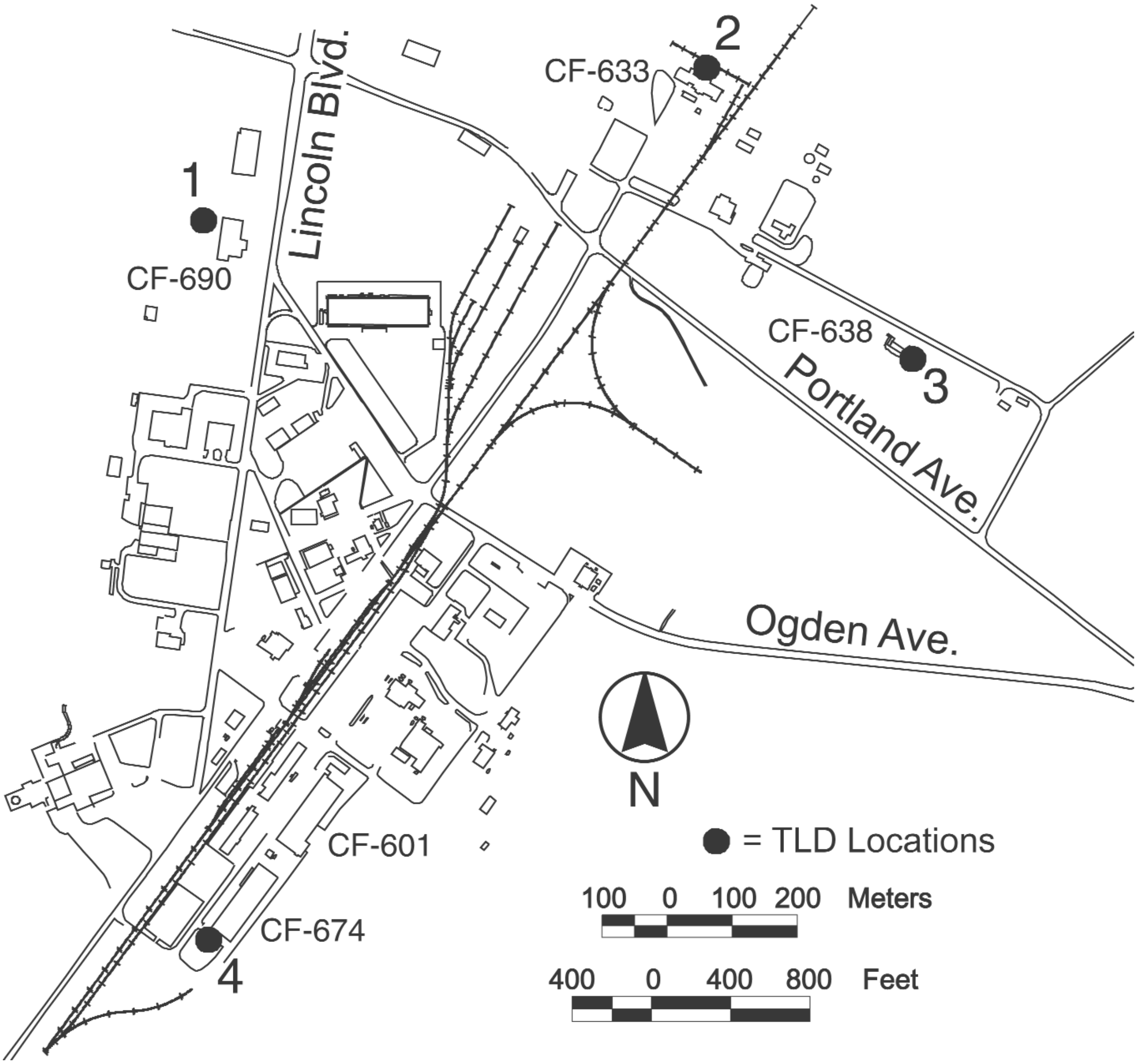

Figure D-3. Environmental dosimeter locations at CFA (2002).

Table D-4. Environmental dosimeter measurements at the Idaho Nuclear Technology and Engineering Center (INTEC) (2002).

Location	Exposure[a]
INTEC 1	153 ± 21
INTEC 9	173 ± 24
INTEC 14	145 ± 20
INTEC 15	145 ± 20
INTEC 16	136 ± 19
INTEC 17	136 ± 19
INTEC 18	136 ± 19
INTEC 19	147 ± 20
INTEC 20	280 ± 39
INTEC 21	173 ± 24
INTEC 22	191 ± 27
INTEC 23	149 ± 21
INTEC 24	135 ± 19
INTEC 25	126 ± 17
INTEC 26	134 ± 19
TREE FARM 1	190 ± 27
TREE FARM 2	162 ± 23
TREE FARM 3	162 ± 23
TREE FARM 4	199 ± 28

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

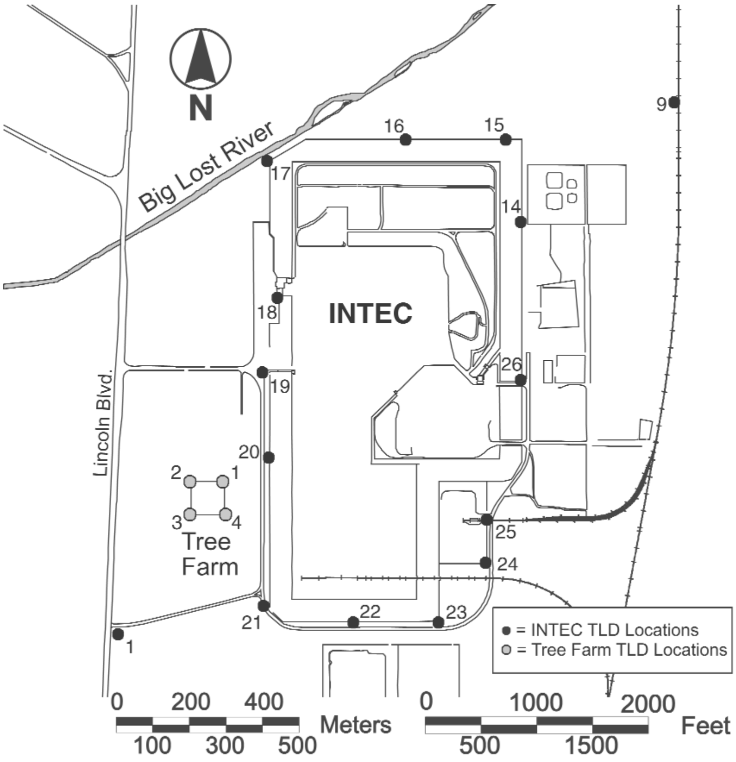

Figure D-4. Environmental dosimeter locations at INTEC (2002).

Table D-5. Environmental dosimeter measurements at the Naval Reactors Facility (NRF) (2002).

Location	Exposure[a]
NRF 4	131 ± 18
NRF 5	135 ± 19
NRF 11	133 ± 18
NRF 12	136 ± 19
NRF 13	135 ± 19
NRF 16	132 ± 18
NRF 17	141 ± 20
NRF 18	140 ± 19
NRF 19	144 ± 20
NRF 20	134 ± 19
NRF 21	134 ± 0

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

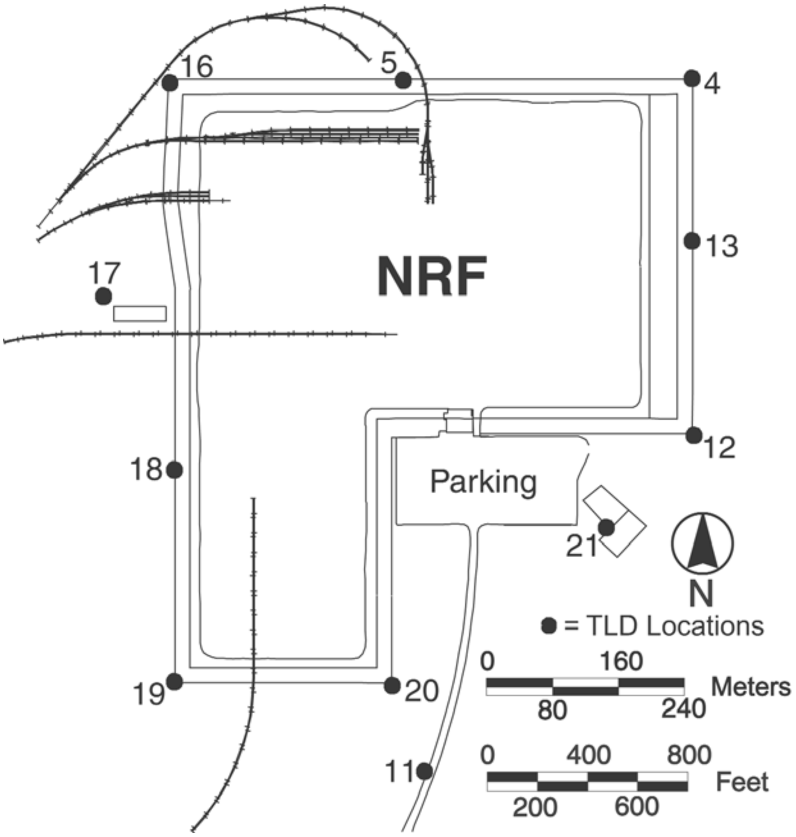

Figure D-5. Environmental dosimeters locations at NRF (2002).

Table D-6. Environmental dosimeter measurements at the Power Burst Facility (PBF) (2002).

Location	Exposure[a]
PBF/SPERT 1	127 ± 18
PBF/SPERT 2	128 ± 18
PBF/SPERT 3	131 ± 18
PBF/SPERT 4	139 ± 19
PBF/SPERT 5	133 ± 19
PBF/SPERT 6	138 ± 19
PBF/WERF1	129 ± 18
PBF/WERF2	114 ± 16
PBF/WERF3	128 ± 18
PBF/WERF4	135 ± 19
PBF/WERF5	136 ± 19
PBF/WERF6	125 ± 17
PBF/WERF7	141 ± 20

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

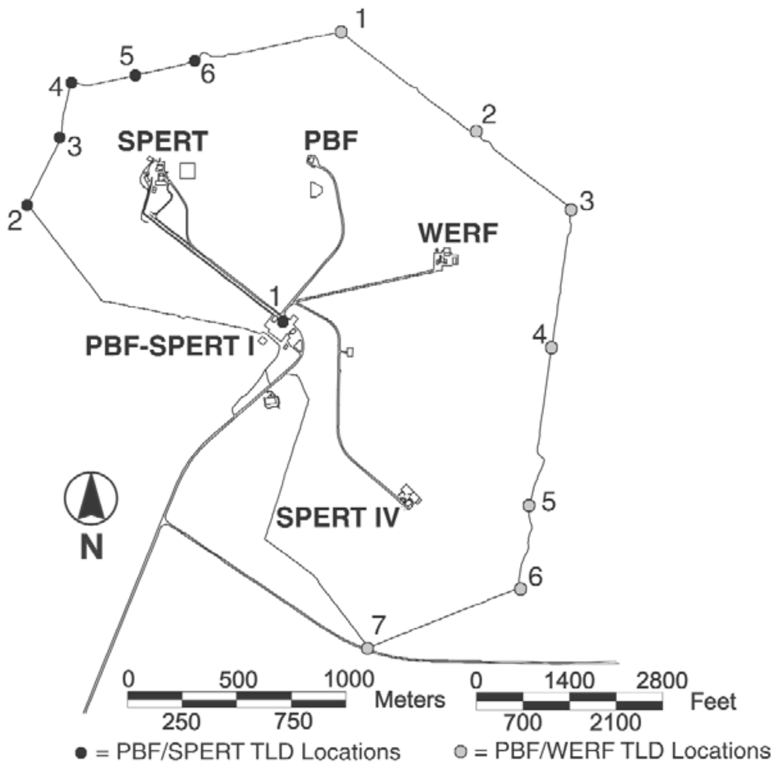

Figure D-6. Environmental dosimeter locations at PBF (2002).

Table D-7. Environmental dosimeter measurements at the Radioactive Waste Management Complex (RWMC) (2002).

Location	Exposure[a]
RWMC 3a	136 ± 19
RWMC 5a	133 ± 18
RWMC 7a	144 ± 20
RWMC 9a	146 ± 20
RWMC 11a	149 ± 21
RWMC 13a	139 ± 19
RWMC15a	136 ± 19
RWMC 17a	135 ± 19
RWMC 19a	136 ± 19
RWMC 21a	144 ± 20
RWMC 23a	141 ± 20
RWMC 25a	154 ± 21
RWMC 27a	190 ± 26
RWMC 29a	211 ± 29
RWMC 31a	170 ± 27
RWMC 37a	132 ± 18
RWMC 39	142 ± 20
RWMC 40	152 ± 21
RWMC 41	300 ± 42
RWMC 42	142 ± 20
RWMC 43	131 ± 18
RWMC 45	134 ± 19
RWMC 46	137 ± 19
RWMC 47	125 ± 17

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

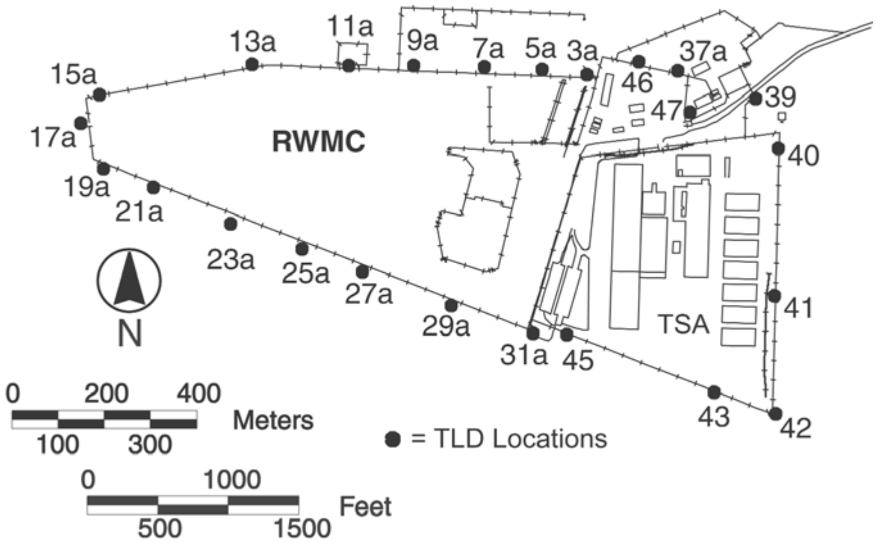

Figure D-7. Environmental dosimeter locations at RWMC (2002).

Table D-8. Environmental dosimeter measurements at the Test Area North (TAN) (2002).

Location	Exposure[a]
TAN/TSF 1	109 ± 15
TAN/TSF 2	130 ± 18
TAN/TSF 3	111 ± 15
TAN/TSF 4	123 ± 17
TAN/LOFT 1	130 ± 18
TAN/LOFT 2	76 ± 15
TAN/LOFT 3	115 ± 16
TAN/LOFT 4	115 ± 16
TAN/LOFT 5	120 ± 17
TAN/LOFT 6	140 ± 19
TAN/LOFT 7	141 ± 20
TAN/WRRTF1	127 ± 18
TAN/WRRTF2	117 ± 16
TAN/WRRTF3	118 ± 16
TAN/WRRTF4	118 ± 16

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

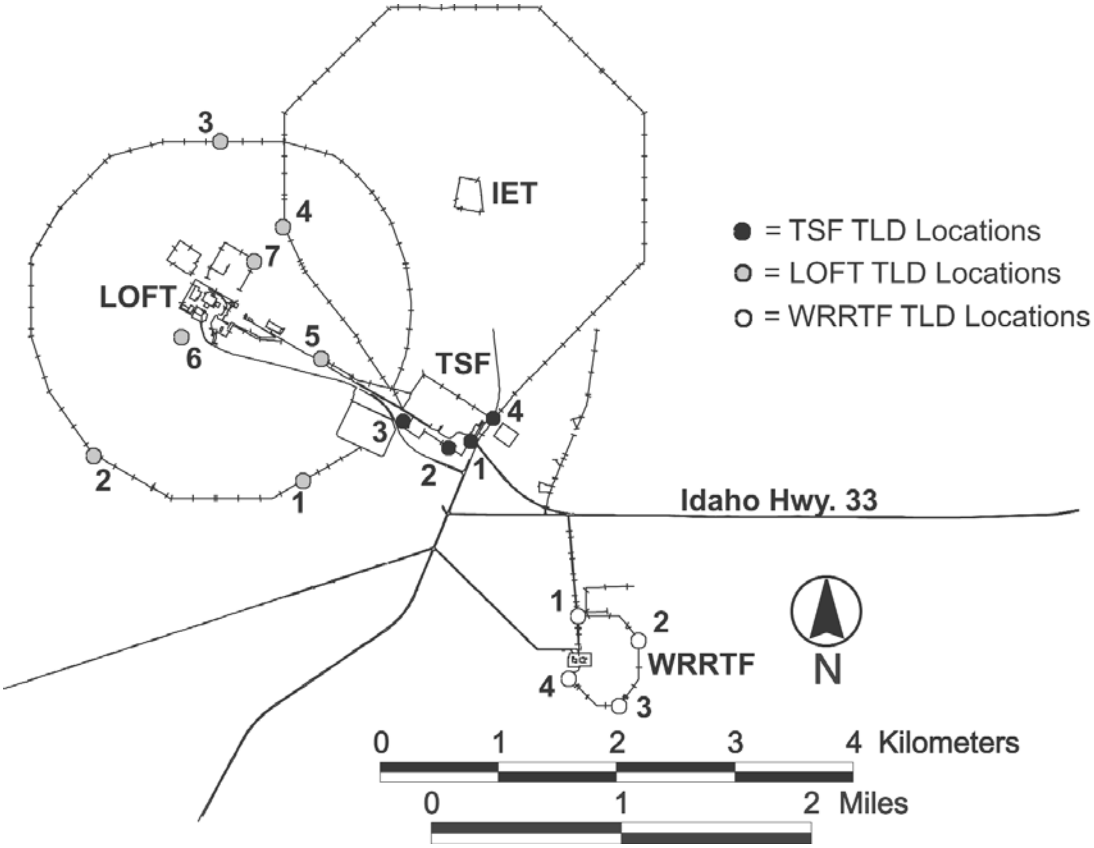

Figure D-8. Environmental dosimeter locations at TAN (2002).

Table D-9. Environmental dosimeter measurements at the Test Reactor Area (TRA) (2002).

Location	Exposure[a]
TRA 1	191 ± 26
TRA 2	682 ± 95
TRA 3	784 ± 110
TRA 4	257 ± 36
TRA 5	173 ± 24
TRA 6	138 ± 19
TRA 7	141 ± 20
TRA 8	161 ± 22
TRA 9	145 ± 20
TRA10	145 ± 20
TRA11	155 ± 22
TRA12	145 ± 20
TRA13	152 ± 21

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

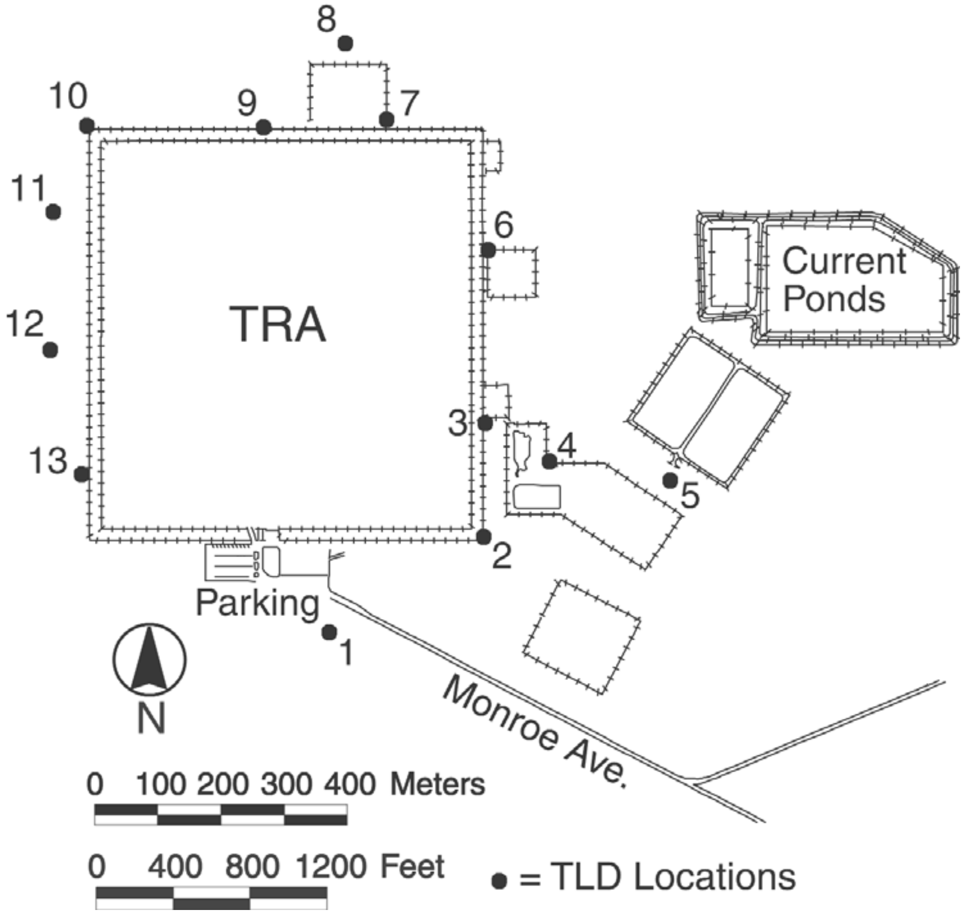

Figure D-9. Environmental dosimeter locations at TRA (2002).

Table D-10. Environmental dosimeter measurements along Lincoln Blvd. and US Highway 20 (2002).

Location	Exposure[a]
LINCOLN BLVD 1	133 ± 19
LINCOLN BLVD 3	152 ± 21
LINCOLN BLVD 5	143 ± 20
LINCOLN BLVD 7	138 ± 19
LINCOLN BLVD 9	138 ± 19
LINCOLN BLVD 11	133 ± 19
LINCOLN BLVD 13	136 ± 19
LINCOLN BLVD 15	137 ±19
LINCOLN BLVD 17	140 ±19
LINCOLN BLVD 19	132 ± 18
LINCOLN BLVD 21	128 ± 18
LINCOLN BLVD 23	128 ±18
LINCOLN BLVD 25	127 ± 18
HWY 26-266	134 ± 19
HWY 26-268	135 ± 19
HWY 26-270	135 ± 19
HWY 20-264	131 ± 18
HWY 20-266	120 ± 17
HWY 20-268	127 ± 18
HWY 20-270	131 ± 18
HWY 20-272	117 ± 16
HWY 20-274	109 ± 15
HWY 20-276	129 ± 18
EBR 1	124 ± 17

a. All values are in milliroentgen (mR) plus or minus 2 standard deviations (± 2s).

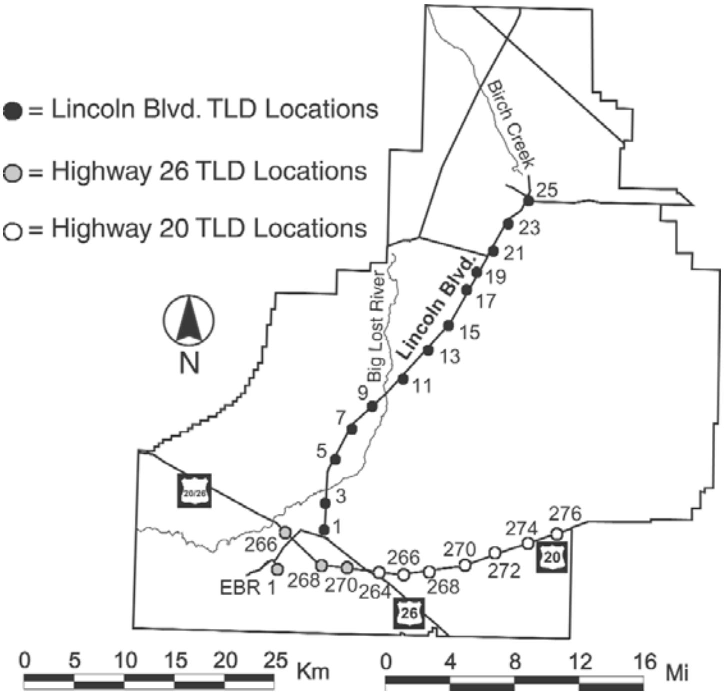

Figure D-10. Environmental dosimeter locations along Lincoln Blvd. and US Highway 20 (2002).

Appendix E - Glossary

Advanced Mixed Waste Treatment Facility: Opened in 2003, this facility is located on the INEEL at the Radioactive Waste Management Complex. Its purpose is the retrieval, preparation, and shipping of stored low-level transuranic waste to the Waste Isolation Pilot Plant.

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 on. Includes the naturally occurring radionuclides thorium and uranium as well as the human-made radionuclides plutonium and americium.

alpha radiation: The emission of alpha particles during radioactive decay. Alpha particles are identical in make up 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 only an inch or so. Despite its low penetration ability, alpha radiation is densely ionizing and, therefore, very damaging when ingested or inhaled. Naturally occurring radioactive elements such as radon emit alpha radiation.

anthropogenic radionuclides: Radionuclides 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 ground water to wells or springs.

aquifer well: A well that obtains its water from below the water table.

background radiation: Radiation present in the environment as a result of naturally occurring radioactive materials, cosmic radiation, or human-made radiation sources, including fallout.

basalt: A fine-grained dark igneous rock.

becquerel (Bq): A quantitative measure of radioactivity. This is an alternate measure of activity used internationally. One becquerel of activity is equal to one nuclear decay per second. All references to quantities of radioactive material in this report are made in curies (Ci), followed in parentheses by the equivalent in becquerels. There 3.7 x 10^{10} Bq in 1 Ci.

beta radiation: Beta radiation is 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, but it may be stopped by materials such as aluminum or Lucite panels. Naturally occurring radioactive elements such as potassium-40 emit beta radiation.

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.

biobarrier: A zone/layer of a cap that consists of some material to prevent intrusion of burrowing animals.

bioremediation: The process of using various natural and/or introduced microbes to degrade, destroy, or otherwise permanently bond contaminants contained in soil and/or water.

biota concentration guide (BCG): The limiting concentration of a radionuclide in soil, sediment, or water that would not cause dose limits for protection of populations of aquatic and terrestrial biota to be exceeded.

blank: A blank is used to demonstrate that cross contamination has not occurred. See field blank and laboratory blank.

blind sample: A blind sample contains a known quantity of some of the analytes of interest added to a sample of the media being collected. A blind sample is used to test if there may be compounds in the sample media that interfere with the analysis of certain analytes.

butte: A steep-sided and flat-topped hill.

calibration: The adjustment of a system and the determination of system accuracy using known sources and instrument measurements of higher accuracy.

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 an individual'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.

collective effective dose equivalent: A measure of health risk to a population exposed to radiation. It is the sum of the total effective dose equivalents of all individuals within a defined population. The unit for collective effective dose equivalent is person-rem or person-sieverts.

committed effective dose equivalent: The total effective dose equivalent received over a 50-year period following the internal deposition of a radionuclide. It is expressed in rem or sieverts.

comparability: A measure of the confidence with which one data set or method can be compared to another.

completeness: A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected, under optimum conditions.

composite sample: A sample of environmental media that contains a certain number of sample portions collected over a period of time. The samples may be collected from the same location or different location. They may or may not be collected at equal time intervals over a predefined period of time (e.g., quarterly).

confidence interval: A numerical range within which the true value of a measurement or calculated value lies. In this report, radiological values are shown with a 95 percent confidence interval, i.e., there is a 95 percent probability that the true value of a measurement or calculated value lies within the specified range.

contaminant: Any physical, chemical, biological, radiological substance, or matter in a location or concentration that is not naturally occurring.

contaminants of concern: Contaminants 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 INEEL, those contaminants that are above a 10^6 (1 in 1 million) risk value.

control sample: A sample collected from an uncontaminated area that is used to compare INEEL analytical results to those in areas that could not have been impacted by INEEL operations.

curie (Ci): A quantitative measure of radioactivity. One Bq equals one nuclear decay per second. One curie of activity is equal to 3.7×10^{10} Bq.

data gap: An area between all available data and the conclusions that are drawn from that data where the existing data are sparse or nonexistent. An example would be inferring the interactions in the environment of one radionuclide that has not been studied from a chemically similar radionuclide that has been studied.

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 scientific and statistical evaluation of data to determine if data obtained from environmental operations are of the right type, quality, and quantity to support their intended use. Data verification also includes documenting the above operations and the outcome of those operations (e.g., data do or do not meet specified requirements). Data verification is not synonymous with data validation.

decay product: A nuclide resulting from the radioactive disintegration of a radioactive disintegration of a radionuclide, being formed either directly or as a result of successive transformations in a radioactive series. A decay product may be either radioactive or stable.

deposition velocity: An empirical rate constant that relates the concentration of a radionuclide in air to that on ground or plant surfaces.

derived concentration guide (DCG): 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/ immersion, water ingestion), would result in an effective dose equivalent of 100 mrem (1 mSv). The U.S. Department of Energy, through Order 5400.5, "Radiation Protection of the Public and the Environment" has established these values.

diffuse sources: A source or potential source of pollutants that is not constrained to a single a 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.

dilution: The process of lowering a constituent's concentration by increasing the volume of the media in which it occurs (e.g., adding water to a drink concentrate).

direct radiation: External radiation from radioactive plumes or from radionuclides deposited on the ground or other surfaces.

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, using data gathered continuously at meteorological stations on and around the INEEL and the MDIFF model, prepared the dispersion coefficients for this report,.

dispersion: The process of molecular movement by physical processes.

dose: Also known as dose equivalent, this is a value for comparing the biological effectiveness of different kinds of radiation on a common scale. Technically, it is the product of the absorbed dose, the quality factor, and any other modifying factors. The unit for dose is the rem. A millirem is one one-thousandth of a rem.

dosimetry: The theory and application of the principles and techniques involved in the measurement and recording of radiation doses.

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. Duplicates samples are analyzed independently as an indication of gross errors in sampling techniques.

ecosystem: The interacting system of a biologic community and its nonliving environment.

effective dose equivalent (EDE): A value used to express the health risk from radiation exposure to a tissue or tissues in terms of an equivalent whole body exposure. It is a normalized value that allows the risk from radiation exposure received by a specific organ or part of the body to be compared with the risk due to whole body exposure. It is equal to the sum of products of the dose to each tissue or organ multiplied by their respective weighting factor for each tissue or organ. The weighting factor is used to put the dose to the different tissue and organs on an equal basis in terms of health risk. The EDE is expressed in units of rem or sieverts.

effluent: Any liquid discharged to the environment, including stormwater runoff at a site or facility.

effluent waste: Treated wastewater leaving a treatment 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 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: Samples 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: Refers to 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.

extremely hazardous chemicals: An extremely hazardous substance listed in the appendices to 40 CFR Part 355, “Emergency Planning and Notification.”

fallout: Radioactive material made airborne as a result of aboveground nuclear weapons testing that has been deposited on the Earth's surface.

field blank: A blank used to provide information about contamination that may be introduced during sample collection, storage, and transport. A known uncontaminated sample, usually deionized water, is exposed to ambient conditions at the sampling site and subjected to the same analytical or measurement process as other samples.

fissile material: Material capable of starting and sustaining a nuclear chain reaction.

fission: The nuclear reaction resulting from the splitting of atoms.

flood plain: Lowlands bordering a river that are subject to flooding. Flood plains are comprised of sediments carried by rivers and deposited on land during flooding.

gamma radiation: A form of electromagnetic radiation, like radio waves or visible light, but with a much shorter wavelength. It is more penetrating than alpha or beta radiation, 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 found beneath the surface of the ground (subsurface water). Groundwater usually refers to a zone of complete water saturation containing no air.

half-life: The amount of time it takes for the radioactivity of a radioactive material to be reduced by half.

halogenated: A compound containing one or more of the halogen elements (fluorine, chlorine, bromine, iodine).

hazardous air pollutant: See hazardous substance.

hazardous chemical: Any hazardous chemical as defined under 29 CFR 1910.1200, (Hazard Communications), and 40 CFR 370.2 (Definations).

hazardous materials: Materials 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; any toxic pollutant listed under Section 307(a) of the Clean Water Act; any element, compound, mixture, solution, or substance designated pursuant to Section 102 of the Comprehensive Environmental Response, Compensation and Liability Act;

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 with respect to which the U.S. Environmental Protection Agency 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 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 of Hazardous Waste) or that exhibits one or more of four characteristics (corrosiveness, reactivity, flammability, and 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.

Idaho National Engineering and Environmental Laboratory (INEEL): Known locally as the Site or the INEEL, it was created as the National Reactor Testing Station by the Atomic Energy Commission in 1949 to build and test nuclear power reactors. The Testing Station was renamed the Idaho National Engineering Laboratory in 1974 and Idaho National Engineering and Environmental Laboratory in January 1997. The INEEL, has recently been renamed the Idaho National Laboratory. Over the life of the INEEL, an assembly of 52 reactors, associated research centers, and waste handling areas have been constructed and tested.

infiltration: The process of water soaking into a soil or rock.

influent waste: Raw or untreated wastewater entering a treatment 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.

isopleth: A line drawn on a map connecting points having the same numerical value of some variable (in this instance the dispersion coefficient).

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 single element possess almost identical chemical properties. An example of isotopes are plutonium-238, plutonium-239, plutonium-240, and plutonium-241, each acts chemically like plutonium but have 144, 145, 146, and 147 neutrons, respectively.

laboratory blank: A sample that is intended to contain none of the analytes of interest, usually deionized water, that is subjected to the same analytical or measurement process as other samples to establish a zero baseline or 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 and/or analysis. Laboratory blanks are sometimes used to adjust or correct routine analytical results.

liquid effluent: A liquid discharged from a treatment facility.

Management and Operating (M&O): The primary contractor responsible for management (human resources, staffing, and budget control) and day-to-day operations (system operations, building maintenance, process monitoring, and trash removal) of a facility or site.

matrices/matrix/media: Refers to the physical form (solid, liquid, or gas) and/or composition (soil, filter, groundwater, air) of a sample.

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.

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).

natural background radiation: Radiation from natural sources to which people are exposed throughout their lives. Natural background radiation is comprised of several sources, the most important of which are:

- 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 gasses in the atmosphere, primarily radon-222.

natural resources: Land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, any state or local government, any foreign government, or any Indian tribe.

noble gas: Any of the chemically inert gaseous elements of the helium group in the periodic table.

noncommunity water system: A public water system that is not a community water system. A noncommunity water system is either a transient noncommunity water system or a nontransient noncommunity water system.

nontransient noncommunity water system: A public water system that is not a community water system and that regularly serves at least 25 of the same persons over six months per year. These systems are typically schools, offices, churches, factories, etc.

organic: Relating or belonging to the class of chemical compounds having a carbon basis; hydrocarbons are organic compounds.

perched water well: A well that obtains its water from a water body above the water table.

performance evaluation sample: Performance evaluation samples are prepared by adding a known amount of a U.S. Environmental Protection Agency reference compound to reagent water and submitting them to the analytical laboratory as a field duplicate or field blank sample. A performance evaluation sample is used to test the accuracy and precision of a laboratory's analytical method.

pH: A measure of hydrogen ion activity. A low pH (0-7) indicates an acid condition; a high pH (7-14) indicates a basic condition. A pH of 7 indicates neutrality.

phytoremediation: The process of using various plants to extract contaminants from soil and water.

playa: A depression that is periodically inundated with water and will retain such water over time. An intermittent or seasonal water body.

PM_{10}: Particles with an aerodynamic diameter less than or equal to 10 microns.

pollutants: Pollutant or contaminant as defined by Section 101(33) of the Comprehensive Environmental Response, Compensation, and Liability Act (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, ingestion, inhalation, or assimilation into any 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 deformations, in such organisms or their offspring. The term does not include petroleum, including crude oil or any fraction thereof which 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 Contigency Plan, the term pollutant or contaminant means any pollutant or contaminant that may present an imminent and substantial danger to public health or welfare of the United States.

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.

polychlorinated biphenyl: A polychlorinated biphenyl is 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.

pollution: Any hazardous or radioactive material naturally occurring or added to an environmental media, such as air, soil, water, or vegetation.

precision: A measure of mutual agreement among individual measurements of the same property. Precision is most often seen as a standard deviation.

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 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 noncommunity water system.

purgeable organic compound: An organic compound that has a low vaporization point (volatile).

quality assurance: Those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or component will perform satisfactorily and safely in service. Quality assurance includes quality control. If quality is the degree to which an item or process meets or exceeds the user's requirements, then quality assurance is those actions that provide the confidence that quality was in fact achieved.

quality control: 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 quality control is to provide quality that is satisfactory, adequate, dependable, and economic.

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 process of a material giving off particles to reach a stable state.

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 happens to emit energy in the form of photons or particles (radiation) during transformation.

radiotelemetry: The tracking of animal movements through the use of a radio transmitter attached to the animal of interest.

raw water hardness: Equivalent to the carbonate concentration of water.

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 in an effort 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 equation:

$$RPD = \frac{(x_1 - x_2)}{0.5x(x_1 - x_2)} \text{ x } 100$$

where X_1 and X_2 are 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: Stands for roentgen equivalent man, a unit by which human radiation dose is assessed. This is a risk-based value used to estimate the potential health effects to an exposed individual or population.

reportable quantity: Any Comprehensive Environmental Response, Compensation, and Liability Act hazardous substance, the reportable quantity for which is established in Table 302.4 of 40 CFR Part 302 (Designation, reportable quantities, and notification), the discharge of which is a violation of federal statutes and requires notification of the regional U.S. Environmental Protection Agency administrator.

representativeness: A measure of a laboratory's ability to produce data that accurately and precisely represent 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 fine grained light-brown to gray igneous rock.

risk assessment: The identification and quantification of the risk resulting from a specific use or occurrence of a chemical, taking into account the possible harmful effects on individual people or society of using the chemical in the amount and manner proposed and all the possible routes of exposure. Quantification ideally requires the establishment of dose-effect and dose-response relationships in likely target individuals and populations.

sediment distribution coefficient: The ratio of the mass of solute species absorbed or precipitated on the sediment to the solute concentration in water.

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.

sink: Similar to a playa with the exception that it rapidly infiltrates any collected water.

Snake River Plain Aquifer: One of the largest groundwater reserves in the United States, it lies beneath the Snake River plain. Water comes from rivers surrounding the plain (the Snake River, Henry's Fork, Big Lost River, Little Lost River, Birch Creek, and Camas Creek) and from rain and snow that soaks down through the soils and rock. This water moves through the cracks in the rocks of the Snake River plain and flows out into the Snake River in the Thousand Springs area between Twin Falls and King Hill.

Snake River Plain: A wide (64-12-km [40-80-mi]) plain of rolling topography extended some 308 km (191 mi) from Ashton to King Hill/Twin Falls. The plain was formed by repeated volcanic eruptions that were the result of the passage of a geologic hot spot beneath the Earth's crust.

sodium absorption ratio (SAR): A measure of the concentration of sodium in soils relative to that of calcium and magnesium. Soils with a high SAR (12-15) have low permeability and are unsuitable for plant growth.

$$SAR = \frac{[NA^{+}]}{\sqrt{\frac{1}{2}([Ca^{2+}] = [Mg^{2+}])}}$$

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, usually divided by the analytical laboratory, split into two separate samples. Each sample is prepared and analyzed independently as an indication of analytical variability and comparability.

spreading areas: At the INEEL, a series of interconnected low areas that are used for flood control by dispersing and evaporating/infiltrating water from the Big Lost River.

stabilization: The planting of rapid growing plants for the purpose of holding bare soil in place.

standards: A sample containing a known quantity of various analytes. Standards may be prepared and certified by commercial vendors, but they must have traceability to the National Institute of Standards and Technology.

storm water: Water produced by the interaction of precipitation event and the physical environment (buildings, pavement, ground surface).

surface water: Water exposed at the ground surface, usually constrained by a natural or human-made channel (streams, rivers, lakes, oceans).

surveillance: Parameters monitored to observe trends but not required by a permit or regulation.

thermoluminescent dosimeter (TLD): A device used to measure radiation dose to occupational workers or radiation levels in the environment. A dosimeter 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.

threshold planning quantity: The quantity of a material listed in Appendices A and B of 40 CFR 355 (Emergency Planning and Notification) that must be present at a site for use in emergency planning preparations.

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.

total organic halogens: A measure of the total organic halogenated compounds in a sample. Will not detect a specific constituent (e.g., Trichloroethylene), but will detect the presence of a halogenated compound.

toxic chemicals: Chemicals that can have toxic effects on the public or environment above 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.

transient noncommunity water system: A water system that is not a community water system, and serves as nonresident persons per day for six months or less per year. These systems are typically restaurants, hotels, large stores, etc.

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.

transuranic (TRU): Elements on the periodic table with an atomic number greater than uranium (> 92). Common isotopes of transuranic elements are neptunium-239, americium-241, and plutonium-238.

tritium: A radioactive isotope of hydrogen, having three times the mass of ordinary hydrogen.

U.S. Department of Energy (DOE): The federal agency that sponsors energy research and regulates nuclear materials used for weapons production. DOE has responsibility for the national laboratories and the science and research conducted at these laboratories, including the INEEL.

vadose zone: That part of the subsurface between the ground surface and the water table.

Waste Isolation Pilot Plant (WIPP): Located in Carlsbad, New Mexico, this is the permanent repository for government-owned low-level transuranic waste.

water quality parameters: Parameters that are commonly measured to determine the quality of a water body/sample (i.e., specific conductivity, pH, temperature, dissolved oxygen content).

weighting factor: A factor that, when multiplied by the dose equivalent delivered to a body organ or tissue, yields the equivalent risk due to a uniform radiation exposure of the whole body.

wetlands: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally included playa lakes, swamps, marshes, bogs, and similar areas such as sloughs, prairie potholes, wet meadows, prairie river overflows, mudflats, and natural ponds.