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Idaho National Engineering and Environmental Laboratory Site Environmental Report Calendar Year 2000

Environmental Surveillance, Education and Research Program

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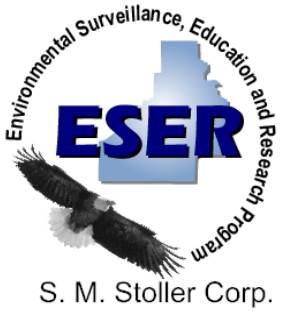

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INEEL's Environmental Policy

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. This is accomplished by integrating environmental laws and regulations and pollution prevention practices into all INEEL activities. Through employee involvement and management commitment to environmental excellence, the DOE 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. DOE will accomplish this by establishing and communicating environmental responsibilities, providing environmental training to the workforce, and implementing controls to mitigate environmental hazards.
- Conduct environmental remediation to minimize impacts on human health and the environment as a result of legacy activities.
- 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, and purchasing 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 and document environmental objectives and milestones, and update them as necessary to reflect the changing needs, missions, and goals of the INEEL.
- Consider the input of stakeholders when weighing options.
- Measure environmental performance and monitor impacts on the environment, and communicate the results to employees and stakeholders.
- Continuously improve the 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

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PREFACE

Every person in the world is exposed to ionizing radiation – radiation that has sufficient energy to remove electrons from atoms, damage chromosomes, and cause cancer. There are three general sources of 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 sources in the ground, cosmic radiation from outer space, and radiation from radionuclides naturally present in the body. Exposures from natural sources may vary depending on geographical location and altitude. When such exposures are substantially higher than 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 that comes from the natural decay of trace amounts of uranium 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, by cracks and other holes in the buildings' foundation, and by poor building ventilation. Another example is the increased exposure to cosmic radiation that airplane passengers receive when traveling at high altitudes.

The third general source includes a variety of 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 at nuclear facilities generally are very small compared to exposures from natural sources [Reference P-1].

To verify that exposures resulting from operations at the 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 whereby 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 2000 for the routine environmental surveillance programs conducted on and around the Idaho National Engineering and Environmental Laboratory (INEEL). Through October 2000, the Environmental Science and Research Foundation (ESRF) conducted offsite surveillance as part of the Environmental, Surveillance, Education and Research (ESER) Program. On November 1, 2000, the contract for the ESER Program was awarded to a team led by the S. M. Stoller Corporation (Stoller). This team includes Montgomery Watson Harza, North Wind Environmental, University of Idaho, and Washington State University. Stoller prepared this report using the 2000 data collected by the ESRF and the Stoller team. This report refers to all data collected by the ESRF or the Stoller team as "ESER contractor data." During 2000, Bechtel BWXT Idaho, LLC (BBWI) performed primarily onsite surveillance. This report refers to BBWI as the management and operating (M&O) contractor. The M&O contractor organization responsible for operating each facility was responsible for effluent and

facility monitoring. The U.S. Geological Survey (USGS) performed groundwater monitoring both onsite and offsite. The M&O contractor also conducted some facility and onsite groundwater monitoring. The National Oceanic and Atmospheric Administration characterized the meteorological conditions at the INEEL.

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 by the M&O contractor, the ESER contractor, the USGS, and others [Reference P-2]. Facilities operated under the Naval Nuclear Propulsion Program, such as the Naval Reactors Facility (NRF), are exempt from the provisions of DOE Order 5400.1 and preparation of this report. The Naval Nuclear Propulsion Program maintains a separate environmental protection program to ensure compliance with all applicable environmental laws and regulations. Monitoring data and information specific to the NRF are provided in a separate annual environmental report issued by the NRF. For completeness, however, some information from onsite monitoring programs at the NRF is also included in this report.

EXECUTIVE SUMMARY

Each year the U.S. Department of Energy (DOE) publishes the Idaho National Environmental and Engineering Laboratory (INEEL) site environmental report to summarize environmental data and information on compliance with environmental regulations, and to highlight major environmental programs and efforts. The results of the various monitoring programs for 2000 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, and briefly describe INEEL environmental surveillance programs (*Chapter 1*);
- Summarize the status of INEEL compliance with environmental regulations and describe major activities and milestones in waste management, environmental restoration, and other environmental programs (*Chapter 2*);
- Present and evaluate radiological environmental monitoring results (*Chapter 3*);
- Present and evaluate nonradiological environmental monitoring results (*Chapter 4*);
- Describe groundwater monitoring activities and present results from those activities (*Chapter 5*);
- Present the results of effluent monitoring at the INEEL (*Chapter 6*);
- Discuss the potential radiation dose to the public for calendar year 2000 INEEL activities (*Chapter 7*); and
- Discuss programs used to ensure environmental data quality (*Chapter 8*).

Compliance with Environmental Regulations in 2000

A brief summary of the INEEL's status of compliance with federal acts in 2000 is presented in Table ES-1. A detailed discussion of the INEEL's compliance with environmental regulations may be found in Chapter 2 of this report.

Table ES-1. Compliance with Federal Acts in 2000.

Act	What it Addresses	2000 Activities
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	This act provides specific procedures to assess and remediate areas where the release of hazardous substances has occurred.	Work on these sites was in compliance with CERCLA requirements and met all enforceable cleanup milestones scheduled in the Federal Facility Agreement and Consent Order signed in 1991 by DOE, Idaho, and EPA.
Resource conservation and Recovery Act (RCRA)	This act establishes regulatory standards for the generation, transportation, storage, treatment and disposal of hazardous waste.	On May 26, 1999, DOE received a Notice of Violation (NOV) from the Idaho State Department of Environmental Quality. A Consent Order to resolve this NOV was signed in 2000.
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.	The annual Site Treatment Plan Report was submitted in November 2000 and approved by the State of Idaho in January 2001.
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 2000 National Emission Standards for Hazardous Air Pollutants Report reported a maximum annual individual dose to a member of the public from INEEL releases of 0.034 mrem, well below the regulatory limit of 10 mrem per year.
Clean Water Act	This act establishes goals to control pollutants discharged to surface waters of the United States.	Revised requirements for the National Pollutant Discharge Elimination System general permit for the discharge of storm water from industrial activities became effective in 2000.
Safe Drinking Water Act	This act establishes primary and secondary standards for drinking water systems.	Drinking water systems at the INEEL were in compliance with drinking water standards.
Toxic Substances Control Act	This act regulates industrial chemicals currently produced or imported into the United States.	Compliance is directed through management of PCBs. Currently, radioactively contaminated PCBs are stored at the INEEL.
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.	DOE received and considered agency and public comments on the draft Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement.
Endangered Species Act	This act provides a means whereby the ecosystems upon which threatened and endangered species depend are conserved.	No threatened or endangered species were observed at the INEEL in 2000.
Emergency Planning and Community Right-to Know Act	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, 312, and 313 Reports were issued as required in 2000.

Radiological Environmental Monitoring Results

Radiological environmental surveillance programs were conducted in 2000 by the Environmental Surveillance, Education and Research (ESER) program contractor and the management and operating (M&O) contractor for the DOE-Idaho Operations Office. As part of the ESER and M&O contractor programs, samples of air, water,

agricultural products, and animal tissue were collected at distant, INEEL boundary, and onsite locations. Environmental radiation measurements were also taken at these locations. Environmental monitoring and surveillance results are summarized in Table ES-2.

Table ES-2. INEEL radiological environmental monitoring results for 2000.

Media	Sample Type	Analysis	Results
Air	Charcoal cartridge	Radioiodine	Iodine-131 was not detected in any sample.
	Particulate filter	Gross alpha & gross beta activity, gamma-emitting radionuclides, strontium-90, and specific actinides	In general, gross alpha and gross beta activities show levels and seasonal variations not attributable to INEEL releases. Gross beta results that were statistically higher onsite than offsite in July may reflect the Tin Cup range fire. All measurements of specific radionuclides were well below DOE's Derived Concentration Guides (DCGs) for radiation protection.
	Atmospheric moisture	Tritium	Tritium was detected in 5 of 15 samples. Measurements were well below the DCG and within background concentrations.
	Precipitation	Tritium	Tritium was detected in 12 of 39 precipitation samples. Measurements were well below the DCG and within background concentrations.
Water	Surface water	Gross alpha & gross beta activity, and tritium	The highest measured gross alpha activity was below the EPA Maximum Contaminant Level (MCL). The gross beta measurements were within background levels. No tritium was detected in any of the samples.
	Drinking water	Gross alpha & gross beta activity, and tritium	The highest measured gross alpha activity was below the EPA Maximum Contaminant Level (MCL). The gross beta measurements were within background levels. Tritium was detected in one drinking water sample at a level well below the MCL.
Agricultural products	Milk, lettuce, wheat, potatoes and sheep	Gamma-emitting radionuclides and strontium-90 Iodine-131 in sheep thyroids	Cesium-137 and ^{90}Sr were detected in samples at levels consistent with worldwide fallout. Iodine-131 was not detected in any sample.
Game animals	Doves, ducks, marmots, mule deer, elk and pronghorn	Gamma-emitting radionuclides, strontium-90 and specific actinides. Iodine-131 in deer, elk and pronghorn thyroids	Cesium-137 was detected in muscle samples of doves, mule deer, elk, and pronghorn at levels consistent with worldwide fallout. No human-made radionuclides were detected in the edible portion of any marmot. Both ^{137}Cs and ^{60}Co were detected in muscle tissues of 4 of 5 ducks collected from TRA ponds. The potential dose from consumption of ducks with the highest concentrations was calculated to be 0.043 mrem (0.01% of background).
Soil	Offsite soil composite samples	Gamma-emitting radionuclides, strontium-90 and specific actinides	Cesium-137, ^{90}Sr, $^{239/240}Pu$, & ^{241}Am detected in all samples, but there is no statistical difference between boundary and distant locations indicating that they are due to worldwide fallout.
Radiation exposure	Thermoluminescent dosimeters (TLDs)	Gamma radiation	Exposures at boundary and distant locations using environmental dosimeters were similar and showed only background levels.

Nonradiological Environmental Monitoring Results

As in most previous years, particulate concentrations in the air were generally higher at distant and boundary locations than at onsite locations. Agricultural activities are a major source of suspended particulates in eastern Idaho. The differences in particulate concentrations are probably due to the limited soil disturbance

on the INEEL. Concentrations of fine particulates ($PM_{2.5}$), nitrogen dioxide, and sulfur dioxide measured on the INEEL were all well within air quality standards. During 2000 there were no storm water discharges from INEEL facilities to be sampled.

Groundwater Monitoring Results

Groundwater monitoring is performed at the INEEL by the U.S. Geological Survey (USGS) using over 125 wells that tap the Snake River Plain Aquifer. Results from a number of special studies of the properties of the aquifer and the water within it were published during 2000. 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 maximum contaminant levels (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. (Throughout this report, measured concentrations of contaminants in groundwater and surface water are compared to the EPA drinking water standards as benchmarks. Concentrations at or below the MCLs are presumed to be safe for human consumption.)

Contractors operating facilities at the INEEL also conducted routine monitoring of groundwater. Elevated levels of tritium and ^{90}Sr 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 0.5 mrem/yr (0.005 mSv/yr), 13 percent of the EPA standard for community drinking water, was calculated for workers at the INEEL. This was calculated at the location with the highest tritium concentration in drinking water (the Central Facilities Area).

Trichloroethylene concentrations in four water samples from the Test Area North (TAN) drinking water wells during 2000 remained below the MCL.

Effluent Monitoring Results

An estimated total of 4,740 Curies (Ci) (1.75×10^{14} Bq) of radioactivity, primarily in the form of short-lived noble gas isotopes, were released as airborne effluents. Approximately 107 Ci (3.96×10^{12} Bq) of radioactivity, mostly tritium, were released as liquid effluents to onsite disposal ponds during the year.

Nonradiological pollutants, including sulfur dioxide and nitrogen dioxide, were monitored in airborne effluents at INEEL facilities. Monitoring results of liquid effluent streams indicated that all were below applicable guidelines.

Potential Radiological Doses from 2000 INEEL Operations

Potential radiological doses to the public from 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 air dispersion model (MDIFF). CAP-88 is required by 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 from 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 maximum potential population dose to the approximately 226,900 people residing within an 80-km (50-mi) radius of any INEEL facility, as estimated using MDIFF and a spreadsheet calculation, was well below that expected from exposure to background radiation. The dose estimates are summarized in Table ES-3.

Table ES-3. Summary of annual effective dose equivalents due to INEEL operations. (2000)

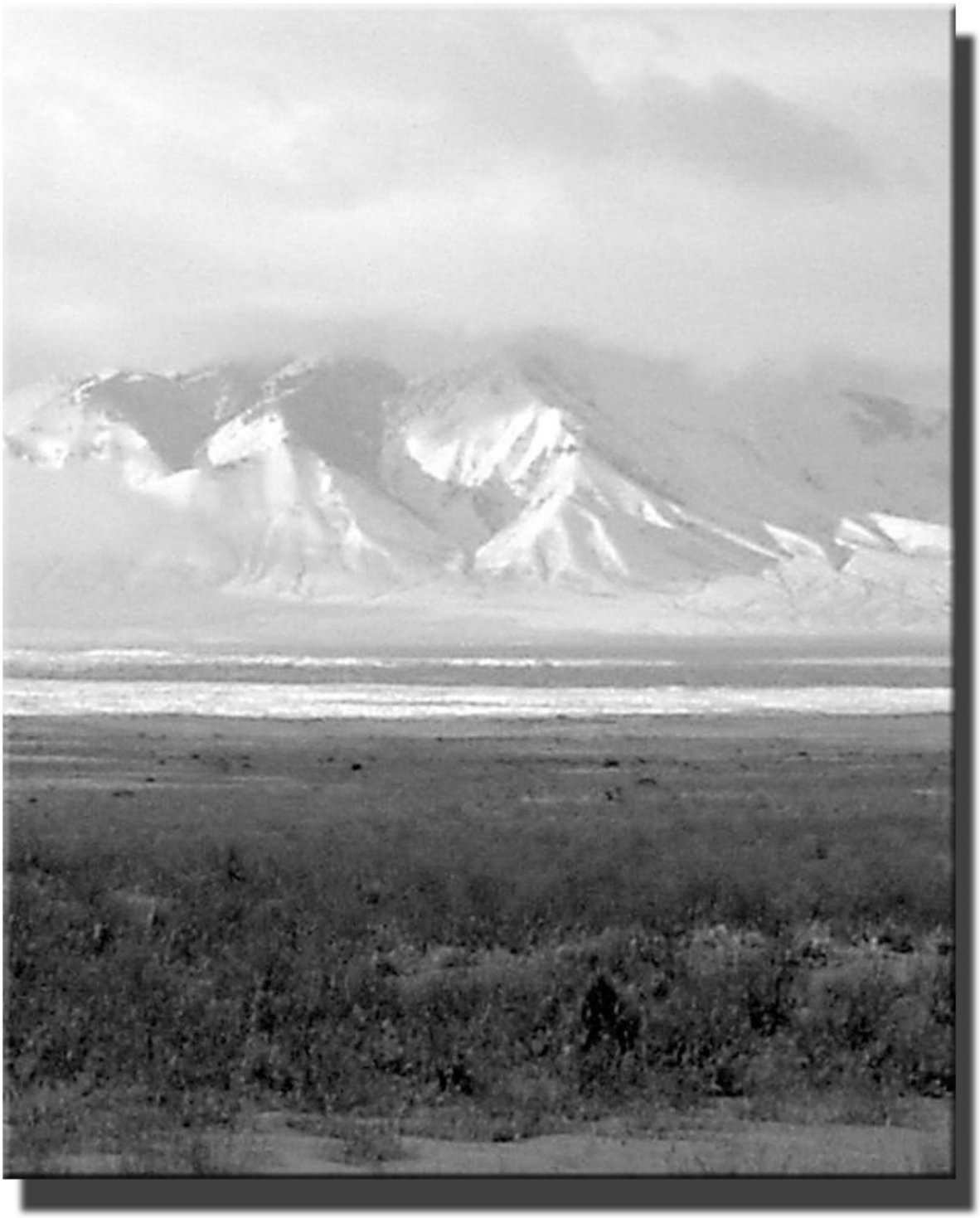
	Maximum Dose to an Individual[a]		Population Dose
	CAP-88[b]	MDIFF[c]	MDIFF[c]
Dose	0.034 mrem 3.4×10^{-4} mSv	0.057 mrem 5.65×10^{-4} mSv	0.53 person-rem 5.3×10^{-3} person-Sv
Location	Frenchman's Cabin	8.9 km (~5.5 mi northwest of Mud Lake, Idaho)	Area within 80 km (50 Mi) of any INEEL facility
Applicable radiation protection standard[d]	10 mrem (1 mSv)	10 mrem (1 mSv)	No applicable standard
Percentage of standard	0.34 %	0.57%	-
Natural background	360 mrem (3.6 mSv)	360 mrem (3.6 mSv)	43,700 person-rem (437 person-Sv)
Percentage of background	0.009 %	0.016 %	0.001 %

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 using the site-specific MDIFF air dispersion model and a spreadsheet calculation based on NRC Regulatory Guide 1.109.

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.



HELPFUL INFORMATION

Scientific Notation

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 more commonly used 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 commonly expressed with a prefix. One example is the prefix kilo (abbreviated k), which means 1,000 of a given unit. One kilometer is, therefore, equal to 1,000 meters. Other prefixes used in this report are listed in the box below.

Unit Prefixes Used in This Report

Prefix	Abbreviation	Meaning
mega-	M	1,000,000 (1×10^{6})
kilo-	K	1,000 (1×10^{3})
centi-	c	1/100 (1×10^{-2})
milli-	m	1/1,000 (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 defined as the number of nuclear 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 is expressed in units of microcuries per milliliter (µCi/mL) of air. Liquid samples, such as water and milk, are expressed as picocuries per liter (pCi/L). Radioactivity in agricultural products is expressed in microcuries per gram (µCi/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 3.7×10^{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 a "±" (uncertainty) term. This report follows convention in reporting the

uncertainty as a 95 percent confidence limit (or interval). That means there is about 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 below.

Radionuclide	Symbol
Americium-241	^{241}Am
Antimony-124	^{124}Sb
Antimony-125	^{125}Sb
Argon-41	^{41}Ar
Barium-137	^{137}Ba
Beryllium-7	^{7}Be
Carbon-14	^{14}C
Cerium-144	^{144}Ce
Cesium-134	^{134}Cs
Cesium-137	^{137}Cs
Cesium-138	^{138}Cs
Chromium-51	^{51}Cr
Cobalt-57	^{57}Co
Cobalt-58	^{58}Co
Cobalt-60	^{60}Co
Curium-244	^{244}Cm
Europium-152	^{152}Eu
Europium-154	^{154}Eu
Europium-155	^{155}Eu
Hafnium-175	^{175}Hf
Hafnium-181	^{181}Hf
Iodine-129	^{129}I
Iodine-131	^{131}I
Iodine-132	^{132}I
Iodine-133	^{133}I
Iodine-135	^{135}I
Iron-55	^{55}Fe
Iron-59	^{59}Fe
Krypton-85	^{85}Kr
Krypton-85m*	^{85m}Kr
Krypton-87	^{87}Kr
Krypton-88	^{88}Kr
Manganese-54	^{54}Mn
Manganese-56	^{56}Mn
Niobium-94	^{94}Nb
Niobium-95	^{95}Nb
Plutonium-238	^{238}Pu
Plutonium-239/240	$^{239/240}Pu$

Radionuclide	Symbol
Potassium-40	^{40}K
Radium-226	^{226}Ra
Radium-228	^{228}Ra
Rubidium-88	^{88}Rb
Rubidium-89	^{89}Rb
Ruthenium-103	^{103}Ru
Ruthenium-106	^{106}Ru
Scandium-46	^{46}Sc
Sodium-24	^{24}Na
Strontium-90	^{90}Sr
Technetium-99m	^{99m}Tc

Radionuclide	Symbol
Tellurium-125m	^{125m}Te
Thorium-232	^{232}Th
Tritium	^{3}H
Uranium-234	^{234}U
Uranium-238	^{238}U
Xenon-133	^{133}Xe
Xenon-135	^{135}Xe
Xenon-138	^{138}Xe
Yttrium-90	^{90}Y
Zinc-65	^{65}Zn
Zirconium-95	^{95}Zr

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

ACRONYMS

AEC	Atomic Energy Commission
ANL-W	Argonne National Laboratory-West
ARA	Auxiliary Reactor Area
ATSDR	Agency for Toxic Substances and Disease Registry
BBWI	Bechtel BWXT Idaho, LLC
BNFL	British Nuclear Fuels Limited
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDC	Centers for Disease Control and Prevention
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CI	Confidence Interval
CMS	Community Monitoring Station
CWA	Clean Water Act
D&D	Decontamination and Decommissioning
DCG	Derived Concentration Guide
DEQ	(Idaho) Department of Environmental Quality
DOE	U.S. Department of Energy
DOE-ID	Department of Energy-Idaho Operations Office
EA	Environmental Assessment
EBR-I	Experimental Breeder Reactor No. 1
EFS	Experimental Field Station
EIS	Environmental Impact Statement
EML	Environmental Measurements Laboratory
EMS	Environmental Management System
EOMA	Environmental Oversight and Monitoring Agreement
EPCRA	Emergency Planning and Community Right-to-Know Act
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Agency
ESER	Environmental Surveillance, Education and Research (Program)
ESRF	Environmental Science and Research Foundation
FAA	Federal Aviation Administration
FFA/CO	Federal Facility Agreement and Consent Order
FONSI	Finding of No Significant Impact
HLW	High-Level (radioactive) Waste
ICDF	INEEL CERCLA Disposal Facility
IMPROVE	Interagency Monitoring of Protected Visual Environments
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center (formerly Idaho Chemical Processing Plant)
ISMS	Integrated Safety Management System
ISO	International Standards Organization
ISU	Idaho State University
LLW	Low-Level (radioactive) Waste
M&O	Management and Operating
MAPEP	Mixed Analyte Performance Evaluation Program

MCL	Maximum Contaminant Level
MDC	Minimum Detectable Concentration
MDIFF	Mesoscale Diffusion
MSC	Monitoring and Surveillance Committee
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
NMFA	Nuclear Materials Focus Area
NOAA	National Oceanic and Atmospheric Administration
NOAA ARL-FRD	National Oceanic and Atmospheric Administration Air Resources Lab-Field Research Division
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRF	Naval Reactors Facility
NSNFP	National Spent Nuclear Fuel Program
NTP	National Transportation Program
NRTS	National Reactor Testing Station
PACE	Paper, Allied-Industrial, Chemical and Energy Workers International Union
PBF	Power Burst Facility
PCB	Polychlorinated Biphenyl
$PM_{2.5}$	Particulate Matter less than 2.5 microns
PM_{10}	Particulate Matter less than 10 microns
RI/FS	Remedial Investigation/ Feasibility Study
RCRA	Resource Conservation and Recovery Act
RESL	Radiological and Environmental Sciences Laboratory
ROD	Record of Decision (CERCLA or NEPA)
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
SNF	Spent Nuclear Fuel
SO_2	Sulfur Dioxide
SRPA	Snake River Plain Aquifer
STP	Site Treatment Plan
TAN	Test Area North
TLD	Thermoluminescent Dosimeter
TRA	Test Reactor Area
TRU	Transuranic
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
WROC	Waste Reduction Operations Complex

UNITS

Btu	British thermal unit
Bq	becquerel
Ci	curie
cm	centimeter
cpm	counts per minute
d	day
dl	detection limit
dpm	disintegrations per minute
ft	foot
g	gram
gal	gallon
h	hour
in.	inch
kg	kilogram
L	liter
lb	pound
m	meter
mi	mile
min	minute
mL	milliliter
mR	milliroentgen
mrem	millirem
µCi	microcurie
µm	micrometer
ng	nanogram
oz	ounce
pCi	picocurie
ppb	parts per billion
ppm	parts per million
rem	roentgen equivalent man
R	roentgen
Sv	sievert
x^2	unit squared
x^3	unit cubed
yd	yard
yr	year
<	less than
>	greater than

TABLE OF CONTENTS

FIGURES

TABLES

Chapter 1

Introduction and Program Information

Environmental Surveillance, Education and Research Program

ESER

1. INTRODUCTION AND PROGRAM INFORMATION

The Idaho National Engineering and Environmental Laboratory (INEEL), locally known as the Site, is owned and administered by the U.S. Department of Energy (DOE). The INEEL occupies approximately 2,300 km^2 (890 mi^2) of the upper Snake River Plain in southeastern Idaho (Figure 1-1). The communities closest to the INEEL are Atomic City (population 25), Arco (population 1,026), Howe (population 20), Monteview (population 10), Mud Lake (population 270), and Terreton (population 100). The larger population centers of Idaho Falls (population 50,730), Blackfoot (population 10,419), and Pocatello (population 51,466) are at least 35 kilometer (km) (22 miles [mi]) from the nearest INEEL boundary (Figure 1-2).

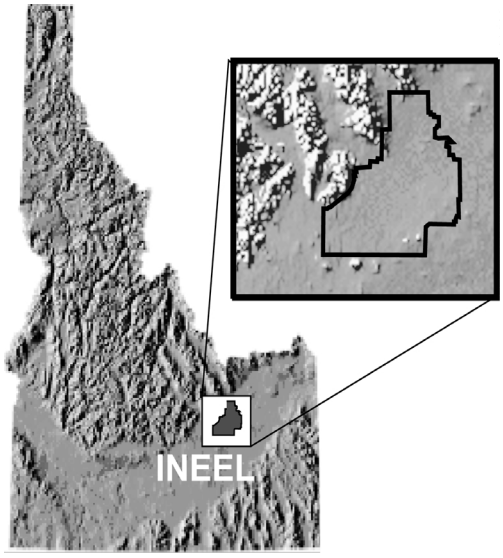


Figure 1-1. Location of the INEEL.

1.1 INEEL MISSION AND FACILITIES

The INEEL's vision is to serve as a multiprogram 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.
- Enhance scientific and technical talent, facilities, and equipment to best serve national and regional interests [Reference 1-1].

During 2000, the INEEL was operated by Bechtel BWXT Idaho, LLC (BBWI) as the management and operating (M&O) contractor to DOE. The University of Chicago's Argonne National Laboratory, Bechtel Bettis, Inc., and British Nuclear Fuels Limited Inc. (BNFL) were responsible for additional facilities. Facilities are located in the city of Idaho Falls and at eight operating areas on the INEEL (Figure 1-3). The current missions of these facilities are outlined 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.

Central Facilities Area

The Central Facilities Area (CFA) provides centralized support for the INEEL, including administrative offices, research

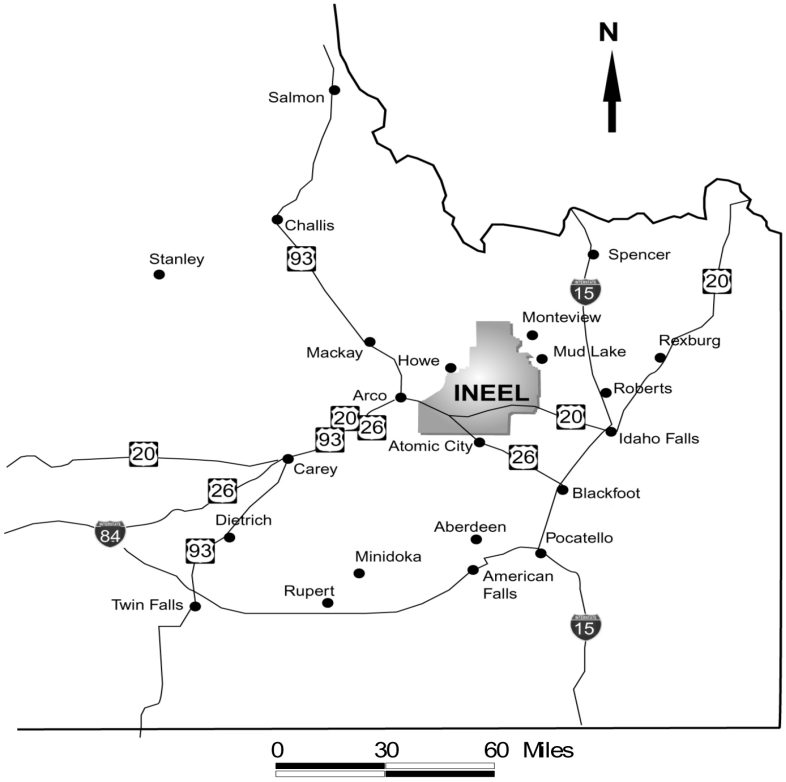


Figure 1-2. INEEL vicinity.

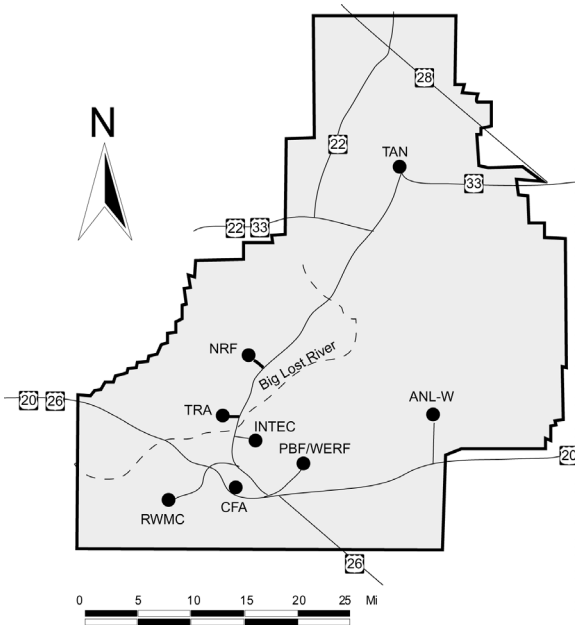


Figure 1-3. INEEL facilities

laboratories, medical services, warehouses, crafts, vehicle support, and a cafeteria.

Idaho Falls Facilities

Idaho Falls facilities include the INEEL Research Center, 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.

Naval Reactors Facility

From 1953 through May 1995, Naval Reactors Facility (NRF) prototypes were used to train Navy personnel who serve aboard nuclear-powered submarines and warships. At the Expended Core Facility, NRF conducts research, inspection, and examination of Naval spent nuclear fuel.

Radioactive Waste Management Complex

The Radioactive Waste Management Complex (RWMC) is used to manage 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. BNFL is currently constructing the Advanced Mixed Waste Treatment Facility. This facility 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 Project manufactures protective armor for the U.S. Army M1-A1 and M1-A2 Abrams tanks. TAN personnel are also conducting research on technologies for the cleanup of 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 and test nuclear fuels and to produce rare and valuable medical and industrial isotopes.

Power Burst Facility / Waste Experimental Reduction Facility

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

1.2 PHYSICAL SETTING OF THE INEEL

The INEEL is located in a large undisturbed expanse of the sagebrush-steppe habitat. Approximately 94% of the land on the INEEL is open and undeveloped. The Site has an average elevation of 1,500 meters (m) (4,900 feet [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 desert, foothills, or agricultural fields. Agricultural activity is concentrated in areas northeast of the INEEL.

The climate of the high desert environment of the INEEL is characterized by sparse precipitation (less than 23 centimeters per year (cm/yr) (9 inches per year [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]) [Reference 1-2]. The altitude, intermountain setting, and latitude of the INEEL combine to produce a semi-arid climate. Prevailing weather patterns are from the southwest, moving up the Snake River Plain. Air masses, which gather moisture over the Pacific Ocean, traverse several hundred miles of mountainous land 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. Beneath these shrubs are grasses and flowering plants, most adapted to the harsh climate. A recent inventory counted 409 plant species on the INEEL [Reference 1-3]. Vertebrate animals found on the INEEL include small burrowing mammals, snakes, birds, and several game species. Published species counts include five fishes, one amphibian, nine reptiles, 159 birds, and 37 mammals [Reference 1-4]. Sixty percent of the INEEL is open to livestock grazing.

The Big Lost River on the INEEL flows toward the northeast ending in a playa area on the northwest portion of the Site, where 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 270 km (165 mi) from St. Anthony, Idaho, 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 charged 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 meters per day (m/d) (5 to 20 feet per day [ft/d]) [Reference 1-5]. The eastern Snake River Plain Aquifer emerges in springs along the Snake River between Milner and Bliss, Idaho. On the Snake River Plain the main use of both surface water and groundwater 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 [References 1-5 and 1-6]. 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 volcanic features (buttes) 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 650-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 usually younger than the rhyolite buttes they surround.

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 4,500 years ago [Reference 1-7].

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.

During World War II, large guns from U.S. Navy ships 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 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 became the first to produce useful electricity. The facility 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 the Idaho National Engineering and Environmental Laboratory in 1997. In 1974, the AEC was renamed the Energy Research and Development Agency (ERDA) which, in 1977, was reorganized to the present-day DOE.

1.4 REGIONAL ECONOMIC IMPACT

Approximately 8,100 people work at the INEEL, making it the largest employer in eastern Idaho and the third largest employer in the State. This number includes about 400 federal employees, most of who work for DOE-ID. The majority of the other 7,700 employees work for the M&O contractor at the INEEL. Other employees work for contractors at facilities operated by other DOE organizations, such as Bechtel Bettis, Inc. at NRF and the University of Chicago at ANL-W.

The INEEL has a tremendous economic impact on eastern Idaho. The following statistics for 2000 demonstrate why the INEEL is an integral component of Idaho's economy and society.

- The INEEL directly and indirectly maintained over 16,000 jobs and accounted for almost half a billion dollars in economic activity for Idaho.
- About $130 million worth of goods and services were purchased by the INEEL from vendors in Idaho.
- $7.4 million was disbursed for economic diversification and community development.
- $4.7 million in equipment was donated to Idaho schools and institutions.
- $2.5 million in research funding was provided to Idaho universities.
- Altogether, INEEL families paid $47.5 million in taxes.

DOE and INEEL contractors consistently give their time and income to the community through various civic activities. In 2000, INEEL employees gave nearly $20 million to charitable causes in their communities. INEEL employees and their households also contributed 1.5 million volunteer hours to community concerns, church affiliations, educational activities, political and issue-related causes, youth, and other areas of interest.

1.5 HISTORY AND STRUCTURE OF ENVIRONMENTAL MONITORING PROGRAMS

Operations of INEEL facilities have the potential to release some materials, which may include both radioactive and nonradioactive contaminants, into the environment. There are two primary routes by which these materials can enter the environment: into the atmosphere as airborne effluents and into surface water and groundwater as liquid effluents. Through a variety of exposure pathways (Figure 1-4), contaminants can be transported away from INEEL facilities, where they could potentially impact the surrounding environment and the population living in those areas.

The primary purpose of the various environmental monitoring programs

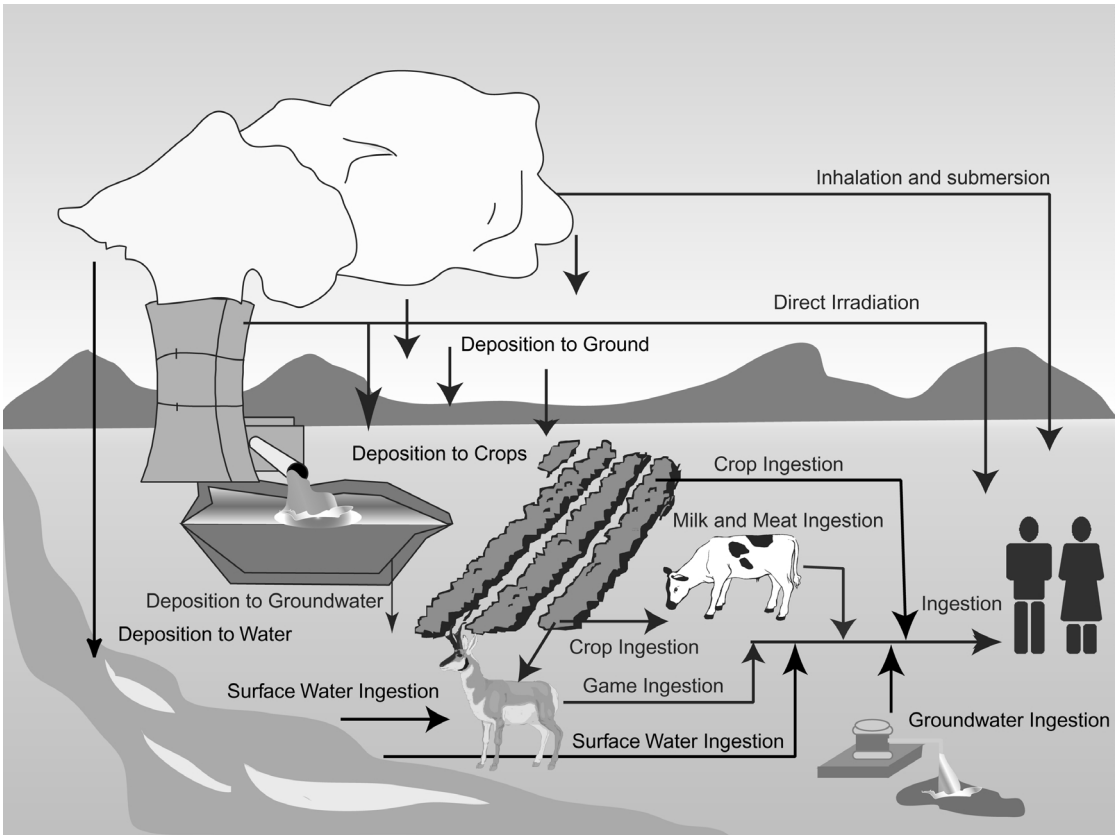


Figure 1-4. Potential pathways from the INEEL to humans.

conducted at the INEEL is to evaluate these different exposure pathways and to determine what effects may be occurring in the environment. In addition, monitoring provides the information to verify compliance with a variety of applicable environmental protection laws and regulations described in Chapter 2. DOE Order 5400.1 also requires DOE sites to conduct an environmental monitoring program [Reference 1-8].

The term environmental monitoring is used to describe two separate activities: effluent monitoring and environmental surveillance. Effluent monitoring is the measurement of the waste stream before its release to the environment, such as the monitoring of stacks or discharge pipes. Environmental surveillance is the measurement of pollutants in the environment. Surveillance involves determining whether or not pollutants are present or measurable and, if present, in what concentrations they are found.

Environmental monitoring has been performed at the INEEL by the DOE and its predecessors, the AEC and ERDA, as well as by other federal agencies, various contractors, and State agencies since its inception in 1949. The following sections present a brief history of the evolution of the monitoring programs and a description of the activities conducted in 2000 for each of the media sampled.

The organization of environmental monitoring programs throughout much of the history of the INEEL remained fairly constant. The AEC's Health Services Laboratory, later named the DOE's

Radiological and Environmental Sciences Laboratory, was responsible for conducting most environmental surveillance from 1949 to 1993 at locations both on and off the INEEL. Contractors operating the various facilities were responsible for monitoring performed within the facility boundaries and for effluent monitoring. Throughout the history of the Site, the U.S. Geological Survey (USGS) has conducted groundwater monitoring and the National Oceanic and Atmospheric Administration (NOAA) has performed meteorological monitoring.

At the end of 1993, the DOE program was divided into separate onsite and offsite programs. Responsibility for the onsite program was transferred to the M&O contractor at the time, Lockheed Martin Idaho Technologies Company. BBWI assumed the M&O contract and the onsite monitoring program in 1999.

The offsite monitoring program was transferred to the Environmental Science and Research Foundation beginning in April 1994. The current Environmental Surveillance, Education and Research (ESER) Program, led by the S. M. Stoller Corporation, began monitoring in November 2000.

Air Monitoring

Historical Background

Low-volume air samplers have operated on and in the vicinity of the INEEL since 1952. Table 1-1 shows the areas where samplers have been located and the dates of operation for these samplers [Reference 1-9]. 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 and CFA from 1973 until October 1996. Also in 1973, a high-volume sampler began operation in Idaho Falls as part of the U.S. Environmental Protection Agency's (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 this radionuclide from INTEC during periods when fuel processing was taking place.

Nitrogen dioxide and sulfur dioxide were first monitored for a 9-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 has operated since 1989 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 micrometers (μm) in diameter ($PM_{2.5}$). These particles have been determined to be the largest cause of visibility degradation. 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 the two samplers collected two 24-hour $PM_{2.5}$ samples a week. Analyses were performed for mass, optical absorption, hydrogen, carbon, nitrogen, and oxygen plus elements from sodium through lead on the periodic table. The CFA sampler operated through May 2000 when EPA removed it from the nationwide network.

Table 1-1. Historical air sampling locations and dates of operations.

Sampling Location	Dates of Operation
Distant Locations	
Aberdeen	1952-1957, 1960-1970
American Falls	1970
Blackfoot	1968-present
Blackfoot Community Monitoring Station	1983 - present
Carey	1961-1970
Craters of the Moon[a]	1973-present
Dietrich	1961-1970
Idaho Falls	1953-1955, 1956-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
Federal Aviation Administration Tower	1981-present
Howe	1958-present
Monteview	1958-present
Mud Lake	1958-present
Reno Ranch/Birch Creek	1958-present
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-I	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-I	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	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 Avenue	1976-present

a. Designated as a boundary location 1973-1981.

Current Programs

Both the ESER and M&O contractors maintain a network of low-volume air samplers to monitor for airborne radioactivity. The ESER contractor operates 12 samplers at offsite locations and 3 onsite samplers (Figure 1-5); the M&O contractor maintains 12 onsite and 4 offsite sampling locations. The M&O contractor added a 13th onsite sampler in August 2000 at the US Highway 20 Rest Area to perform monitoring following the range fire of July 27, 2000.

Each low-volume air sampler maintains an average airflow of 50 liters per minute (L/min) (2 cubic feet per minute [ft^3/min]) through a set of filters consisting of a 1.2-µm pore membrane filter followed by a charcoal cartridge. The filters are 99% efficient for airborne particulates and iodides.

Filters from the low-volume air samplers are collected and analyzed weekly. 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 filter in that batch is recounted individually.

Particulate filters are analyzed weekly using a proportional counting system. Filters are analyzed after waiting a minimum of 4 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 alpha-emitting radionuclides (plutonium-238 [^{238}Pu], plutonium-239/240 [$^{239/240}Pu$], and americium-241 [^{241}Am]) and for strontium-90 (^{90}Sr). The analyses for alpha-emitting radionuclides use chemical separation

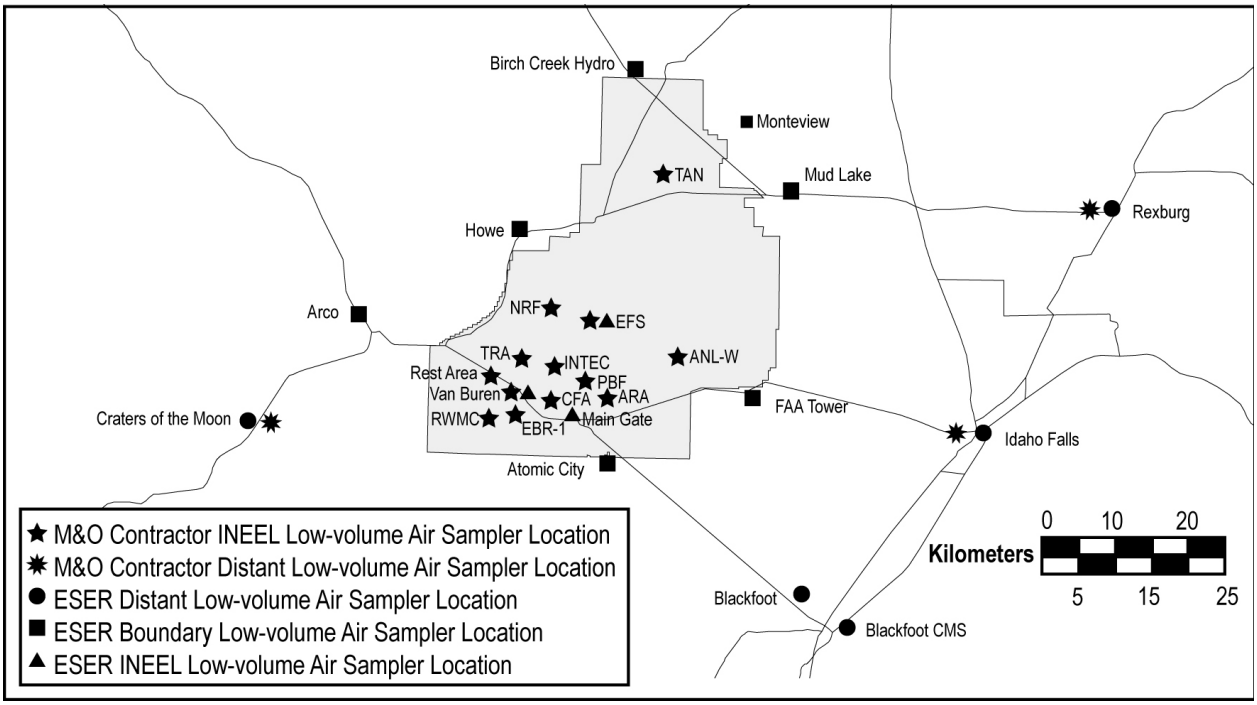


Figure 1-5. Low-volume air sampling locations.

techniques followed by alpha spectrometry; for ^{90}Sr, the chemical separation is followed by beta counting.

Measurements of total suspended particulates are performed on the 1.2-µm pore membrane filters from the low-volume air samplers. The M&O contractor weighs these filters on a weekly basis before and after sampling to determine the amount of material collected. The ESER contractor weighs a set of clean filters at the beginning of the quarter and reweighs the filter composite at the end of each quarter. In both cases the amount of material collected is determined by subtracting the presampling (clean filter set) weight from the post sampling (or composite) weight. The concentration of total suspended particulates is calculated by dividing the amount of material collected on the filters by the total volume of air passing through the filters.

Samplers for tritium in atmospheric moisture are located at two onsite and five offsite locations. In these samplers, air is passed through a column of either silica gel or molecular sieve material at 0.3–0.5 L/min (0.6–1.0 ft^3/min). 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). Tritium concentrations are then determined by liquid scintillation counting of the water extracted from the columns.

Tritium is also monitored using precipitation samples collected on the INEEL monthly at CFA and weekly at the Experimental Field Station. A monthly sample is also obtained offsite in Idaho Falls. A portion of each precipitation sample is submitted for tritium analysis by liquid scintillation counting.

Water Monitoring

Historical Background

The USGS has conducted studies of groundwater at the INEEL since the Site's inception in 1949. The agency was initially tasked to characterize water resources before developing nuclear reactor testing facilities. The USGS has since maintained a groundwater quality and water level measurement program on the INEEL to support research and follow 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. An INEEL Project Office has been located at CFA since 1958 [Reference 1-10].

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* and the *INEL Groundwater Protection Management Plan*. 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 [Reference 1-11].

Sampling 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 3 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 required to develop a storm water monitoring program. Sampling of snowmelt and rain runoff began in 1993, and included up to 16 sites at 8 INEEL

facilities. Samples were collected from storms of at least 0.25 centimeters (cm) (0.1 inches [in.]) of precipitation preceded by a minimum of 72 hours without precipitation [Reference 1-12].

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." The permit required sample collection and laboratory analysis every four years (last done in 1999) at 18 potential contaminant sites and from coal piles at INTEC whenever there is a discharge to the Big Lost River System. In addition, quarterly visual examination was required.

Current Programs

The USGS currently maintains 125 aquifer observation wells on or near the INEEL. An additional 45 wells are available for sampling perched groundwater bodies. In addition, more than 120 auger holes have been drilled to monitor shallow perched groundwater bodies (see Chapter 5).

USGS personnel collect water samples for analysis of radiological and nonradiological substances in water from monitoring and production wells on schedules ranging from monthly to annually. These samples are submitted to the USGS National Water Quality Laboratory in Denver, Colorado, for analysis of 60 purgeable organic compounds. Sampling for trace elements is also performed by the USGS. Other parameters in groundwater are measured based on the needs of special studies that are being conducted by the organization. Results of these studies are published in USGS Water Resources Investigation Reports and Open-File Reports on a periodic basis.

The USGS also records water levels in selected wells to determine depth to water and potentiometric surface characteristics. In addition to work on the INEEL, the USGS also conducts special studies of the groundwater of the Snake River Plain. These special studies provide more specific geological and hydrological information on the flow and recharge of the aquifer and the movements of radioactive and nonradioactive substances in the groundwater.

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 2000, this included collection of 234 groundwater samples yielding 482 parameter results. More detailed information is included in the *2000 Environmental Monitoring Program Report* [Reference 1-13] and in Chapter 5.

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 10 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. NRF maintains a separate program for sampling drinking water at that facility. 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 onsite drinking water samples from active facilities on a quarterly basis for radiological analysis. Paragon Laboratory, located in Fort Collins, Colorado, performed these analyses during 2000. Each water sample is submitted for gross analyses of alpha- and beta-emitting radionuclides. Tritium analyses are also performed on all drinking water samples. Strontium-90 analyses are performed on quarterly samples from drinking water wells in the INTEC area because water quality monitoring data indicate these wells may contain water with elevated ^{90}Sr levels.

The Environmental Hygiene Laboratory operated by the M&O contractor analyzes potable water at the INEEL for coliform

bacteria monthly. If indications of contamination by bacteria are found in a sample, that particular drinking water system is disinfected, resampled, and tested again until it is clear of bacteria. Corrective action to purify the water may vary among facilities.

The M&O contractor Drinking Water Program samples drinking water from wells and distribution systems at the INEEL 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 and other monitoring locations did not discharge to the Big Lost River System in 2000; so analytical monitoring was not required. Thus, monitoring in 2000 consisted only of quarterly visual examination of storm water at 18 locations.

The ESER contractor collects drinking water samples semiannually from boundary and distant communities. Surface water samples are also collected from the Snake River at Idaho Falls and Bliss. Each water sample is analyzed for gross alpha- and beta-emitting radionuclides, as well as for tritium.

Agricultural 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 picocuires per liter (pCi/L) in early sampling to the current detection level of about 2 pCi/L.

Wheat was first sampled as part of radioecology research programs 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 4-L (1-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, cesium-137 (^{137}Cs), and one analysis for ^{90}Sr and tritium at each location was 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 INEEL vicinity, 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 were 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 annually from the Industrial Waste Pond and Industrial Waste Ditch. These samples are analyzed for low-level 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 radioactive waste disposal ponds occurred the following year. Waterfowl studies have covered the periods 1974–1978, 1984–1986, and 1993–1998. 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. Regular dove sampling as part of the environmental surveillance program was initiated in 1996. In 1998, sampling of yellow-bellied marmots was added to the sampling program.

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.

Current Programs

Selected tissues (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 three 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 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 and from a control area southeast of Idaho Falls. Because of the small size of a typical dove, muscle tissues from several doves are composited into one sample. Samples are analyzed for gamma-emitting radionuclides, ^{90}Sr, and transuranic radionuclides.

Yellow-bellied marmots are collected from the RWMC and a control location near Idaho Falls. All marmot samples are analyzed for gamma-emitting radionuclides, with randomly selected samples also receiving analysis for ^{90}Sr and transuranic radionuclides.

Samples of tissue (muscle, liver, and thyroid) are collected from sheep grazing on the INEEL. Control samples are collected from Blackfoot. The muscle and liver are processed and analyzed by gamma spectrometry. The thyroid is placed in a vial and analyzed specifically for ^{131}I.

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, then every 2 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 (~10-ft^2) area. In all other years, the five cores were collected from a 100-m^2 (~1,000-ft^2) area.

A soil sampling program began in 1973 around onsite facilities. Soils at each facility were sampled every 7 years.

Current Programs

Twelve offsite locations are sampled in even numbered years. Following collection, soil samples are dried for at least 3 hours at 120°C (250°F) and sieved. Only soil particles less than 500 microns in diameter (35 mesh) are analyzed. All offsite samples

are analyzed for gamma-emitting radionuclides, ^{90}Sr, and transuranic radionuclides.

The M&O performs soil sampling around each of the major facilities on a rotating three-year basis. This schedule will be increased to every other year starting in 2001. Soils are collected from 0 – 5 cm (0 – 2 in.) and analyzed for gamma-emitting radionuclides and ^{90}Sr.

Argonne National Laboratory-West collects soil samples annually at locations along the major wind directions and at crosswind locations. Samples are analyzed for low-level alpha, beta and gamma radionuclides.

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 later 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 dosimeters, known as TLDs, are used to measure ambient ionizing radiation exposures. The TLDs measure ionizing radiation exposures from all external sources (i.e., 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. The scanner is mounted on a four-wheel drive vehicle, which is driven at approximately 8 kilometers per hour (km/hr) (5 miles per hour [mi/hr]). Two plastic scintillation detectors are used, and radiometric and global positioning system data are continuously recorded.

Meteorological Monitoring

Historical Background

The National Oceanic and Atmospheric Administration 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 33 meteorological stations in the vicinity of the INEEL. These stations provide continuous measurement of a variety of parameters, including temperature at two or three elevations, wind direction and speed, relative humidity, and precipitation. In addition, continuous measurements are taken using a wind profiling radar system and a radio acoustic sounding system located on the INEEL. Data are transmitted via radio to the NOAA Idaho Falls facility, where they are stored in a computerized archive.

Oversight Monitoring Programs

Historical Background

Idaho State University (ISU) began an independent verification program under a contractual agreement with the DOE in 1989. Under this program, ISU air sampling units obtained samples simultaneously with those collected by DOE and USGS, and ISU performed independent analyses. Sample media obtained included air, water, and milk.

The INEEL Oversight Program was established in 1989 by the state of Idaho to evaluate the environmental impacts and health risks of operations at the INEEL. Initial monitoring activities focused on groundwater. In 1993, the INEEL Oversight Program consolidated its environmental surveillance efforts into a comprehensive program to collect data from air, water, and terrestrial sampling. In January 1994, the ISU program was combined with the INEEL Oversight Program.

Current Programs

The INEEL Oversight Program operates a network of ten air monitoring stations to collect airborne particulate matter, gaseous radioiodine, precipitation, and atmospheric moisture. Fourteen environmental radiation stations have electret ionization chambers, which are a passive integrating system to make field measurements of gamma radiation over a calendar quarter. Ten of the 14 stations also have high-pressurized ion chambers. These are capable of real-time measurement and can detect small changes in radiation levels. In addition, the INEEL Oversight Program conducts extensive water monitoring, both for radiological and nonradiological constituents in groundwater, surface water, drinking water, and springs. A terrestrial sampling program includes collection of milk and soil.

Many of these samples are taken simultaneously with other organizations performing environmental surveillance or are from sites collocated with other organizations. The ISU Environmental Monitoring Laboratory performs all radiological analyses. The INEEL Oversight Program produces quarterly and annual reports detailing results of the monitoring [Reference 1-14].

1.6 SUMMARY

Tables 1-2 through 1-4 present a summary of the environmental surveillance programs conducted by the ESER contractor, the M&O contractor, and the USGS in 2000. The minimum detectable concentrations listed for the M&O contractor are for environmental surveillance samples. Those listed in the *2000 Environmental Monitoring Program Report* are for waste surveillance samples.

Table 1-2. ESER environmental surveillance program summary (2000).

Medium Sampled	Type of Analysis	Number of Locations and Frequency: Onsite	Number of Locations and Frequency: Offsite	Minimum Detectable Concentration
Air (low volume)	Gross alpha	3 weekly	13 weekly	1×10^{-15} µCi/mL
	Gross beta	3 weekly	13 weekly	3×10^{-12} µCi/mL
	Specific gamma	3 quarterly	13 quarterly	4×10^{-10} µCi/mL
	^{238}Pu	1-2 quarterly	7 quarterly	2×10^{-18} µCi/mL
	$^{239/240}Pu$	1-2 quarterly	7 quarterly	2×10^{-18} µCi/mL
	^{241}Am	1-2 quarterly	7 quarterly	2×10^{-18} µCi/mL
	^{90}Sr	1-2 quarterly	7 quarterly	1×10^{-6} µCi/mL
	^{131}I	3 weekly	13 weekly	4×10^{-15} µCi/mL
	Total particulates	3 quarterly	13 quarterly	10 µg/m^3
Air (PM_{10})		None	3 weekly	
Air (NPS IMPROVE)	H, Na-Pb, $PM_{2.5}$	1 biweekly	1 biweekly	
Air (atmospheric moisture)	^{3}H	None	4 locations, 2 to 4 per quarter	4×10^{-12} µCi/mL
Air (precipitation)	^{3}H	1 weekly/ 1 monthly	1 monthly	3×10^{-7} µCi/mL
Drinking Water	Gross alpha	None	15 semiannually	3×10^{-9} µCi/mL
	Gross beta	None	15 semiannually	2×10^{-9} µCi/mL
	^{3}H	None	15 semiannually	3×10^{-7} µCi/mL
Surface Water	Gross alpha	None	5 semiannually	3×10^{-9} µCi/mL
	Gross beta	None	5 semiannually	2×10^{-9} µCi/mL
	^{3}H	None	5 semiannually	3×10^{-7} µCi/mL
Animal Tissue (sheep)[a]	Specific gamma	4 annually	2 annually	5×10^{-9} µCi/g
	^{131}I	4 annually	2 annually	3×10^{-9} µCi/g
Animal Tissue (game)	Specific gamma	Varies annually[b]	-----	5×10^{-9} µCi/g
	^{131}I			3×10^{-9} µCi/g
Agricultural products (milk)	^{131}I	None	1 weekly	3×10^{-9} µCi/mL
	^{131}I	None	9 monthly	3×10^{-9} µCii/mL
	Specific Gamma	None	9 annually	1×10^{-7} µCi/g
	^{90}Sr	None	9 annually	5×10^{-9} µCi/mL
	^{3}H	None	9 annually	3×10^{-7} µCi/mL
Agricultural products (potatoes)	Specific gamma	None	8 annually	1×10^{-7} µCi/g
	^{90}Sr	None	8 annually	2×10^{-7} µCi/g
Agricultural products (wheat)	Specific gamma	None	11 annually	1×10^{-7} µCi/g
	^{90}Sr	None	11 annually	2×10^{-7} µCi/g
Agricultural products (lettuce)	Specific gamma	None	9 annually	1×10^{-7} µCi/g
	^{90}Sr	None	9 annually	2×10^{-7} µCi/g
Soil	Specific gamma	None	12 biennially	1×10^{-7} µCi/g
	^{238}Pu	None	12 biennially	5×10^{-9} µCi/g
	^{238}Pu	None	12 biennially	1×10^{-8} µCi/g
	Am	None	12 biennially	5×10^{-9} µCi/g
	^{90}Sr	None	12 biennially	5×10^{-8} µCi/g
Direct Radiation Exposure (thermoluminescent dosimeters)	Ionizing Radiation	None	14 semiannually	5 mR

a. Onsite animals grazed onsite for at least 4 weeks before being sampled. Offsite animals have never grazed onsite and serve as controls.

b. Only game animals that are victims of road-kills or natural causes are sampled onsite. No controls are generally collected except for specific ecological studies.

Table 1-3. M&O contractor site environmental surveillance program summary (2000).

Medium Sampled	Type of Analysis	Locations and Frequency		Approximate Minimum Detectable Concentration
		Onsite	Offsite	
Air (low volume)	Gross alpha	12 weekly	4 weekly	1×10^{-15} µCi/mL
	Gross beta	12 weekly	4 weekly	5×10^{-15} µCi/mL
	Specific gamma	12 quarterly	4 quarterly	[a]
	^{238}Pu	12 quarterly	4 quarterly	8×10^{-18} µCi/mL
	$^{239/240}Pu$	12 quarterly	4 quarterly	8×10^{-18} µCi/mL
	^{241}Am	12 quarterly	4 quarterly	8×10^{-18} µCi/mL
	^{90}Sr	12 quarterly	4 quarterly	1×10^{-16} µCi/mL
	^{131}I	12 weekly	4 weekly	2×10^{-14} µCi/mL
	Total particulates	12 weekly	4 weekly	10 µg/m^3
Air (atmospheric moisture)	Tritium	1 to 2 per quarter	----[b]	1×10^{-11} µCi/m
Air	Nitrogen oxides	Continuous	-----	NA[c]
Air	Sulfur dioxide	Continuous	-----	NA
Soil	Specific gamma	Varies annually		1×10^{-7} µCi/g
	^{238}Pu	Varies annually	-----	3×10^{-9} µCi/g
	$^{239/240}Pu$	Varies annually	-----	3×10^{-9} µCi/g
	^{241}Am	Varies annually	-----	3×10^{-9} µCi/g
	^{90}Sr	Varies annually	-----	6×10^{-8} µCi/g
Vegetation	Specific gamma	Varies annually	-----	[a]
	^{90}Sr	Varies annually	-----	
Storm Water	Gross alpha	No analytical samples required in 2000.	-----	1 pCi/L
	Gross beta		-----	4 pCi/L
	^{3}H		-----	1,000 pCi/L
	Inorganics		-----	[d]
Drinking Water	Gross alpha	12 Quarterly	-----	1 pCi/L
	Gross beta	12 Quarterly	-----	4 pCi/L
	^{3}H	12 Quarterly	-----	1,000 pCi/L
	^{90}Sr[e]	4 Quarterly		2 pCi/L
	Volatile organics	10 Quarterly/ 4 Annually[f]	-----	0.5 parts per billion (ppb)
	Semivolatile organics	12 Triennially	-----	[d]
	Inorganics	12 Triennially	-----	[d]
Direct Radiation Exposure (TLDs)	Ionizing radiation	135 semiannually	13 semiannually	5 mR
Direct Radiation Exposure (radiation surveys)	Gamma radiation	Facilities INEEL Roads	-----[g]	Not Applicable

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

b. Onsite soil sampling is performed each year at different onsite facilities on a rotating 7-year schedule.

c. NA = not applicable. Values are taken off the instrument at the time of reading.

d. Minimum detectable concentration for these analyses varies depending on constituent and analytical method used. For drinking water samples this is normally 1/10th of the applicable MCL.

e. Strontium-90 is only analyzed for at CFA and INTEC.

f. Annual samples are collected at RWMC, TAN, and TAN/TSF.

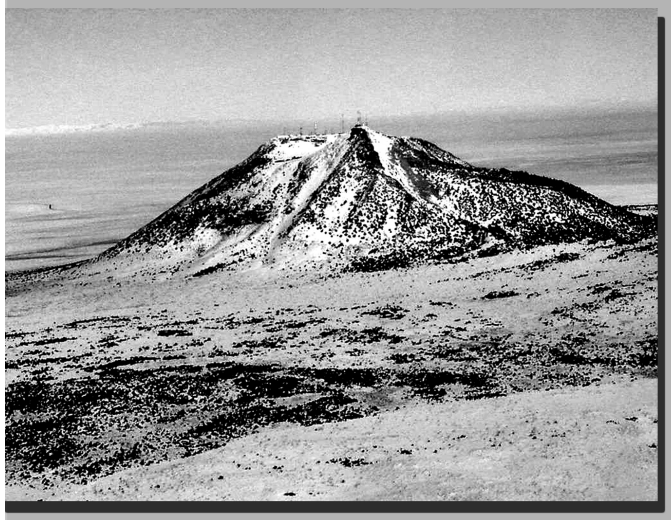
g. Surveys are performed each year at different onsite facilities on a rotating 3-year schedule. All INEEL roadways over which waste is transported are surveyed annually.

Table 1-4. U.S. Geological Survey monitoring program summary (2000).

		Groundwater		Surface water		
Constituent	Frequency	Number of Sites	Number of Samples	Number of Sites	Number of Samples	Minimum Detectable Concentration
Gross alpha	Semiannually	43	86	4	8	3×10^{-9} µCi/mL
Gross beta	Semiannually	43	86	4	8	4×10^{-9} µCi/mL
Tritium	Quarterly	30	120	—[a]	—	4×10^{-7} µCi/mL
	Semiannually	95	190	7	14	
	Annually	39	39	—	—	
Specific gamma	Quarterly	5	20	—	—	[b]
	Semiannually	58	116	4	8	
	Annually	26	26	—	—	
Strontium-90	Quarterly	25	100	—	—	5×10^{-9} µCi/mL
	Semiannually	60	120	—	—	
	Annually	33	33	—	—	
Americium-241	Quarterly	5	20	—	—	5×10^{-11} µCi/mL
	Semiannually	13	26	—	—	
	Annually	3	3	—	—	
Plutonium isotopes	Quarterly	5	20	—	—	4×10^{-11} µCi/mL
	Semiannually	13	26	—	—	
	Annually	3	3	—	—	
Conductivity	Quarterly	30	120	—	—	Not applicable
	Semiannually	96	192	7	14	
	Annually	39	39	—	—	
Sodium Ion	Quarterly	2	8	—	—	1×10^{-1} mg/L
	Semiannually	46	92	—	—	
	Annually	98	98	—	—	
Chloride Ion	Quarterly	30	120	—	—	1×10^{-1} mg/L
	Semiannually	95	190	7	14	
	Annually	39	39	—	—	
Nitrates (as nitrogen)	Semiannually	42	84	—	—	5×10^{-2} mg/L
	Annually	67	67	—	—	
Sulfate	Quarterly	2	8	—	—	1×10^{-1} mg/L
	Triennially	3	9	—	—	
	Semiannually	10	20	—	—	
	Annually	103	103	—	—	
Chromium (dissolved)	Quarterly	4	16	—	—	5×10^{-3} mg/L
	Semiannually	71	142	—	—	
	Annually	17	17	—	—	
Purgeable Organic Compounds[c]	Monthly	1	12	—	—	2×10^{-3} mg/L
	Quarterly	4	16	—	—	
	Semiannually	17	34	—	—	
	Annually	7	7	—	—	
Total Organic Carbon	Annually	42	42	—	—	1×10^{-1} mg/L
Trace Elements	Semiannually	9	18	—	—	varies

a. A line (—) indicates that surface water is not analyzed for that constituent.
b. Minimum detectable concentration for gamma spectroscopic analyses varies depending on radionuclide.
c. Each volatile organic water sample is analyzed for 60 purgeable organic compounds.

Chapter 2



Environmental Compliance Summary

Environmental Surveillance, Education and Research Program

ESER

2. ENVIRONMENTAL COMPLIANCE SUMMARY

Operations at the Idaho National Engineering and Environmental Laboratory (INEEL) are subject to numerous Federal, and State environmental statutes and regulations. These are listed in Appendix A. A brief summary of the INEEL's status with these regulations is presented in the following sections.

2.1 COMPLIANCE STATUS

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides broad Federal authority to respond directly to releases or potential releases of hazardous substances that may endanger public health or the environment. Through the National Contingency Plan, CERCLA provides specific procedures to assess and remediate areas of actual or potential releases. The ultimate goal of CERCLA actions is to reduce or eliminate the potential risk to human health and the environment from these potential or actual releases. Nuclear research and other operations 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. Environmental restoration activities at the INEEL are being conducted in accordance with the Federal Facility Agreement and Consent Order (FFA/CO) signed in December 1991 by the U.S. Department of Energy-Idaho Operations Office (DOE-ID), the state of Idaho, and the U.S. Environmental Protection Agency (EPA) Region 10.

Field investigations are used to evaluate many potential release sites when existing data are expected 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 cleanup 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 10 Waste Area Groups (WAGs) containing 26 areas for conducting environmental investigations as a result of the FFA/CO. By the end of 2000, 21 investigations were complete with legally binding RODs. The remaining investigations to be completed include:

- A combined investigation of the Experimental Breeder Reactor No. 1 (EBR-I)/Boiling Water Reactor Experiment area and contaminated surface areas outside facility boundaries;
- Buried waste at the Radioactive Waste Management Complex (RWMC);
- Soil and groundwater contamination at the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm; and
- Snake River Plain Aquifer contamination from the INEEL.

All 15 FFA/CO enforceable milestones scheduled for 2000 were completed during the year. Cleanup was completed at one area at the INEEL in 2000, bringing the total number of cleaned up areas to 12. Cleanup actions are in progress at nine other areas.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) established

regulatory standards for generation, transportation, storage, treatment, and disposal of hazardous waste. The Idaho Department of Environmental Quality (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.

Notice of Violation

On May 26, 1999, DOE received a Notice of Violation from the Idaho DEQ. The alleged violations stem from inspections on April 15-17, June 8-12, June 29, July 14-16, July 31, August 12, and August 18-24, 1998. DEQ alleged 86 violations with a fine of $839,550. In 2000, DOE-ID and DEQ signed a consent order to resolve the alleged violations with a final fine amount of $445,600, of which $170,000 will be used for two Supplemental Environmental Projects ($20,000 to the Shoshone-Bannock Tribes Land Use Department and $150,000 to the Sagebrush Steppe Reserve).

Closure Plans

The state of Idaho approved the following closure plans in November 2000:

- The Heat Transfer Reactor Experiment No. 3 at EBR-I;
- Process Experimental Pilot Plant Incinerator and Waste Stabilization at TAN; and
- The Hazardous Chemical Waste Handling and Neutralization Facility at INTEC.

Two additional facilities were administratively closed in 2000. They were the Waste Characterization Facility at the RWMC and the Waste Experimental Reduction Facility Waste Storage/Feed Tanks at the Waste Experimental Reduction Facility/Power Burst Facility area.

Reports

As required by the state of Idaho, INEEL submitted the Idaho Hazardous Waste Generator Annual Report for 2000. The report contains information on waste generation, treatment, recycling, and disposal activities at INEEL facilities.

DOE-ID submitted the INEEL 2000 Affirmative Procurement Report to 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 CFA and some areas at ANL-W requires submittal of an annual certification to 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, 2000.

A 45-day Notification for 2000 Treatability Studies was submitted to DEQ in October 1999. This report was submitted in addition to the notification normally provided in the DOE Annual Report on Treatability Studies submitted to DEQ in March 1999. Treatability Studies, as defined by the regulation [Reference 2-1], are those in which a hazardous waste is subjected to a treatment process to determine:

- Whether the waste is amenable to the treatment process;
- What pretreatment, if any, is required;
- The optimal process conditions needed to achieve the desired treatment;
- The efficiency of a treatment process for a specific waste or wastes; and
- The characteristics and volumes of residuals from a particular treatment process.

The notifications briefly describe the types of studies performed on both hazardous waste and mixed waste and the

quantities of waste used in the studies. A Treatability Study is not a means to commercially treat or dispose of hazardous waste.

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 Site Treatment Plan (STP) was published on October 31, 1995. DOE and DEQ developed a Consent Order that provides the legal framework for implementing the STP. By November 1, 1995, both DOE and DEQ had signed the Consent Order, thereby implementing the STP. For more information see Section 2.4.

In November 2000, the annual STP report was submitted to the State for review and final approval, and the State approved the report in January 2001. In 2000, the INEEL treated 59.2 m^3 (2,090.6 ft^3) of mixed waste from offsite sources and 1,214 m^3 (42,872 ft^3) from onsite sources.

Clean Air Act

The Clean Air Act sets standards for ambient air quality and for emission of hazardous air pollutants. 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 may demonstrate that the project/process either is below emission thresholds or listed as an exempted source category in state of Idaho regulations;
- Submittal of an application for a Permit to Construct—if emissions are deemed major under Prevention of Significant Deterioration regulations then a Prevention of Significant Deterioration analysis, as described in the regulations, must be completed;
- Request for a Permit to Construct; or
- Request for a Permit to Construct for sources of significant emissions through a Prevention of Significant Deterioration analysis.

Permitting actions for sources of air pollutants at the INEEL are listed in Section 2.9.

Title V Operating Permit

Title V of the 1990 amendments to the Clean Air Act 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 the Idaho Division of Environmental Quality (DEQ) in March 2001.

National Emission Standards for Hazardous Air Pollutants

DOE-ID submitted the *2000 INEEL National Emission Standards for Hazardous Air Pollutants-Radionuclides* report to EPA, DOE-Headquarters, and state of Idaho officials in June 2001. This statute requires the use of the CAP-88 computer model to calculate the hypothetical maximum individual effective dose equivalent to a member of the public resulting from INEEL airborne radionuclide emissions. The 2000

calculations for this code are discussed further in Chapter 7, "Dose to the Public."

Clean Water Act

The Clean Water Act (CWA), passed in 1972, established goals to control pollutants discharged to United States 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.

Clean Water Act Section 404 Permits.

In October 1994, the U.S. Army Corps of Engineers granted a 10-year Section 404 permit that authorizes DOE-ID to discharge dredge and fill material associated with the excavation of soil in Spreading Area B. Fill removal activities have ceased in this area since then.

Spill Prevention, Control, and Countermeasure Plans

Only the Test Area North (TAN), the INTEC, and the RWMC require Spill Prevention, Control, and Countermeasure Plans. These INEEL facilities were evaluated in 2000 in accordance with Title 40 Code of Federal Regulations (CFR), Part 112.

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 (DOE/ID-10431) was implemented in 1993 [Reference 2-2]. This plan provides for baseline and tailored controls and measures to prevent pollution of storm water. 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 Management and Operating (M&O) contractor monitors storm water in accordance with the permit requirements and with DOE orders. Results from this monitoring in 2000 are provided in Chapters 3 and 4.

The National Oceanic and Atmospheric Administration (NOAA) 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, most recently in 1998. The INEEL Storm Water Pollution Prevention Plan for Construction Activities (DOE/ID-10425) was distributed in January 1994 [Reference 2-3]. The plan provides for measures and controls to prevent pollution of storm water. Worksheets are completed for construction projects and are appended to the plan. Inspections of construction sites are performed in accordance with permit requirements.

Safe Drinking Water Act

The Safe Drinking Water Act was reauthorized on August 6, 1996. It establishes primary standards for drinking 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 those criteria and are classified as either nontransient noncommunity or transient noncommunity systems. The INEEL operates 12 active public water systems,

two of which serve NRF and ANL-W. All INEEL facilities performed sampling of drinking water as required by the State and EPA. See Chapter 5 for details on drinking water monitoring results.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA), which is administered by EPA, requires testing and regulation of chemical substances that enter the consumer market. TSCA supplements sections of the Clean Air Act, the CWA, and the Occupational Safety and Health Act. Since the INEEL does not produce chemicals, compliance with TSCA at the INEEL is primarily directed toward management of polychlorinated biphenyls (PCBs).

Storage of PCB-contaminated Materials

Radioactively contaminated PCBs continue to be stored at the INEEL. Negotiations between the Headquarters offices of DOE and EPA resulted in a complexwide agreement (May 8, 1996) for storage longer than one year. DOE-ID and EPA Region 10 are in the process of resolving issues associated with one-year storage of these materials.

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 CFR 1021 and assigns authorities and responsibilities according to DOE Order 451.1B. Processes specific to DOE-ID are set forth in its NEPA Planning and Compliance Program Manual, ID M 451.A-1. The DOE-ID NEPA Compliance Officer and NEPA Planning Board implement the process.

Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement

This Environmental Impact Statement (EIS) evaluates potential environmental impacts of various alternatives for managing high-level radioactive waste (HLW) and related radioactive wastes and facilities at the INTEC. The state of Idaho is a cooperating agency with DOE in preparation of the EIS. In 2000, 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 should be available to the public in the fall of 2002. The ROD for that EIS will be available no sooner than 30 days after the announcement of the Notice of Availability of the final EIS.

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 undertaking will have an adverse effect on historic property, the cognizant federal agency must enter into an agreement with the State Historic Preservation Officer for the purpose of mitigating those adverse effects.

A comprehensive draft Historic Context of the INEEL was prepared in 1997. This Historic Context 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. It will be used to guide a more comprehensive approach to managing the preservation and documentation of buildings scheduled to be modified or dismantled.

Draft Tribal Consultation Procedures were developed in partnership with the Shoshone-Bannock Tribes. These procedures provide clarity and guidance to ensure continued good communication between the Tribes, DOE, and the M&O contractor regarding cultural resource

management on the INEEL. The procedures are also an integral component of the Agreement-in-Principle, signed in August 1998, between DOE-ID and the Tribes. DOE-ID also organized and hosted a first-of-its-kind Cultural Resource training course. The course was specifically organized to allow for participation and representation from several Tribes in the northwest, government agencies, and contractor personnel.

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 (NAGPRA) 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. No NAGPRA items were discovered or repatriated in 2000.

Endangered Species Act

The purposes of the Endangered Species Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved; to provide a program for the conservation of such endangered species and threatened species; and to take 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 utilize their authorities in furtherance of the purposes of this Act.

The Environmental Surveillance, Education and Research Program conducts ecological research, field surveys, and NEPA evaluations regarding ecological resources on the INEEL. Particular emphasis is given to threatened and endangered species and species of special concern identified by the U.S. Fish and Wildlife Service.

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. Ute's ladies tresses *(Spiranthes diluvialis)* may occur on the INEEL, but they have never been reported. It is, however, unlikely that suitable habitat (wet meadows) exists on the INEEL long enough each year to support this threatened species.

Research and monitoring continued on several species of special biological, economic, and social concern, including Townsend's big-eared bat (*Corynorhinus townsendii*), pygmy rabbit (*Brachylagus idahoensis*), burrowing owl (S*peotyto cunicuilaria*), sage grouse (*Centrocercus urophasianus),* elk (*Cervus elaphus*), and pronghorn antelope (*Antilocapra americana*).

Emergency Planning and Community Right-to-Know Act

The purpose of the Emergency Planning and Community Right-to-Know Act (EPCRA) is to provide the public with information about hazardous chemicals at a facility (such as the INEEL) and to establish 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 2000. 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 2000 by March 1, 2001. 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 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, 2001. The report identifies quantities of 313 listed toxic chemicals that exceeded a threshold value. Once a threshold value is exceeded (for manufacturing, processing, or other uses), an EPA 313 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, air emissions, recycling, and other activities. Seven reports were prepared at the INEEL during 2000. These reports were for dioxins/dioxin-like compounds, nitric acid, nitrates, naphthalene, mercury/mercury compounds, toluene, and mixed isomer xylenes. The 313 reports vary year-to-year depending on the chemical processes at the Site. It is anticipated that fewer 313 reports will be completed in the future because of the Waste Experimental Reduction Facility (WERF) incinerator shutdown and cessation of calciner operations.

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, U.S. Department of Interior (Bureau of Land Management and the U.S. Fish and Wildlife Service), and the Shoshone-Bannock Tribes.

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. The Environmental Restoration Program coordinates with DOE-ID co-trustees on any INEEL Natural Resources Damage Assessment issues arising as a result of the comprehensive RI/FS study for each WAG.

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 [Reference 2-4]. Ecological risk assessments at the INEEL have been conducted using the established guidance manual for conducting screening level ecological risk assessments [Reference 2-5].

Executive Order 11990 – Protection of Wetlands

The Big Lost River Sinks are the only area of the INEEL identified as jurisdictional wetlands. 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. Currently, there are no identified operations at the INEEL that have a significant impact on jurisdictional wetlands.

State of Idaho Wastewater Land Application Permits

DOE-ID has applied for state of Idaho Wastewater Land Application Permits for all existing land application facilities, and permits have been issued for the Central Facilities Area (CFA) Sewage Treatment Plant, INTEC Percolation Ponds, INTEC Sewage Treatment Plant, and TAN/Technical Support Facility (TSF) Sewage Treatment Plant. The Idaho DEQ is reviewing permit applications for the Water Reactor Research Test Facility Sewage and Process Ponds at TAN, the Naval Reactors Facility (NRF) Industrial Waste Ditch, and the Argonne National Laboratory-West (ANL-W) industrial and sanitary waste ponds. A land application permit was submitted for the new INTEC percolation ponds in January 2000.

2.2 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. INEEL's goal for certification under ISO 14001 demonstrates continued commitment to improved environmental performance to regulators, the public, and the international business community.

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.

In 2000, efforts continued on schedule toward implementing the elements of the EMS based on the ISO 14001 standard, in support of the contractual requirement to achieve ISO 14001 registration by June 2002. Specific actions taken include:

- Completion of an overall project plan for ISO 14001 registration;
- Issuance of an improved, more comprehensive INEEL environmental management policy;
- Successful integration of environmental protection into the Integrated Safety Management System (ISMS) and completion of all ISMS milestones related to the implementation of the INEEL EMS;
- Updates to strengthen INEEL documents to ensure full integration of environmental requirements flow-down into the work planning processes used;

- Development of a communication plan for ISO 14001 registration;
- Consolidation of functional Environmental Safety and Health support services in order to provide efficiency; and
- Increased emphasis on incorporating pollution prevention and environmental protection within the ISMS and environmental awareness programs.

This effort is being developed in concert with the ISMS and quality initiatives currently being implemented by DOE-ID and the M&O contractor. Both the EMS and ISMS are based on the "plan, do, check, act" concept, and they both involve work planning, analysis of hazards and impacts, operational controls, feedback, and continuous improvement. DOE-ID and the M&O contractor already have in place many ISMS and EMS components. However, links can be improved and redundancies can be minimized. A primary goal of both DOE-ID and the M&O contractor is for work planning and execution to proceed with full consideration of environmental, safety, and health objectives and targets.

2.3 ENVIRONMENTAL RESTORATION PROGRAM

Overview

In 2000, streamlining environmental restoration activities at the INEEL by DOE, the EPA, and the state of Idaho has saved millions of dollars when compared to original baseline estimates. This streamlining was possible due to the flexibility and management principles established under the FFA/CO. This streamlining includes such activities as:

- Making cleanup decisions as soon as sufficient data are present;
- Using existing data whenever possible;
- Avoiding duplication of analyses and documentation; and
- Matching the level of investigation to the level of complexity of each release site.

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, PCBs, heavy metals, and other hazardous wastes. The INEEL Environmental Restoration Program has maintained significant progress in accomplishing its goals. As of December 2000, a tally of environmental restoration activities at the INEEL showed:

- Twenty-six areas for conducting environmental investigations have been identified;
- Twenty-one environmental investigations have been completed;
- Twenty-one RODs have been signed;
- Nine areas have cleanup underway; and
- Twelve areas have completed cleanup.

Comprehensive RI/FSs have been completed for WAGs 1, 2, 3, 4, 5, 8, and 9. Only WAGs 7 and 10 have ongoing RI/FS efforts. 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. Only four investigations remain to be completed:

1. Buried waste at the RWMC;
2. Soil contamination at the INTEC Tank Farm;
3. Miscellaneous sites, including EBR-I/ Boiling Water Reactor Experiment-I; and
4. Snake River Plain Aquifer contamination.

Waste Area Group 1 – Test Area North

Waste Area Group 1 – Groundwater Remediation

Cleanup of the TAN injection well began in 1993. The well was used from 1953 until 1972 to inject liquid wastes into the fractured basalt of the Snake River Plain Aquifer. The wastes included organic and inorganic compounds and low-level radioactive wastes (LLW) combined with industrial and sanitary wastewaters. The resulting plume contaminated some of the drinking water wells used by TAN workers. The drinking water is treated to meet drinking water standards, and untreated groundwater is not accessible to workers or the public.

The TAN groundwater final remedial action ROD was approved in August 1995. The Groundwater Treatment Facility, designed and constructed under a 1994 interim action, has been in continuous operation since November 1996. The Groundwater Treatment Facility is a pump and treat unit that uses air strippers and filters to remove contaminants. More than 98 million L (26 million gal) of contaminated groundwater was treated in 2000.

In 1999, new innovative technologies, such as in-situ bioremediation and in-situ chemical oxidation, were evaluated to determine if there was a more effective technology than pump and treat. The evaluation showed that in-situ bioremediation was a better alternative for the area around the old injection well (also called the “hot spot”), and that monitored natural attenuation was a better alternative for the distal portion of the plume. The evaluation showed that pump and treat was still the best alternative for the medial zone of the plume. As a result, a Proposed Plan was distributed for public comment proposing that the remedy be changed to in situ bioremediation at the hot spot and monitored natural attenuation in the distal zone. Pump and treat would remain the technology for the medial zone.

Waste Area Group 1 – Comprehensive RI/FS

Eleven operable units, including tanks containing PCBs, hazardous, and radioactive wastes (the V-tanks), were evaluated during the final investigation. A ROD for the comprehensive investigation was signed at the end of 1999. Remediation began at eight contaminated sites identified in the ROD. By the end of 2000, 532 m^3 (696 yd^3) of contaminated soil had been packaged and shipped to the RWMC for disposal. Another 761 m^3 (995 yd^3) of contaminated materials was sent offsite for disposal.

Waste Area Group 2 – Test Reactor Area

Waste Area Group 2 – Perched Water System

Perched water under the Test Reactor Area (TRA) is a zone of groundwater standing on a relatively impermeable layer of clay 100 m (330 ft) above the Snake River Plain Aquifer. It was formed over time by percolation from the TRA wastewater

disposal ponds. Routine compliance monitoring continued in 2000 to aid regulatory agencies in comparison of predicted and actual contaminant concentrations in the perched water.

Waste Area Group 2 – Newly Identified Sites

Six potentially contaminated sites were identified since the original RI/FS report. These sites contain either contaminated soils, abandoned underground acid pipelines, or abandoned underground fuel oil pipelines. These sites are scheduled to be investigated further in 2001.

Waste Area Group 2 – Comprehensive RI/FS

In 2000, remediation was completed at eight sites identified in the 1997 ROD. Sites included the Warm Waste Pond, Chemical Waste Pond, and Sewage Leach Pond. Cleanup actions at the three ponds consisted of covering them with intrusion resistant soil barriers, implementation of institutional controls for access, and use restrictions to protect current and future users. Some of the remediated sites, totaling almost 3.2 hectares (8 acres), were replanted.

Waste Area Group 3 – Idaho Nuclear Technology and Engineering Center

Waste Area Group 3 – Tank Farm

The RI/FS to investigate contaminated soils and the aquifer beneath the INTEC Tank Farm began in 2000. The Tank Farm consists of 20 underground stainless steel tanks, and associated equipment for waste transfer, used to store the radioactive liquid waste generated during the reprocessing of spent fuel. Approximately 95 percent of the existing environmental contamination at the Tank Farm is the result of leakage from transfer lines and piping. The tanks themselves have not leaked. This investigation will gather information on the distribution, quantities, and concentrations of contaminants associated with the Tank Farm soil. Once the investigation phase is complete, a separate ROD will be prepared to detail cleanup actions.

Workers began an interim action to prevent the percolation of water, from precipitation, into the Tank Farm. The barrier is scheduled to be completely installed in 2001.

Waste Area Group 3 – New Wastewater Disposal Ponds.

One of the actions under the approved ROD for WAG 3 is to reduce contributions to perched water beneath the INTEC that might be contributing to contaminant migration. A large part of this task includes curtailment of the use of the current wastewater disposal ponds (percolation ponds). Construction of two new percolation ponds, at a distance of almost 3.2 km (2 mi) from the facility, began in August 2000. The ponds are scheduled for completion in 2001 and to be put into service in 2002.

Instruments are being installed around the new ponds to allow scientists to observe water movement in the vadose zone as the ponds fill. The understanding gained from this work will be applied to other areas across the INEEL.

Waste Area Group 3 – INEEL CERCLA Disposal Facility.

The INEEL CERCLA Disposal Facility (ICDF) was selected as a remedy in the 1999 ROD for INTEC to address Sitewide soil contamination. The purpose of the facility is to consolidate INEEL wastes generated from CERCLA cleanup actions at a single engineered facility onsite. In 2000, geologic studies at INTEC were used to select a location for construction of the ICDF. Construction on the facility is expected to begin in 2001, with operations expected to commence in 2003.

Waste Area Group 3 – Comprehensive RI/FS

The major source of contamination at INTEC is HLW generated from past spent nuclear fuel (SNF) reprocessing activities that is stored in underground storage tanks.

The Site also has contaminated groundwater from a now sealed injection well, contaminated soils around and beneath buildings, and waste disposal ponds. The chief contaminants are radionuclides. A total of 101 sites of known or suspected contaminant releases were evaluated in the comprehensive RI/FS (December 1997) and summarized in a Proposed Plan (October 1998). Sixty-six of the 101 sites require cleanup; the majority of these sites were addressed in the ROD finalized in October 1999.

The ROD also included a large, onsite disposal facility at INTEC for cleanup-related waste from INEEL (see previous discussion of the ICDF). DOE, EPA, and the State approved remedial action work plans for the Tank Farm Interim Action, Perched Water, and Snake River Plain Aquifer. Remedial actions were begun in 2000 for the Tank Farm Interim Action, Perched Water, Snake River Plain Aquifer, and Gas Cylinder sites.

Waste Area Group 4 – Central Facilities Area

Waste Area Group 4 – Comprehensive RI/FS

A total of 13 operable units and 52 potential release sites were examined during this investigation. The main sources of contamination are landfills, a waste disposal pond, a wastewater drain field, and underground storage tanks. Major contaminants are metals, radionuclides, and nitrates. A final ROD for the CFA was signed July 2000 addressing surface contamination at three sites, including a now dry waste disposal pond, a sewage treatment plant drain field, and a transformer yard. These three areas will be remediated one site at a time, beginning with the transformer yard.

The comprehensive RI/FS was near completion in 1999 when nitrates were detected in one well in the area in excess of drinking water standards. During 2000, analysis of monitoring data and computer modeling indicated that levels of nitrates would fall below the drinking water standard by 2009. DOE, EPA, and the State agreed that no further action was necessary to address this contamination issue.

Waste Area Group 5 – Power Burst Facility/Auxiliary Reactor Area

Waste Area Group 5 – Comprehensive RI/FS

The comprehensive RI/FS report was published in 1999. This report covered 13 operable units and 55 potential release sites. Contaminants include heavy metals, radionuclides, and organic chemicals originating from such sources as underground tanks, hot cells, waste disposal ponds, a sewage system, and buried reactor debris. The comprehensive investigation identified seven sites that require cleanup: three evaporation ponds, a large contaminated surface soil area, soil beneath now dismantled hot cells, a sanitary waste system, and an underground storage tank. The remaining 48 sites require no remediation and will remain under institutional controls.

A proposed plan based on the RI/FS was published in 1999 and describes the risks associated with the seven sites, possible remediation alternatives, and preferred alternatives. Following public comment on the proposed plan, a final ROD was signed in February 2000.

Remediation began in June 2000 on the sanitary waste system and tank and three of the five contaminated soils sites. Approximately 60 m^3 (78 yd^3) of debris was removed for disposal offsite. Remediation of the largest soil site (23.5 hectares [58 acres]) will be coordinated with completion of the ICDF, where the soil will be disposed.

Waste Area Group 6 – Boiling Water Reactor Experiment

Waste Area Group 6 – Comprehensive RI/FS

This comprehensive investigation is being conducted in combination with the WAG 10 comprehensive RI/FS.

Waste Area Group 7 – Radioactive Waste Management Complex

Waste Area Group 7 – Remedial Action of Organic Contamination in the Vadose Zone

The ROD to use the vapor vacuum extraction with treatment as the remediation technology for the vadose zone in the Subsurface Disposal Area (SDA) at the RWMC became final on December 2, 1994. The vadose zone is the area between the land surface and the top of the water table. Organic vapors were released into the vadose zone as buried drums containing volatile organic compounds, such as degreasers and solvents, deteriorated over time.

The full-scale extraction/treatment system consists of three treatment units that extract vapors from three wells and break down the majority of organic compounds chemically to form carbon dioxide, hydrogen chloride, and water. The system began operations in January 1996 and as of 2000 over 37,195 kg (82,000 lb) of total volatile organic compounds have been removed from the vadose zone. The system will continue to extract and treat organics from the SDA in 2001.

Waste Area Group 7 – Pit 9 Interim Action

The staged interim action, a three-stage approach agreed to by the DOE, EPA, and the State, has two main objectives:

1. Remediate contamination to a level that protects human health and the environment; and
2. Generate information to support the RI/FS and the final remedial decision for the RWMC SDA.

The first stage of the staged interim action will provide information on specific subsurface conditions, including whether, how far, and which contaminants have migrated. This information is necessary to support the transport modeling and baseline risk assessment activities for WAG 7. Stage I will also include a limited treatment technology evaluation. Stage II activities include construction, soil treatment studies, and retrieval of buried material from an area of the pit selected during Stage I. Stage III will complete the remediation of Pit 9.

In 2000, Stage I investigations included installation of 85 probes within Pit 9 and other areas of the SDA. The probes are 15-cm (6-in.) diameter hollow steel tubes. Probes were installed using sound waves (a method known as sonic drilling) to advance the probe through the waste to the top of the underlying basalt. Data gathered from geophysical instruments placed in the probe tubes provide vertical waste and soil profile information, apparent distribution of contaminants, and identification of localized areas of radionuclide contamination. In addition, the Stage I 90 percent design was also completed in 2000.

Waste Area Group 7 – Comprehensive RI/FS

The work plan addendum, detailing how the comprehensive investigation will be performed, was finalized in August 1998. The addendum reflects schedule and scope changes that resulted from significant delays in the Pit 9 interim action, and it describes additional scope to be completed. These changes will allow DOE to evaluate a wider range of remedial alternatives for the buried waste, including several treatability studies, in support of pit and trench remedial options.

In 2000, a treatability study of the in-situ grouting of buried transuranic (TRU) waste was performed. Because it is done in place, this process has the advantages of low cost and low worker exposure.

Groundwater and perched water samples continue to be collected quarterly

in and around the RWMC to assess potential migration of contaminants from the site.

Waste Area Group 8 – Naval Reactors Facility

Waste Area Group 8 – Naval Reactors Facility Remediation

DOE, EPA, and the state of Idaho signed a ROD for 10 sites at NRF in 1994. Three of these sites were landfills that were capped with native soil covers in 1996. The agencies agreed the other sites (the industrial waste ditch and six other landfills) required no further action. Remediation continued in 2000 at the nine sites of concern, including completion of remedial actions at one site.

Waste Area Group 8 – Comprehensive RI/FS

A ROD for the comprehensive investigation of the NRF was signed in September 1998. It addressed 64 sites, including 9 sites with potentially unacceptable risk to human health or the environment. Fifty-five sites were determined to not require additional actions. Remediation continued in 2000 at the nine sites of concern, including completing remedial actions at one site. The effort includes excavating and consolidating soils contaminated with low levels of radionuclides.

Waste Area Group 9 – Argonne National Laboratory-West

Waste Area Group 9 – Comprehensive RI/FS

In 1998, DOE, EPA, and the state of Idaho signed the comprehensive investigation ROD for ANL-W, which identified five sites requiring cleanup. The ROD identified phytoremediation (the use of plants to extract contaminants through their root systems) as the preferred method for removing contaminants from the soil at these five sites, except for portions of two sites. These two sites have additional contamination on which phytoremediation would not be effective. Remediation of these two sites was performed in 2000 with the excavation and disposal of 69 m^3 (90 yd^3) of soil from these sites.

At WAG 9, phytoremediation involves using koscia and willows to extract contaminants. The plants are periodically harvested, dried, packaged, and disposed at an appropriate facility. The phytoremediation project began in 1999 and continued through 2000. Results of analysis on plants at the end of the second year showed that contaminants of concern should meet risk levels by the 6-year deadline. Also in 2000, willows that had been growing in three industrial waste ditches were harvested. Willows are used to extract chromium, silver, and mercury from the soil. Analysis of the plant matter showed the willows extracted significant amounts of these metals from the soil. New trees will be planted in the spring of 2001 for another 2-year growing cycle.

Waste Area Group 10 – Miscellaneous Sites/Snake River Plain Aquifer

Waste Area Group 10 – Comprehensive RI/FS

This comprehensive investigation will address WAG 6 and 10 sites and the Snake River Plain Aquifer, as well as conducting the Sitewide ecological risk assessment, collectively referred to as Operable Unit 10-04. A new Operable Unit, 10-08, was created in 1999 to evaluate new contamination release sites that may be identified at the INEEL in the future and to perform a Sitewide cumulative groundwater assessment. The comprehensive Sitewide ecological risk assessment was completed in 2000. The results of this assessment will be included in a Proposed Plan scheduled for completion in 2001. Additional groundwater monitoring wells were drilled in 2000 to improve understanding of contaminant movement within the aquifer.

A comprehensive investigation of contaminated land surface areas within the INEEL was completed in 2000. This investigation encompassed impacts of INEEL activities upon surface water, surface

soils, and air. The investigation included all areas outside facility fences as well as the EBR-I/Boiling Water Reactor Experiment area.

2.4 WASTE MANAGEMENT PROGRAM

Overview

The mission of the Waste Management Program 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 goals of the program are to ensure that workers and the public are protected and the environment is not further impacted. INEEL waste management activities consist of:

- Reducing the total amount of wastes generated;
- Treating wastes already generated by reducing their toxicity, mobility, and volume;
- Storing wastes awaiting development of new disposal and treatment options; and
- Disposing of wastes.

Another challenge faced in managing wastes at the INEEL is involving the citizens of Idaho in the search for solutions to significant waste management issues. The Waste Management Program continues to provide presentations to the INEEL Citizens Advisory Board to explain issues related to the program. The Waste Management Program continues to promote openness with stakeholders in regard to these issues and works closely with the State INEEL Oversight Program and the Congressional delegation. Stakeholders were also notified of the timeframes for regulatory-required public comment periods and where documents could be found for their review. In addition, stakeholders participated in several tours of the INEEL that featured the mission and accomplishments of the Waste Management Program.

Federal Facility Compliance Act

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

In accordance with the Site Treatment Plan, the INEEL began receiving offsite mixed waste for treatment in January 1996. The INEEL has 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 WERF in 2000. The INEEL is storing the backlog of mixed waste at the Waste Reduction Operations Complex (WROC) and INTEC RCRA-permitted storage. 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 using incineration, stabilization, neutralization, and carbon absorption technologies. Additional treatment services will be obtained from offsite commercial treatment vendors. Other offsite mixed wastes may be treated at the Advanced Mixed Waste Treatment Facility planned to begin operation at the INEEL in 2003.

Advanced Mixed Waste Treatment Project

The overall goal of the Advanced Mixed Waste Treatment Project is the treatment of alpha low-level mixed and 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 services 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 BNFL, Inc. in December 1996. The contract was awarded in three phases:

- Phase I — licensing, permitting and environmental compliance;
- Phase II — construction and process demonstration to be completed in December 2002;
- Phase III — treatment operations to begin by March 2003.

The facility is scheduled to treat 65,000 m^3 (85,017 yd^3) of retrievably stored transuranic waste by 2015, but no later than 2018.

Sodium Process Facility and Experimental Breeder Reactor-II Sodium Removal and Treatment Activities

The Sodium Process Facility (SPF) at ANL-W continued treatment of radioactive sodium stored at ANL-W. SPF treated 178,274 L (47,095 gal) of sodium in 2000.

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 (HLW), including radioactive liquid waste and sodium-bearing liquid waste (SBW). Those wastes were placed into interim storage in underground tanks at the INTEC Tank Farm Facility. 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, known as bin sets, at the Calcine Solids Storage Facility. Processing of spent nuclear fuel was curtailed in 1992. The INEEL completed calcining of all non-sodium-bearing liquid HLW on February 20, 1998, four months ahead of the June 30, 1998 Idaho Settlement Agreement milestone. Calcining of SBW began on February 20, 1998, more than three years ahead of the Settlement Agreement milestone. Per that Agreement, all such waste is required to be calcined by the end of the year 2012.

During 2000, 90,000 L (23,775 gal) of SBW were calcined prior to the Calciner being placed in standby. Therefore, at the end of 2000, approximately 4,500,000 L (1,188,774 gal) of SBW in the tank farm, and 4,400 m^3 (5,755 yd^3) of calcined HLW in the bin sets, remains in storage at INTEC. The calciner was placed in standby prior to the extended deadline of June 1, 2002 per the 1999 Modification to Notice of Noncompliance Consent Order, while DOE determines whether to upgrade and permit

the facility to current standards or develop a new method of treating the stored liquid HLW. Treatment alternatives for the remaining liquid and calcined wastes are being evaluated in the Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement.

Low-Level Radioactive Waste and Mixed Low-Level Radioactive Waste

Significant accomplishments were achieved during 2000 in the disposal of the legacy backlog of LLW stored at the INEEL. Activities at the RWMC SDA were highlighted by the disposal of 4,535 m^3 (5,932 yd^3) of legacy and newly generated LLW in 2000.

WROC treated 3,071 m^3 (4,018 yd^3) of LLW. Two cubic meters of mixed LLW were stabilized at the WERF. The WERF incinerator treated 193 m^3 (252 yd^3) of mixed LLW. The WERF incinerator was shut down in September 2000 because DOE decided to use commercially available mixed waste treatment facilities and because the Idaho DEQ denied the final RCRA Part B permit application. During its operation, the incinerator treated approximately 12,000 m^3 (15,695 yd^3) of LLW and more than 1,000 m^3 (1,308 yd^3) of mixed LLW from both INEEL and other facilities. Also, approximately 470 m^3 (615 yd^3) of mixed LLW was sent to Envirocare in Utah for disposal in 2000.

The goals for 2001 include the treatment of 150 m^3 (196 yd^3) of mixed LLW and disposal of 400 m^3 (523 yd^3) of mixed LLW offsite.

Waste Minimization/Pollution Prevention

The mission of the INEEL Pollution Prevention Program is to reduce the generation and release of wastes and pollutants by implementing cost-effective pollution prevention techniques, practices, and policies. Pollution prevention is also required by various federal edicts, including but not limited to, the Pollution Prevention Act, RCRA, Executive Order 12856 (Federal Compliance with Right-To-Know Laws and Pollution Prevention Requirements), and Executive Order 12873 (Federal Acquisition, Recycling, and Waste Prevention).

It is the policy of the INEEL to incorporate pollution prevention into every activity. Pollution prevention is one of the key underpinnings of the INEEL Environmental Management System (see Section 2.2). 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 2000, the INEEL reported 23 pollution prevention projects, which resulted in a waste reduction of 10,810 m^3 (14,139 yd^3) and decreased the cost of operations by $31.9 million. Noteworthy pollution prevention accomplishments in 2000 include

- INEEL Environmental Restoration personnel are decontaminating, decommissioning, and dismantling buildings and equipment and are reusing/recycling the resulting concrete, steel, water, and wood materials, reducing sanitary waste by 5,262 metric tons (5,800 tons) and saving almost $9 million.
- The INTEC coal-fired steam plant was shut down and replaced with oil-fired boilers, saving just over $8 million. Approximately 2,630 kg (5,800 lb) of hydrogen chloride, hydrogen fluoride, hydrogen sulfate, chromium, and zinc air emissions was eliminated, as well as ash output of 430 metric tons (474 tons).

Lead Management Program

The intent of the INEEL Lead Management Program is to:

- Minimize new lead purchases;
- Evaluate lead substitutes;

- Maximize reuse of contaminated lead for shielding;
- Protect lead from contamination;
- Reduce the accumulation of contaminated lead;
- Recycle contaminated lead to the scrap metal market (by decontamination and surface/volumetric survey for free release) as allowable; and
- Provide the means for generators to disposition mixed waste lead.

To date, 87.6 m^3 (114.6 yd^3) of waste have been processed through the cask dismantlement activity, including 7 m^3 (9.1 yd^3) in 2000 in accordance with the Site Treatment Plan.

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 SNF 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 SNF into the State and setting milestones for shipments of SNF and radioactive waste out of the State. Both Settlement Agreement milestones scheduled for 2000 were met as follows:

- Empty the south basin of CPP-603. The milestone of December 31, 2000, was met on April 28, 2000, 8 months ahead of schedule; and
- Receive no more than 20 Naval spent fuel shipments per year (1997—2000). Sixteen shipments were received in 2000.

As part of the Settlement Agreement, the state of Idaho received another $6 million from DOE for economic development in eastern Idaho. Idaho awarded grants to the Regional Development Alliance and State universities and colleges to reduce economic dependence on the INEEL. Awards to date have totaled $30 million and created nearly 2,600 jobs.

Transuranic Waste

The TRU Program accomplished several major goals in 2000. The INEEL completed 26 shipments to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico, for a total of 849 drums containing 177 m^3 (232 yd^3) of TRU waste. A total of 3,100 m^3 (4,056 yd^3) of stored TRU waste must be shipped to WIPP by December 31, 2002, to meet a Settlement Agreement milestone. Approximately 60 percent of DOE's current inventory of contact-handled TRU waste is stored at the RWMC. The Settlement Agreement requires that all of INEEL's stored TRU waste, currently estimated at about 64,700 m^3 (84,628 yd^3), must be shipped to WIPP by a target date of 2015 but no later than 2018.

2.5 ENVIRONMENTAL RISK REDUCTION

Decontamination, Decommissioning, and Demolition Activities

Decontamination, decommissioning, and demolition activities at the INEEL are primarily concerned with the safe and compliant decontamination and decommissioning (D&D) 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 4 years more than 100 buildings have been demolished. Specific projects at various facilities are described below.

Central Facilities Area

The CFA Sewage Treatment Plant served as the sewage treatment facility for CFA since 1944 with multiple upgrades. D&D was started on the facility in October 1996 and completed in February 2000. The D&D activities were focused on the removal of all existing structures, equipment, utility components such as the pump-house, and ancillary equipment.

Test Area North

Demolition of the aboveground portion of the Initial Engine Test Facility was completed in 2000. This facility was used from the late 1950s through 1961 to test experimental jet engines for use in nuclear-powered aircraft. The remaining buildings at this facility are being removed. The engines themselves are on display near the EBR-I facility.

The Process Experimental Pilot Plant incinerator located at TAN was designed to process TRU waste into an acceptable form to meet disposal requirements at WIPP. The facility was only used one time. The facility was decontaminated from June 1999 through March 2000 to an approved closure plan.

Test Reactor Area

Decontamination and dismantlement of the Continuous Aerosol Collection System Test Platform in TRA Building 654 was completed in December 2000.

Building 660 (TRA-660) at TRA, houses two 100-kilowatt water-cooled nuclear research reactors: the Advanced Reactivity Measurement Facility reactor and the Coupled Fast Reactivity Measurement Facility reactor. A NEPA Environmental Assessment (EA) was prepared to determine whether there would be any significant environmental impacts associated with D&D of the reactors and whether an EIS would be necessary. Drafts of the EA and finding of no significant impact (FONSI) were released for public review and comment, and no comments were received. The final EA and FONSI were released in March 2000. The reactors will be dismantled and disposed in 2001.

The Engineering Test Reactor was dismantled and removed in September 2000. The building it was housed in was left intact for potential future use.

INEEL Large Scale Demonstration and Deployment Project

The INEEL Large Scale Demonstration and Deployment Project demonstrates technologies to make DOE's D&D operations more efficient through the use of better technologies. Technologies are demonstrated in an actual D&D operation, side-by-side with baseline technology. Three INEEL areas are included in the project: TRA-660 Fuel Storage Canals, TRA Filter Pit System, and TAN-620 Initial Engine Test Control Room. The following technologies were demonstrated in 2000:

- En-Vac Robotic Climber with Scabbler;
- In-Situ Object Counting System Far Field Release Radiation Measurement System;
- SAMS® Radiation Survey Instrument; and
- In-Situ Underwater Gamma Survey Underwater Radiation Measurement System.

2.6 NATIONAL PROGRAMS MANAGED BY DOE-ID

Nuclear Materials Focus Area

The Nuclear Materials Focus Area (NMFA) is chartered under the DOE Office of Environmental Management to conduct a research and development program to develop technologies to support the safe management and expeditious stabilization of nuclear materials currently under the purview of the Office of Environmental Management.

NMFA is a multi-year, complexwide program that includes collaboration on technology ventures with Russian scientists as part of the U.S.-Russian nonproliferation program. NMFA research and development projects for 2000 include:

- Advanced Technologies for Stabilization of ^{238}Pu-Contaminated Combustible Waste;
- Porous Crystalline Matrix (Gubka) for Stabilizing Actinide Solutions;
- Chemically-Bonded Phosphate Ceramics;

- Modular Arm for Accelerated Plutonium Glovebox Operation; and
- Moisture Measurement in Pure and Impure Plutonium Bearing Materials.

Transuranic and Mixed Waste Focus Area

DOE-Headquarters established an integrated approach for addressing waste issues based on focus or problem areas. The INEEL was selected as the lead laboratory for mixed waste technology development. Comanaged by DOE-ID and the DOE Carlsbad Field Office, the Transuranic and Mixed Waste Focus Area operates in close partnership with end users and regulators to address and meet priority needs and ensure that demonstrated solutions are accepted and approved for deployment. DOE identified more than 2,300 mixed waste streams at its sites, including stored inventory and waste generated by ongoing processes and cleanup activities.

Several new developments have taken place in the past year. The program's name changed from the Mixed Waste Focus Area to reflect the importance the DOE places on ensuring uninterrupted, safe, and efficient shipments of TRU waste from storage to the WIPP. Solutions were deployed for an array of mixed LLW debris and TRU waste problems. The DOE's waste operations managers now have a quick, inexpensive method for analyzing the chlorine content in waste destined for treatment. They also have a new method for treating mixed LLW debris that results in a 25 percent volume reduction over conventional techniques. Surrogates were also deployed for standard waste boxes and crates, which were needed at several sites for evaluating, calibrating, and refining nondestructive crate/box assay systems. In addition, a major technical milestone was met with the completion of Phase I of Handling and Segregating System for 55-gal drums (HANDSS-55), a remote, modular waste sorting and repackaging system for the DOE Savannah River Site. The completion of Phase I allows the program to move on to greater challenges like mounting an automated handling system on a mobile platform for sites with small TRU waste quantities. In total, support for five technology demonstrations and six technology deployments were completed at the various DOE sites.

The Transuranic and Mixed Waste Focus Area was also in the forefront supporting the Blue Ribbon Panel on Emerging Technological Alternatives to Incineration and developing the DOE's path forward in this area. Testing and demonstration of alternatives to incineration technologies will occur in the next few years. Significant accomplishments occurred in the area of payload enhancement. The TRUPACT-II Matrix Depletion Program report was submitted to the Carlsbad Field Office and will assist in a greater percentage of the current contact-handled TRU/mixed TRU waste inventory being certified for shipment to WIPP. The program has and will continue to address technology needs identified by the DOE sites for managing their waste issues.

National Spent Nuclear Fuel Program

DOE-ID manages the National Spent Nuclear Fuel Program (NSNFP). The NSNFP mission is to provide the technology and guidance needed to ensure safe, efficient handling, characterization, and disposition of DOE SNF. In completing this mission, the NSNFP, while working with stakeholders, will protect the environment and the health and safety of workers and the public while fully complying with applicable federal, state, Tribal, and local laws, orders, and regulations.

The NSNFP provides technology solutions and guidance for safe, efficient management at DOE SNF operating sites. It supports the repository program by providing the analyses and research needed to include all DOE SNF in the license application for the proposed geologic repository in Yucca Mountain, Nevada. Located at the INEEL, the

program collaborates with other DOE laboratories to develop and deploy technologies that address DOE SNF management needs. By coordinating common needs for research, technology development, and testing programs, the NSNFP is achieving cost efficiencies and eliminating gaps and redundant activities.

The NSNFP is divided into technical elements that address repository analysis, materials analysis, and packaging and transportation. Major 2000 accomplishments are identified below as part of these elements.

Repository Analysis

- Included DOE SNF in the repository's Total System Performance Assessment-Site Recommendation;
- Significantly reduced repository qualification requirements for DOE SNF;
- Completed intact and degraded mode criticality analysis and geochemical analysis for several DOE fuels;
- Initiated external criticality source term of DOE SNF; and
- Performed preliminary DOE SNF design basis events analysis showing that DOE SNF will not pose unacceptable radiological hazards in the repository.

Materials Analysis

- Defined the need and feasibility of advanced neutron absorbers for the repository;
- Began development of advanced neutron absorbers;
- Identified a potential issue with fission product attack;
- Initiated canister remote weld development;
- Performed release rate testing showing that DOE mixed oxide SNF reactions are similar to commercial; and
- Continued development of the Multi Detector Analysis System nondestructive assay system.

Packaging and Transportation

- Completed draft design requirements for the DOE SNF standardized canister;
- Performed fracture mechanics evaluation studies of standardized canister drop events;
- Completed transportation cask system concept development; and
- Completed draft transportation cask system design and licensing specification.

National Transportation Program

The National Transportation Program (NTP) serves as the corporate center of packaging and transportation expertise within the DOE Office of Environmental Management. It supports infrastructure and coordinates transportation activities for all nonclassified shipments of hazardous materials, including radioactive and mixed wastes and other commodities such as coal, other fuels, maintenance materials, and supplies.

The NTP is responsible for ensuring the availability of safe, secure, and economical transport services; consistency in regulatory implementation; and coordinated outreach for DOE. A corporate team, comprised of personnel from the DOE-Headquarters, DOE-ID, and DOE-Albuquerque offices, manages the NTP. NTP Idaho is uniquely responsible for transportation planning and integration activities in support of the DOE Office of Environmental Management disposition programs.

Nuclear Reactor Technology Lead Laboratories

The Secretary of Energy designated the INEEL and Argonne National Laboratory as lead laboratories for nuclear reactor technology for the DOE's Office of Nuclear Energy, Science, and Technology in 1999. Both Argonne and INEEL were pioneers in the development of safe commercial nuclear power. Argonne's EBR-I located at the INEEL produced the first usable quantities of nuclear energy in 1951. In 1955, Arco,

Idaho, was the first city in the world lighted by nuclear power, using electricity generated by INEEL's Boiling Water Reactor Experiment-III reactor. A total of 52 nuclear reactors have been designed, built, and operated at the INEEL over the last 50 years. The lead laboratories are chartered to:

- Maintain world-class staff and key facilities to pursue advanced nuclear reactor technology;
- Maintain a living knowledge base;
- Evaluate and integrate the results of research and development and propose new research;
- Stay abreast of developments associated with nuclear energy-related research; and
- Organize national and international forums to address key issues.

The lead laboratories were chosen for their complementary expertise and facilities. The INEEL has extensive expertise in light water and gas-cooled nuclear systems, design, development, and testing. The INEEL serves needs for nuclear regulatory and safety technical support, probabilistic risk analysis, nuclear engineering and design, nuclear fuels development and testing, and radiation measurements. Argonne has extensive expertise in liquid metal-cooled reactors and fuel-cycle analysis. Argonne serves needs for safety analysis, nuclear engineering and design, fuels and fuel-cycle development, and nonproliferation.

Sagebrush Steppe Ecosystem Reserve

In 1999, DOE signed a memorandum of agreement 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 hectares (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 was part of a complexwide 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 to develop a management plan that will provide management direction to DOE for continuance of this unique habitat for scientific study and future generations' benefit.

2.7 ADDITIONAL ENVIRONMENTAL PROGRAMS

Public Involvement Activities

To foster public understanding of environmental issues involving the INEEL, concerted communication and education efforts are made by DOE-ID and its contractors. A wide array of tours, speaking engagements, newspaper inserts, newsletters, displays, and opportunities to request INEEL information are made available to interested persons. News releases and other contacts with journalists spread INEEL messages to much wider audiences. Through a toll-free telephone number (800-708-2680), anyone can call the INEEL to ask questions and request copies of documents. Many documents can be accessed on the Internet at http://www.inel.gov/ under "About us." INEEL public involvement activities during 2000 included:

- Publishing four *INEEL Reporters;*
- Making 205 presentations to various groups*;*
- Hosting 176 tours with a combined attendance of 2,365 people; and
- Holding several public meetings on various topics.

American Indian Programs

DOE-ID is currently focusing on expanding and strengthening the

government-to-government relationship with the Shoshone-Bannock Tribes of Fort Hall, Idaho. The Tribes are close neighbors of the INEEL and are potentially affected by INEEL operations. They have a vested interest in the INEEL, as they have inhabited the Snake River Plain continuously for the past 4,500 years. DOE-ID has developed an Agreement-in-Principle with the Tribes that addresses DOE-Indian policy and Shoshone-Bannock Tribal objectives. DOE-ID also funds programs and projects through a cooperative agreement, sponsored by the DOE-Headquarters Office of Environmental Management, intended to enhance Tribal awareness, capabilities, and participation in INEEL activities. The core program addresses environmental management activities including NEPA, transportation, environmental monitoring and training, cultural resources management, and emergency response and management.

2.8 OTHER MAJOR ENVIRONMENTAL ISSUES AND ACTIVITIES

Groundwater Monitoring Program Activities

The INEEL Groundwater Monitoring Plan established a programmatic framework for ensuring compliance with all state, federal, and DOE groundwater-related standards. In accordance with DOE Order 5400.1, the plan documents local and regional hydrologic regimes, known and potential sources of groundwater contamination at the INEEL, and the monitoring networks and sampling programs necessary to evaluate the effects of the INEEL's activities on the local and regional groundwater resources.

The INEEL Groundwater Monitoring Program was designed using a three-tiered approach that integrates regional, area-specific, and facility-specific/unit-specific monitoring networks. These networks are being installed and groundwater monitoring schedules are being implemented using a phased approach. The regional monitoring network is mostly in place and is being implemented by the U.S. Geological Survey (USGS) as part of its ongoing program. This program has been conducted since 1949. The development of area-specific monitoring networks was initiated in 1993 and networks have been completed at the Auxiliary Reactor Area, Special Training Facility, Power Burst Facility, and INTEC. Area-specific monitoring networks are being installed in accordance with the INEEL Groundwater Monitoring Plan implementation schedule. Unit- and facility-specific monitoring networks were designed to provide leak detection. These wells are designed, installed, and monitored as needed.

The INEEL CERCLA RODs for WAG 2 (TAN), WAG 3 (INTEC), WAG 4 (CFA), and WAG 7 (RWMC) all contain groundwater monitoring requirements to monitor known plumes and the long-term performance of remedial actions. The CERCLA groundwater monitoring requirements are being integrated with the Groundwater Monitoring Program and the Compliance Monitoring Program so that access to specific wells is coordinated and data from all sources can be used to analyze groundwater flow and contaminant transport.

In 2000, compliance groundwater monitoring was conducted at TAN and INTEC as required by the Wastewater Land Application Permit. Observational groundwater monitoring was conducted by the USGS in accordance with its Interagency Agreement with DOE-ID (see Chapter 5), and the Environmental Restoration Program conducted groundwater monitoring and characterization in accordance with the INEEL FFA/CO.

Health Studies

In August 1996, DOE and the Department of Health and Human Services revised a Memorandum of Understanding under which agencies of the Department of Health and Human Services conduct and

manage epidemiological studies at DOE facilities. The studies, including historical dose reconstruction and worker epidemiology, are financially supported by DOE and conducted by the Centers for Disease Control and Prevention (CDC), the Agency for Toxic Substances and Disease Registry (ATSDR), and the National Institute of Occupational Safety and Health (NIOSH). The INEEL also conducts its own studies related to worker health. These studies are discussed below.

INEEL Medical Surveillance

The INEEL has a medical surveillance program to monitor the health of current workers. The program is based on routinely collected health data, such as recordable injuries and illnesses specified by the Occupational Safety and Health Administration. The program will help identify emerging health issues at the INEEL.

A medical surveillance program for former workers at the INEEL was initiated in 1997. The program, required by Section 3162 of Public Law 102-484, will evaluate the long-range health conditions of former employees who may have been subjected to significant health risks from exposure to hazardous substances as a result of their employment at the INEEL. A Phase I pilot project was completed in October 1998 by a group of investigators consisting of the Paper, Allied-Industrial, Chemical, and Energy Workers International Union (PACE); Mt. Sinai School of Medicine; the University of Massachusetts at Lowell; and Alice Hamilton College. The pilot project resulted in findings that former INEEL workers have had significant exposure to pulmonary toxins, carcinogens, renal toxins, neurotoxins, hepatotoxins, and noise. The study also concluded that epidemiological studies at the INEEL are lacking, workers are concerned about previous exposures, and workers are interested in medical screening and education programs. The findings supported initiation of Phase II in 1999, a targeted medical surveillance program that included medical examinations and educational workshops. This is being conducted by PACE in conjunction with Queens College of New York.

INEEL Health Effects Subcommittee

The Department of Health and Human Services established a public advisory group, the INEEL Health Effects Subcommittee, to provide recommendations to CDC and ATSDR regarding INEEL health studies. The Subcommittee is composed of Idaho citizens and meets four times a year, usually in different cities in Idaho.

INEEL Dose Reconstruction Study

The CDC is conducting the INEEL Dose Reconstruction Project. Phase II began in 1996 with the start of a task to determine the feasibility of estimating exposures to the offsite public from toxic chemicals released from the INEEL. A final report was issued in 1999 concluding that none of the chemical releases from past INEEL operations were of sufficient quantities to have caused health effects to the offsite public and, therefore, did not justify inclusion in a dose reconstruction. A similar task for radionuclides began near the end of 1997 and a draft report was issued in 2000. More information can be found at the INEEL Dose Reconstruction website at http://www.cdc.gov/nceh/radiation/brochure/profile_ineel.htm.

Epidemiological Study of Workers at the INEEL

NIOSH is conducting several studies of INEEL workers. The INEEL Epidemiological Study of Workers will evaluate patterns of mortality in all workers at the INEEL since 1949 by using an all-cause cohort mortality to evaluate the feasibility of a prospective cancer incidence study among INEEL employees. Exposures of interest are external ionizing radiation and a variety of chemicals. The first phase of the study, analysis of standardized mortality ratios, is planned for completion by 2001. Under a NIOSH cooperative agreement, the INEEL was part of a complexwide epidemiological evaluation of childhood leukemia and paternal exposure

to ionizing radiation. The results indicated no correlation between childhood leukemia and paternal exposure to ionizing radiation.

CERCLA Public Health Assessment

ATSDR 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. The majority of the public health assessment is expected to be completed in 2001.

Environmental Occurrences

Several small spills occurred at the INEEL during 2000 that were not reportable to external agencies under environmental regulations. Six releases were determined to be reportable to external agencies. Release notifications were conducted in accordance with DOE, EPA, and state of Idaho requirements. At INTEC, oxides of nitrogen released from the calciner exceeded air permit limits due to a temperature increase and were, therefore, reportable. There was also a release of more than 95 L (25 gal) of diesel fuel to soil at INTEC. CFA had two reportable releases: a petroleum release of less than 19 L (5 gal) to soil that could not be cleaned up within 24 hours of discovery and an opacity exceedance for the CFA-609 boiler. A release of less than 95 L (25 gal) of petroleum products to the soil at Fire Station #2 was reported because it could not be cleaned up within 24 hours of discovery. At WROC, exceedance of the CERCLA reportable quantity for friable asbestos triggered external agency notifications.

Environmental Oversight and Monitoring Agreement

The Environmental Oversight and Monitoring Agreement (EOMA) between DOE-ID, DOE-Pittsburgh Naval Reactors Office, 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 INEEL Oversight Program (INEEL Oversight Program). The main objectives as established under the third 5-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.

Oversight Program activities produced many accomplishments in 2000, due in large part to a well-coordinated working relationship with DOE, INEEL contractors, the Shoshone-Bannock Tribes, USGS, NOAA, and Idaho State University.

Monitoring and Surveillance Committee

The INEEL Monitoring and Surveillance Committee (MSC) was formed in March 1997 and holds monthly 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; Shoshone-Bannock Tribes; Idaho DEQ; Oversight Program; NOAA; and USGS. The MSC has served as a valuable forum to review monitoring, analytical, and quality assurance methodologies; to coordinate efforts; and to avoid unnecessary duplication.

Environmental Surveillance Program

The Environmental Surveillance Program verifies and supplements existing surveillance programs operated by INEEL contractors. The program's approach is designed to provide independent assessments of potential contaminants

resulting from DOE activities at the Site. It monitors multiple environmental media that have been or potentially could be contaminated by INEEL activities, including air, soil, milk, surface water, and groundwater. External gamma radiation is also monitored under this program. Results are reported in the annual INEEL Oversight Program Environmental Surveillance Report.

Emergency Response and Preparedness Program

The EOMA requires emergency preparedness assistance to local authorities. DOE has assisted the Oversight Program in establishing a Statewide Interagency Planning Group. The group provides a process for coordinating emergency preparedness issues and concerns among the various State agencies as well as increased communication among the organizations. A five-phase radiological emergency response plan and emergency response training has been cooperatively established with the Oversight Program to assist the local governments to meet local emergency response needs. The community monitoring stations have helped enhance the monitoring parameters and locations of meteorological conditions for use in emergency planning as well as emergency response. This information is available to the state of Idaho as well as the local emergency response personnel for use in actual emergencies and for use in drills and exercises.

Impact Assessment Program

The Impact Assessment Program produces scientific validation through independent risk assessment of current and future operations specific to Idaho. A collaborative effort improves and scientifically validates DOE'S processes. The activity allows the State and DOE to more effectively and efficiently plan future needs in surveillance and emergency response.

Citizens Advisory Board

The INEEL Citizens Advisory Board, formerly called the Site Specific Advisory Board, was formed in March 1994. Its charter is to provide input and recommendations on environmental management's strategic decisions that impact future use, risk management, economic development, and budget prioritization activities.

The board has produced 78 recommendations to date. In 2000, 14 recommendations were made on the following:

- Rehabilitation of Areas Affected by Wildfire;
- Long-Term Stewardship;
- Operations of the Waste Experimental Reduction Facility Incinerator;
- Draft Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions to the United States, including the Role of the Fast Flux Test Facility;
- Environmental Impact Statement for the Proposed Relocation of the Los Alamos National Laboratory Technical Area 18 Missions;
- Idaho High-Level Waste and Facilities Disposition Draft Environmental Impact Statement;
- The Idaho National Engineering and Environmental Laboratory Institutional Plan;
- The Future of the Waste Experimental Reduction Facility at the Idaho National Engineering and Environmental Laboratory;
- Accessibility of Contractor Resources to Support Citizen Advisory Board Deliberations;

- Evaluation of Ecological Health at the Idaho National Engineering and Environmental Laboratory;
- Stakeholder Involvement in Long-Term Stewardship Planning;
- Draft Hazardous and Polychlorinated Biphenyl Waste Facility Partial-Permit for the Advanced Mixed Waste Treatment Facility; and
- Draft Environmental Impact Statement for a Geologic Repository for Spent Nuclear Fuel and High-Level Waste, Nye County, Nevada.

2.9 PERMITS

Table 2-1 summarizes permits applied for, granted or amended and active at the INEEL through year-end 2000.

Table 2-1. Permit summary for calendar year 2000 for the INEEL.

Media/Permit Type	Issuing Agency	Active	Granted and/or Amended	Pending
Air [a]				
Permit to Construct	State of Idaho	10	6	0
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	4		3
404 Permit	Corps of Engineers	1		0
Industrial Waste Acceptance	City of Idaho Falls	15		0
RCRA				
Part A	State of Idaho	7		0
Part B[c]	State of Idaho	7[c]		5[c]

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 Part B permit for the INEEL is a single permit comprised of several volumes.

Chapter 3

Radiological Environmental Monitoring Results

Environmental Surveillance, Education and Research Program

ESER

3. RADIOLOGICAL ENVIRONMENTAL MONITORING RESULTS

In 2000, environmental sampling for radionuclides was performed on the Idaho National Engineering and Environmental Laboratory (INEEL) and at boundary and distant locations.

3.1 AIR SAMPLING

The following sections present the results from both the Environmental Surveillance, Education and Research (ESER) contractor and the Management and Operating (M&O) contractor samples collected from air.

Low-Volume Charcoal Cartridges

Both the ESER contractor and the M&O contractor collected charcoal cartridges weekly and analyzed them for gamma-emitting radionuclides. Charcoal cartridges are used primarily to collect gaseous radioiodine. If any anthropogenic (human-made) radionuclides were detected, the cartridges were individually analyzed. During 2000, the M&O contractor analyzed a total of 620 cartridges, looking specifically for iodine-131 (^{131}I). The ESER contractor analyzed 883 charcoal cartridges for ^{131}I. Iodine-131 was not detected in samples from either contractor at a minimum detectable concentration (MDC) of 4 x 10-15 µCi/mL.

Low-Volume Gross Alpha

Particulates filtered from the air were sampled from 26 locations weekly. All were analyzed for gross alpha activity (Table 3-1). Gross alpha concentrations found in ESER contractor samples, both onsite and offsite, tended to be higher than those found in M&O contractor samples at common locations (Table 3-1). Reasons for differences in concentrations measured at the same locations are likely due to differences in laboratory analytical techniques and instrumentation. Both sets of data indicated gross alpha concentrations were generally higher at distant locations than at boundary and onsite locations.

Weekly gross alpha concentrations in ESER samples ranged from a low of (-0.65 ± 1.6) x 10^{-15} µCi/mL in March at the quality assurance (QA) sampler at Monteview to a high of (9.4 ± 4.3) x 10^{-15} µCi/mL at Van Buren Boulevard in August. M&O contractor samples ranged from a low of (2.6 ± 1.1) x 10^{-15} µCi/mL at the Idaho Nuclear Technology and Engineering Center (INTEC) in April to a high of (12.0 ± 3.0) x 10^{-15} µCi/mL at the Experimental Field Station (EFS) during July.

ESER contractor annual mean gross alpha concentrations ranged from (1.3 ± 0.2) x 10^{-15} µCi/mL at Craters of the Moon to (2.2 ± 0.4) x 10^{-15} µCi/mL at the Blackfoot Community Monitoring Station (CMS) (Table 3-1). M&O contractor data indicated an annual mean range of (0.3 ± 0.5) x 10^{-15} µCi/mL at the Idaho Nuclear Technology and Engineering Center (INTEC) to (1.6 ± 0.4) x 10^{-15} µCi/mL at Rexburg (Table 3-1).

Low-Volume Gross Beta

As with gross alpha, gross beta concentrations in ESER samples were consistent with those found in M&O samples at common locations (Table 3-2). Chapter 8 includes a graphic comparison of weekly gross beta concentrations obtained by the M&O contractor and the ESER contractor at common locations. The state of Idaho INEEL Oversight Program reports another comparison [Reference 3-1].

Figure 3-1 displays the average weekly gross beta concentrations for the INEEL, boundary, and distant station groups. These data are typical of the annual 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.

Weekly gross beta concentrations in ESER samples ranged from a low of (-1 ± 1) x 10^{-15} µCi/mL in June at the Blackfoot CMS

Table 3-1. Gross alpha activity in air (2000).

ESER Contractor Data			Concentration (x 10^{-15} µCi/mL)	
Group	Location	No. of Samples	Range of Samples	Annual Mean ± 95 % C.I.[a]
Distant	Blackfoot	52	0.03 – 5.8	2.0 ± 0.3
	Blackfoot CMS	52	0.4 – 8.2	2.2 ± 0.4
	Craters of the Moon	52	0.1 – 3.9	1.3 ± 0.2
	Idaho Falls	52	0.3 – 6.1	2.0 ± 0.3
	Rexburg CMS	52	0.4 – 5.8	2.2 ± 0.3
			Grand Mean:	**1.9 ± 0.1**
Boundary	Arco	52	0.1 – 4.1	1.7 ± 0.3
	Atomic City	52	-0.1 – 5.8	1.6 ± 0.3
	FAA Tower[b]	52	0.2 – 6.9	1.5 ± 0.3
	Howe	52	0.1 – 7.2	1.8 ± 0.4
	Monteview	52	0.2 – 5.6	1.8 ± 0.4
	Mud Lake	52	0.6 – 6.7	1.8 ± 0.3
	Reno Ranch/Birch Creek	52	-0.2 – 6.9	1.7 ± 0.4
			Grand Mean:	**1.7 ± 0.1**
INEEL	EFS	52	0.3 – 7.0	1.7 ± 0.4
	Main Gate	52	0.3 – 5.5	1.5 ± 0.3
	Van Buren	52	0.2 – 7.4	1.5 ± 0.3
			Grand Mean:	**1.6 ± 0.2**
M&O Contractor Data			**Concentration (x 10^{-15} µCi/mL)**	
Group	Location	No. of Samples	Range of Samples	Annual Mean ± 95 % C.I.[a]
Distant	Blackfoot	50	-1.1 – 8.0	1.1 ± 0.4
	Craters of the Moon	51	-1.6 - 3.0	0.6 ± 0.3
	Idaho Falls	48	-1.4 – 5.0	0.9 ± 0.4
	Rexburg	52	-0.9 – 5.2	1.6 ± 0.4
			Grand Mean:	**1.0 ± 0.2**
INEEL	ANL-W	52	-1.1 – 6.1[c]	0.6 ± 0.3
	ARA	49	-1.8 – 3.7	0.5 ± 0.4
	CFA	53	-1.6 – 7.1	1.0 ± 0.4
	EBR-I	50	-1.7 – 3.4	0.6 ± 0.3
	EFS	50	-1.5 – 12	1.0 ± 0.5
	INTEC	52	-2.6 - 8.0	0.3 ± 0.5
	NRF	52	-2.0 – 4.6	0.8 ± 0.4
	PBF	52	-0.9 – 5.5	0.9 ± 0.3
	Rest Area[d]	18	-0.5 – 3.6	1.2 ± 0.6
	RWMC	52	-0.8 – 3.5	0.6 ± 0.2
	TAN	53	-1.0 - 2.6	0.7 ± 0.2
	TRA	49	-1.3 – 5.0	1.0 ± 0.4
	Van Buren	51	-1.7 – 10.0	0.8 ± 0.5
			Grand Mean:	**0.7 ± 0.1**

a. Confidence interval.
b. FAA = Federal Aviation Administration.
c. Maximum differs from that reported in the M&O's 2000 Environmental Monitoring Program Report (INEEL/EXT-01-00447). After the M&O report was published the previous maximum was found to be associated with an invalid sample due to low sample volume.
d. New sampler installed August 23, 2000.

Table 3-2. Gross beta activity in air (2000).

ESER Contractor Data			Concentration (x 10^{-15} µCi/mL)	
Group	**Location**	**No. of Samples**	**Range of Samples**	**Annual Mean ± 95 % C.I.[a]**
Distant	Blackfoot	52	9.9 – 61.1	26.4 ± 3.1
	Blackfoot CMS	52	-1.0 – 74.9	25.2 ± 4.0
	Craters of the Moon	52	8.0 – 55.5	22.3 ± 2.8
	Idaho Falls	52	10.2 – 89.6	29.3 ± 4.2
	Rexburg CMS	52	4.3 – 61.5	25.2 ± 3.1
			Grand Mean:	**25.7 ± 1.4**
Boundary	Arco	52	10.1 – 61.9	25.5 ± 3.2
	Atomic City	52	9.2 – 72.2	25.3 ± 3.3
	FAA Tower	52	9.1 – 69.4	25.9 ± 3.4
	Howe	52	10.3 – 90.1	29.5 ± 4.2
	Monteview	52	11.1 – 80.1	28.3 ± 3.5
	Mud Lake	52	10.8 – 91.5	27.1 ± 4.0
	Reno Ranch/Birch Creek	52	-0.5 – 117	26.3 ± 4.8
			Grand Mean:	**26.9 ± 1.4**
INEEL	EFS	52	11.1 – 81.0	28.1 ± 3.8
	Main Gate	52	9.4 – 68.0	25.9 ± 3.7
	Van Buren	52	10.2 – 73.3	27.3 ± 3.6
			Grand Mean:	**27.7 ± 2.6**

M&O Contractor Data			Concentration (x 10^{-15} µCi/mL)	
Group	**Location**	**No. of Samples**	**Range of Samples**	**Annual Mean ± 95 % C.I[a]**
Distant	Blackfoot	50	4.0 – 67.0	27.2 ± 3.7
	Craters of the Moon	51	6.0 – 45.0	22.2 ± 2.6
	Idaho Falls	48	8.0 – 55.0	24.4 ± 3.2
	Rexburg	52	9.0 – 53.0	23.9 ± 2.7
			Grand Mean:	**24.4 ± 1.5**
INEEL	ANL-W	52	7.0 – 51.0	23.6 ± 2.8
	ARA	49	9.7 – 50.0	23.5 ± 3.0
	CFA	53	7.0 – 59.0	26.0 ± 3.2
	EBR-I	50	2.0 – 55.0	24.3 ± 2.9
	EFS	50	12.2 – 67.0	27.5 ± 3.3
	INTEC	52	11.0 – 61.0	23.7 ± 3.1
	NRF	52	4.0 – 78.0	25.8 ± 3.5
	PBF	52	7.8 – 53.0	22.2 ± 2.4
	Rest Area[b]	18	16.0 – 41.0	28.0 ± 3.8
	RWMC	52	5.3 – 44.6	19.3 ± 2.3
	TAN	53	7.3 – 66.4	22.6 ± 3.3
	TRA	49	8.0 – 60.2	26.1 ± 3.3
	Van Buren	51	10.0 – 58.0	25.6 ± 3.2
			Grand Mean:	**24.3 ± 0.8**

a. Confidence interval.
b. New sampler installed August 23, 2000.

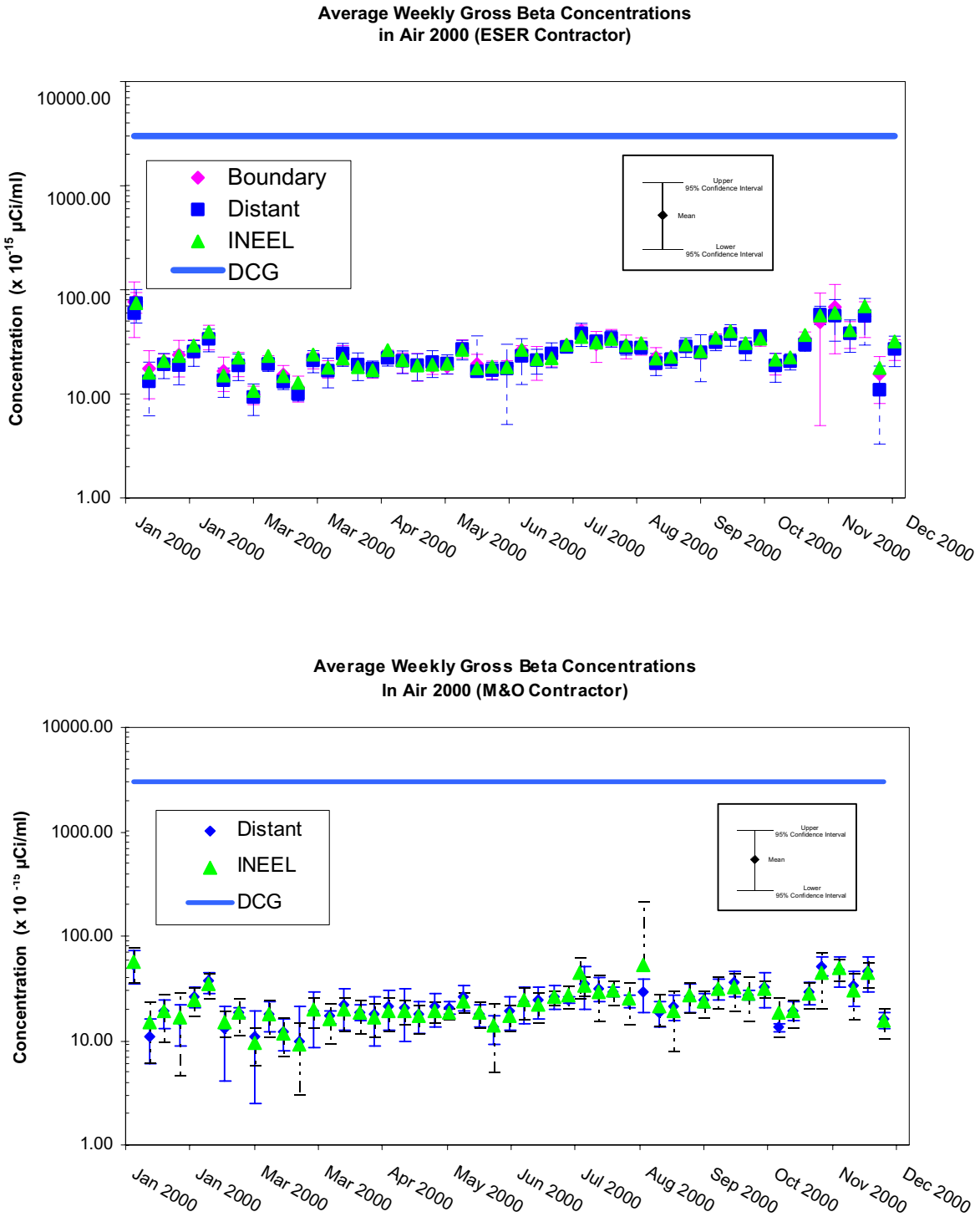


Figure 3-1. Average weekly gross beta concentrations in air (2000).

to a high of (117 ± 5) x 10^{-15} µCi/mL at Reno Ranch in November. M&O contractor samples ranged from a low of (2 ± 10) x 10^{-15} µCi/mL at Experimental Breeder Reactor No. 1 (EBR-I) in June to a high of (78 ± 6) x 10^{-15} µCi/mL at the Naval Reactors Facility (NRF) during January.

ESER contractor annual mean gross beta concentrations ranged from (22.3 ± 2.8) x 10^{-15} µCi/mL at Craters of the Moon to (29.5 ± 4.2) x 10^{-15}µCi/mL at Howe (Table 3-2). M&O contractor data indicated an annual mean range of (19.3 ± 2.3) x 10^{-15} µCi/mL at the Radioactive Waste Management Complex (RWMC) to (27.5 ± 3.3) x 10^{-15} µCi/mL at the Experimental Field Station (EFS) (Table 3-2). The average for the sampler at the Rest Area location was (28.0 ± 3.8) x 10^{-15} µCi/mL (Table 3-2), but it does not represent data for the entire year as the sampler was installed in August 2000.

In general, levels of airborne radioactivity for the INEEL, boundary, and distant groups track each other closely throughout the year. This suggests that the pattern of fluctuations occurred over the entire sampling network and, therefore, was not caused by a localized source such as a facility or activity at the INEEL.

Statistical Comparisons

Statistical comparisons were done between monthly mean gross beta radioactivity from each onsite and boundary location and the distant group mean gross beta radioactivity (see Appendix B for a description of statistical methods). ESER contractor data showed onsite and boundary station concentrations were not significantly different from distant stations (Table 3-3). For M&O contractor samples, concentrations on the INEEL were statistically higher than distant stations for 4 of 144 (<3 percent) comparisons. INEEL gross beta concentrations were statistically higher than the distant group during July at the EFS, INTEC, and Van Buren Boulevard and during October at the Test Reactor Area (TRA) (Table 3-3). The Tin Cup range fire that occurred in July affected the results for that month. A detailed discussion on the effects of this fire is included in the *2000 Environmental Monitoring Program Report*, INEEL/EXT-01-00447 [Reference 3-2].

Statistical comparisons were also made between annual gross beta mean concentrations at individual onsite and boundary locations and the annual mean of distant stations. For both the ESER contractor and M&O contractor samples, no annual gross beta concentrations for individual stations were statistically greater than the distant mean annual gross beta concentration.

The few statistically significant differences in concentrations that were found may be due to INEEL operations. However, gross beta concentrations can vary widely from location to location as a result of factors such as local soil type and meteorological conditions. Thus, when statistical differences are found, nuclide analyses discussed in the following section are examined to try to pinpoint the possible specific radionuclide(s) that may have contributed to the elevated concentrations and to identify a possible INEEL cause, if any, for the differences.

Specific Radionuclides in Air Samples

Anthropogenic (human-made) radionuclides were detected in ESER contractor samples (Table 3-4), although most are in the range of concentrations where detection is questionable. Detections of specific human-made radionuclides reported by the M&O contractor can also be found in Table 3-4 (see Appendix B for a discussion of the relative confidence in the presence of constituents at the reported values).

The concentrations of specific radionuclides measured are within the range of values measured in recent years and within the range expected from global fallout events. Measured specific radionuclides do not coincide in time or location with statistical gross beta

Table 3-3. Statistical comparison of gross beta concentrations in air at distant, boundary, and INEEL locations (2000).[a]

ESER Contractor Data

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
INEEL													
EFS													
Main Gate													
Van Buren													
Boundary													
Arco													
Atomic City													
FAA Tower													
Howe													
Monteview													
Mud Lake													
Reno Ranch/ Birch Creek													
Distant													
Craters of the Moon													
Blackfoot CMS													
Blackfoot NOAA													
Idaho Falls													
Rexburg CMS													

No significant differences between any listed location and average of distant locations.

M&O Contractor Data

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
INEEL													
ANL-W													
ARA													
CFA													
EBR-I													
EFS													
INTEC													
NRF													
PBF													
RWMC													
Rest Area													
TAN													
TRA													
V. Buren													

a. Shaded area indicates the mean gross beta concentration for that location is statistically greater than the mean gross beta concentration for the distant group for the given time period. A single-tailed t-test ($\alpha = 0.05$) was used. See Appendix B for a full discussion of the statistical methods used.

Table 3-4. Human-made radionuclides in ESER and M&O contractor air samples (2000).[a]

ESER Contractor Samples

	Location	Strontium-90	Cesium-137	Plutonium-239/240	Americium-241
1st Quarter	Arco	ND[b]	ND	ND	0.12 ± 0.11
	Atomic City	0.40 ± 0.26	ND	ND	ND
	FAA Tower	ND	0.26 ± 0.17	ND	ND
	Monteview	ND	ND	ND	0.22 ± 0.18
	Rexburg CMS	0.27 ± 0.26	ND	ND	ND
2nd Quarter	Blackfoot CMS	ND	ND	0.16 ± 0.14	ND
	Monteview	ND	0.27 ± 0.19	ND	ND
3rd Quarter	All Sites	ND	ND	ND	ND
4th Quarter	All Sites	ND	ND	ND	ND

M&O Contractor Samples

	Location	Strontium-90	Cesium-137	Plutonium-239/240	Americium-241
1st Quarter	All Sites	ND	ND	ND	ND
2nd Quarter	All Sites	ND	ND	ND	ND
3rd Quarter	Rest Area	ND	ND	0.11 ± 0.08	ND
	TRA	ND	ND	0.13 ± 0.06	ND
4th Quarter	Rest Area	1.1 ± 0.8	ND	ND	ND
	NRF	ND	0.35 ± 0.20	ND	ND

a. All values shown are x 10^{-16} µCi/mL with ± 2 standard deviations.
b. ND = not detected.

differences shown in Table 3-3. The statistical differences are, therefore, are not believed to be INEEL inputs of specific radionuclides.

Atmospheric Moisture

During 2000, the ESER contractor collected 15 atmospheric moisture samples from four locations, including Atomic City, Blackfoot CMS, Idaho Falls, and Rexburg CMS. Tritium was detected in five of the samples (Table 3-5). During the first quarter, the Rexburg CMS sample had a tritium concentration of (7.2 ± 7.1) x 10^{-14} µCi/mL in air. The sample from Idaho Falls had a concentration of (8.2 ± 6.5) x 10^{-14} µCi/mL in the second quarter. The Blackfoot CMS sample contained (29.7 ± 14.7) x 10^{-14} µCi/mL tritium in air during the third quarter and (16.9 ± 10.1) x 10^{-14} µCi/mL during the fourth quarter. Also during the fourth quarter, the Idaho Falls sample had a measured tritium concentration of (26.5 ± 9.2) x 10^{-14} µCi/mL. All tritium detections in atmospheric moisture were at locations distant from the INEEL. The M&O contractor also collected atmospheric moisture samples at the EFS and at Van Buren Boulevard on the INEEL (from one to three samples at each location each quarter). Laboratory analyses indicate that all samples were below detection limits (see Table 1-3 for detection limits).

No tritium was detected at monitoring locations on or near the INEEL. This suggests the detections probably represent a combination of tritium from natural production in the atmosphere by cosmic ray bombardment, residual tritium from weapons testing fallout, and possible analytical variations. The highest observed

Table 3-5. Tritium concentrations in ESER contractor atmospheric moisture samples. (2000)

	Maximum Concentrations[a, b]			
	April	June	September	December
Atomic City	0.56 ± 1.40	1.15 ± 1.24	0.27 ± 0.57	0.70 ± 1.38
Blackfoot	0.18 ± 0.31	0.94 ± 1.50	2.97 ± 1.47	1.67 ± 1.01
Idaho Falls	----[c]	0.83 ± 0.65	1.45 ± 3.19	2.65 ± 0.92
Rexburg	0.73 ± 0.72	-0.42 ± 0.63	2.53 ± 2.56	0.90 ± 1.11

a. All values are x 10^{-13} microcuries per milliliter (µCi/mL) of air ± 2 standard deviations.
b. Detection limit is 4 x 10^{-12} µCi/mL.
c. No sample collected during the first quarter of 2000.

radioactivity (from the Blackfoot CMS)represents approximately 0.0003 percent of the U.S. Department of Energy (DOE) Derived Concentration Guide (DCG) of 1 x 10^{-7} µCi/mL.

Precipitation

The ESER contractor collects precipitation samples weekly at the EFS, monthly at the Central Facilities Area (CFA), and offsite in Idaho Falls, when an adequate amount of precipitation is present. A total of 39 precipitation samples were collected during 2000 from the three sites. Tritium was detected in 12 of the samples at concentrations ranging from (0.83 ± 0.82) x 10^{-7} µCi/mL to (5.53 ± 0.78) x 10^{-7} µCi/mL (Table 3-6). The highest concentration was from the EFS. The values are within the range observed worldwide in recent years and are likely due to weapons-produced tritium and from natural production of tritium in the upper atmosphere.

3.2 WATER SAMPLING

This section presents results from radiological analyses performed on drinking water and surface water samples taken at offsite locations by the ESER contractor. The ESER contractor collected 41 offsite water samples: 12 from surface water locations and 29 from drinking water locations. Radiological results from onsite production well sampling can be found in Chapter 5, "Groundwater," together with results from additional sampling conducted by the M&O contractor's Drinking Water Program.

Offsite Water Sampling – Gross Alpha

In 2000, three surface water samples and five drinking water samples contained detectable concentrations of gross alpha ranging from 0.9 ± 0.8 pCi/L to 1.1 ± 0.8 pCi/L in surface water and from 0.9 ± 0.8 pCi/L to 3.1 ± 1.9 pCi/L in drinking water. The highest measured radioactivity was below the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) of 15 pCi/L for gross alpha in drinking water.

Offsite Water Sampling – Gross Beta

Gross beta concentrations greater than the samples' 2-sigma uncertainty were measured in 34 of the 41 offsite water samples. Concentrations ranged from 1.9 ± 1.8 pCi/L to 9.7 ± 2.5 pCi/L in drinking water and from 2.9 ± 1.6 pCi/L to 7.5 ± 2.0 pCi/L in surface water. The EPA has not established a numerical MCL for gross beta in drinking water. However, concentrations in this range are within the expected values for natural decay products of thorium and uranium, trace amounts of which dissolve into water as the water passes through the fractured basalts of the Snake River Plain.

Table 3-6. Maximum tritium concentration in ESER contractor precipitation samples. (2000)

Location	Date	Concentration[a, b]
Central Facilities Area	7 - August	0.2 ± 0.27
	5 - September	0.76 ± 0.65
	6 - November	12.1 ± 3.63
	4 - December	0.68 ± 0.67
	31 – December	0.0 + 0.0
Idaho Falls	31 - December	1.02 ± 0.50
Experimental Field Station	14 - March	39.4 ± 5.58
	11 - April	2.43 ± 1.20
	18 - July	21.1 ± 3.73
	5 - September	1.04 ± 0.78
	17 - October	4.07 ± 3.97
	31 - October	5.07 ± 2.74

a. All values are x 10^{-13} microcuries per milliliter (µCi/mL) of air ± 2 standard deviations.
b. Detection limit is 3 x 10^{-7} µCi/mL.

Offsite Water Sampling – Tritium

No tritium was detected in surface water samples, but it was measured in one drinking water sample taken during 2000. That sample, from Shoshone, had a concentration of $(1.6 \pm 0.7) \times 10^2$ pCi/L. This value is two orders of magnitude less than the EPA MCL of 2×10^4 pCi/L for tritium in water. The measured level cannot be distinguished from natural and laboratory variability.

Storm Water Sampling

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, which set monitoring requirements that applied to the INEEL. Both analytical and visual monitoring is required. However, storm water did not discharge to the Big Lost River system from monitoring locations during 2000. Therefore, all storm water monitoring activities were visual examinations only.

More detailed information and data on storm water monitoring was included in the *2000 Environmental Monitoring Program Report*, INEEL/EXT-01-00447 [Reference 3-2].

3.3 AGRICULTURAL PRODUCT and WILDLIFE SAMPLING

Milk

During 2000, 138 milk samples were collected. All of the samples were analyzed for gamma emitting radionuclides with special interest in iodine-131 (^{131}I). During the second and fourth quarters, selected samples were analyzed for strontium-90 (^{90}Sr).

Iodine-131 was not detected in any milk samples during 2000. Strontium-90 was detected in eight samples with concentrations ranging from 0.46 ± 0.41 pCi/L in a sample from Minidoka in May to 1.7 ± 1.6 pCi/L at Roberts in November. All levels of ^{90}Sr in milk are consistent with those previously reported by the EPA as resulting from worldwide fallout

deposited on soil, then taken up by ingestion of grass by cows [Reference 3-3]. There is no indication that activities at the INEEL are contributing significantly to ^{90}Sr in milk.

Cesium-137 was detected in 20 samples during 2000. Concentrations ranged from 2.59 ± 2.22 pCi/L in January in Howe to 15.4 ± 5.94 pCi/L at Minidoka in October. No tritium analyses were performed in 2000.

Lettuce

Eight lettuce samples, including one duplicate, were collected from regional private gardens. No cesium-137 (^{137}Cs) was detected in any of the samples. Strontium-90 was detected in seven of the samples (Table 3-7). Other than the high values measured in the Carey sample, all samples are similar. Concentrations of ^{90}Sr derived from aboveground nuclear weapons testing that took place between 1945 and 1980 are present in soil. This is likely the source of the ^{90}Sr detected in lettuce.

Wheat

Ten wheat samples and one quality assurance duplicate were collected during 2000. One sample, from Dietrich, contained ^{137}Cs at a concentration of (3.2 ± 3.1) x 10^{-9} µCi/g. Measurable concentrations of ^{90}Sr were found in ten samples and the duplicate at similar levels from both distant and boundary locations (Table 3-8). The concentrations of ^{90}Sr are similar to those detected in recent years and are attributed to historic aboveground nuclear weapons testing.

Potatoes

Nine potato samples were collected during 2000: three samples from boundary locations and six from distant locations including three from different states (Center, Colorado; Fairbanks, Alaska; and Tiverton, Rhode Island). The only human-made gamma emitting radionuclide measured was ^{137}Cs in a sample from Arco [(6.0 ± 4.1) x 10^{-9} µCi/g], though a recount of the sample

Table 3-7. Strontium-90 concentrations in garden lettuce (1995–2000).[a]

Location	1995	1996	1997	1998	1999	2000
Distant Group						
Blackfoot	740 ± 200	270 ± 240	90 ± 70	100 ± 80	130 ± 60	80 ± 30
Carey	-50 ± 180	---[b]	70 ± 50	200 ± 50	120 ± 80	295 ± 140
Idaho Falls	60 ± 30	---	50 ± 30	70 ± 40	60 ± 40	61 ± 50
Pocatello	NS[c]	---	NS	NS	NS	89 ± 60
Mean	140 ± 50	270 ± 240	60 ± 40	120 ± 60	103 ± 60	155 ± 77
Boundary Group						
Arco	140 ± 50	200 ± 200	70 ± 70	200 ± 100	120 ± 40	81 ± 41
Atomic City	300 ± 120	120 ± 100	160 ± 60	100 ± 70	90 ± 40	NS
Howe	NS	100 ± 160	80 ± 80	100 ± 90	60 ± 70	88 ± 48
Monteview	100 ± 90	NA	90 ± 40	100 ± 50	225 ± 200	NS
Mud Lake	80 ± 40	160 ± 360	170 ± 80	100 ± 80	160 ± 80	51 ± 51
Mean	160 ± 160	140 ± 70	130 ± 60	120 ± 80	130 ± 90	70 ± 48

a. Values shown are the analytical results x 10^{-9} µCi/g (dry weight) ± 2 standard deviations. Approximate MDC of ^{90}Sr in lettuce is 80 x 10^{-9} µCi/g dry weight.

b. --- a sample was collected and submitted to the laboratory but lost before analysis.

c. NS = no sample collected.

Table 3-8. Strontium-90 concentrations in wheat (1995–2000). [a]

Location	1995	1996	1997	1998	1999	2000
Distant Group						
American Falls	8 ± 4	7 ± 5	9 ± 5	6 ± 4	6 ± 5	5 ± 3
Blackfoot	4 ± 4	6 ± 6	14 ± 6	8 ± 4	5 ± 5	6 ± 6
Carey	11 ± 7	5 ± 6	5 ± 4	NS[b]	8 ± 3	NS
Dietrich	NS	5 ± 5	4 ± 4	4 ± 3	5 ± 4	6 ± 4
Idaho Falls	9 ± 5	9 ± 18	4 ± 4	7 ± 3	8 ± 6	5 ± 3
Minidoka	3 ± 5	8 ± 5	5 ± 4	6 ± 3	4 ± 3	6 ± 4
Mean	7 ± 4	7 ± 2	7 ± 4	6 ± 3	6 ± 4	6 ± 4
Boundary Group						
Arco	3 ± 5	16 ± 40	4 ± 3	6 ± 3	5 ± 3	6 ± 4
Monteview	4 ± 4	3 ± 4	5 ± 5	9 ± 4	6 ± 5	2 ± 2
Mud Lake	4 ± 5	5 ± 5	4 ± 4	8 ± 4	3 ± 3	5 ± 4
Taber	12 ± 6	10 ± 6	5 ± 5	6 ± 3	8 ± 6	6 ± 4
Terreton	7 ± 5	8 ± 6	6 ± 4	7 ± 3	5 ± 4	3 ± 3
Mean	6 ± 5	8 ± 6	5 ± 1	7 ± 3	5 ± 4	4 ± 3

a. Values shown are the analytical results x 10^{-9} µCi/g (dry weight) ± 2 standard deviations. Approximate MDC of ^{90}Sr in wheat is 4 x 10^{-9} µCi/g dry weight.

b. NS = no sample collected.

did not confirm the detection. Strontium-90 was not detected in any of the samples.

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 2000, six sheep were sampled: two from a flock grazing the north end of the INEEL, two from a flock grazing the south end of the INEEL, and two from Blackfoot as controls. Thyroid, muscle, and liver tissue were analyzed for gamma-emitting radionuclides. Iodine-131 was not found in any of the samples. Three animals had detectable amounts of ^{137}Cs: one in muscle from the control flocks and one each in the liver from both the northern and southern flocks. All concentrations are similar to those measured in past years at both control and onsite locations.

Game Animals

Nine mule deer, five elk, and one pronghorn that had been accidentally killed on INEEL roads or died of malnutrition were sampled. Thyroid, muscle, and liver tissue from each were analyzed for gamma-emitting radionuclides. Iodine-131 was not detected in any of the thyroid glands. Two mule deer had detectable concentrations of ^{137}Cs in liver tissue. Two elk, one pronghorn, and a different mule deer had detectable concentrations of ^{137}Cs in muscle tissue. Cesium-137 concentrations ranged from (2.6 ± 2.4) x 10^{-9} µCi/g to (6.2 ± 2.2) x 10^{-9} µCi/g.

Cesium-137 is an analog of potassium and is readily incorporated into muscle and organ tissues. The ^{137}Cs concentrations detected in big game on the INEEL during 2000 were at low levels and indistinguishable from that available from fallout from nuclear weapons tests or releases from Chernobyl. In 1998 and 1999, big game animals sampled in

Colorado, Idaho (distant from the INEEL), Montana, Oregon, Utah, and Wyoming had ^{137}Cs concentrations in muscle tissue ranging from -10×10^{-9} µCi/g to 152×10^{-9} µCi/g (wet weight).

Mourning doves are a game bird commonly hunted across the United States. A total of 18 mourning doves were sampled during 2000: seven from locations near radioactive waste ponds at the TRA, six from locations near contaminated waste ponds at the INTEC, and five, for comparison, from a location approximately 3.2 km (2 mi) southeast of Idaho Falls. Because of the small size of the birds, two to three birds were composited in each sample. Samples of muscle tissue were analyzed for gamma-emitting radionuclides (i.e., ^{137}Cs) with a subset analyzed for ^{90}Sr, plutonium-238 (^{238}Pu), plutonium-239/240 ($^{239/240}Pu$), and americium-241 (^{241}Am). The only human-made radionuclide detected was ^{137}Cs in two samples from INTEC (consisting of muscle tissue from three birds each) and in one sample from TRA (consisting of muscle tissue from three birds) (Table 3-9). Potential doses from consuming these doves are discussed in Section 7.3.

Table 3-9. Cesium-137 measured in muscle tissue of doves near INEEL waste ponds. (2000)

Sample ID[a]	Concentration[b]
00-DV-TRA3-MUS	0.037 ± 0.035
00-DV-INTEC2-MUS	0.041 ± 0.036
00-DV-INTEC1-MUS	0.032 ± 0.028

a. Each sample contained muscle tissue from three doves.

b. All values are x 10^{-6} µCi/g ± 2 standard deviations (2s).

Seven ducks were collected from waste ponds on the INEEL and three were collected from an offsite location (Mud Lake). Of the ducks collected from the INEEL, five were collected from radioactive waste ponds at the TRA, one from percolation ponds at the INTEC, and one from the industrial waste pond at the Argonne National Laboratory-West (ANL-W) facility. No human-made radionuclides were detected in the samples from Mud Lake, INTEC, or ANL-W. Both ^{137}Cs and ^{60}Co were detected in the muscle tissue of four of the ducks sampled from the TRA ponds (Table 3-10). The potential dose from consuming these ducks is discussed in Section 7.3.

Table 3-10. Detected radionuclides in edible tissue of ducks using TRA ponds. (2000)

Species	Radionuclides Detected	Concentration[a]
Redhead	^{60}Co	4.3 ± 0.6
	^{137}Cs	0.6 ± 0.2
Redhead	^{60}Co	2.1 ± 0.3
	^{137}Cs	0.2 ± 0.1
Ruddy	^{60}Co	0.3 ± 0.1
	^{137}Cs	0.8 ± 0.2
Ruddy	^{60}Co	0.5 ± 0.1
	^{137}Cs	0.7 ± 0.2

a. All values are x 10^{-6} µCi/g with ± 2 standard deviations (2s).

Marmots, otherwise known as rockchucks, are a large member of the squirrel family and are hunted and consumed by Native American people in the area. A population of yellow-bellied marmots exists within the boundaries of the RWMC. During the second quarter of 2000, three marmots were collected from the Subsurface Disposal Area of the RWMC.

Three marmots were also collected, as controls, from the Idaho Falls area. Each marmot was dissected into two samples: (1) the muscle tissue and (2) the skin, fur, viscera, and bones. All samples were analyzed for gamma-emitting radionuclides with a subset analyzed for ^{90}Sr, ^{238}Pu, $^{239/240}Pu$, and ^{241}Am. Two samples had detectable concentrations of human-made radionuclides. One marmot sampled from the RWMC had ^{137}Cs in the fur, skin, viscera, and bone sample at $(11.5 \pm 7.2) \times 10^{-9}$ µCi/g. A different marmot from the RWMC had ^{90}Sr in its fur, skin, viscera, and

bone sample at (90.4 ± 56.0) x 10^{-6} µCi/g. No human-made radionuclides were detected in the edible portion of any marmots sampled during 2000. Calculated hypothetical doses to humans from marmot consumption can be found in Section 7.3.

3.4 SOIL SAMPLING

Offsite soil samples are collected every two years to evaluate long-term trends. Samples were collected during the third quarter 2000. Sample locations include boundary and distant localities (Figure 3-2). Five points were sampled at each location within a 10-m by 10-m grid. At each point two discrete depth intervals: 0 to 5 centimeters (cm) (0 to 2 inches [in.]) and 5 to 10 cm (2 to 4 in.) were sampled. Samples from each depth at all five points were combined to make two composite samples: one for the 0 to 5 cm (0 to 2 in.) depth interval and one for the 5 to 10 cm (2 to 4 in.) depth interval, for each location. Samples were analyzed for gamma-emitting radionuclides, ^{90}Sr, and certain actinides.

One sample, from the 5 to 10 cm (2 to 4 in.) depth interval at the Mud Lake 1 location, had a ^{60}Co result slightly greater than its 2-standard deviation uncertainty. Because the 2-standard deviation uncertainty nearly overlapped zero and three recounts of this sample had negative results for ^{60}Co, the result of the initial analysis is deemed a false positive. Cobalt-60 has a relatively short half-life (5 years), and ^{60}Co was not detected in air or surface soils at that location in previous years, which reinforces the false positive assessment.

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 due to their abundance from nuclear fission events (e.g., ^{137}Cs and ^{90}Sr) or from their persistence in the environment due to long half-lives (e.g., plutonium). All soil samples collected during the third quarter 2000 had amounts of ^{137}Cs, ^{90}Sr, $^{239/240}$Pu, and ^{241}Am greater than their associated uncertainty value (positive detections) (Figure 3-3).

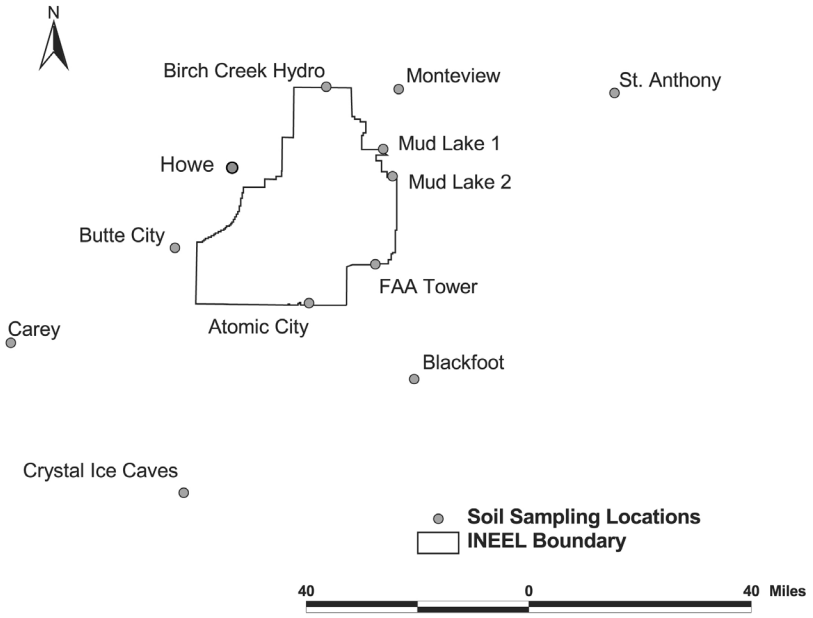


Figure 3-2. Offsite soil sample locations.

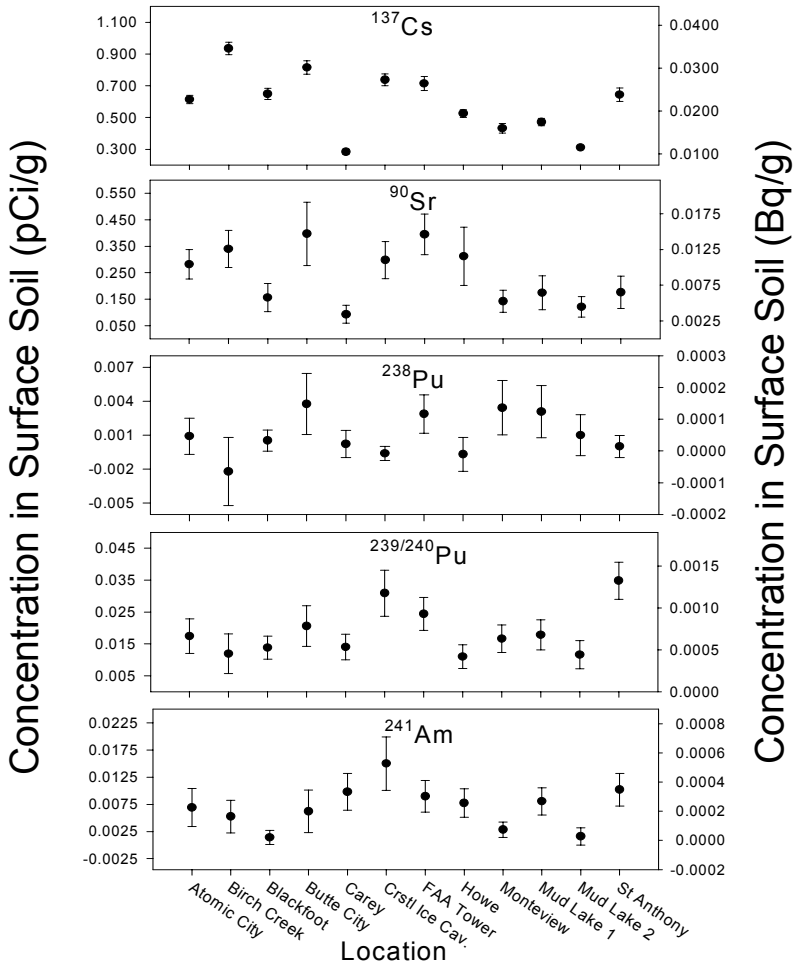


Figure 3-3. Concentrations of selected radionuclides in soil sampled during the third quarter 2000. Values with error bars (error bars equal 2 standard deviations) that overlap zero are not considered detected.

Thirty-three percent of the ^{238}Pu values were greater than their associated uncertainty value. 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 α= 0.05) between boundary and distant group concentrations for any of these radionuclides.

Figure 3-4 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 log-normally skewed. The shorter-lived radionuclides (^{90}Sr and ^{137}Cs) show overall decreases through time.

3.5 DIRECT RADIATION EXPOSURE

The measured cumulative radiation exposure for offsite locations from November 1999 through October 2000 is shown in Table 3-11 for two adjacent sets of dosimeters maintained by the ESER contractor and the M&O contractor. For purposes of comparison, annual exposures from 1997–1999 are also included on Table 3-11 for each location.

The mean annual exposures from distant locations in 2000 were 146 ± 20 mR as measured by ESER contractor

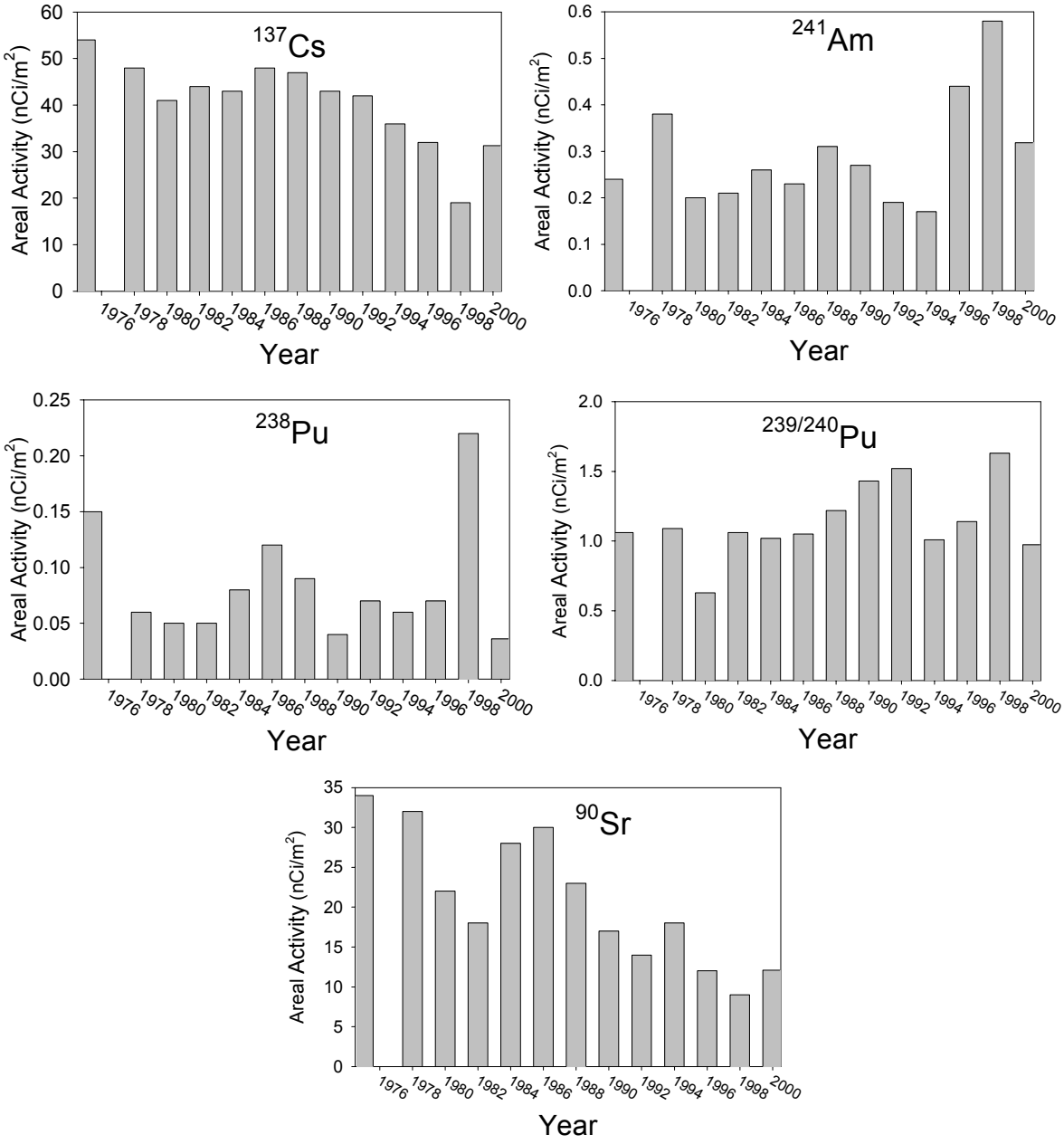


Figure 3-4. Geometric mean areal activity in offsite surface (0 to 5 cm [0 to 2 in.]) soils (1975–2000).[a]

a. The first bar of each graph is for the year 1975. No samples were collected in 1976 or 1977 (thus the gap). Samples have been collected every two years beginning in 1978.

Table 3-11. Environmental exposures (1997–2000).[a]

	Annual Exposure (mR)							
	1997		1998		1999		2000	
Distant Group	**ESER**	**M&O**	**ESER**	**M&O**	**ESER**	**M&O**	**ESER**	**M&O**
Aberdeen	137 ± 8	134 ± 4	128 ± 8	157 ± 18	130 ± 9	124 ± 7	152 ± 21	137 ± 19
Blackfoot	129 ± 6	116 ± 4	130 ± 6	134 ± 7	111 ± 4	111 ± 6	145 ± 20	136 ± 18
Blackfoot CMS	122 ± 5	NS[b]	113 ± 4	NS	113 ± 14	NS	134 ± 13	NS
Craters of the Moon	122 ± 7	119 ± 6	122 ± 6	121 ± 8	115 ± 12	120 ± 13	137 ± 19	136 ± 18
Idaho Falls	132 ± 7	119 ± 7	124 ± 6	115 ± 6	124 ± 13	108 ± 10	147 ± 20	127 ± 17
Minidoka	110 ± 5	113 ± 8	116 ± 7	113 ± 6	112 ± 7	113 ± 12	131 ± 18	122 ± 17
Rexburg CMS	144 ± 8	120 ± 5	144 ± 7	116 ± 4	129 ± 5	110 ± 11	155 ± 22	131 ± 18
Roberts	140 ± 11	140 ± 7	130 ± 6	137 ± 8	131 ± 9	129 ± 10	157 ± 22	144 ± 21
Mean	130 ± 8	123 ± 9	126 ± 6	128 ± 11	121 ± 9	116 ± 10	145 ± 20	133 ± 18
Boundary Group								
Arco	125 ± 9	125 ± 9	128 ± 7	117 ± 6	128 ± 12	124 ± 7	143 ± 20	134 ± 18
Atomic City	134 ± 10	137 ± 11	132 ± 6	124 ± 5	124 ± 8	133 ± 6	147 ± 20	137 ± 18
Howe	125 ± 6	122 ± 9	125 ± 5	116 ± 7	118 ± 6	116 ± 10	133 ± 18	130 ± 18
Monteview	127 ± 8	108 ± 4	124 ± 4	113 ± 8	114 ± 6	108 ± 14	134 ± 19	120 ± 16
Mud Lake	127 ± 9	125 ± 9	137 ± 7	130 ± 4	129 ± 9	128 ± 13	151 ± 21	140 ± 20
Reno Ranch/ Birch Creek	126 ± 8	111 ± 8	117 ± 6	105 ± 6	113 ± 10	113 ± 18	114 ± 16	107 ± 15
Mean	127 ± 3	121 ± 11	127 ± 5	118 ± 6	121 ± 9	120 ± 11	137 ± 19	128 ± 18

a. Values shown are annual exposure ± 2 standard deviations.

b. NS = No sample collected.

dosimeters and 133 ± 18 mR, as measured by the M&O contractor's dosimeters. For boundary locations, the mean annual exposures were 137 ± 19 mR as measured by ESER contractor dosimeters and 128 ± 18 mR as measured by M&O contractor dosimeters. Using both ESER and M&O data, the average exposure of the distant group was equivalent to 143 ± 20 mrem, when a dose equivalent conversion factor of 1.03 was used to convert from milliroentgen to millirem in tissue [Reference 3-4]. The average exposure for the boundary group was 137 ± 19 mrem.

The terrestrial portion of natural background radiation exposure is based on concentrations of naturally occurring radionuclides found in soil samples collected in 1976. Data indicated the average concentrations of Uraniuim-238 (^{238}U), Thorium-232 (^{232}Th), and Potassium-40 (^{40}K) were 1.5, 1.3, and 19 pCi/g, respectively. Calculated average 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 2000, this resulted in a 3 mrem/yr reduction to 73 mrem/yr due to the shielding effect of snow cover (Table 3-12). Snow cover ranged from 2.54 to 12.7 cm (1 to 5 in) in depth with an average of 2.97 cm (1.2 in) over 67 days with recorded snow cover.

Table 3-12. Estimated natural background effective dose equivalent in millirem for a person residing on the Snake River Plain (2000).

Source of Radiation Dose Equivalent		Total Average Annual (mrem) Estimated	Measured at Distant Locations
External			
	Terrestrial	73	N/A[a]
	Cosmic	48	N/A
	Subtotal	**121**	**107 - 157**
Internal			
	Cosmogenic	1	
	Inhaled Radionuclides	200	
	Potassium-40 and others	39	
	Subtotal	**240**	
Total		**361**	

a. N/A = terrestrial and cosmic radiation parameters were not measured individually.

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 1,500 meters (m) (4,900 feet [ft]) [Reference 3-5]. Cosmic radiation varies due to 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 2000 was 121 mrem. This is within the range of values measured at distant locations by thermoluminescent dosimeters (TLDs), after conversion from milliroentgen to millirem tissue.

The component of background dose that varies the most is inhaled radionuclides. According to the National Council on Radiation Protection and Measurements, the major radionuclides contributing to this component are short-lived decay products of radon. 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 U.S. average of 200 mrem has been used in Table 3-12 for this component of the total background dose because no specific estimate for southeastern Idaho has been made, and few specific measurements of radon in homes have been made 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 361 mrem shown in Table 3-12 and may vary from one location to another.

Onsite TLDs representing the same exposure period as the offsite dosimeters are shown in Figures 3-5 through 3-14. 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 were located in the vicinity of radioactive materials storage areas. At some facilities, slightly elevated exposures resulted from areas of soil contamination around the perimeter of these facilities.

Location	Annual Exposure ± 2 Standard Deviations (mR)
ANL 7	160 ± 22
ANL 8	137 ± 19
ANL 9	165 ± 23
ANL 10	149 ± 21
ANL 11	151 ± 21
ANL 12	143 ± 20
ANL 13	150 ± 21
ANL 14	146 ± 20
ANL 15	187 ± 25
ANL 16	178 ± 25
ANL 17	140 ± 19
ANL 18	146 ± 21

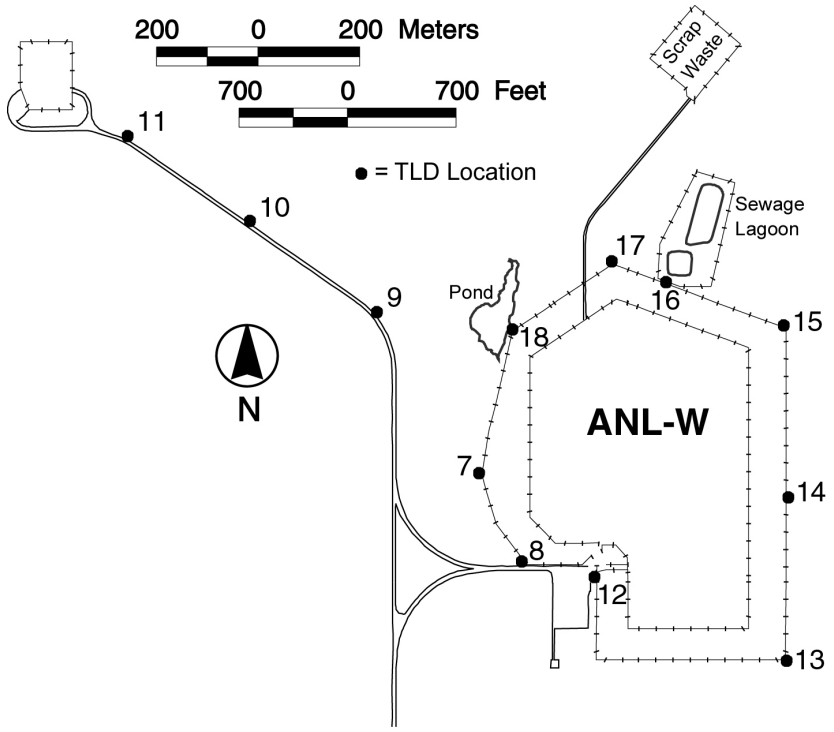
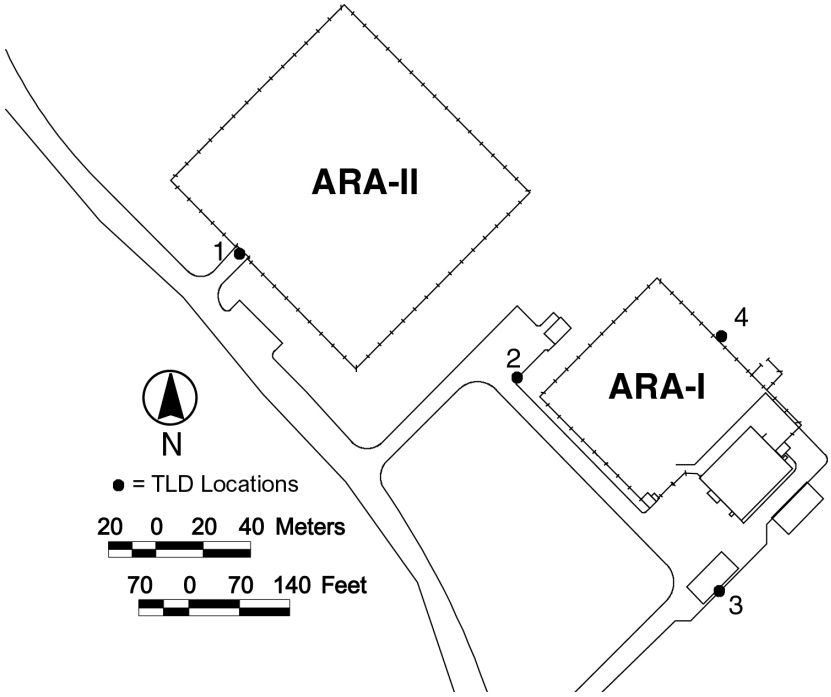


Figure 3-5. Environmental dosimeter locations and values at ANL-W (2000).



Location	Annual Exposure ± 2 Standard Deviations (mR)
ARA 1	176 ± 25
ARA 2	195 ± 27
ARA 3	100 ± 20[a]
ARA 4	235 ± 34

a. Exposure for first half of 2000 only. TLD damaged during second half of 2000.

Figure 3-6. Environmental dosimeter locations and values at the Auxiliary Reactor Area (ARA) (2000).

Location	Annual Exposure ± 2 Standard Deviations (mR)
CFA 1	151 ± 21
CFA 2	131 ± 18
CFA 3	160 ± 22
CFA 4	151 ± 21

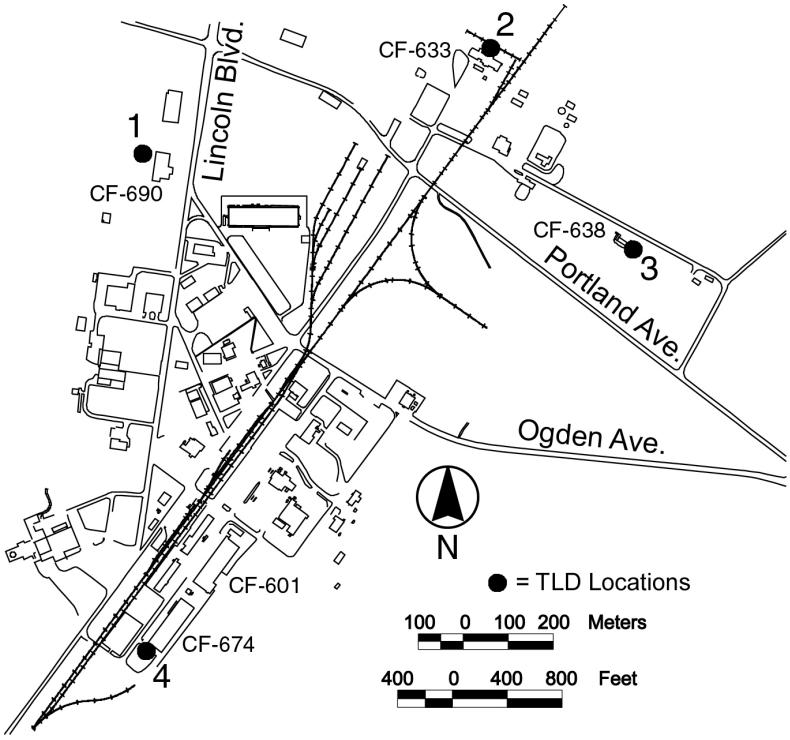


Figure 3-7. Environmental dosimeter locations and values at CFA (2000).

Location	Annual Exposure ± 2 Standard Deviations (mR)
INTEC 1	176 ± 24
INTEC 9	211 ± 29
INTEC 14	163 ± 22
INTEC 15	166 ± 23
INTEC 16	152 ± 21
INTEC 17	152 ± 21
INTEC 18	153 ± 21
INTEC 19	161 ± 23
INTEC 20	268 ± 37
INTEC 21	188 ± 26
INTEC 22	217 ± 30
INTEC 23	157 ± 21
INTEC 24	141 ± 20
INTEC 25	135 ± 19
INTEC 26	144 ± 20
TREE FARM 1	205 ± 29
TREE FARM 2	182 ± 25
TREE FARM 3	194 ± 28
TREE FARM 4	224 ± 31

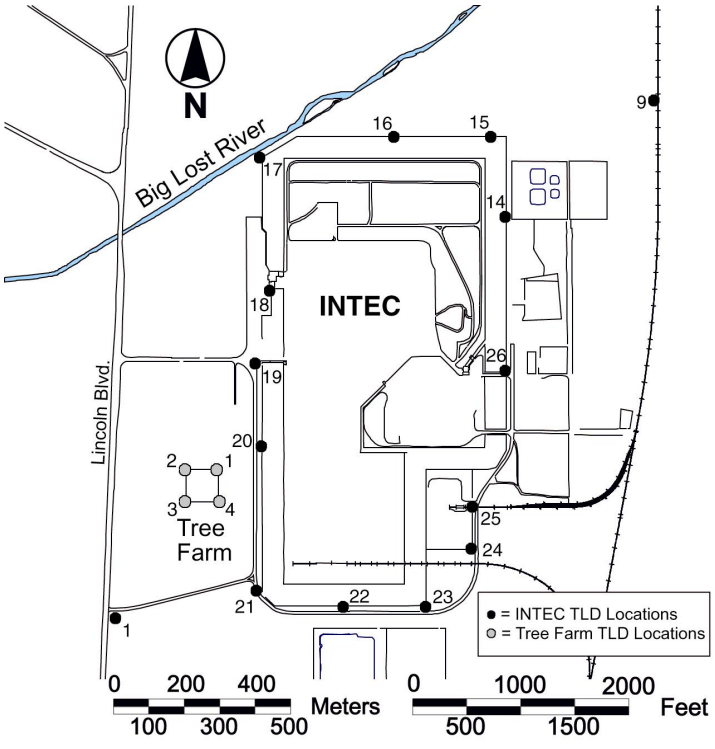


Figure 3-8. Environmental dosimeter locations and values at INTEC (2000).

Location	Annual Exposure ± 2 Standard Deviations (mR)
NRF 4	151 ± 21
NRF 5	169 ± 23
NRF 11	153 ± 22
NRF 12	155 ± 21
NRF 13	152 ± 21
NRF 16	148 ± 21
NRF 17	153 ± 21
NRF 18	156 ± 22
NRF 19	148 ± 21
NRF 20	157 ± 22
NRF 21	147 ± 21

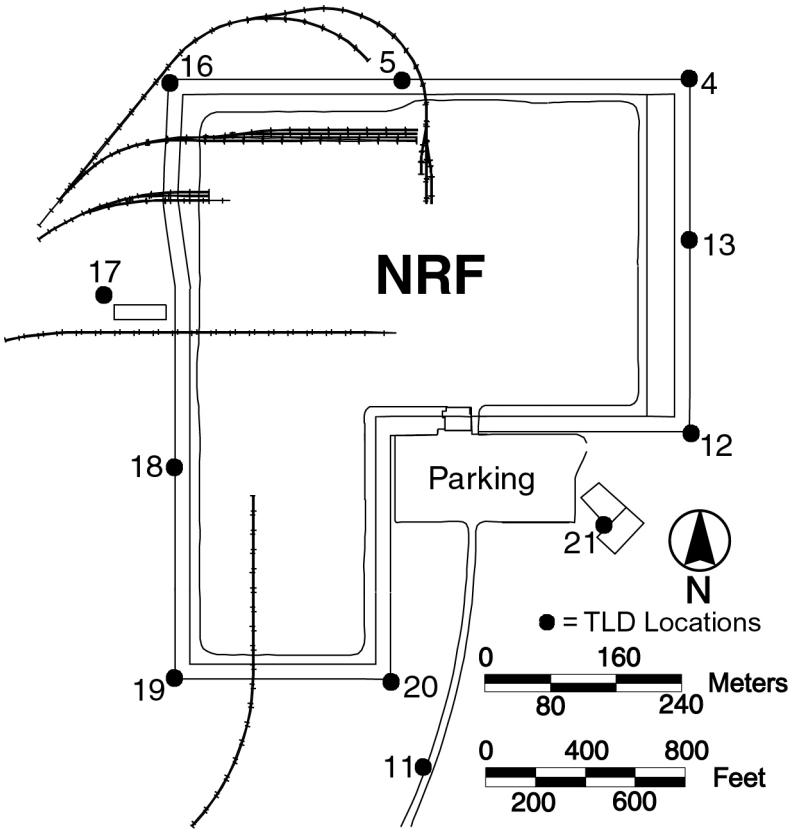


Figure 3-9. Environmental dosimeter locations and values at NRF (2000).

Location	Annual Exposure ± 2 Standard Deviations (mR)
PBF/SPERT 1	140 ± 19
PBF/SPERT 2	142 ± 20
PBF/SPERT 3	148 ± 21
PBF/SPERT 4	159 ± 22
PBF/SPERT 5	151 ± 21
PBF/SPERT 6	160 ± 22
PBF/WERF 1	145 ± 20
PBF/WERF 2	125 ± 17
PBF/WERF 3	142 ± 20
PBF/WERF 4	150 ± 21
PBF/WERF 5	143 ± 20
PBF/WERF 6	138 ± 19
PBF/WERF 7	146 ± 21

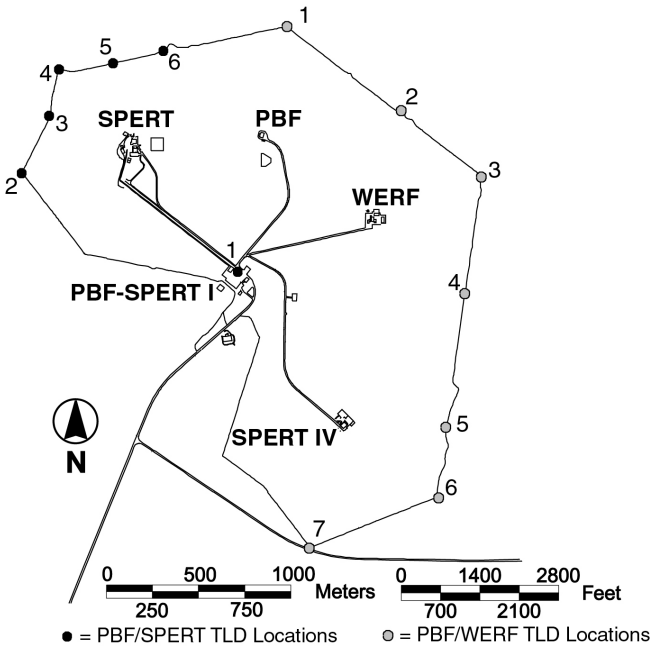


Figure 3-10. Environmental dosimeter locations and values at the Power Burst Facility (PBF) (2000).

Location	Annual Exposure ± 2 Standard Deviations (mR)
RWMC 3a	142 ± 20
RWMC 5a	139 ± 20
RWMC 7a	147 ± 21
RWMC 9a	148 ± 21
RWMC 11a	153 ± 21
RWMC 13a	75 ± 15[a]
RWMC15a	149 ± 21
RWMC 17a	146 ± 21
RWMC 19a	138 ± 19
RWMC 21a	148 ± 21
RWMC 23a	142 ± 20
RWMC 25a	154 ± 21
RWMC 27a	174 ± 24
RWMC 29a	195 ± 27
RWMC 31a	174 ± 24
RWMC 37a	151 ± 21
RWMC 39	168 ± 23
RWMC 40	185 ± 25
RWMC 41	486 ± 68
RWMC 42	159 ± 22
RWMC 43	143 ± 20
RWMC 45	154 ± 21
RWMC 46	169 ± 24
RWMC 47	69 ± 14[a]

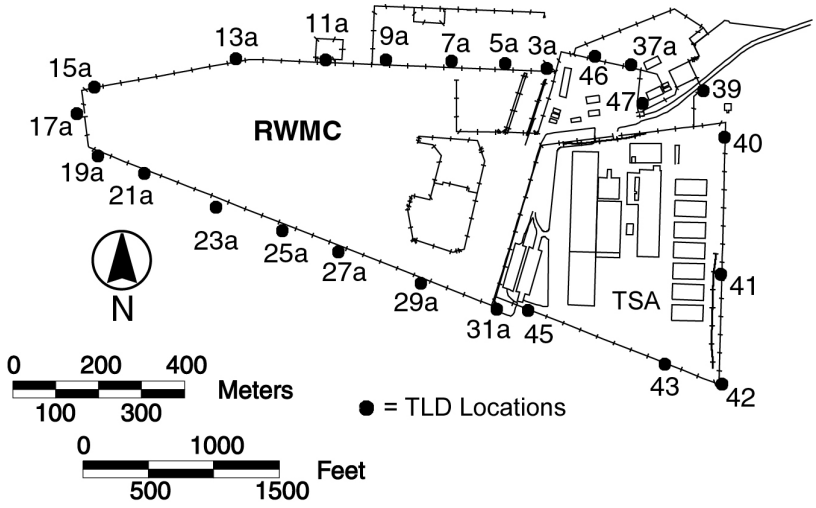


Figure 3-11. Environmental dosimeter locations and values at RWMC (2000).

a Exposure for first half of 2000 only. TLD missing for second half of 2000.

Location	Annual Exposure ± 2 Standard Deviations (mR)
TAN/TSF 1	128 ± 18
TAN/TSF 2	153 ± 21
TAN/TSF 3	115 ± 16
TAN/TSF 4	146 ± 21
TAN/LOFT 1	148 ± 21
TAN/LOFT 2	153 ± 22
TAN/LOFT 3	129 ± 18
TAN/LOFT 4	130 ± 18
TAN/LOFT 5	132 ± 18
TAN/LOFT 6	157 ± 21
TAN/LOFT 7	163 ± 23
TAN/WRRTF1	141 ± 19
TAN/WRRTF2	136 ± 19
TAN/WRRTF3	134 ± 18
TAN/WRRTF4	136 ± 19

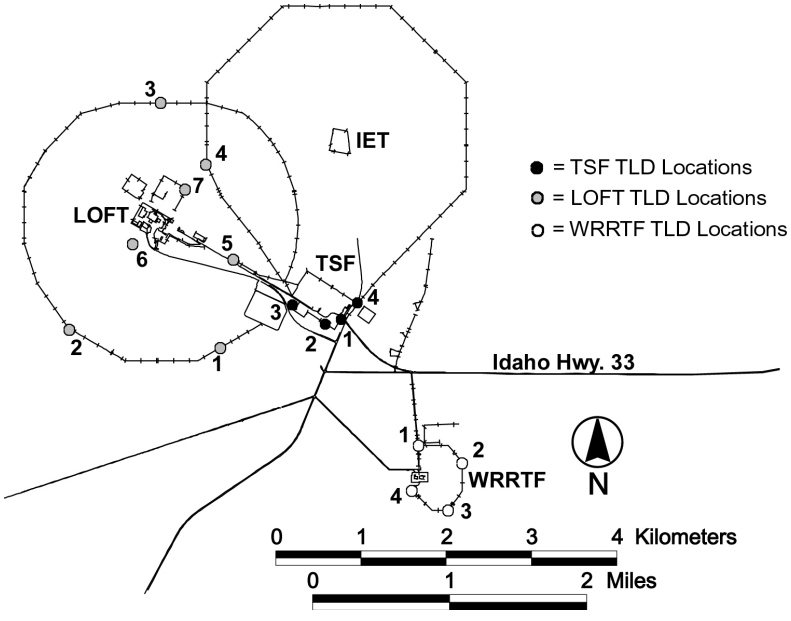


Figure 3-12. Environmental dosimeter locations and values at the Test Area North (TAN) (2000).

Location	Exposure ± 2 Standard Deviations (mR)
TRA 1	88 ± 17[a]
TRA 2	466 ± 68
TRA 3	692 ± 98
TRA 4	282 ± 39
TRA 5	202 ± 28
TRA 6	156 ± 22
TRA 7	181 ± 25
TRA 8	215 ± 30
TRA 9	174 ± 24
TRA10	184 ± 26
TRA11	185 ± 26
TRA12	168 ± 23
TRA13	178 ± 25

a. Exposure for first half of 2000 only. TLD destroyed by fire during second half of 2000.

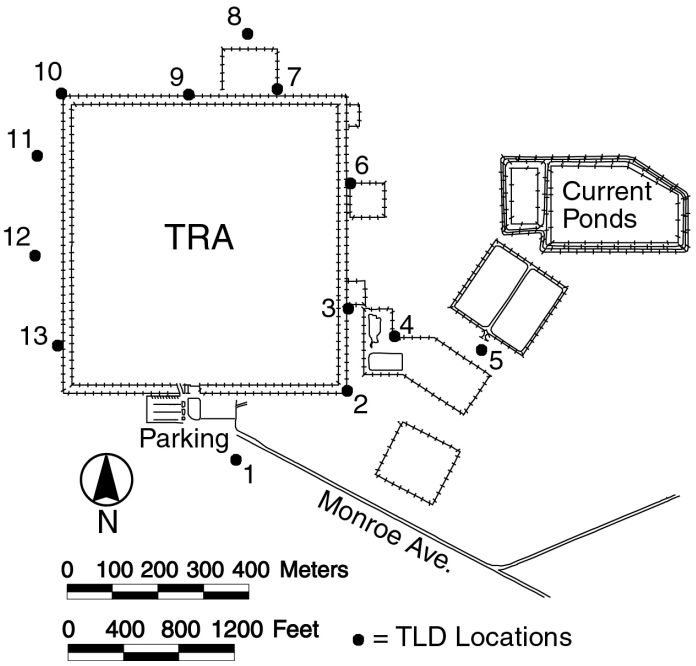
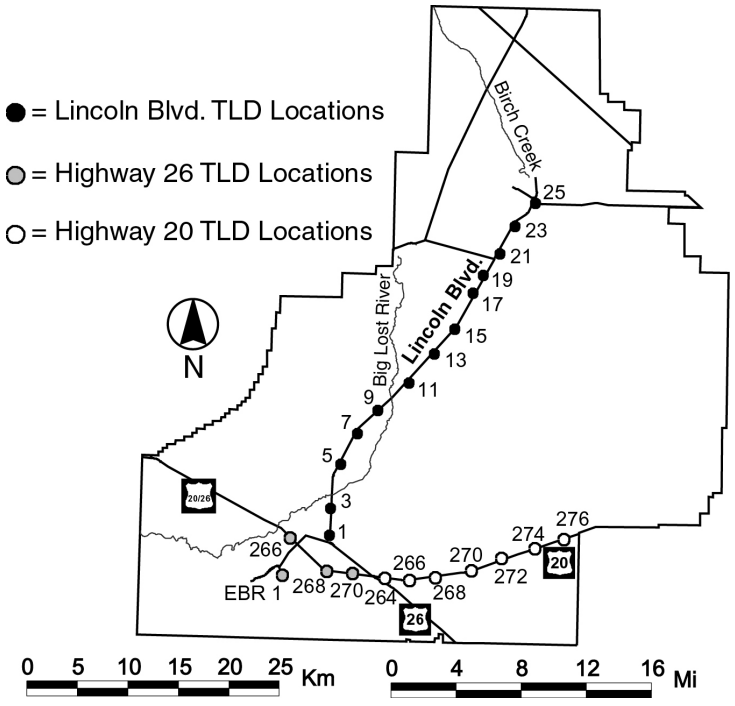


Figure 3-13. Environmental dosimeter locations and values at TRA (2000).

Location	Annual Exposure ± 2 Standard Deviations (mR)
LINCOLN BLVD 1	150 ± 21
LINCOLN BLVD 3	168 ± 23
LINCOLN BLVD 5	166 ± 23
LINCOLN BLVD 7	153 ± 21
LINCOLN BLVD 9	157 ± 22
LINCOLN BLVD 11	150 ± 21
LINCOLN BLVD 13	149 ± 21
LINCOLN BLVD 15	155 ± 21
LINCOLN BLVD 17	153 ± 21
LINCOLN BLVD 19	147 ± 20
LINCOLN BLVD 21	132 ± 18
LINCOLN BLVD 23	138 ± 19
LINCOLN BLVD 25	145 ± 20
HWY 26-266	151 ± 21
HWY 26-268	151 ± 21
HWY 26-270	153 ± 21
HWY 20-264	142 ± 20
HWY 20-266	131 ± 18
HWY 20-268	139 ± 19
HWY 20-270	140 ± 20
HWY 20-272	65 ± 13[a]
HWY 20-274	118 ± 17
HWY 20-276	141 ± 20
EBR-I	115 ± 17



a. Exposure for first half of 2000 only. TLD missing during second half of 2000.

Figure 3-14. Environmental dosimeter locations and values along Lincoln Blvd. and U.S. Highway 20 (2000).

Chapter 4

Nonradiological Environmental Monitoring Results

Environmental Surveillance, Education and Research Program

ESER

4. NONRADIOLOGICAL ENVIRONMENTAL MONITORING RESULTS

The following sections present results for nonradiological parameters sampled by both the Environmental Surveillance, Education and Research (ESER) contractor and the Management and Operating (M&O) contractor in 2000.

4.1 SUSPENDED PARTICULATES

In 2000, the U.S. Department of Energy (DOE) ESER contractor and the M&O contractor measured concentrations of suspended particulates using filters collected from 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 Section 4.2, 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.

The annual means of suspended particulate concentrations ranged from 5 µg/m^3 at the INEEL Main Gate to 48 µg/m^3 at the Test Reactor Area (TRA) (Table 4-1). Particulate concentrations are generally higher at distant and boundary locations than at the INEEL stations. This is mostly due to agricultural activities in offsite areas. During 2000, however, particulate concentrations increased at some INEEL locations due to dust storms following the range fire of July 27. Overall, concentrations are similar to those observed in the past 10 years (Figure 4-1).

4.2 FINE PARTICULATES

The U.S. Environmental Protection Agency (EPA) began using a standard for concentrations of airborne particulate matter in 1987. The standard refers only to "particles with an aerodynamic diameter less than or equal to a nominal 10 microns" (PM_{10}) [Reference 4-1]. Particles of this size can reach the lungs and are considered to be

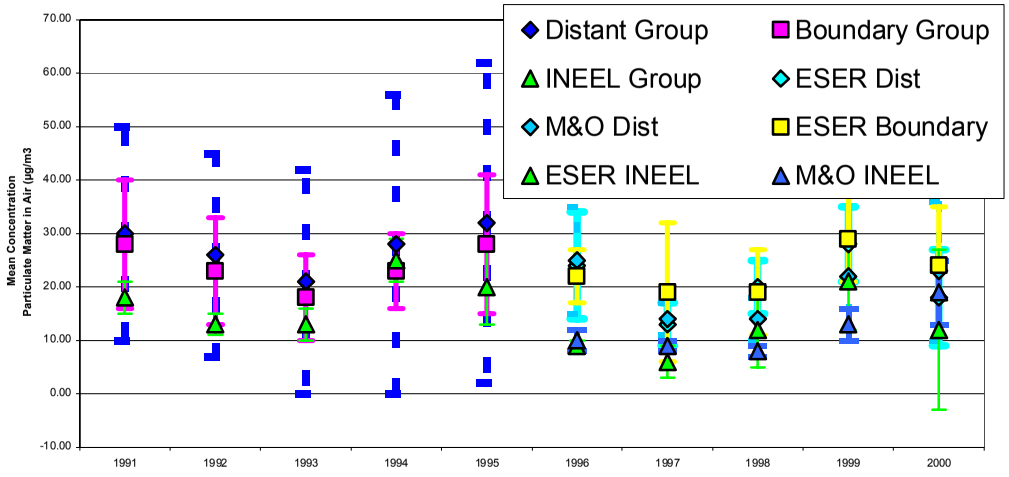


Figure 4-1. Ten-year summary of total particulate matter concentrations (1991–2000).

Table 4-1. Particulate concentrations in air (2000).

ESER Contractor Data

Group	Location	Concentration (µg/m^3) Range	Mean ± 95% C.I.[a]
Distant	Blackfoot	6 - 35	21 ± 19
	Craters of the Moon	3 - 17	9 ± 10
	Idaho Falls	-40 - 36	12 ± 56
	Blackfoot CMS	10 - 42	24 ± 21
	Rexburg CMS	23 - 28	26 ± 4
		Distant Mean	18 ± 9
Boundary	Arco	13 - 70	35 ± 40
	Atomic City	2 - 27	16 ± 17
	FAA Tower	3 - 27	14 ± 18
	Howe	5 - 31	18 ± 17
	Monteview	6 - 47	22 ± 28
	Mud Lake	9 - 133	45 ± 94
	Reno Ranch/Birch Creek	3 - 27	15 ± 18
		Boundary Mean	24 ± 11
INEEL	EFS	-9 - 38	13 ± 32
	Main Gate	-27 - 21	5 ± 35
	Van Buren	9 - 34	17 ± 19
		INEEL Mean	12 ± 15

M&O Contractor Data

Group	Location	Concentration (µg/m^3) Range	Mean ± 95% C.I.
Distant	Blackfoot	8 - 38	23 ± 20
	Craters of the Moon	7 - 20	12 ± 9
	Idaho Falls	14 - 37	26 ± 15
	Rexburg	28 - 35	32 ± 5
		Distant Mean	23 ± 13
INEEL	ANL-W	9 - 27	17 ± 12
	ARA	6 - 22	11 ± 12
	CFA	5 - 18	10 ± 9
	EBR-I	6 - 37	17 ± 22
	EFS	10 - 53	24 ± 32
	INTEC	6 - 39	17 ± 23
	NRF	9 - 48	22 ± 28
	PBF	9 - 24	15 ± 11
	Rest Area[b]	38 - 222	----
	RWMC	6 - 29	14 ± 17
	TAN	6 - 33	16 ± 19
	TRA	7 - 125	48 ± 87
	Van Buren	11 - 37	19 ± 19
		INEEL Mean	19 ± 6

a. Confidence interval.
b. Location operated from late August through December. Not included in annual mean for INEEL.

responsible for most of the adverse health effects associated with airborne particulate pollution. The air quality standards for PM_{10} particulates are an annual average of 50 µg/m^3, with a maximum 24-hour concentration of 150 µg/m^3. The ESER contractor collected 58 samples at the Rexburg Community Monitoring Station (CMS) from January through December 2000. Concentrations of fine particulates ranged from 0 µg/m^3 to 117 µg/m^3, with a mean of 20 ± 5 µg/m^3 (± 95 percent confidence interval of the mean). At the Blackfoot CMS, 59 samples were collected from January through December. Concentrations ranged from 4 µg/m^3 to 164 µg/m^3. The mean concentration at this location was 22 ± 6 µg/m^3. At Atomic City, 58 samples were collected from January through December. Concentrations ranged from 3 to 114 µg/m^3, with a mean of 23 ± 7 µg/m^3.

4.3 NITROGEN DIOXIDE

The M&O contractor monitored nitrogen dioxide on a continuous basis throughout 2000 at Van Buren Boulevard and the Experimental Field Station (EFS) (Figure 4-2). At Van Buren Boulevard, quarterly mean concentrations ranged from 1.5 µg/m^3 to 3.0 µg/m^3 (1.6 ppb to 3.2 ppb) with an annual mean of 2.2 µg/m^3 (2.3 ppb).

This annual concentration is about 2 percent of the EPA air quality standard of 100 µg/m^3 (106 ppb) for nitrogen dioxide. The maximum 24-hour concentration measured was 11.7 µg/m^3 (12.4 ppb) on July 27, the date of a large range fire at the INEEL. Data were successfully obtained at the Van Buren Boulevard station for 93 percent of the hours in 2000.

Quarterly means at EFS ranged from 2.6 µg/m^3 (2.8 ppb) during the first quarter to 12.5 µg/m^3 (13.3 ppb) during the fourth quarter. For the year, the mean concentration was 7.7 µg/m^3 (8.2 ppb), or about 8 percent of the EPA standard. The maximum 24-hour average concentration occurred on the date of the range fire,

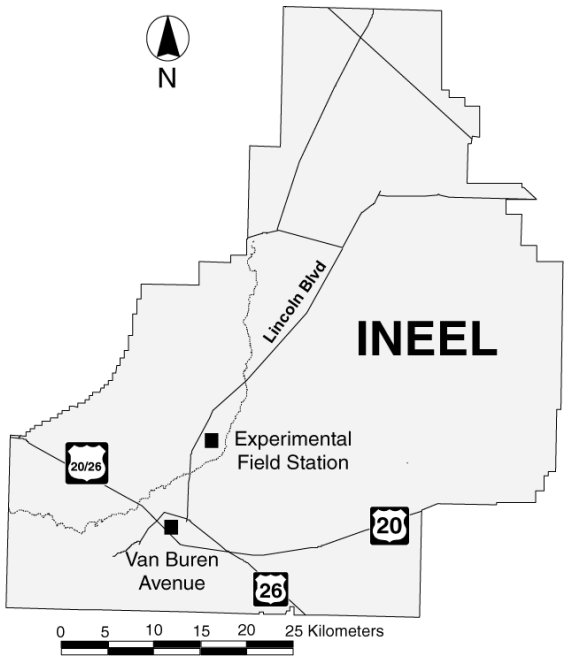


Figure 4-2. Nitrogen dioxide and sulfur dioxide monitoring locations.

July 27, when a value of 16.6 µg/m^3 (17.7 ppb) was recorded. Data were obtained at the EFS location for 92 percent of the hours during 2000. A graph of nitrogen dioxide concentrations observed at the two sampling locations is shown in Figure 4–3.

When operating, the New Waste Calcining Facility at the Idaho Nuclear Technology and Engineering Center (INTEC) was the largest single source of nitrogen dioxide at the INEEL. The EFS sampler was located approximately 5 km (3 mi) in the prevailing wind direction from INTEC. All quarterly concentrations have remained below half of the annual standard throughout the time period of monitoring. Further information on airborne nitrogen dioxide effluents released during 2000 is provided in Chapter 6.

4.4 SULFUR DIOXIDE

Sulfur dioxide was measured at the Van Buren Boulevard monitoring location (Figure 4-2), and the analyzer operated satisfactorily for 93 percent of the year. For

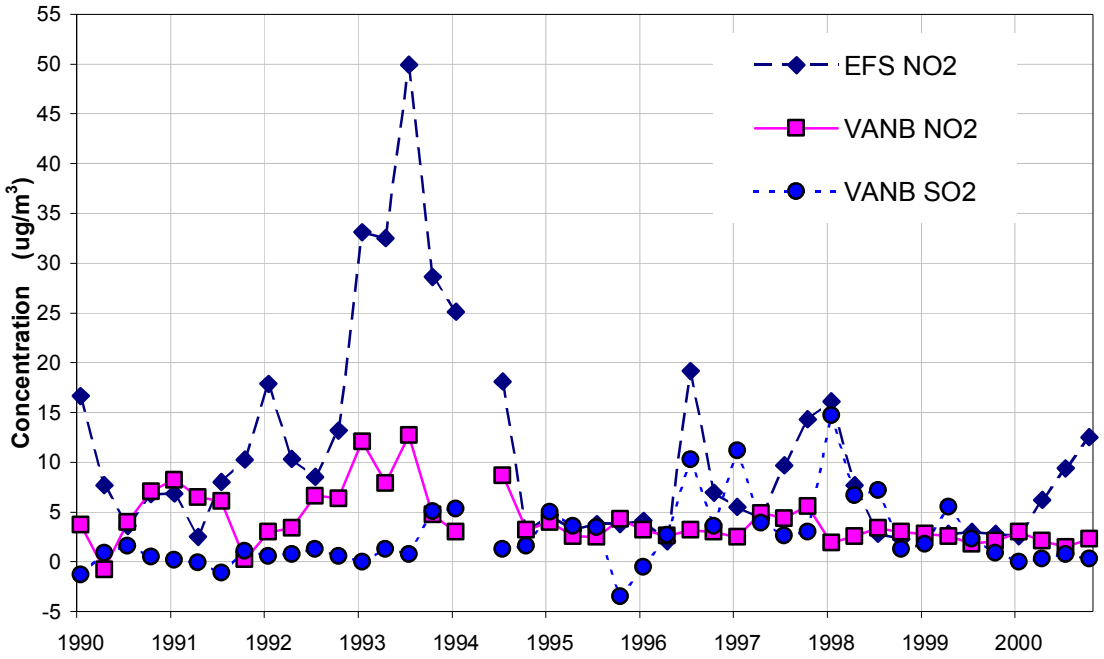


Figure 4-3. Quarterly mean nitrogen dioxide and sulfur dioxide concentrations at the INEEL (1990–2000).

sulfur dioxide, there are three separate EPA standards [Reference 4-3]. An annual primary air quality standard of 80 µg/m^3 (61 ppb), a second primary air quality standard for the maximum 24-hour concentration not to be exceeded more than once per year of 365 µg/m^3 (279 ppb), and a secondary ambient air quality standard for the maximum 3-hour concentration that cannot exceed 1,300 µg/m^3 (994 ppb) more than once per year. The mean sulfur dioxide concentration for 2000 was 0.3 µg/m^3 (0.2 ppb)–well below the standard of 80 µg/m^3 (61 ppb). In 2000, the maximum recorded 24-hour sulfur dioxide concentration at Van Buren Boulevard was 4.0 µg/m^3 (3.1 ppb)–much lower than the standard of 365 µg/m^3 (279 ppb).

The highest 3-hour concentration occurred during the range fire of July 27 at 22.1 µg/m^3 (16.9 ppb), which is approximately 1.7 percent of the secondary standard. Exclusive of this event, the maximum 3-hour value was 8.0 µg/m^3 (6.1 ppb), or 0.6 percent of the standard.

4.5 IMPROVE SAMPLERS

Interagency Monitoring of Protected Visual Environments (IMPROVE) samplers began continuous operation at Craters of the Moon National Monument and the Central Facilities Area (CFA) during the spring of 1992. The EPA removed the CFA sampler from the network in May 2000. The most recent data available are through February 2000 [Reference 4-4]. A summary of the data for the entire time period of sampling is presented in Table 4-2.

Both locations exhibit similar elemental concentrations. Several elements measured, including aluminum, silicon, calcium, titanium, and iron, are derived from soils and show a seasonal variation with lower values during the winter when the ground is often covered by snow. Potassium may be derived from soils, but is also a component of smoke.

Other elements are considered tracers of various industrial and urban activities. Lead

Table 4-2. Data for IMPROVE samplers at CFA and Craters of the Moon (May 1992–May 2000).

	% Detected[a]		Range (ng/m^3)[b]		Mean (ng/m^3)[b] ± 95% C.I.[c]	
Constituent	**CFA**	**Craters**	**CFA[d]**	**Craters[d]**	**CFA**	**Craters**
Hydrogen	100	100	24 – 1,256	19 – 1,339	165 ± 8	138 ± 7
Sodium	49	54	<dl – 214	<dl – 257	25 ± 3	27 ± 2
Magnesium	25	20	<dl – 399	<dl –145	9 ± 2	5.6 ± 1.0
Aluminum	69	69	<dl – 1,146	<dl – 965	51 ± 6	45 ± 5
Silicon	99	99	<dl – 2,869	<dl – 2,115	153 ± 16	124 ± 10
Phosphorus	11	8	<dl – 120	<dl – 103	2.6 ± 0.7	1.5 ± 0.5
Sulfur	100	100	23 – 1,509	16 – 678	187 ± 9	155 ± 7
Chlorine	4	6	<dl – 37	<dl – 57	0.35 ± 0.17	0.37 ± 0.19
Potassium	98	99	<dl – 468	<dl – 447	42 ± 4	34 ± 3
Calcium	99	98	<dl – 880	<dl – 396	52 ± 4	40 ± 3
Titanium	78	80	<dl – 75	<dl – 48	4.5 ± 0.4	4.2 ± 0.3
Vanadium	37	37	<dl – 7.0	<dl – 12	0.77 ± 0.09	0.78 ± 0.09
Chromium	30	31	<dl – 4.6	<dl – 5.4	0.47 ± 0.06	0.46 ± 0.06
Manganese	42	45	<dl – 15	<dl – 11	0.95 ± 0.11	0.89 ± 0.09
Iron	100	100	0.5 – 706	0.6 – 410	34 ± 4	30 ± 2
Nickel	12	12	<dl - 0.4	<dl – 1.1	0.016 ± 0.004	0.020 ± 0.004
Copper	76	70	<dl – 107	<dl – 6.4	0.5 ± 0.3	0.31 ± 0.03
Zinc	98	99	<dl – 70	<dl – 20	1.8 ± 0.2	1.68 ± 0.09
Arsenic	45	46	<dl – 1.7	<dl – 6.0	0.12 ± 0.01	0.14 ± 0.02
Lead	90	89	<dl – 7.5	<dl – 4.4	0.67 ± 0.04	0.61 ± 0.04
Selenium	77	61	<dl – 2.3	<dl – 1.3	0.21 ± 0.02	0.12 ± 0.01
Bromine	100	100	<dl – 8.8	<dl – 7.7	1.62 ± 0.08	1.47 ± 0.08
Rubidium	57	55	<dl – 1.4	<dl – 1.1	0.12 ± 0.01	0.11 ± 0.01
Strontium	74	71	<dl – 7.2	<dl – 12	0.27 ± 0.03	0.23 ± 0.03
Zirconium	14	13	<dl – 2.0	<dl – 1.7	0.05 ± 0.01	0.04 ± 0.01
Fine Mass ($PM_{2.5}$)	100	100	524 – 28,217	409 – 25,103	4,188 ± 202	3,443 ± 169

a. % Detected indicates percentage of samples analyzed that were greater than the detection limit.
b. ng = nanograms (1 ng = 10^{-9} g) .
c. Confidence interval.
d. <dl = at least one value was at or below the detection limit for that parameter.

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 10 times higher than at the two southeast Idaho sites. Selenium, in the range of 0.1 to 0.2 ng/m^3 at the CFA and Craters of the Moon stations, is a tracer of emissions from coal-fired plants (Table 4-2). At Mammoth Cave in Kentucky, annual selenium concentrations of 1.4 ng/m^3 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, $PM_{2.5}$ particulates have ranged from 409 ng/m^3 to 25 ng/m^3, 103 ng/m^3 with a mean of 3,443 ng/m^3 over the period of sampler operation.

Concentrations at CFA during the same time period varied from 524 to 28,217 ng/m^3, with a mean of 4,188 ng/m^3. In general, the highest levels of very fine particulates have been seen during the late summer and early fall, particularly in 1994, when smoke from western forest fires covered the Snake River Plain. Elevated very fine mass concentrations are also found occasionally during wintertime inversion conditions, most notably during January 1993 at CFA.

4.6 STORM WATER SAMPLING

Both analytical and visual monitoring is required under the EPA Final Modification of the National Pollutant Discharge Elimination System Storm Water Multi-Sector General Permit for Industrial Activities at the INEEL. However, storm water did not discharge to the Big Lost River system from monitoring locations. Therefore, during 2000, storm water monitoring consisted only of visual examinations.

More detailed information and data on storm water monitoring is included in the *2000 Environmental Monitoring Program Report* [Reference 4-5].

Chapter 5

Groundwater

Environmental Surveillance, Education and Research Program

ESER

5. GROUNDWATER

The following chapter presents both radiological and nonradiological sample analytical results from groundwater monitoring activities associated with the Idaho National Engineering and Environmental Laboratory (INEEL).

5.1 PROGRAM SUMMARIES

The Snake River Plain Aquifer (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 U.S. Geological Survey (USGS).

U.S. Geological Survey

The USGS has maintained a presence at the INEEL since 1949 and has operated a project office at the INEEL since 1958. The INEEL project office of the USGS is operated by the Water Resources Division of the USGS and performs groundwater monitoring, analyses, and studies of the SRPA under and adjacent to the INEEL. This office has been involved in the investigation of hydrologic conditions at the INEEL, and currently conducts an extensive monitoring program of the SRPA and perched water bodies above the aquifer. This is done through an extensive network of strategically placed observation wells both on the INEEL (Figures 5-1 and 5-2) and at locations throughout the Eastern Snake River Plain. The USGS routine groundwater surveillance program is summarized in Chapter 1. In 2000, monitoring program personnel collected 286 samples for radionuclides and inorganic constituents including trace elements and 86 samples for purgeable organic compounds.

In addition, the USGS through an interagency agreement performs groundwater monitoring activities for the Naval Reactors Facility (NRF). As part of the 2000 NRF sampling program, the USGS performed quarterly sampling from 9 NRF and 4 USGS wells, collecting a total of 60 samples. Samples were analyzed for radioactivity, inorganic constituents, and purgeable organic compounds.

Various USGS reports contain maps showing the location of water level measurements and water sample collection points. Recent information has also been published on the plume shape and extent of various constituents in the water of the SRPA and perched water beneath INEEL facilities. The most recent report presents information between 1996 and 1998 [Reference 5-1].

The USGS also conducts special studies of the groundwater resources of the Eastern Snake River Plain. A summary of the studies published in 2000 is provided in Appendix C. These special studies provide more specific geological, chemical, and hydrological information on the characteristics of the SRPA 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 Hagerman area, referred to 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 SRPA to the Snake River in the Twin Falls-Hagerman area. Current results of this study are summarized in References C-2 and C-7.

The USGS INEEL Project Office can assist in obtaining copies of the publications presented in Appendix C.

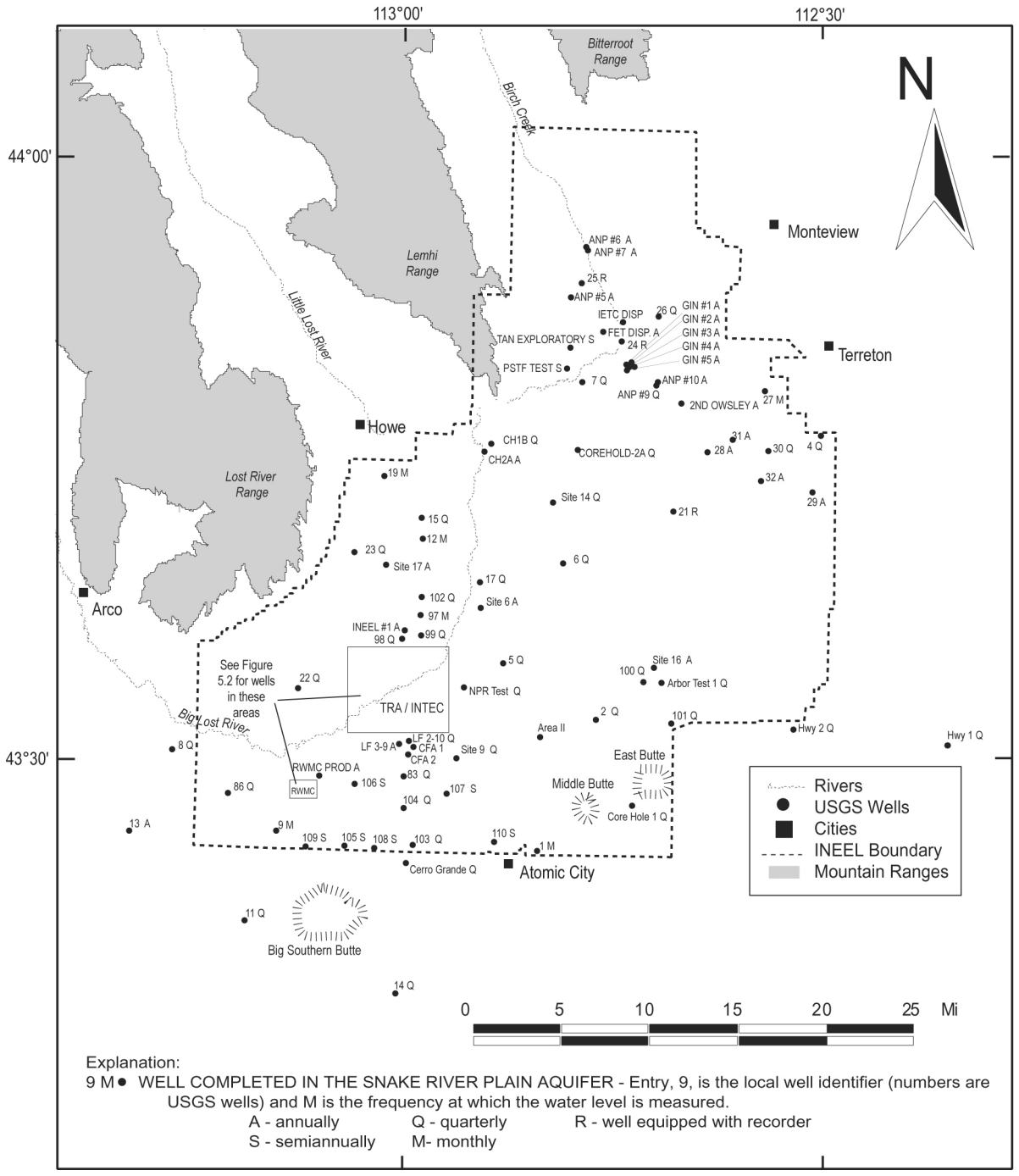


Figure 5-1. USGS well locations [Reference 5-1].

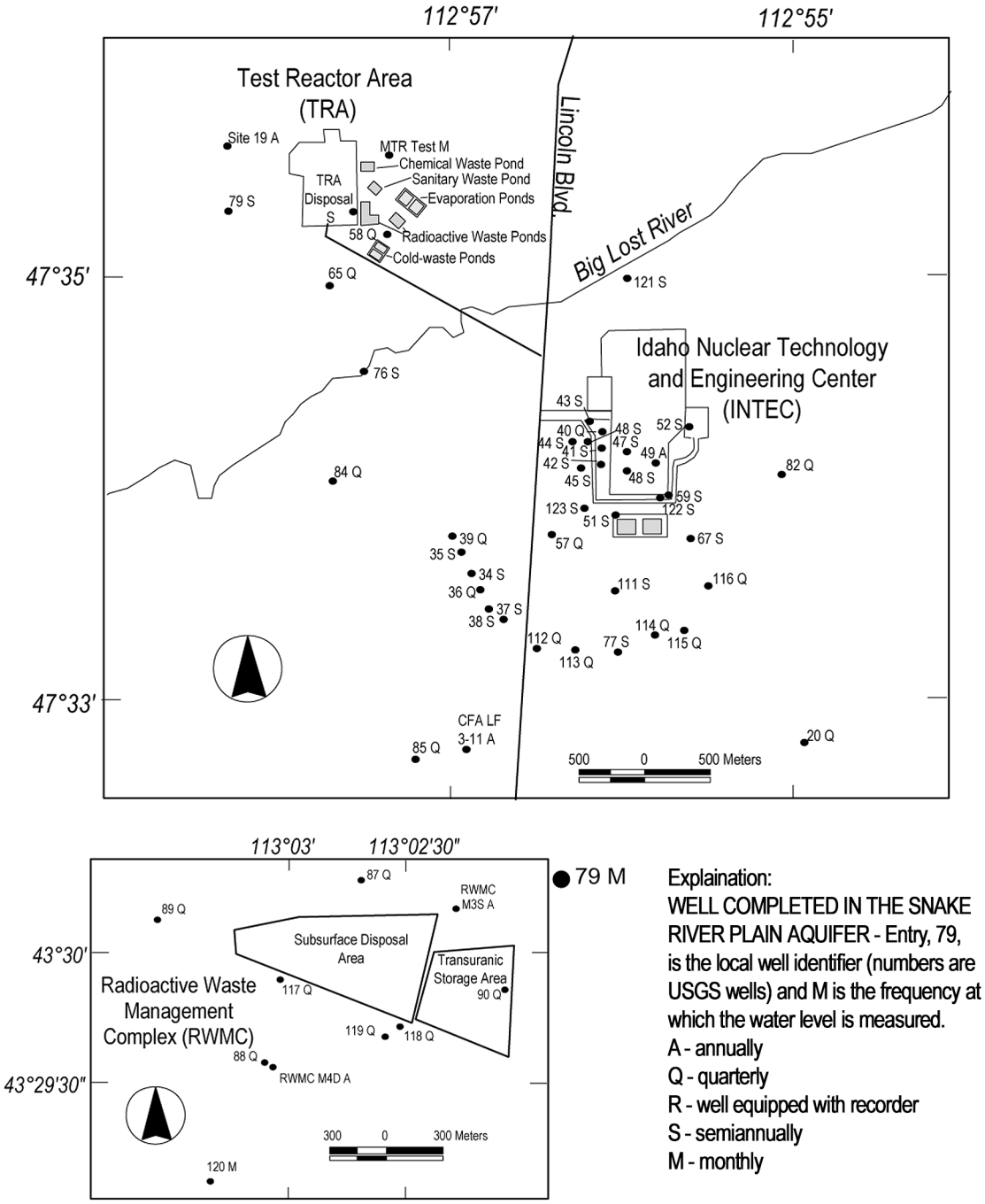


Figure 5-2. USGS well locations at the Idaho Nuclear Technology and Engineering Center, Test Reactor Area, and Radioactive Waste Management Complex [Reference 5-1].

Management and Operating Contractor

The Management and Operating (M&O) contractor conducts groundwater monitoring in support of Wastewater Land Application Permit requirements and the Environmental Restoration Program, as well as general surveillance monitoring. More detailed information and data are available in the 2000 *Environmental Monitoring Program Report* [Reference 5-2].

5.2 NONRADIOLOGICAL MONITORING

U.S. Geological Survey

Sampling for purgeable (volatile) organic compounds in groundwater was conducted by the USGS at the INEEL during 2000. Water samples from 1 onsite production well and 11 groundwater monitoring wells were collected and submitted to the USGS National Water Quality Laboratory in Denver, 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 [Reference 5-3]. Concentrations of five purgeable organic compounds above the laboratory reporting level of 0.2 µg/L were detected in at least one well. These contaminants and their respective concentrations are shown in Table 5-1.

The Radioactive Waste Management Complex (RWMC) production well contained detectable concentrations of five of these purgeable organic compounds. Annual average concentrations of these compounds in this well were slightly below those observed in 1999. Carbon tetrachloride concentrations remained at levels slightly above the U.S. Environmental Protection Agency's (EPA's) Maximum Contaminant Level (MCL) of 5 µg/L at the end of 2000 (Table 5-1). Well 92 contained detectable levels of an additional eight purgeable organic compounds. This well also contained measurable levels of 1,1,1-trichloroethane; 1,1,2-trichloroethane; 1,1-Dichloroethane; 1,2-Dichloroethane; Benzene; Freon-113; 1,2-Dichloropropane; and cis-1,2-Dichloroethene. Well Highway 3 had only a single detection of 0.15 µg/L for Dichlorobenzene.

Management and Operating Contractor

The M&O contractor Environmental Monitoring Unit regularly samples drinking water from wells and distribution systems at INEEL facilities for volatile organic compounds. In 1987, concentrations of trichloroethylene in samples collected from TSF #1 Well at the Test Area North (TAN) Technical Support Facility (TSF) exceeded the EPA MCL of 5 µg/L. As a result the production wells and distribution systems at this facility are sampled more frequently.

In 1988, an aerating device (air sparger system) was installed in the storage tank between the TSF #1 Well and the point of entry to the TSF distribution system to remove trichloroethylene from TSF drinking water. In the third quarter of 1997, TSF #1 Well was placed in standby and TSF #2 Well was brought online as the primary production well. Trichloroethylene concentrations in TSF #2 Well have not exceeded the MCLs. As a result, the air sparger in the storage tank is no longer operated unless TSF #1 Well is being used. The concentration of trichloroethylene in water collected from both TSF #1 Well and TSF #2 Well remained below the MCL in the two samples collected in 2001 (Table 5-2).

Chlorinated drinking water systems are also monitored for total trihalomethanes (bromodichloromethane, bromoform, chloroform, and dibromochloromethane). The concentration of trihalomethanes in each of the tested distribution systems in 2000 remained significantly below the MCL. The highest concentration of total trihalomethanes in water came from the Idaho Nuclear Technology and Engineering Center (INTEC) distribution system in June with a level of 26 µg/L, or 26 percent of the EPA MCL of 100 µg/L. All other measurements were less than 10 µg/L.

Table 5-1. Purgeable organic compounds in USGS well samples (2000).[a]

Well ID	Date	Carbon Tetra-chloride	Chloroform	Tetrachloro-ethylene	Trichloroethylene	1,1,1-Trichloro-ethane
34 (SW of INTEC)	10/17	ND[b]	ND	ND	ND	0.15
38 (SW of INTEC)	10/11	ND	ND	ND	ND	0.15
65 (S of TRA)	04/06	ND	ND	ND	ND	0.30
	10/03	ND	ND	ND	ND	0.28
84 (S of TRA)	04/04	ND	ND	ND	ND	0.14
	10/26	ND	ND	ND	ND	0.11
87 (N of RWMC)	01/13	2.28	0.15	ND	0.59	0.20
	04/17	3.07	0.16	0.12	0.68	0.24
	07/13	2.70	0.13	ND	0.61	0.21
	10/12	3.04	0.20	0.11	0.66	0.22
88 (S of RWMC)	01/20	1.54	0.50	ND	0.72	0.72
	04/10	1.78	0.52	ND	0.71	0.18
	07/12	1.65	0.56	ND	0.80	0.23
	10/02	1.50	0.46	ND	0.56	0.15
92 (S of RWMC)	04/17	290.6	324.8	43.03	279.7	47.16
119 (S of RWMC)	04/06	0.26	ND	ND	ND	ND
	10/11	0.22	ND	ND	ND	ND
120 (SW of RWMC)	01/13	4.49	1.01	0.18	1.90	0.47
	04/17	5.31	1.00	0.20	1.94	0.52
	07/13	4.66	0.83	0.15	1.60	0.43
	10/12	5.43	1.01	0.17	1.84	0.49
NRF 6 (NW of NRF)	08/10	ND	0.1	ND	ND	ND
RWMC PROD	01/13	4.96	0.90	0.26	2.47	0.57
	02/16	4.04	0.80	0.22	2.15	0.49
	03/15	7.18	1.19	0.30	3.27	0.73
	04/17	5.59	0.89	0.30	2.69	0.67
	05/15	5.11	0.85	0.26	2.54	0.56
	06/22	5.43	0.93	0.27	2.58	0.58
	07/13	4.91	0.85	0.22	2.34	0.53
	08/15	3.30	0.46	0.18	1.45	0.35
	09/13	3.42	0.70	0.17	1.57	0.36
	10/18	4.24	0.67	0.21	1.97	0.45
	11/15	4.25	0.78	0.22	2.06	0.44
	12/14	5.48	0.88	0.24	2.45	0.50
MCL		5.00	NE[c]	5.00	5.00	200.00

a. All values are in micrograms per liter.

b. ND = not detected. The concentration is less than the reporting limit for the analysis.

c. NE = Not established. The EPA has not established an MCL for this constituent.

Table 5-2. Purgeable organic compounds in INEEL drinking water (2000).[a]

Well	Feb[b]	Mar	Apr	Jun	Jul	Aug	Sep	Oct	Nov
			1,1,1-Trichloroethane					(MCL = 200 µg/L)	
RWMC Dist.	0.3	--[c]	--	0.25J[d]	--	--	--	0.3	--
RWMC Well	0.5	--	--	0.41J	--	--	--	0.5	--
			Carbon tetrachloride					(MCL = 5 µg/L)	
RWMC Well	4.4	--	--	3.8	--	--	--	4.8	--
RWMC Dist.	2.2	--	--	1.9	--	--	--	2.9	--
			Tetrachloroethylene					(MCL = 5 µg/L)	
RWMC Well	0.2	--	--	--	--	--	--	--	--
TSF #1 Well	--	--	--	0.91	--	--	--	1.2	--
TSF Dist.	0.2	--	--	0.31J	--	--	--	0.3	--
			Total Trihalomethanes					(MCL = 100 µg/L)	
CFA Dist.	8.8	--	--	4	--	--	--	3.9	--
INTEC Dist.	0.7	--	--	26	--	--	--	9.7	--
CTF Dist.	3.8	--	--	2.1	--	--	--	2.5	--
Gun Range Dist.	0.3	--	--		--	--	--	1.9	--
PBF Dist.	3.4	--	--	6.1	--	--	--	4.7	--
TRA Dist.	1.6	--	--		--	--	--	0.4	--
TSF Dist.	1.4	--	--	2.1	--	--	--	1.1	--
			Trichloroethylene					(MCL = 5 µg/L)	
RWMC Dist.	1.2	--	--	1.3	--	--	--	1.3	--
RWMC Well	1.8	--	--	1.8	--	--	--	2	--
TSF #1 Well	--	--	--	2.9	--	--	--	4.4	--
TSF Dist.	0.6	--	--	1	--	--	--	1.3	--
			p-Dichlorobenzene					(no MCL established)	
RWMC Dist.	1.1	--	--	--	--	--	--	--	--

a. All units are in micrograms per liter.

b. Only those months when samples were collected are shown.

c. A double dash (--) denotes the system was not sampled during that month.

d. J value is an estimate. The value reported was above the instrument detection limit but below the minimum detectable concentration.

Table 5-3. Purgeable organic compounds in TSF distribution drinking water (2000).[a]

Constituent	Feb	Mar	Apr	Jun	Jul	Aug	Sep	Oct	Nov
1,2-Xylene	--[b]	--	--	0.56	--	--	--	--	--
Chlorodibromomethane	0.4	--	--	--	--	--	--	0.5	--
Ethylbenzene	0.2	--	--	0.5	--	--	--	--	--
m- + p-Xylene	--	--	--	1.2	--	--	--	--	--
Toluene	1.7	--	--	3.5	--	--	--	--	--
Xylenes (total)	1	--	--	--	--	--	--	1.2	--

a. All units are in micrograms per liter.

b. A double dash (--) denotes the system was not sampled during that month.

Table 5-4. Inorganic chemicals in INEEL potable production wells (2000).

Well	Date	Parameter	Concentration (mg/L)	MCL (mg/L)
CFA Dist.	08/29/2000	Nitrogen, as nitrate	3.70	10
INTEC Dist.	08/29/2000	Nitrogen, as nitrate	0.93	10
CTF Dist.	08/29/2000	Nitrogen, as nitrate	0.86	10
EBR-I Dist.	08/29/2000	Nitrogen, as nitrate	0.40	10
Gun Range Dist.	08/29/2000	Nitrogen, as nitrate	0.86	10
Main Gate Dist.	08/29/2000	Nitrogen, as nitrate	0.72	10
PBF Dist.	08/29/2000	Nitrogen, as nitrate	0.91	10
RWMC Dist.	08/29/2000	Nitrogen, as nitrate	0.83	10
TRA Dist.	08/29/2000	Nitrogen, as nitrate	1.00	10
TSF Dist.	08/29/2000	Nitrogen, as nitrate	0.92	10

Water from the production and established potable wells at each of the facilities was sampled and analyzed in 2000 for nitrate as nitrogen (Table 5-4). None of these measurements were above EPA MCLs or state of Idaho drinking water limits in 2000. More detailed information and data are included in the 2000 Environmental Monitoring Program Report [Reference 5-2].

Argonne National Laboratory-West

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. Only the common metals calcium, magnesium, and sodium were detected. Only chloride, nitrate, total dissolved solids and uranium have established MCLs. All samples were well below these levels. Other water quality parameters were within ranges of past values. During 2000, the only radionuclide detected was uranium-234. Table 5-5 gives the range of values for the detected metals and water quality parameters.

The drinking water system at ANL-W was sampled in 2000 in accordance with the Safe Drinking Water Act. This regulation provides maximum allowable concentrations for inorganics, gross alpha and gross beta radioactivity, uranium, and radium in drinking water. All parameters were well below applicable standards.

Naval Reactors Facility

Drinking water samples were collected prior to entering the distribution system and monitored for volatile organic compounds, inorganic constituents, and water quality parameters. These were drawn from a sampling port immediately downstream from the NRF water softening treatment system.

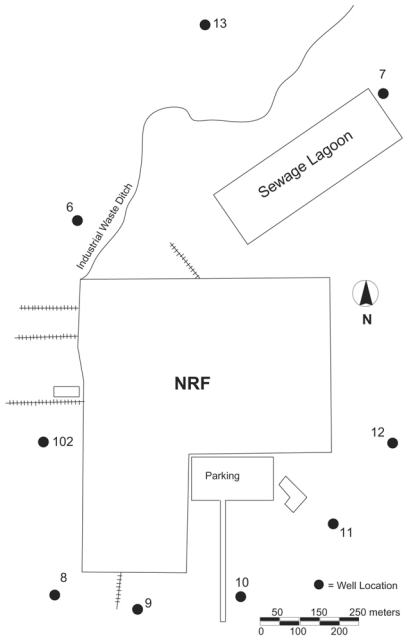


Figure 5-3. Monitoring wells around NRF.

Table 5-5. Metals and water quality parameters in ANL-W monitoring wells (2000).

Minimum Well	Maximum Well	Date	Parameter	Concentration[a]		
				Minimum	Maximum	MCL
M-11	M-12	06/26/00	Bicarbonate Alkalinity	118	154	NE[b]
M-14	M-12	06/26/00	Calcium	34.2	39.9	NE
M-12	M-11	06/26/00	Chloride	17.6	21.3	250
M-12	M-13	06/26/00	Conductivity	320 µmhos/cm	403 µmhos/cm	NE
M-14	M-13	06/26/00	Magnesium	39.9	10.9	NE
M-12	M-11	06/26/00	Nitrate	1.9	1.6	10
M-14	M-13	06/26/00	Sodium	15.4	21.3	NE
M-12	M-13	06/26/00	Sulfate	14.8	31.1	NE
M-12	M-11	06/26/00	Total Alkalinity	122	154	NE
M-11	M-13	06/26/00	Total Dissolved Solids	234	282	500
M-12	M-13	06/26/00	Total Sulfide	0.6	3.9	NE
M-14	M-13	06/26/00	Uranium-234	1.39 ± 0.26 pCi/L	1.61 ± 0.23 pCi/L	30
M-12	M-13	10/09/00	Bicarbonate Alkalinity	123	137	NE
M-14	M-12	10/09/00	Calcium	38.5	41.2	NE
M-11	M-13	10/09/00	Chloride	21.9	18.3	250
M-12	M-13	10/09/00	Conductivity	322 µmhos/cm	385 µmhos/cm	NE
M-12	M-13	10/09/00	Magnesium	11.7	13.3	NE
M-12	M-11 & M-14	10/09/00	Nitrate	0.13	1.6	10
M-11	M-13	10/09/00	Sodium	17.1	21.3	NE
M-12	M-13	10/09/00	Sulfate	15.7	48.3	NE
EBR-II #2	M-13	10/09/00	Total Alkalinity	128	141	NE
M-11	M-13	10/09/00	Total Dissolved Solids	231	280	500
M-14	M-13	10/09/00	Total Sulfide	1.7	20.6	NE
EBR-II #2	M-11	10/09/00	Uranium-234	1.33 ± 0.27 pCi/L	1.57 ± 0.24 pCi/L	30

a. All values are in mg/L unless otherwise noted.
b. NE means there is no MCL established for that constituent.

No volatile organic compounds were detected above minimum detection levels. Concentrations of inorganic analytes and water quality parameters were all below regulatory limits. The USGS continued groundwater monitoring around NRF (Figure 5-3) under an interagency agreement. Specifics regarding this monitoring are published in the 2000 Environmental Monitoring Report for the Naval Reactors Facility [Reference 5-4].

5.3 RADIOLOGICAL 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 strontium-90 (^{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 percolation ponds, where the water infiltrates into the subsurface. The Test Reactor Area (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.

The average combined rate of tritium disposal at the TRA and INTEC during 1952-1983 was 910 Ci/yr; during 1984-1991, it was 280 Ci/yr; and during 1992-1995, it was 107 Ci/yr. Between 1952 and 1998, the INEEL disposed of about 93 Ci of ^{90}Sr at TRA and about 57 Ci at INTEC. During this period there was no direct injection of ^{90}Sr at TRA, but at INTEC a portion of the ^{90}Sr was injected directly to the SRPA. During the period 1996-1998, the INEEL disposed of about 0.03 Ci of ^{90}Sr to the INTEC percolation ponds.

To date only tritium and ^{90}Sr have been detected at levels at or above their respective MCL values.

U.S. Geological Survey

Tritium

Because tritium is equivalent to water in chemical behavior, it has formed the largest plume of radiochemical pollutants. The configuration and extent of the tritium contamination area, based on the latest data, are shown in Figure 5-4 [Reference 5-1]. The area of contamination within the 0.5 pCi/mL contour line decreased from about 104 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 the Central Facilities Area (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) have continually shown the highest tritium concentrations in the aquifer over time. For this reason these two wells are considered representative of concentration trends in the rest of the aquifer. The average tritium concentration in Well 65 south of TRA (Figure 5-2) decreased from (2.12 ± 0.09) x 10^4 pCi/L in 1995 to (1.59 ± 0.07) x 10^4 pCi/L in 1998. The average tritium concentration in Well 77 south of INTEC (Figure 5-2) decreased from (2.51 ± 0.10) x 10^4 pCi/L in 1995 to (1.82 ± 0.07) x 10^4 pCi/L in 1998.

The EPA MCL for tritium in drinking water is 2.0 x 10^4 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 data, are shown in Figure 5-5 [Reference 5-1]. The contamination originates from the INTEC as a remnant of the earlier injection of wastewater. No ^{90}Sr in groundwater has been 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 the wells have remained relatively constant since 1989. The concentrations during 1996-1998 ranged from 2.1 ± 0.6 pCi/L to 41.1 ± 1.5 pCi/L. 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 1996 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 infiltration ponds may have changed the affinity of ^{90}Sr on soil and rock surfaces,

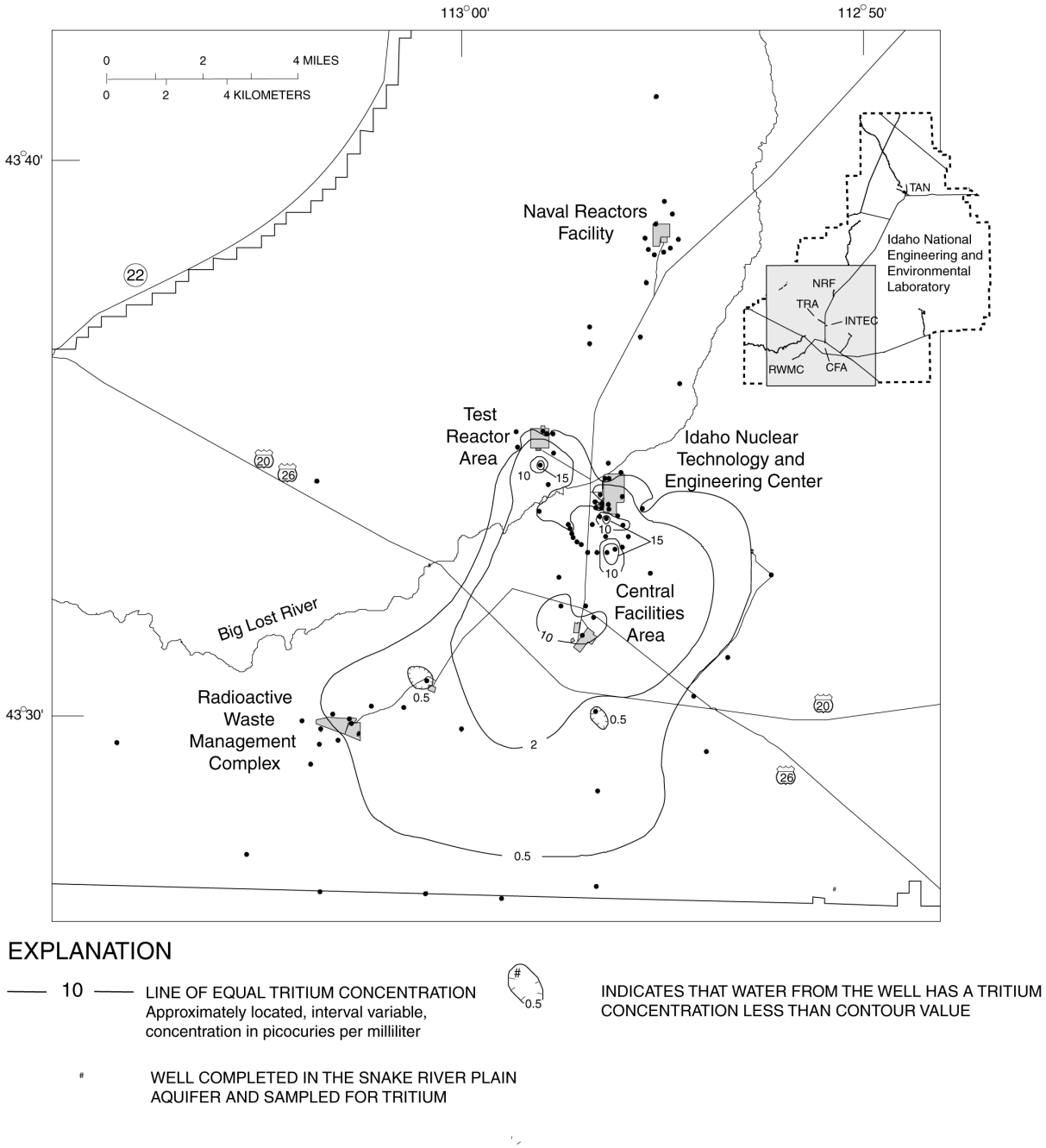


Figure 5-4. Distribution of tritium in the SRPA on the INEEL (1998). [Reference 5-1]

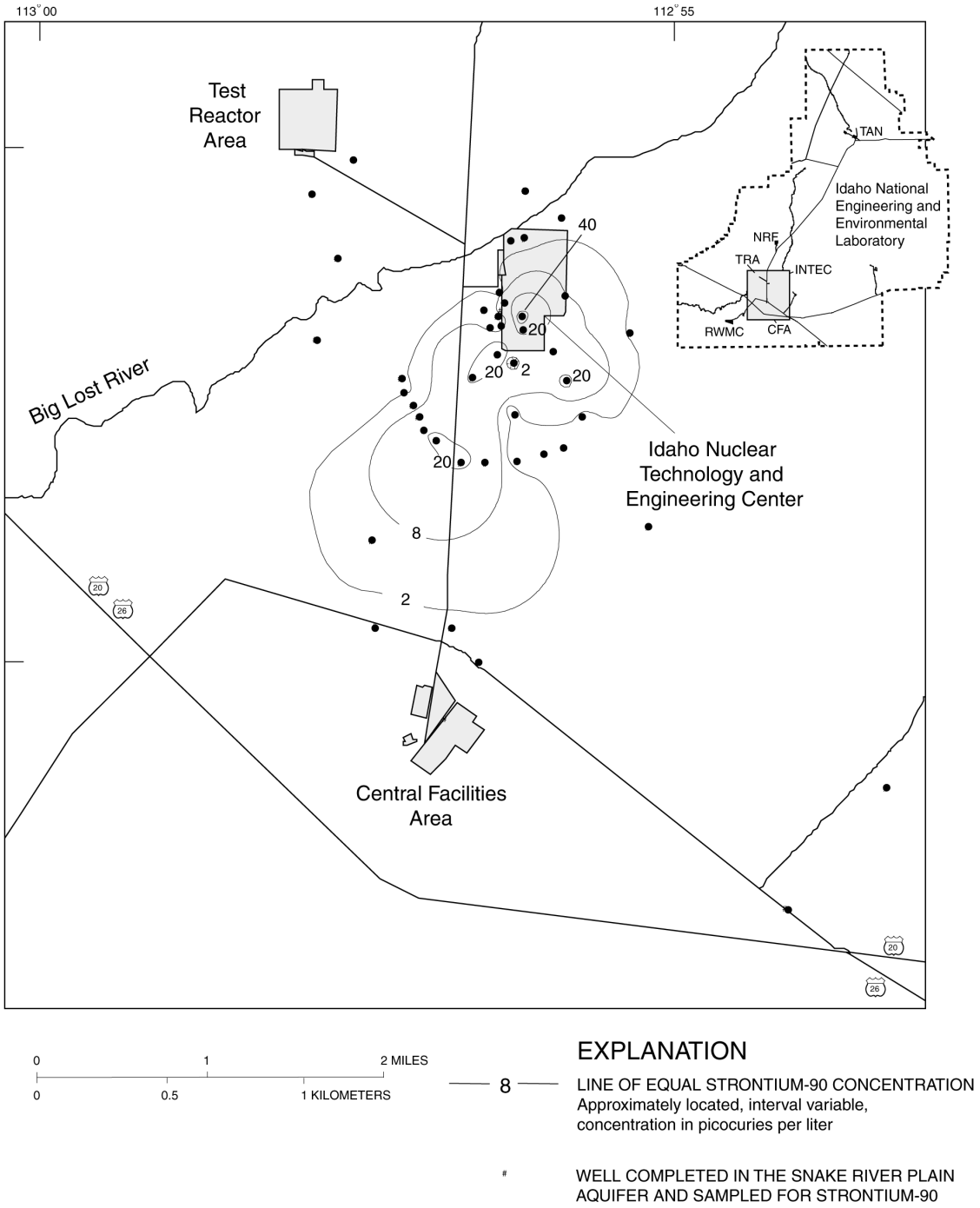


Figure 5-5. Distribution of strontium-90 in the SRPA on the INEEL (1998). [Reference 5-1]

causing it to become more mobile [Reference 5-1].

Management and Operating Contractor

Gross Alpha

Of the 53 onsite production well and distribution system samples analyzed for gross alpha in 2000, a total of 14 samples contained radioactivity above the minimum detectable concentration. The highest concentration observed was 3.83 ± 0.66 pCi/L in a sample collected on January 19 from the CFA Well #2. This value is below the EPA MCL of 15 pCi/L for gross alpha in drinking water.

According to USGS reports, alpha-emitting wastes plutonium-238 (^{238}Pu), plutonium-239/240 ($^{239/240}$Pu), and americium-241 (^{241}Am) from INEEL operations have not migrated far from their entrance into the SRPA near INTEC. This is primarily due to these radionuclides being highly sorbed onto subsurface materials (sediments and rock).

Gross Beta

Of the 53 onsite production well samples analyzed for gross beta in 2000, 32 samples had gross beta activities above the minimum detectable concentration. All were within the range typically found for background concentrations from natural radioactivity in the SRPA. The highest observed activity was 7.98 ± 1.2 pCi/L in a sample from CFA Well #1 on April 18. Again this value is below the EPA screening limit of 50 pCi/L for gross beta in drinking water.

Tritium

Samples from three of the onsite production wells and four drinking water distribution systems that were sampled in 2000 showed detectable concentrations of tritium in one or more samples (Table 5-6). Figure 5-6 shows 12 years of tritium data for the two of the production wells and two distribution systems that have continually shown the highest tritium concentrations. Concentrations of tritium in these wells show a decreasing trend over time.

Strontium-90

Because of the localized presence of ^{90}Sr in the groundwater near INTEC, sampling from several production wells at INTEC is routinely performed. While samples have historically contained detectable levels of ^{90}Sr, none of the 11 samples collected in 2000 had detectable concentrations.

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 2000 calculation was based on:

- Mean tritium concentration for the CFA distribution system in 2000.
- Data from a 1990-1991 USGS study for iodine-129 (^{129}I) using the accelerator mass spectrographic analytical technique that indicated water from CFA #1 contained ^{129}I at a concentration of 0.26 ± 0.05 pCi/L (the average of two samples) and water from CFA # 2 had a concentration of 0.14 ± 0.03 pCi/L (also the average of two samples). For perspective, the current EPA drinking water standard for ^{129}I in drinking water is 1 pCi/L.
- Water usage information for 2000 showing CFA #1 was used for approximately 38 percent of the drinking water and CFA #2 for 62 percent of the drinking water.

For the 2000 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

Table 5-6. Tritium concentrations in INEEL production wells and distribution systems (2000).

Well Code	Number of Samples[a]	Tritium Concentration		Percent of the MCL[c]
		Minimum[b]	Maximum[b]	
CFA # 1	4	1.06 ± 0.069	1.30 ± 0.084	65
CFA # 2	3	0.97 ± 0.063	1.05 ± 0.069	48
CFA Dist.	4	1.01 ± 0.066	1.25 ± 0.164	63
INTEC Well # 4	4	-0.0148 ± 0.009	-0.00133 ± 0.010	--
INTEC Well # 5	1	-0.00478 ± 0.01	-0.00478 ± 0.01	--
INTEC Dist.	3	-0.00503 ± 0.01	-0.00133 ± 0.01	--
CTF Dist.	4	-0.0038 ± 0.02	0.025 ± 0.011	1
EBR-I Dist.	3	-0.011 ± 0.01	0.005 ± 0.01	0.3
Gun Range	3	0.163 ± 0.016	0.207 ± 0.037	10
Main Gate Dist.	3	-0.0074 ± 0.02	0.0046 ± 0.01	0.2
PBF Dist.	4	-0.0033 ± 0.02	0.0039 ± 0.01	0.2
RWMC Dist.	4	0.011 ± 0.15	0.154 ± 0.015	7
RWMC Well	4	0.115 ± 0.014	0.162 ± 0.016	8
TRA Dist.	3	-0.011± 0.02	-0.00075 ± 0.001	--
TRA Dist.	4	-0.014 ± 0.02	0.014 ± 0.01	0.7

a. Samples taken only from wells in use at collection time.
b. Values shown are x 10^4 pCi/L with ± 1 standard deviation.
c. EPA drinking water MCL for tritium is 2 x 10^4 pCi/L.

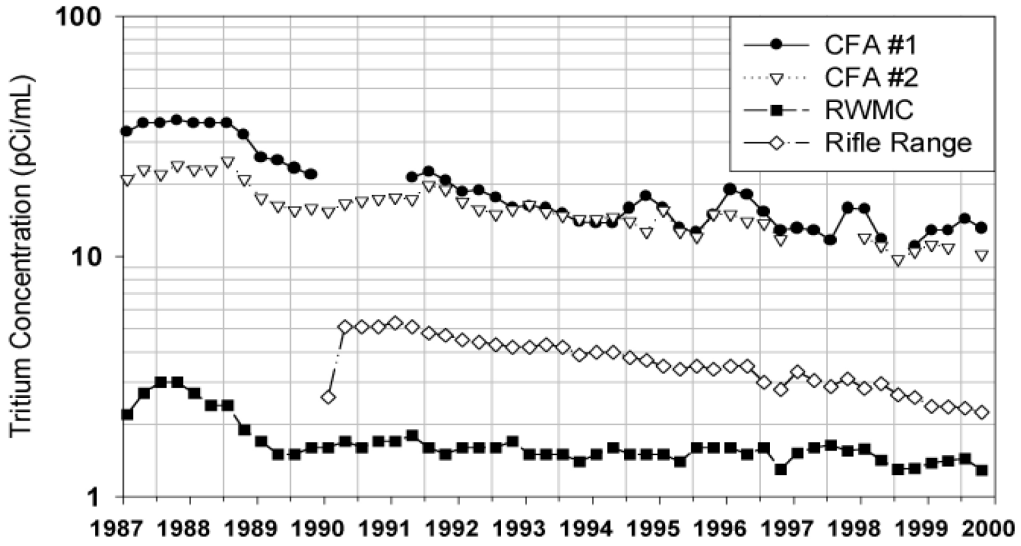


Figure 5-6. Tritium concentrations in four INEEL wells (1987–2000).

hours and typically work only 240 days rather than 365 days per year. The estimated committed effective dose equivalent to a worker from consuming all drinking water at CFA during 2000 was 0.5 mrem/yr, 13 percent of the EPA standard of 4 mrem/yr for community drinking water systems.

Argonne National Laboratory-West

During 2000, ANL-W analyzed four 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. No detectable concentrations of any constituent were observed.

Naval Reactors Facility

Groundwater monitoring from NRF groundwater wells did not detect any gross alpha or gross beta activity in excess of natural background concentrations. For more information, see the *2000 Environmental Report for the Naval Reactors Facility* [Reference 5-4].

5.4 BACTERIOLOGICAL MONITORING

Management and Operating Contractor

Potable water at the INEEL is monitored for coliform bacteria either monthly or quarterly by contractor personnel and analyzed by the M&O contractor Environmental Hygiene Laboratory. A total of 286 samples were collected for routine monitoring purposes at 12 INEEL facilities during 2000. None of the samples tested positive for bacterial contamination.

An additional 55 samples were collected as part of clean system certifications for distribution systems that have undergone repair work. All samples showed negative results and the systems were certified as clean and placed in service.

Argonne National Laboratory-West

ANL-W personnel collected a total of 42 samples in 2000 from various locations within the ANL-W distribution system. None of the samples collected in 2000 tested positive for bacterial contamination.

Naval Reactors Facility

NRF personnel collected a total of 85 monthly samples for bacteriological analysis. Again, none of the samples contained any bacterial contamination.

Chapter 6

Effluent Monitoring

Environmental Surveillance, Education and Research Program

ESER

6. EFFLUENT MONITORING

This chapter details the 2000 results of effluent monitoring by the Idaho National Engineering and Environmental Laboratory (INEEL) Management and Operating (M&O) contractor.

6.1 RADIOACTIVE EFFLUENTS

Radionuclides released to the environment via airborne and liquid effluents were monitored during 2000 at potentially significant release sites as required by the federal Clean Air Act and State wastewater land application permits. These sites included stacks and liquid effluent streams monitored by INEEL contractors at the relevant facilities.

Airborne Effluents

During 2000, a reported 4,740 Ci of radioactivity was released to the atmosphere from all INEEL sources (Figure 6-1). The *National Emissions Standards for Hazardous Air Pollutants (NESHAP) – Calendar Year 2000 INEEL Report for Radionuclides* [Reference 6-1] includes 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 largest facility contributions to the total came from the Test Reactor Area (TRA) at 38 percent (Table 6-1), the Idaho Nuclear Technology and Engineering Center (INTEC) at 29 percent, Test Area North (TAN) with 21 percent and Argonne National Laboratory-West (ANL-W) with 8.5 percent. Approximately 85 percent of the radioactive effluent was in the form of noble gases (argon, krypton, and xenon). Most of the remaining 15 percent was tritium.

Liquid Effluents

Table 6-2 summarizes the radioactive liquid effluents released onsite during 2000. Nearly all of the radioactive liquid effluent was released from TRA into two hypalon plastic-lined evaporation ponds, in use since August 1993. These ponds serve to prevent percolation of contaminated water into the ground. Radioactive liquid effluent was not released to the offsite environment from INEEL facilities during 2000. Injections of radioactive liquid effluents into the Snake River Plain Aquifer ceased in 1984.

Argonne National Laboratory-West

Argonne National Laboratory-West (ANL-W) samples its Industrial Waste Pond and Secondary Sanitary Lagoon monthly. The water samples were analyzed for gross alpha, gross beta, tritium, and gamma-emitting radionuclides. The only detections in 2000 were gross beta activity in samples from the secondary sanitary lagoon (average [4.2 ± 0.4] x 10^{-8} µCi/mL, 95 percent confidence interval).

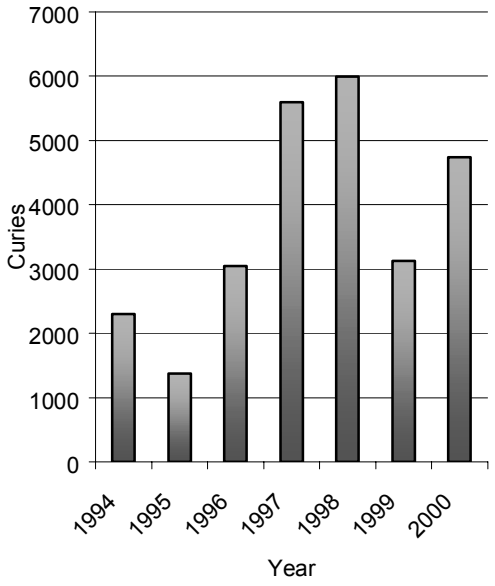


Figure 6-1. INEEL airborne radioactive effluent.

Table 6-1. Radionuclide composition of INEEL airborne effluents (2000).[a]

Effluent Type	Radionuclide	Half-Life	Airborne Effluent (Ci)					Total
			ANL-W[b]	INTEC[b]	NRF[b]	TAN[b]	TRA[b]	
	^{85}Kr	10.7 yr	398	1,230	0.68	915	--[c]	2,540
	^{41}Ar	1.83 h	4.32	--	--	--	1,420	1,420
	^{135}Xe	9.10 h	--	--	--	--	51.8	51.8
	^{133}Xe	5.25 d	--	--	--	--	19.1	19.1
	^{88}Kr	2.84 h	--	--	--	--	7.95	7.95
	^{85m}Kr	4.48 h	--	--	--	--	6.83	6.83
Particulates	^{88}Rb	17.7 min	--	--	--	--	2.26	2.26
	^{137}Cs/^{137}Ba	30.2 yr	--	0.11	3.40×10^{-5}	7.45×10^{-4}	1.25×10^{-4}	0.11
	^{90}Sr/^{90}Y	28.6 yr	--	0.10	--	2.55×10^{-5}	3.08×10^{-5}	0.10
	^{138}Cs	32.2 min	--	--	--	--	5.85×10^{-2}	5.85×10^{-2}
	^{51}Cr	27.8 d	--	--	--	--	5.29×10^{-3}	5.29×10^{-3}
	^{152}Eu	12.7 yr	--	4.85×10^{-3}	--	2.40×10^{-14}	7.70×10^{-5}	4.93×10^{-3}
	^{154}Eu	16 yr	--	3.57×10^{-3}	--	4.10×10^{-10}	9.08×10^{-5}	3.66×10^{-3}
	^{175}Hf	70 d	--	3.57×10^{-3}	--	--	7.10×10^{-7}	3.57×10^{-3}
	^{89}Rb	15.4 min	--	--	--	--	3.05×10^{-3}	3.05×10^{-3}
	^{60}Co	5.27 yr	--	4.98×10^{-4}	4.00×10^{-6}	8.53×10^{-7}	1.68×10^{-3}	2.21×10^{-3}
	^{99m}Tc	6.01 h	--	--	--	2.11×10^{-6}	1.22×10^{-3}	1.22×10^{-3}
	^{238}Pu	87.7 yr	--	1.04×10^{-3}	--	4.20×10^{-9}	--	1.04×10^{-3}
	^{239}Pu	2.4×10^{4} yr	--	4.18×10^{-6}	--	2.94×10^{-14}	1.24×10^{-7}	1.04×10^{-5}
	^{125}Sb/^{125m}Te	2.73 yr	--	7.63×10^{-6}	--	6.82×10^{-7}	6.52×10^{-7}	9.22×10^{-6}
Tritium, ^{14}C,	^{3}H	12.3 yr	2.48	159	5.30×10^{-2}	92.7	303	684[d]
and Iodine	^{14}C	5,700 yr	--	--	0.64	6.60×10^{-17}	9.80×10^{-9}	1.50[e]
Isotopes	^{132}I	2.3 h	--	--	--	--	0.188	0.188
	^{133}I	20.8 h	--	--	--	--	8.45×10^{-2}	8.45×10^{-2}
	^{135}I	6.57 h	--	--	--	--	6.19×10^{-2}	6.19×10^{-2}
	^{131}I	8.04 d	--	--	9.00×10^{-6}	--	5.56×10^{-2}	5.56×10^{-2}
	^{129}I	1.6×10^{7} yr	--	1.42×10^{-2}	--	7.87×10^{-3}	--	2.20×10^{-2}
All others		-	7.59×10^{-5}	1.03×10^{-3}	1.17×10^{-4}	5.42×10^{-4}	3.05×10^{-3}	5.03×10^{-3}
Totals[f]		**-**	**404**	**1,390**	**1.37**	**1,010**	**1,810**	**4,740**

a. Radioactive release information provided by the *National Emissions Standard for Hazardous Air Pollutants –Calendar Year 2000 INEEL Report for Radionuclides,* DOE/ID-10890, June 2001.

b. Radionuclides specifically listed are those with total releases greater than 1×10^{-3} Ci (1×10^{-4} for isotopes of iodine). Some radionuclides of special concern (^{125}Sb and ^{239}Pu) are also included.

c. A double dash signifies the radionuclide was not released from that facility during the calendar year.

d. Total includes 127 Ci from diffuse sources at the Radioactive Waste Management Complex (RWMC).

e. Total includes 0.86 Ci from diffuse sources at the RWMC.

f. Rounded totals include small amounts from facilities not listed.

Table 6-2. Radionuclide composition of liquid effluents released onsite (2000).[a]

		Liquid Effluent (Ci)		
Radionuclide[b]	**Half-Life**	**INTEC**	**TRA**	**Total**
^{3}H	12.3 yr	2.78×10^{-2}	103.4	103.5
^{60}Co	5.27 yr	--	1.10	1.10
^{51}Cr	27.8 d	--	0.91	0.91
$^{90}Sr/^{90}Y$	28.6 yr	--	0.21	0.21
^{24}Na	15.0 hr	--	0.14	0.14
^{137}Cs	30.2 yr	--	8.73×10^{-2}	8.73×10^{-2}
^{154}Eu	16 yr	--	4.33×10^{-2}	4.33×10^{-2}
^{181}Hf	42.4 d	--	4.27×10^{-2}	4.27×10^{-2}
^{124}Sb	60.4 d	--	3.97×10^{-2}	3.97×10^{-2}
^{40}K	1.26×10^{9} yr	3.83×10^{-2}	--	3.83×10^{-2}
^{152}Eu	12.7 yr	--	3.41×10^{-2}	3.41×10^{-2}
^{155}Eu	1.81 yr	--	1.67×10^{-2}	1.67×10^{-2}
All others		3.41×10^{-3}	1.28	1.29
Totals		**6.95×10^{-2}**	**107.3**	**107.4**

a. Preliminary radioactive release data provided by the INEEL M&O contractor Environmental Monitoring Program.

b. Table includes all radionuclides with total releases greater than 1×10^{-2} Ci.

6.2 NONRADIOACTIVE EFFLUENTS

Airborne Effluents

Sitewide Air Emission Inventory

The M&O contractor publishes the Air Emission Report for the INEEL annually. This document provides a compilation of emissions from sources at all facilities [Reference 6-2].

Nonradioactive airborne effluents are monitored at relevant INEEL facilities. Pollutants of particular interest include two oxides of nitrogen, nitrogen oxide (NO) and nitrogen dioxide (NO_2), which are collectively referred to as NO_x. Other substances monitored include sulfur oxides (primarily in the form of sulfur dioxide [SO_2]), carbon monoxide, volatile organic compounds, and particulates less than 10 microns in diameter (PM_{10}).

Argonne National Laboratory - West

Emissions from the Experimental Breeder Reactor No. 2 auxiliary boilers do not require continuous monitoring because they are below the state of Idaho's 250 million BTU/hour emission limit. ANL-W provides certified emissions estimates of nitrogen oxides, sulfur dioxide, and other criteria pollutants for use in the annual INEEL Air Emissions Inventory Report. These estimates are based on annual fuel throughput, type of fuel and sulfur content, and the hours of operation for boilers and other fuel burning equipment.

Liquid Effluents

General Information

In 1986, a Nonradiological Liquid Effluent Monitoring Program was instituted to provide environmental monitoring for nonradioactive parameters and pollutants in liquid wastes generated by INEEL facilities. Nonradioactive liquid effluents are disposed primarily to the following areas on the INEEL:

- an industrial waste ditch and evaporative sewage lagoon at the Naval Reactors Facility (NRF);
- lined sewage lagoons at ANL-W, Central Facilities Area, Special Manufacturing Capability, TRA, and INTEC; and

- industrial waste ponds at ANL-W, INTEC, and Technical Support Facility.

Injection wells and the Big Lost River are not used for disposal of any liquid wastes, except for storm water runoff.

Argonne National Laboratory-West

During 2000, the Industrial Waste Pond at ANL-W was monitored monthly for iron, sodium, mercury, chloride, fluoride, sulfate, phosphate, pH, biological oxygen demand, and total coliform. The Secondary Sanitary Lagoon was monitored monthly for a variety of inorganic constituents, general water quality parameters, biological oxygen demand, total suspended solids, and total coliform. All parameters for both ponds were well below applicable standards.

Idaho Nuclear Technology and Engineering Center

Liquid effluent from INTEC, discharged to the percolation ponds since 1995 under a Waste Water Land Application Permit, consists primarily of cooling water from facility operations. Monitoring results are presented in Table 6-3. During 2000, measured concentrations for each parameter were below levels that would define the effluent as a hazardous waste stream [Reference 6-3].

Test Reactor Area

Nonradioactive liquid effluents were discharged from TRA into three types of ponds: the Cold Waste Pond, the Chemical Waste Pond, and two sewage lagoons. The Cold Waste Pond receives primarily secondary cooling water from the Advanced Test Reactor. Table 6-4 summarizes the nonradiological monitoring data for effluents released into the Cold Waste Pond from TRA during 2000. The Chemical Waste Pond was closed and covered with a protective cap during 1999.

Naval Reactors Facility

Liquid effluent monitoring confirmed all discharges in 2000 were controlled in accordance with applicable federal and State laws. Specifics regarding this monitoring are published in the *2000 Environmental Monitoring Report for the Naval Reactors Facility* [Reference 6-4].

Table 6-3. INTEC-797 effluent monitoring data (2000).

Parameter	Concentration[a] Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Toxicity Limit[b]
Aluminum	<dl[c]	<dl	0.0112	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	--[d]
Antimony	<dl	<dl	<dl	<dl	NA[e]	NA	NA	NA	NA	NA	NA	NA	--
Arsenic	0.0067	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.0040	5
Barium	0.0594	0.0595	0.0671	0.0672	0.0646	0.0626	0.0304	0.0913	0.0912	0.0990	0.0979	0.0440	100
Beryllium	<dl	<dl	0.0001	<dl	NA	NA	NA	NA	NA	NA	NA	NA	--
Calcium	32.8	31.6	38.4	40.4	NA	NA	NA	NA	NA	NA	NA	NA	--
Cadmium	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	1
Chloride	200	97	239	176	185	146	80	298	292	220	311	103	--
Chromium	0.0053	0.0041	0.0043	0.0036	0.0041	0.0059	0.0063	0.0043	0.0036	0.0045	0.0049	0.0045	5
Cobalt	<dl	<dl	<dl	<dl	NA	NA	NA	NA	NA	NA	NA	NA	--
Copper	0.0048	0.0070	0.0031	0.0030	0.0020	0.0017	0.0012	0.0016	0.0026	0.0028	0.0054	<dl	--
Iron	0.0751	0.0146	0.0265	0.0103	<dl	<dl	<dl	<dl	<dl	<dl	0.0353	0.169	--
Fluoride	0.21	0.22	0.21	0.23	0.21	0.20	0.22	0.22	0.19	0.23	0.20	0.22	--
Lead	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	--
Magnesium	9.97	8.95	13.2	11.6	NA	NA	NA	NA	NA	NA	NA	NA	--
Manganese	0.0007	<dl	0.0010	0.0011	0.0011	0.0005	0.0005	<dl	<dl	<dl	0.0007	0.0025	--
Mercury	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.2
Nickel	<dl	<dl	<dl	<dl	NA	NA	NA	NA	NA	NA	NA	NA	--
N, Total Kjeldahl	<dl	<dl	<dl	<dl	0.15	<dl	<dl	<dl	0.11	<dl	6.9	6.2	--
N, as Ammonia	0.15	<dl	<dl	<dl	NA	NA	NA	NA	NA	NA	NA	NA	--
N, as Nitrite	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	--
N, as Nitrate	0.91	0.94	0.88	0.87	0.78	0.75	0.80	0.83	0.88	0.92	0.99	1.00	--
Phosphate	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	--
Potassium	2.05	2.62	2.23	2.27	NA	NA	NA	NA	NA	NA	NA	NA	--
Selenium	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	0.0049	<dl	<dl	<dl	1
Silver	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	<dl	5
Sodium	91	100	137	138	144	101	79	137	139	139	172	86	--
Sulfate	33.4	30.1	24.9	24.5	24.5	38.8	40.2	24.3	24.7	25.1	27.1	46.9	--
Thallium	0.0014	0.0017	<dl	0.0012	NA	NA	NA	NA	NA	NA	NA	NA	--
Vanadium	0.0027	0.0049	0.0037	0.0030	NA	NA	NA	NA	NA	NA	NA	NA	--
Zinc	<dl	0.0031	0.0036	0.033	NA	NA	NA	NA	NA	NA	NA	NA	--
TDS[f]	390	379	560	504	508	447	346	698	691	711	746	393	--
TOC[f]	NA	NA	NA	<dl	NA	NA	NA	NA	NA	NA	NA	NA	--
TSS[f]	<dl	<dl	<dl	<dl	NA	NA	NA	NA	NA	NA	NA	NA	--
pH (standard units)	8.22	8.35	8.32	8.33	8.26	8.09	8.08	8.15	8.23	8.12	8.28	7.99	< 2 to > 12.5
Conductivity (µmhos)	707	681	1060	909	944	800	626	1360	1310	1300	1330	727	--

a. Concentration reported in milligrams per liter (mg/L) unless otherwise noted.
b. U.S. Environmental Protection Agency (EPA) maximum concentration of contaminants for the toxicity characteristics is from 40 CFR 261.24 [Reference 6-3].
c. <dl = less than detection limit.
d. double dash (--) indicates there is no toxicity limit for that constituent.
e. NA = No analysis (for that constituent during that month.
f. TDS = Total dissolved solids; TOC = Total organic carbon; TSS = Total suspended solids.

Table 6-4. TRA-764 effluent monitoring data (2000).

Parameter	Concentration[a]				Toxicity Limit[b]
	January	April	August	October	
Biological Oxygen Demand	<dl[c]	NA[d]	NA	NA	--[e]
Conductivity (µmhos)	1062	1060	1169	432	--
pH (standard units)	7.62	7.93	8.14	8.25	< 2 to > 12.5
Total Dissolved Solids	787	881	926	265	--
Total Suspended Solids	<dl	NA	NA	NA	--
Aluminum	0.0306	0.0116	0.118	0.0255	--
Arsenic	0.0050	0.0029	0.0042	<dl	5
Barium	0.128	0.138	0.137	0.051	100
Beryllium	<dl	<dl	<dl	<dl	--
Boron	<dl	0.0655	0.0758	0.0316	--
Cadmium	<dl	0.0015	<dl	<dl	1
Chloride Ion	28.5	26.5	34.5	11.5	--
Cobalt	<dl	<dl	<dl	<dl	--
Chromium	0.0108	0.0103	0.0084	0.0030	5
Copper	<dl	0.0065	0.0043	0.0030	--
Fluoride	0.30	0.408	0.309	0.2	--
Iron	0.285	0.0755	0.0508	<dl	--
Lead	<dl	<dl	<dl	<dl	5
Magnesium	49	51	51	18	--
Manganese	0.0013	<dl	0.0117	<dl	--
Mercury	<dl	<dl	<dl	<dl	0.2
Molybdenum	0.0157	0.0099	0.0104	<dl	--
Nickel	<dl	<dl	<dl	<dl	--
Nitrogen, Total Kjeldahl	1.1	NA	NA	NA	--
Nitrogen, as Ammonia	<dl	0.0157			--
Nitrogen, Nitrate + Nitrite	3.2	0.97	3.0	1.03	--
Phosphorus, Total	1.4	NA	NA	NA	--
Sodium	25	26	29	9.5	--
Selenium	<dl	0.0036	<dl	<dl	1
Silver	<dl	<dl	<dl	<dl	5
Sulfate	374	243	459	44.4	--
Thallium	<dl	<dl	<dl	<dl	--
Tin	<dl	<dl	<dl	<dl	--
Vanadium	0.0102	0.0084	0.0116	0.0043	--
Zinc	<dl	0.0050	<dl	<dl	--

a. All concentrations in milligrams per liter (mg/L) unless otherwise noted.
b. EPA maximum concentration of contaminants for the toxicity characteristics is from 40 CFR 261.24 .
c. Less than detection limit.
d. NA = No analysis (for that constituent during that month.
e. A double dash (--) in this column means no limit has been established.

Chapter 7

Dose to the Public

Environmental Surveillance, Education and Research Program

ESER

7. DOSE TO THE PUBLIC

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" [Reference 7-1]. 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..." [Reference 7-2]. It is the purpose of this chapter to describe the dose to members of the public and to the environment based on the 2000 radionuclide concentrations from operations at the Idaho National Engineering and Environmental Laboratory (INEEL).

7.1 GENERAL INFORMATION

During 2000, no statistically significant differences were detected in samples of environmental media taken at locations distant from the INEEL compared with those taken near the boundaries (see Chapter 3). Therefore, there was no measured increase in exposure due to radionuclides from the INEEL in the offsite environment during 2000. Because individual radiological impacts to the public surrounding the INEEL were too small to be measured by routine monitoring and to show compliance with federal regulations set to ensure the safety of the public, the dose from INEEL operations has been estimated using the reported amounts of radionuclides released during the year from INEEL facilities (see Chapter 6) and appropriate air dispersion models. During 2000, this was accomplished for the radionuclides summarized in Table 6-1.

The following estimates were calculated:

- The effective dose equivalent to the maximally exposed individual residing offsite using the CAP-88 model [Reference 7-3];
- The effective dose equivalent to the maximally exposed individual residing offsite using dispersion calculations from the Mesoscale Diffusion (MDIFF) model [Reference 7-4]; and
- The collective effective dose equivalent (population dose) within 80 km (50 mi) of an INEEL facility. The estimated population dose is based on the effective dose equivalent calculated with the MDIFF air dispersion model for the maximally exposed individual.

In this chapter, the term "dose" refers to 50-year committed effective dose equivalent unless another term is specifically stated. Dose was calculated by summing the effective dose equivalents from each exposure pathway evaluated. 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-year integration period were used in calculations with both air dispersion models for internally deposited radionuclides [Reference 7-5] and for radionuclides deposited on ground surface [Reference 7-6]. No allowance is made in the MDIFF model for shielding by housing materials, which is estimated to reduce the dose by about 30 percent, nor is allowance made for less than year-round occupancy time in the community. The CAP-88 model includes 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 1-4), atmospheric transport is likely to be the principal potential pathway for exposure to the surrounding population. This is the likely exposure pathway since winds can carry airborne radioactive material some distance from its source. Furthermore, no surface water flows off the INEEL and no radionuclides from the INEEL have been found in drinking water wells offsite. Because of this, the maximally exposed

individual dose is determined through the use of models of atmospheric dispersion of airborne materials.

7.2 MAXIMUM INDIVIDUAL DOSE-AIRBORNE EMISSIONS PATHWAY

Summary of Models

The National Emission Standards for Hazardous Air Pollutants (NESHAP), as outlined in the Code of Federal Regulations, Title 40, Part 61, (40 CFR Part 61), requires the demonstration that radionuclides released to air from any nuclear facility do not result in a dose to the public of greater than 10 mrem/yr. This includes releases from stacks and diffuse sources. The U.S. Environmental Protection Agency (EPA) requires the use of an approved computer model to demonstrate compliance with 40 CFR Part 61. The INEEL uses the code CAP-88.

Due to concerns over the generalizations used in the CAP-88 model, the National Oceanic and Atmospheric Administration Air Resources Laboratory–Field Research Division (NOAA ARL-FRD) developed the MDIFF (formerly known as MESODIF) air dispersion model. The MDIFF diffusion curves, developed by the NOAA ARL-FRD from tests in desert environments (i.e., the INEEL and the Hanford Site in eastern Washington), are more appropriate for the INEEL than the generalizations used in CAP-88.

The MDIFF model has been in use for over 20 years to calculate doses to members of the public residing near the INEEL. In previous years, doses calculated with the MDIFF air dispersion model have been somewhat higher than doses calculated using CAP-88. Differences between the two models were discussed in detail in the 1986 annual report [Reference 7-7]. The offsite concentrations calculated using both models were compared to actual monitoring results at offsite locations in 1986, 1987, and 1988. Concentrations calculated for several locations using the MDIFF model showed good agreement with concentrations from actual measurements, with the model generally predicting concentrations higher than those measured [References 7-7, 7-8, and 7-9].

There are differences in the atmospheric dispersion portions of the MDIFF and CAP-88 air dispersion codes. CAP-88 is a Gaussian plume model that transports pollutants in a straight line using wind data from a single tower near the source. MDIFF is a puff model that transports pollutants along nonlinear trajectories based on wind data from over 30 towers in the Upper Snake River Plain. This allows MDIFF dispersion estimates to account for temporal and spatial variations in the wind field. As a result of differing assumptions, the two models may not agree on the location of the maximally exposed individual or the magnitude of the maximum dose.

CAP–88 Model

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 2000 INEEL Report for Radionuclides* [Reference 7-10]. For these calculations, 63 potential maximum locations were evaluated. The CAP-88 model predicted the highest dose to be at Frenchman's Cabin, located at the southern boundary of the INEEL. The CAP-88 model assumes year-round occupancy, so although this location is only inhabited during portions of the year, it meets the EPA definition of a residence. At Frenchman's Cabin, an effective dose equivalent of 0.034 mrem (3.4×10^{-4} mSv) was calculated. The facilities making the largest contributions to this dose were the Idaho Nuclear Technology and Engineering Center (INTEC) at 71 percent, Test Reactor Area (TRA) at 18 percent, and the Radioactive Waste Management Complex (RWMC) at 10 percent. The dose of 0.034 mrem is well below the whole body dose limit of 10 mrem, set in 40 CFR Part 61 for airborne releases of radionuclides.

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 2000 concentrations normalized to a unit release rate distributed among the various INEEL facilities based on their relative contributions to the total. The unit released was partitioned as follows: TRA (38.1%), INTEC (29.3%), Test Area North (TAN) (21.3%), Argonne National Laboratory-West (ANL-W) (8.5%), RWMC (2.7%), and Central Facilities Area (CFA) (0.1%). Summing the contributions from these release points created the isopleths shown in Figure 7-1. The average air concentration (in curies per square meter) for a radionuclide released from a facility at any point along any dispersion coefficient isopleth (line of equal air concentration) in Figure 7-1 is obtained by multiplying the value of the dispersion coefficient of the isopleth by the number of curies of the radionuclide released during the year, and divide by the number of hours in a year squared ([8,760 hours]^2 or 7.67 x 10^7). Concentrations for points between isopleths can be obtained by extrapolating values between the isopleths.

During 2000, a revision of the methods and values used for the calculation of the maximally exposed individual from the MDIFF dispersion values was undertaken.

Values for the deposition and plant uptake rates of radionuclides, most noticeably radioiodines, were modified to reflect the present operations and values as used in 2000. The most notable change, mathematically, is the increase of the iodine-129 (^{129}I) deposition velocity from 0.01 to 0.035 meters per second (m/sec). These changes resulted in a mathematical increase in the amount of radionuclides deposited on the ground and available for plant uptake.

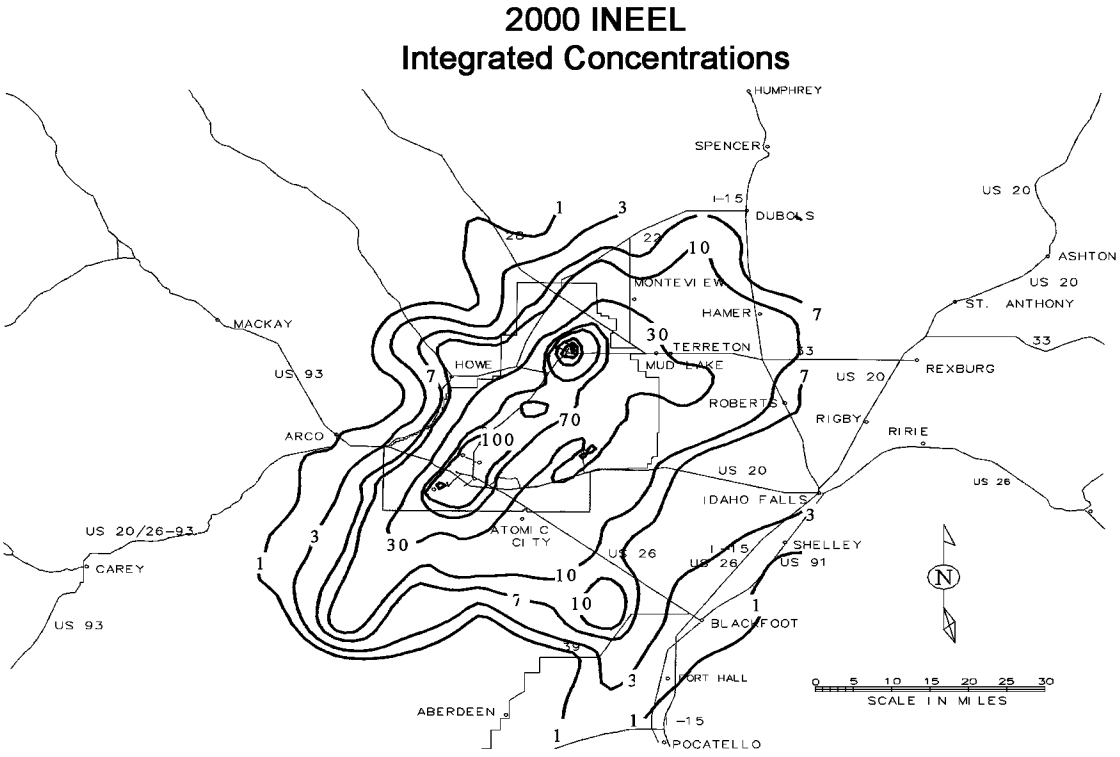


Figure 7-1. Average mesoscale dispersion isopleths of air concentrations at ground level for all INEEL facilities.

The MDIFF model predicted that the highest concentration of radionuclides in air at an inhabited area during 2000 would have occurred approximately 8.9 km (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 due to deposition of radioactive particles on the ground. The calculation was based on data presented in Table 6-1 and in Figure 7-1.

Using the calculated dispersion coefficient of 5.49×10^{-8} hr^2/m^3, the largest dispersion coefficient value from TRA and INTEC at a location inhabited by a full-time resident and allowing for radioactive decay during the 44 km (27 mi) transit of the radionuclides from TRA and INTEC to the area northwest of Mud Lake, the potential annual effective dose equivalent from all radionuclides released was calculated to be 0.057 mrem (5.7×10^{-4} mSv) (Table 7-1). This dose well below the whole body dose limit of 10 mrem set in 40 CFR Part 61 for airborne releases of radionuclides.

As a result of the above-mentioned changes, the ingestion pathway is now the primary route of exposure and accounted for 87 percent of the total dose, with inhalation accounting for 7 percent and immersion accounting for 5 percent. For 2000, ^{129}I contributed approximately 54 percent of the total dose, followed by ^{90}Sr contributing 18 percent (Figure 7-2).

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 to be approximately 361 mrem (Table 3-12).

7.3 INDIVIDUAL DOSE-GAME INGESTION PATHWAY

Waterfowl

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 waterfowl that reside briefly at waste ponds used for the disposal of low-level radioactive wastes and dose to individuals who may eat game birds and game animals that may migrate across the INEEL.

A study was initiated in 1994 to obtain data on the potential doses from waterfowl using the 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 this facility.

In the fall of 2000, seven ducks were collected from waste ponds on the INEEL and three were collected from an offsite location (Mud Lake) as a control group. Of the waterfowl collected from the INEEL, five were collected from radioactive waste ponds at the TRA, one from percolation ponds at the INTEC, and one from the industrial waste pond at the ANL-W facility. The potential dose from eating 225 g (8 oz) of meat from those ducks collected is tabulated in Table 7-2. Radionuclide concentrations driving these doses are reported in Table 3-10. Doses from consuming waterfowl are based on the assumption that ducks are killed and eaten immediately after leaving the ponds.

The potential dose from these waterfowl samples are substantially below the 10 mrem average whole-body dose equivalent from gamma-emitting radionuclides estimated during a 1974 to 1978 study at the former TRA percolation pond [Reference 7-11] and from the 4.0 mrem estimated for the most contaminated duck taken from the percolation pond in 1984–1986 [Reference 7-12].

Table 7-1. Maximum individual effective dose equivalent as calculated from MDIFF model results (2000).

Radionuclide[a]	Radionuclide Concentration in Air At Maximum Offsite Location[b] (Ci/m^3)	Maximum Effective Dose Equivalent	
		mrem	mSv
^{129}I[c]	6.793×10^{-18}	3.082×10^{-2}	3.082×10^{-3}
^{90}Sr + D[d]	7.464×10^{-17}	1.016×10^{-3}	1.016×10^{-4}
^{238}Pu	7.433×10^{-19}	5.155×10^{-3}	5.155×10^{-5}
^{131}I	3.951×10^{-17}	3.836×10^{-3}	3.836×10^{-5}
^{137}Cs + D[d]	7.941×10^{-17}	3.231×10^{-3}	3.231×10^{-5}
^{41}Ar	4.465×10^{-13}	2.961×10^{-3}	2.961×10^{-5}
^{3}H	4.924×10^{-13}	2.606×10^{-4}	2.606×10^{-6}
^{135}Xe	3.146×10^{-14}	3.933×10^{-5}	3.933×10^{-7}
^{88}Kr	3.317×10^{-15}	3.748×10^{-5}	3.748×10^{-7}
^{60}Co	1.582×10^{-18}	3.577×10^{-5}	3.577×10^{-7}
^{152}Eu	3.529×10^{-18}	2.569×10^{-5}	2.569×10^{-7}
^{154}Eu	2.623×10^{-18}	2.448×10^{-5}	2.448×10^{-7}
^{85}Kr	1.818×10^{-12}	2.036×10^{-5}	2.036×10^{-7}
^{14}C	1.075×10^{-15}	1.869×10^{-5}	1.869×10^{-7}
^{88}Rb	3.725×10^{-15}	1.643×10^{-5}	1.643×10^{-7}
^{133}I	5.612×10^{-17}	1.448×10^{-5}	1.448×10^{-7}
Total		**0.057**	**5.65×10^{-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 0.1 day transport time using the distance to Mud Lake (44 km [27.4 mi]) and the average wind speed (20 km/hr [12.6 mi/hr]).
c. Concentration adjusted for plume depletion.
d. When indicated (+D), the contribution of progeny decay products was also included in the dose calculations.

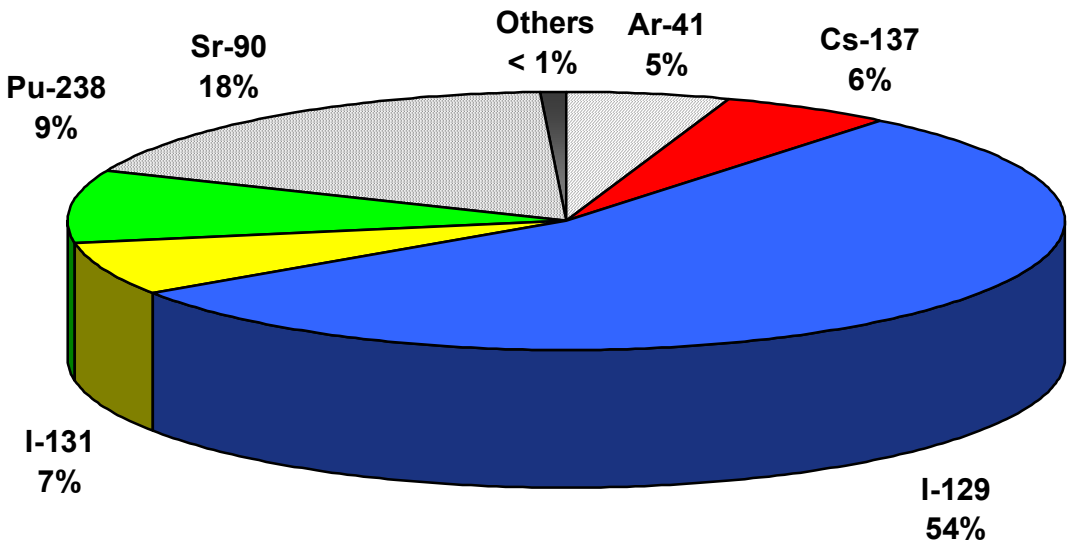


Figure 7-2. Radionuclides contributing to maximum individual dose (as calculated using the MDIFF air dispersion model) (2000).

Table 7-2. Maximum potential dose from ingestion of edible tissue of waterfowl using INEEL waste disposal ponds in 2000[a].

Species	Nuclide	Dose[b]	Total Dose[b]
Redhead	^{60}Co	0.0099	0.0166
	^{137}Cs	0.0067	
Redhead	^{60}Co	0.0048	0.0071
	^{137}Cs	0.0023	
Ruddy	^{60}Co	0.0007	0.0097
	^{137}Cs	0.0090	
Ruddy	^{60}Co	0.0012	0.0091
	^{137}Cs	0.0079	
Total			**0.0425**

a. Committed (50-yr) effective dose equivalent from consuming 225 g (8 oz) based on DOE dose conversion factors.
b. All values are in millirem (mrem)

Mourning Doves

During 2000, 18 mourning doves were collected: seven from the area around the evaporation ponds at TRA, six from INTEC, and five control samples collected approximately 3.2 km (2 mi) southeast of Idaho Falls, Idaho. Human-made radionuclide concentrations in the edible portion of the doves reported in Table 3-9 were used to estimate the potential dose resulting from the ingestion of 50 g (~2 oz) of the edible portion of the mourning doves. The potential dose from a dove containing the maximum measured radionuclides was calculated to be 1.0×10^{-4} mrem, compared to undetected in the control doves from 2000. The largest human-made contributor to the dose from doves was cesium-137 (^{137}Cs). The highest estimated potential whole-body dose equivalent to a person eating the entire muscle mass of a mourning dove from the INEEL was 0.3 mrem in 1974-1977 [Reference 7-13].

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 0.2 mrem in 1975 [Reference 7-14]. Game animals collected at the INEEL during the past few years have shown much lower concentrations of radionuclides than in 1975. Based on the highest concentration of radionuclides found in a game animal during 2000 of $(6.2 \pm 2.2) \times 10^{-9}$ µCi/g and assuming a total edible mass of 65 kilograms, the potential dose was approximately 0.02 mrem.

Yellow-Bellied Marmots

Marmots were again sampled in 2000. During 2000, a total of six yellow-bellied marmots were collected: three from the RWMC and three from a control location outside of Idaho Falls. Since no human-made radionuclides were measured in the edible portions of the marmots sampled in 2000, no potential dose from consumption of marmots can be calculated.

7.4 EIGHTY-KILOMETER (FIFTY-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 Geographic Information System (ArcView 3.0), 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 80 km (50 mi) radius of any INEEL facility. This takes into account changes in facility operations, particularly the fact that INTEC is no longer the single largest contributor of released radionuclides (Table 6-1).

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 any INEEL facility. The population dose was calculated using a spreadsheet program that multiplies the population number in each square kilometer by the dispersion coefficient at that point (in hours squared per cubic meter [hr^2/m^3]) and the normalized dose received at the location of the maximally exposed individual (in rem

per year over hours squared per cubic meter [rem/yr/hr^2/m^3]). This gives an approximation of the dose received by the entire population in a given census division.

The average 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 44 km (27 mi) distance from the TRA and INTEC midpoint to the residence of the maximally exposed individual located near Mud Lake. Idaho Falls, for example, is about 66 km (41 mi) from TRA and INTEC. Neither residence time nor shielding by housing was considered when calculating the MDIFF 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 maximally exposed individual. This individual is potentially exposed through ingestion of contaminated leafy garden vegetables and ingestion of milk from cows grazing solely upon contaminated pasture grass.

The 2000 MDIFF population dose within each census division was obtained by averaging the results from appropriate areas contained within those divisions (Table 7-3). The total population dose is the sum of the population doses for the various census divisions. The estimated potential population dose was 0.53 person-rem (0.0053 person-Sv) to a population of approximately 226,900. When compared with an approximate population dose of 43,700 person-rem (437 person-Sv) from natural background radiation, this represents an increase of only about 0.004 percent. The dose of 0.53 person-rem can also be compared to the following estimated population doses for the same size population: 3,600 person-rem for medical diagnostic procedures, about 480 person-rem from exposure to highway and road construction materials, or 6 to 12 person-rem for television viewing.

The largest collective doses are found in the Idaho Falls and Hamer census divisions. Idaho Falls is relatively high because of its greater population. Hamer is relatively high because it includes population centers such as Mud Lake and Terreton, which are in the predominant downwind direction from the INEEL.

7.5 SUMMARY

Table 7-4 summarizes the annual effective dose equivalents for 2000 from INEEL operations using both the CAP-88 and MDIFF air dispersion models. A comparison is shown between these doses and the EPA airborne pathway standard and the estimated dose from natural background. The reasons for such a disparity in the MDIFF and CAP-88 dose is a result of the changes made to the calculations in 2000. While the population dose appears much larger, this is a direct result of incorporating a much larger population in the calculations as well as the higher individual dose that resulted from changes made in 2000 to the calculation for the maximal exposed individual.

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 (see Reference 7-15). 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.

The calculated dose to hunters consuming the edible portion of a game animal (ducks, dove, deer, elk, pronghorn) with the maximum radionuclide concentration continues to decline. This is a result of less radionuclides being released in wastewaters to the environment where it is accessible to wildlife.

Table 7-3. Dose to population within 80 kilometers (50 miles) of INEEL facilities (2000).

		Population Dose	
Census Division	**Population[a]**	**Person-rem**	**Person-Sv**
Aberdeen	3,228	1.70×10^{-3}	1.70×10^{-5}
Alridge (part)[b]	555	7.77×10^{-5}	7.77×10^{-7}
American Falls (part)	2,802	5.15×10^{-4}	5.15×10^{-6}
Arbon (part)	28	1.80×10^{-5}	1.80×10^{-7}
Arco	2,556	2.97×10^{-2}	2.97×10^{-4}
Atomic City (city)	25	2.44×10^{-2}	2.44×10^{-4}
Atomic City (division)	2,634	5.80×10^{-4}	5.80×10^{-6}
Blackfoot	13,009	1.60×10^{-2}	1.60×10^{-4}
Carey (part)	855	1.40×10^{-3}	1.40×10^{-5}
East Clark (part)	70	8.20×10^{-5}	8.20×10^{-7}
Firth	3,195	2.98×10^{-3}	2.98×10^{-5}
Fort Hall (part)	2,004	1.41×10^{-3}	1.41×10^{-5}
Hailey-Bellevue (part)	4	7.24×10^{-13}	7.24×10^{-15}
Hamer	2,273	6.87×10^{-2}	6.87×10^{-4}
Howe	343	8.67×10^{-3}	8.67×10^{-5}
Idaho Falls	74,378	1.52×10^{-1}	1.52×10^{-3}
Idaho Falls (west)	1,777	1.10×10^{-2}	1.10×10^{-4}
Inkom (part)	552	1.18×10^{-4}	1.18×10^{-6}
Island Park (part)	79	1.90×10^{-9}	1.90×10^{-11}
Leadore (part)	6	7.61×10^{-8}	7.61×10^{-10}
Lewisville-Menan	3,696	1.89×10^{-2}	1.89×10^{-4}
Mackay (part)	1,210	2.45×10^{-6}	2.45×10^{-8}
Moody Creek (part)	4,265	2.56×10^{-3}	2.56×10^{-5}
Moreland	9,197	3.58×10^{-2}	3.58×10^{-4}
Pocatello (part)	46,152	2.70×10^{-2}	2.70×10^{-4}
Rigby	10,161	2.75×10^{-2}	2.75×10^{-4}
Ririe	1,405	8.28×10^{-5}	8.28×10^{-7}
Roberts	1,620	1.26×10^{-2}	1.26×10^{-4}
St. Anthony (part)	2,039	2.08×10^{-3}	2.08×10^{-5}
Shelley	7,051	1.58×10^{-2}	1.58×10^{-4}
South Bannock (part)	281	1.31×10^{-4}	1.31×10^{-6}
Sugar City (part)	4,831	1.15×10^{-2}	1.15×10^{-4}
Swan Valley (part)	454	3.25×10^{-5}	3.25×10^{-7}
Thorton	18,047	3.41×10^{-2}	3.41×10^{-4}
Ucon	5,207	1.74×10^{-2}	1.74×10^{-4}
West Clark	949	2.07×10^{-3}	2.07×10^{-5}
Totals	**226,938**	**0.53**	**5.26×10^{-2}**

a. Population based on 2000 census report for Idaho.
b. (Part) means only part of this county census division lies within 80 km (50 mi) of an INEEL facility.

Table 7-4. Summary of annual effective dose equivalents due to INEEL operations (2000).

	Maximum Dose to an Individual[a]		Population Dose
	CAP-88[b]	MDIFF[c]	MDIFF
Dose	0.034 mrem 3.4×10^{-4} mSv	0.057 mrem 5.65×10^{-4} mSv	0.53 person-rem 5.26×10^{-3} person-Sv
Location	Frenchman's Cabin	8.9 km (~ 5.5 mi) northwest 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)	NA[e]
Percentage of standard	0.34 %	0.57 %	NA
Natural background	361 mrem (3.6 mSv)	361 mrem (3.6 mSv)	43,700 person-rem (437 person-Sv)
Percentage of background	0.009 %	0.016 %	0.001 %

a. Hypothetical dose to the maximally exposed individual residing near the INEEL.
b. Effective dose equivalent calculated using the CAP-88 code.
c. Effective dose equivalent calculated using the MDIFF air dispersion model. MDIFF calculations 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.
e. No applicable standard.

Chapter 8

Quality Assurance

Environmental Surveillance, Education and Research Program

ESER

8. QUALITY ASSURANCE

Quality assurance and quality control programs are maintained by contractors conducting environmental monitoring and by laboratories performing environmental analyses.

8.1 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. Elements of typical quality control 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 replicate samples;
- Analysis of quality control standards in appropriate matrices to test accuracy;
- Analysis of reagent blanks to measure possible radiochemical contamination occurring during analysis;
- Analysis of blind spike samples (samples containing a known amount of a contaminant) to verify the accuracy of a measurement;
- Internal and external surveillance to verify quality elements; and
- Data verification and validation programs.

8.2 LABORATORY INTERCOMPARISON PROGRAMS

Data reported in this document were obtained from several commercial, university, government, and government contractor laboratories. In 2000, the Management and Operating (M&O) contractor used their Idaho National Engineering and Environmental Laboratory (INEEL) Radiological Measurements Laboratory and Paragon Analytics, Inc. for radiological analyses; the Environmental Health Laboratory in South Bend, Indiana, for inorganic and organic analyses; and the INEEL Environmental Hygiene Laboratory for bacteriological analyses. The Environmental Surveillance, Education and Research (ESER) contractor used the Environmental Analysis Laboratory located at Idaho State University and Quanterra, Inc. of Richland, Washington, (which was acquired by Severn Trent in February 2000). 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 conducted nonradiological 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 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 analytical method for the samples, and 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/.

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.

Dosimetry

To verify the quality of the environmental dosimetry program conducted by the M&O contractors, 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 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.

8.3 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 radioactive nuclides 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.

Both the ESER contractor and the M&O contractor maintained duplicate air samplers at two locations during 2000. The ESER contractor operated duplicate samplers at the Federal Aviation Administration (FAA) Tower and Monteview locations. The M&O contractor duplicate samplers were located at the Test Area North (TAN) and the Central Facilities Area (CFA). Filters from these samplers were collected and analyzed in the same manner as filters from

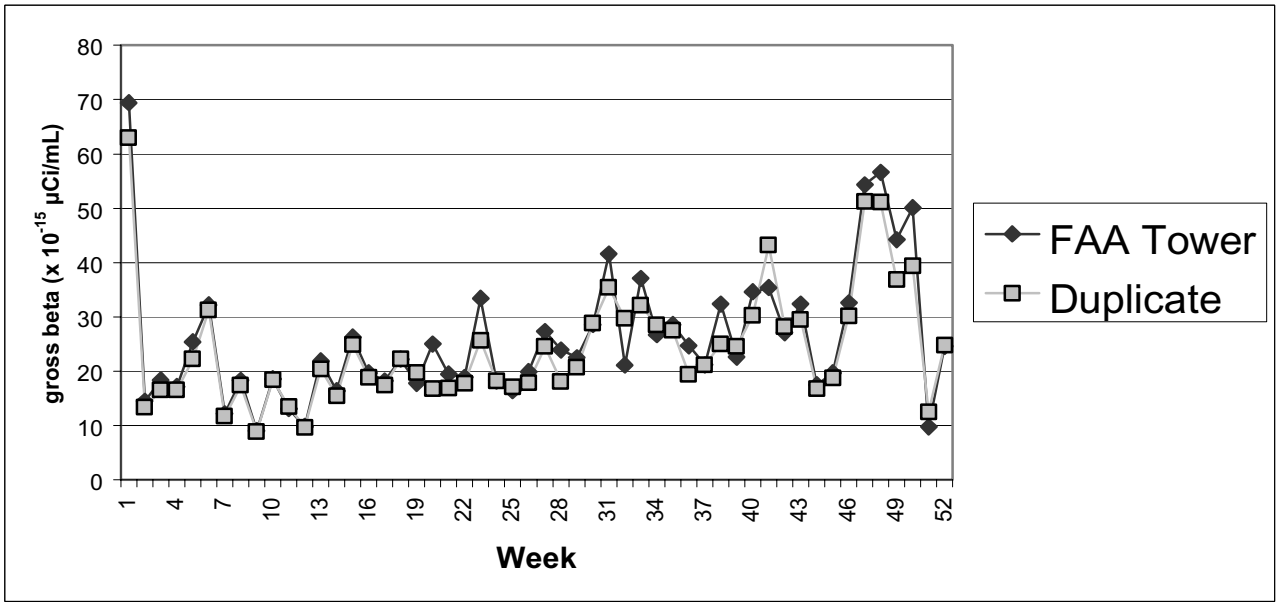
regular air samplers. Graphs of gross beta activity for the duplicate samplers are shown in Figures 8-1 and 8-2.

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 2000 in conjunction with the INEEL at three sampling locations: the distant location of Craters of the Moon National Monument and on the INEEL at the Experimental Field Station (EFS) and Van Buren Boulevard. Data from these three sampling locations for gross beta are shown in Figure 8-3. The data collected by the three organizations track each other quite well. The INEEL Oversight Program tends to show higher values as a result of the longer counting times used by that organization.

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 8-1 contains results of the gross alpha, gross beta, and tritium analyses for the 2000 samples taken from these locations.

The USGS also collects groundwater samples simultaneously with the INEEL Oversight Program on a routine basis. Results from this sampling are regularly documented in reports prepared by the two organizations.



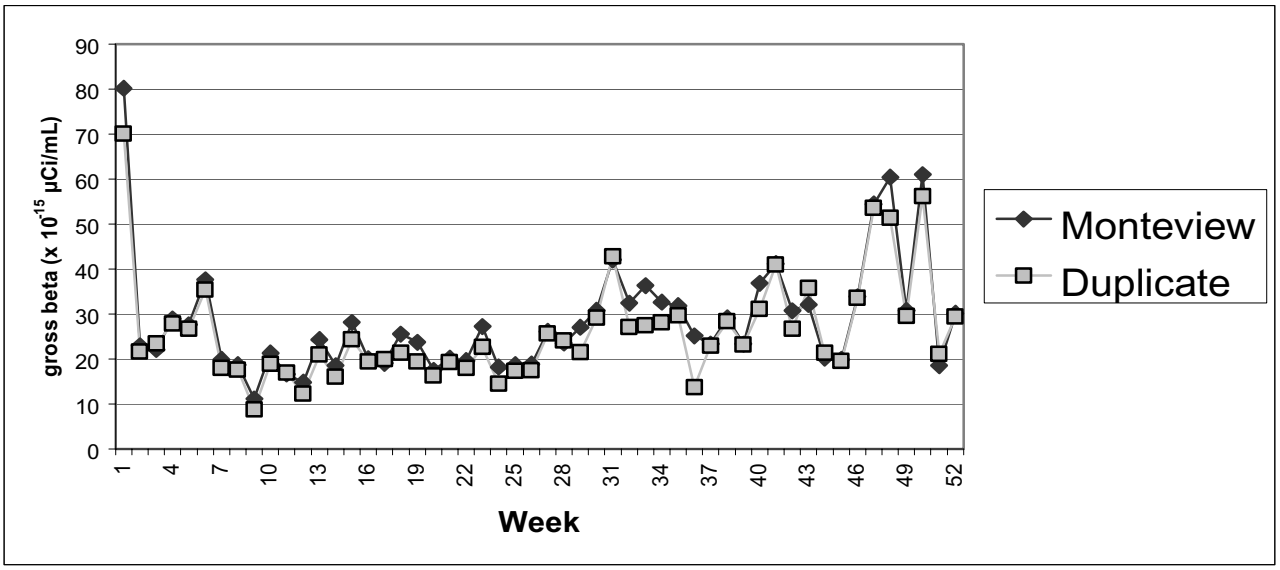
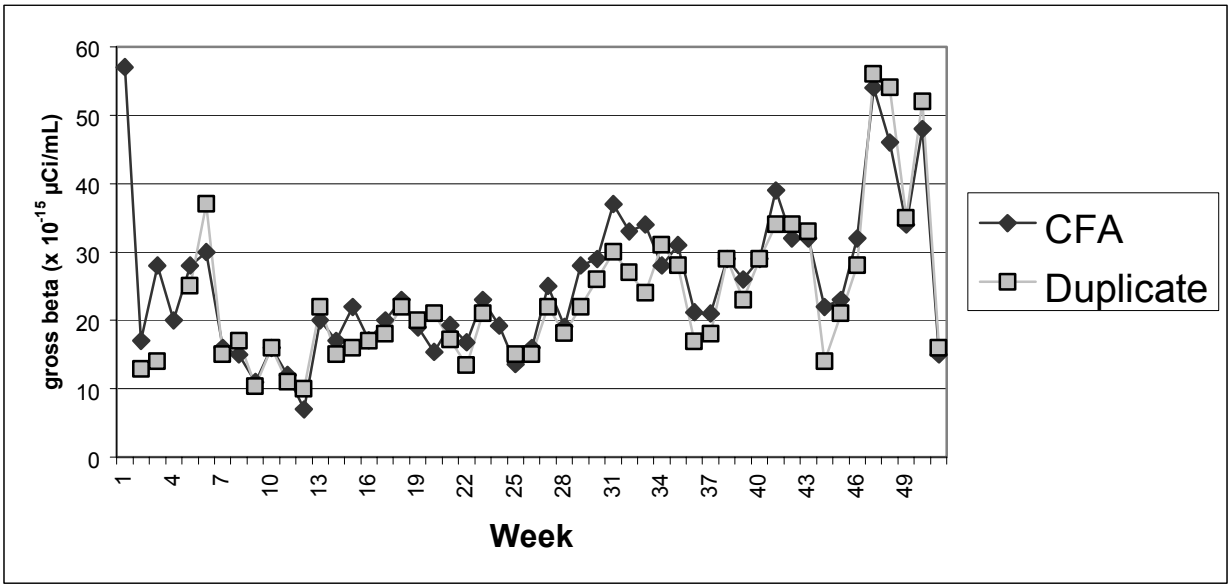


Figure 8-1. ESER contractor duplicate air sampling gross beta results (2000).



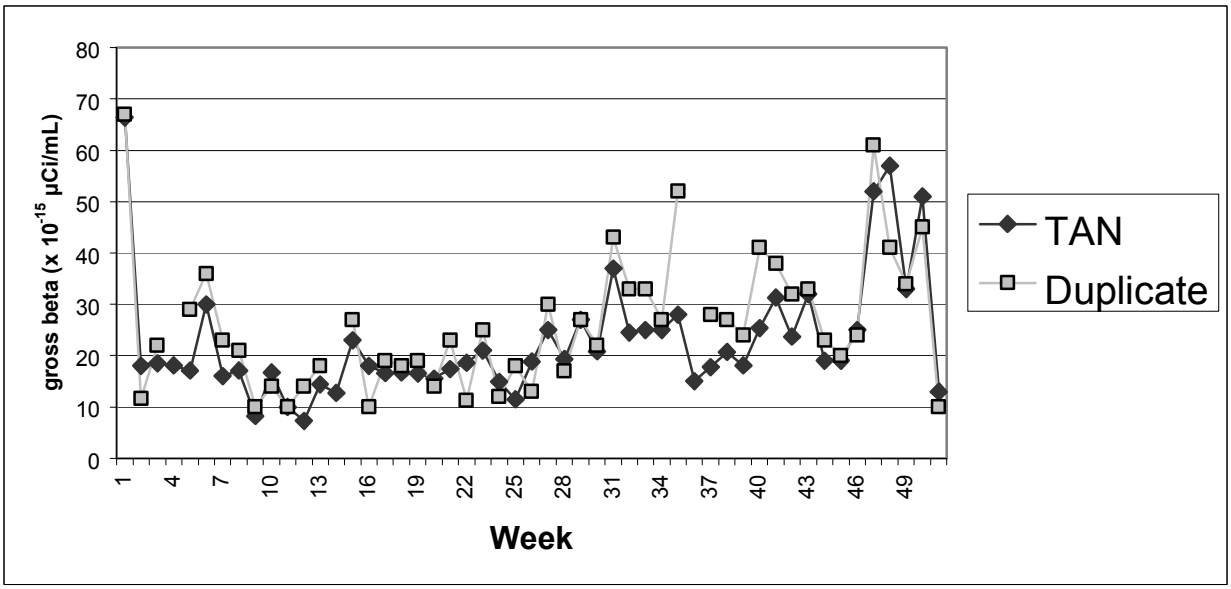


Figure 8-2. M&O contractor duplicate air sampling gross beta results (2000).

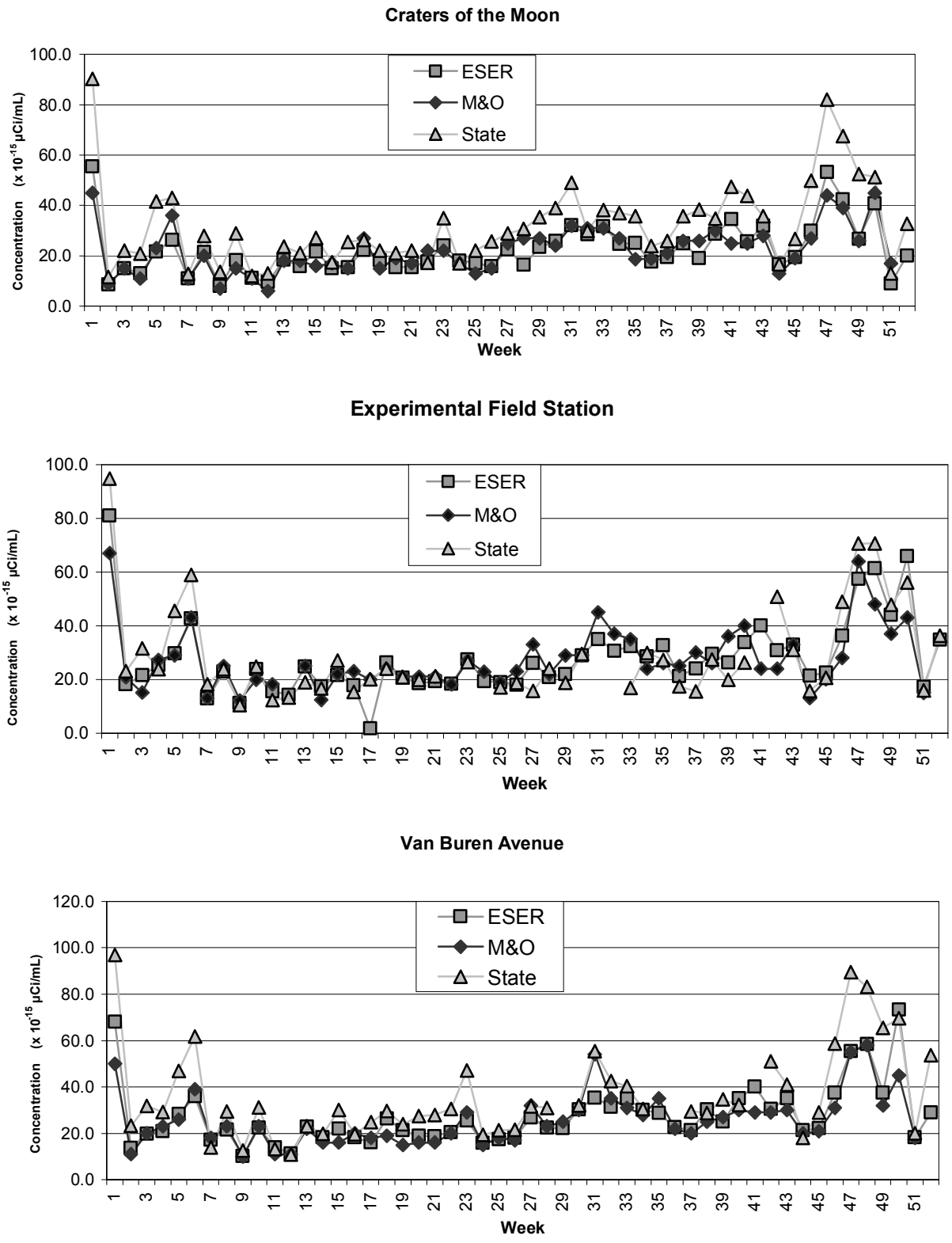
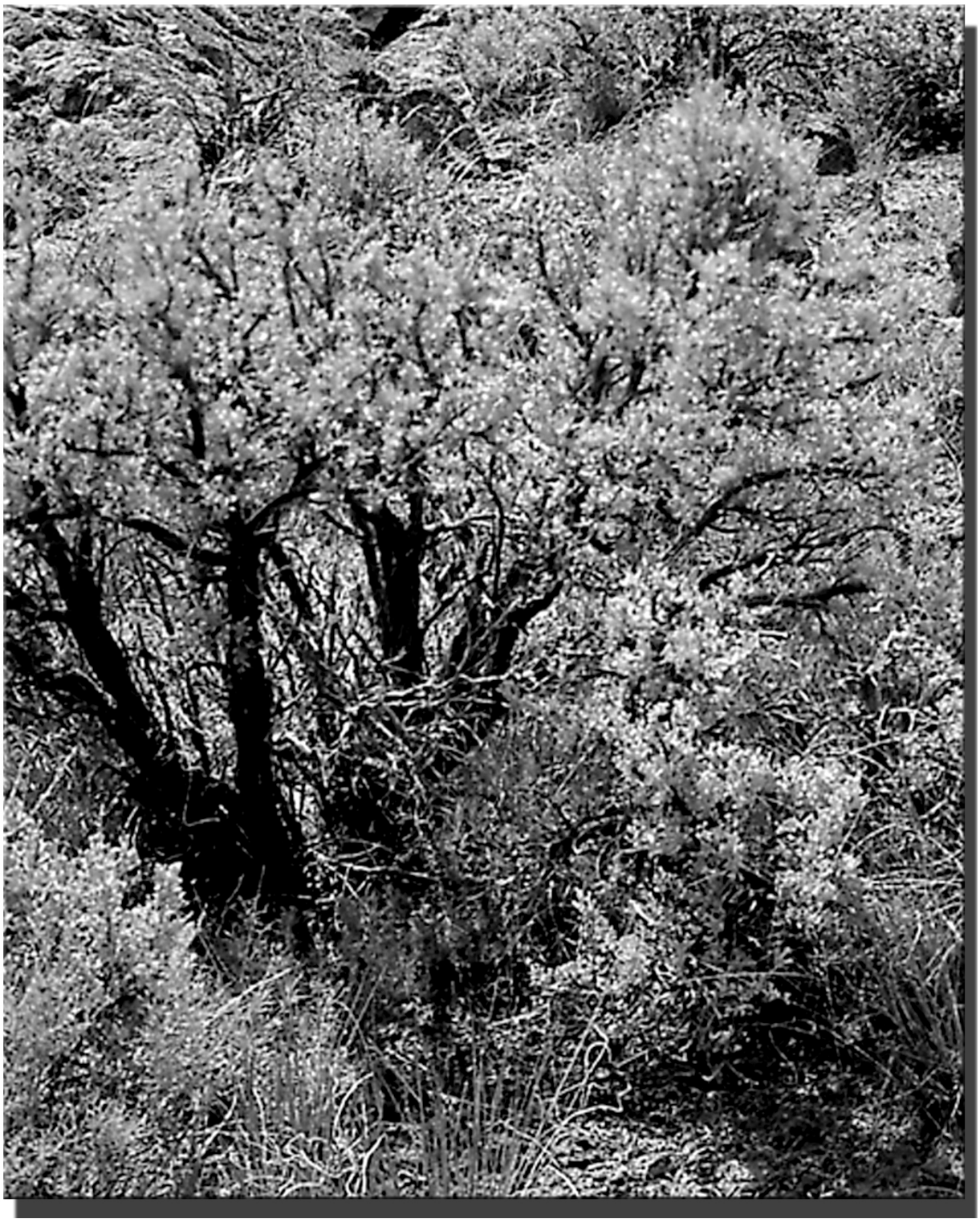


Figure 8-3. Comparison of gross beta concentrations measured by ESER contractor, M&O contractor, and state of Idaho (2000).

Table 8-1. Comparison of ESER and INEEL Oversight Program water monitoring results (2000).[a]

		Gross Alpha (10^{-9} µCi/mL)		Gross Beta (10^{-9} µCi/mL)		Tritium (10^{-9} µCi/mL)	
Location	**Date**	**ESER**	**State**	**ESER**	**State**	**ESER**	**State**
Minidoka	05/00	0.3 ± 1.2	0.1 ± 1.3	3.3 ± 2.6	0.3 ± 0.7	-82 ± 122	10 ± 70
(Drinking Water)	11/00	0.0 ± 0.8	3.1 ± 2.2	2.0 ± 1.8	2.7 ± 0.9	58 ± 71	-50 ± 80
Shoshone	05/00	1.1 ± 1.4	3.1 ± 2.7	4.5 ± 2.7	1.1 ± 0.9	-52 ± 123	-60 ± 70
(Drinking Water)	11/00	0.5 ± 0.9	1.8 ± 1.7	2.0 ± 1.8	1.1 ± 0.8	161 ± 73	0 ± 80
Bill Jones	05/00	1.1 ± 1.2	3.4 ± 1.7	1.1 ± 1.2	1.7 ± 0.8	-16 ± 124	-10 ± 70
Hatchery	11/00	0.6 ± 0.7	1.2 ± 2.3	3.4 ± 1.7	2.5 ± 0.9	-73 ± 63	10 ± 80
(Surface Water)							
Clear	05/00	0.5 ± 1.2	-2.1 ± 1.8	4.8 ± 2.8	0.9 ± 0.9	-69 ± 122	30 ± 70
Springs	11/00	0.9 ± 0.8	2.0 ± 2.6	3.7 ± 1.8	2.2 ± 0.9	44 ± 72	10 ± 80
(Surface Water)							
Alpheus	05/00	0.2 ± 1.2	1.0 ± 1.8	7.5 ± 3.1	3.8 ± 0.9	-51 ± 123	10 ± 80
Spring	11/00	0.5 ± 0.9	0.9 ± 2.0	6.7 ± 2.0	2.2 ± 0.9	-48 ± 63	-30 ± 80
(Surface Water)							

a. The result is ± 2 standard deviations, where the standard deviation is an estimate of the population standard deviation (see Appendix B)



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A-1 U.S. Department of Energy Order 5400.5, "Radiation Protection of the Public and the Environment," January 1993.

A-2 U.S. Department of Energy, *Internal Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0071, July 1988.

A-3 U.S. Department of Energy, *External Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0070, July 1988.

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C-1 U.S. Geological Survey, *Chemical and Radiochemical Constituents in Water From Wells in the Vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho, 1996*, Water-Resources Investigation Report, DOE/ID-22160, 2000.

C-2 U.S. Geological Survey, *Radiochemical and Chemical Constituents in Water from Selected Wells and Springs from the Southern Boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman Area, Idaho, 1998,* Water-Resources Investigation Report, DOE/ID-22162, 2000.

C-3 U.S. Geological Survey, *Chemical and Isotopic Composition and Gas Concentrations of Groundwater and Surface Water from Selected Sites at and Near the Idaho National Engineering and Environmental Laboratory, Idaho, 1994–97,* Open-File Report 00-81, DOE/ID-22164, May 2000.

C-4 U.S. Geological Survey, *A Transient Numerical Simulation of Perched Groundwater Flow at the Test Reactor Area, Idaho National Engineering and Environmental Laboratory, Idaho, 1952–94,* Open-File Report, DOE/ID-22165.

C-5 U.S. Geological Survey, *Chemical and Radiochemical Constituents in Water from Wells in the Vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho, 1997-98,* Water-Resources Investigation Report, DOE/ID-22166, 2000.

C-6 U.S. Geological Survey, *Distribution of Selected Radiochemical and Chemical Constituents in Perched Groundwater, Idaho National Engineering and Environmental Laboratory, Idaho, 1996–98,* Water-Resources Investigation Report 00-4222, DOE/ID-22168, October 2000.

C-7 U.S. Geological Survey, *Radiochemical and Chemical Constituents in Water from Selected Wells and Springs from the Southern Boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman Area, Idaho, 1999,* Open File Report 00-399, DOE/ID-22169, October 2000.

C-8 U.S. Geological Survey, *In Situ Production of Chlorine-36 in the Eastern Snake River Plain Aquifer, Idaho: Implications for Describing Groundwater Contamination Near a Nuclear Facility*, Open-File Report 99-473, 1999, DOE/ID-22161, 2000.

C-9 Perkins, K.S. and Nimmo, J.R., *Measurement of hydraulic properties of the B-C interbed and their influence on contaminant transport in the unsaturated zone of the Idaho National Engineering and Environmental Laboratory, Idaho*, U.S. Geological Survey Water-Resources Investigation Report 00-4073, DOE/ID-22170, 2000.

C-10 Perkins, K.S., *Hydrologic and meteorological data for an unsaturated-zone study near the radioactive Waste Management Complex Idaho National engineering and Environmental Laboratory, Idaho, 1997 to 1999*, U.S. Geological Survey, Open- File Report 00-248, DOE/ID-22171, 2000.

APPENDIX A
ENVIRONMENTAL STANDARDS AND REGULATIONS

The following environmental standards 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, 2000.

U.S. Environmental Protection Agency, "National Emission Standards for Hazardous Air Pollutants," 40 CFR 61, 2000.

U.S. Environmental Protection Agency, "National Pollutant Discharge Elimination System," 40 CFR 122, 2000.

U.S. Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," 40 CFR 141, 2000.

U.S. Environmental Protection Agency, "Hazardous Waste Management System: General," 40 CFR 260, 2000.

U.S. Environmental Protection Agency, "Identifying and Listing of Hazardous Wastes," 40 CFR 261, 2000.

U.S. Environmental Protection Agency, "Standards Applicable to Generators of Hazardous Waste," 40 CFR 262, 2000.

U.S. Environmental Protection Agency, "Standards Applicable to Transporters of Hazardous Waste," 40 CFR 263, 2000.

U.S. Environmental Protection Agency, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," 40 CFR 264, 2000.

U.S. Environmental Protection Agency, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," 40 CFR 265, 2000.

U.S. Environmental Protection Agency, "Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities," 40 CFR 267, 2000.

Department of Health and Welfare, State of Idaho, "Rules and Regulations for the Control of Air Pollution in Idaho," 1972, as amended through May 1990.

Department of Health and Welfare, State of Idaho, "Idaho Regulations for Public Drinking Water Systems," 16.01.8000-16.01.8999, October 1993.

The Derived Concentration Guides (DCGs) are based on the U.S. Department of Energy (DOE) standard [Reference A-1] and have been calculated using DOE models and parameters for internal [Reference A-2] and external [Reference A-3] 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 standard for protection of the public, airborne pathway only.

Ambient air quality standards are shown in Table A-3. Water quality standards 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 community drinking water systems in 40 CFR 141.

Table A-1. Derived concentration guides for radiation protection.

Derived Concentration Guide[a] (µCi/mL)			Derived Concentration Guide (µCi/mL)		
Radionuclide	**In Air**	**In Water**	**Radionuclide**	**In Air**	**In Water**
Gross Alpha[b]	2×10^{-14}	3×10^{-8}	^{129}I	7×10^{-11}	5×10^{-7}
Gross Beta[c]	3×10^{-12}	1×10^{-7}	^{131}I	4×10^{-10}	3×10^{-6}
^{3}H	1×10^{-7}	2×10^{-3}	^{132}I	4×10^{-8}	2×10^{-4}
^{14}C	5×10^{-7}	7×10^{-5}	^{133}I	2×10^{-9}	1×10^{-5}
^{24}Na[d]	4×10^{-9}	1×10^{-4}	^{135}I	1×10^{-8}	7×10^{-5}
^{41}Ar	1×10^{-8}	—	^{131m}Xe	2×10^{-6}	—
^{51}Cr	5×10^{-8}	1×10^{-3}	^{133}Xe	5×10^{-7}	—
^{54}Mn	2×10^{-9}	5×10^{-5}	^{133m}Xe	6×10^{-7}	—
^{58}Co	2×10^{-9}	4×10^{-5}	^{135}Xe	8×10^{-8}	—
^{60}Co	8×10^{-11}	5×10^{-6}	^{135m}Xe	5×10^{-8}	—
^{65}Zn	6×10^{-10}	9×10^{-6}	^{138}Xe	2×10^{-8}	—
^{85}Kr	3×10^{-6}	—	^{134}Cs	2×10^{-10}	2×10^{-6}
^{85m}Kr	1×10^{-7}	—	^{137}Cs	4×10^{-10}	3×10^{-6}
^{87}Kr	2×10^{-8}	—	^{138}Cs	1×10^{-7}	9×10^{-4}
^{88}Kr	9×10^{-9}	—	^{139}Ba	7×10^{-8}	3×10^{-4}
^{88d}Rb	3×10^{-8}	8×10^{-4}	^{140}Ba	3×10^{-9}	2×10^{-5}
^{89}Rb	3×10^{-7}	2×10^{-3}	^{141}Ce	1×10^{-9}	5×10^{-5}
^{89}Sr	3×10^{-10}	2×10^{-5}	^{144}Ce	3×10^{-11}	7×10^{-6}
^{90}Sr	9×10^{-12}	1×10^{-6}	^{238}Pu	3×10^{-14}	4×10^{-8}
^{91m}Y	4×10^{-7}	4×10^{-3}	^{239}Pu	2×10^{-14}	3×10^{-8}
^{95}Zr	6×10^{-10}	4×10^{-5}	^{240}Pu	2×10^{-14}	3×10^{-8}
^{99m}Tc	4×10^{-7}	2×10^{-3}	^{241}Am	2×10^{-14}	3×10^{-8}
^{103}Ru	2×10^{-9}	5×10^{-5}			
^{106}Ru	3×10^{-11}	6×10^{-6}			
^{125}Sb	1×10^{-9}	5×10^{-5}			

a. Derived concentration guides (DCGs) are from DOE Order 5400.5 and are based on an effective dose equivalent of 100 mrem/yr.

b. Based on ^{241}Am, ^{239}Pu, and ^{240}Pu.

c. Based on the most restrictive beta emitter (^{228}Ra).

d. Submersion in a cloud of gas is more restrictive than the inhalation pathway.

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 ($\mu g/m^3$)[b]
SO_2	Secondary	3-hour average	1300
	Primary	24-hour average	365
	Primary	Annual average	80
NO_2	Secondary and Primary	Annual average	100
	Secondary	24-hour average	150
Total Particulates[c]	Secondary and Primary	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. 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 nontransient noncommunity drinking water systems.

Constituent	Maximum Contaminant Levels[a]
Gross alpha	15 pCi/L
Gross beta[b]	50 pCi/L
Beta/photon Emitters	Concentrations resulting in 4 mrem total body or organ dose equivalent
Nitrate (as N)	10
Fluoride	4
Trihalomethanes (Chloroform)	0.1
Carbon Tetrachloride	0.005
Tetrachloroethylene	0.005
Toluene	1.0
1,1,1-trichloroethane	0.2
Trichloroethylene	0.005
Arsenic	0.05
Barium	2
Cadmium	0.005
Chromium	0.1
Lead	0.05
Mercury	0.002
Selenium	0.05
Silver	0.05

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

b. The MCL for gross beta is established as an exposure (4 mrem/yr). As a screening level 50 pCi/L is used.

APPENDIX B
STATISTICAL METHODS USED BY THE ENVIRONMENTAL SURVEILLANCE, EDUCATION AND RESEARCH PROGRAM

Relatively simple statistical procedures are used to analyze the data from the 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 Idaho National Engineering and Environmental Laboratory (INEEL) operations, meteorological data, and worldwide events that might conceivably have an affect on the regional environment.

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 "σ." Many of the results were less than or equal to 2s (and, in fact, some were negative), which means that they were below the minimum detectable concentration (MDC). 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. For example, in gamma spectrometric analyses, a given radionuclide is not considered detected unless the net count in the peak is greater than three times its estimated analytical uncertainty (3s). 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. If the result exceeds 3s, there is higher confidence that the material was detected (or, that the radionuclide was indeed present in the sample).

A deliberate search for specific radionuclides can be made and results reported, but such results might include negative values or small positive values where the result is less than or equal to 2s. Analyses with results in the questionable range (2s to 3s) are published in this report with the understanding that there is some doubt as to whether the material was actually present.

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.

Arithmetic means were calculated using actual assay results, regardless of their being above or below the MDC. The uncertainty of the mean, or the 95 percent confidence interval, was determined by multiplying the standard deviation of the mean (also called the standard error of the mean) or $s/(n)^{½}$ by the $t_{(0.05)}$ statistic. Means for which the 95 percent confidence interval does not include zero were assumed to indicate detectable amounts of activity. In situations where the analytical results of a group of samples are near the MDC, the 95 percent confidence interval for the mean may not include zero and, thus, appears to be statistically significant even though, on the basis of the 2s to 3s criterion, it is doubtful that any individual sample contained detectable radioactivity.

Geometric means were calculated by summing the natural logarithms (*ln*) of the positive analytical results, dividing by the number of samples (n), and then transforming the quotient. If the result was either a negative number or a zero, the *ln* of the smallest positive, nonzero measurement in the group was used. The 95 percent confidence interval was determined by multiplying the standard deviation of the geometric mean by the $t_{(0.05)}$ statistic and then transforming the result. The actual interval is determined by dividing the transformed mean by the transformed 95 percent confidence interval term for the lower limit, then multiplying the mean by the confidence interval term for the upper limit.

Unpaired t-tests were used to determine whether the annual means for the INEEL or boundary stations were greater than the annual means for the distant stations. All statistical tests used a level of significance of 95 percent ($\alpha = 0.05$).

APPENDIX C
U.S. GEOLOGICAL SURVEY 2000 IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY PUBLICATION ABSTRACTS

Chemical and Radiochemical Constituents in Water from Wells in the Vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho, 1996 **[Reference C-1]**

The U.S. Geological Survey (USGS), in response to a request from the U.S. Department of Energy's (DOE's) Pittsburgh Naval Reactors Office, Idaho Branch Office, sampled water from 13 wells during 1996 as part of a long-term project to monitor water quality of the Snake River Plain Aquifer (SRPA) in the vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory (INEEL), Idaho.

Water samples were analyzed for naturally occurring constituents and human-made contaminants. A total of 51 samples were collected from the 13 monitoring wells. Seven quality assurance samples also were collected and analyzed: one was a field-blank sample, one was a spiked organic sample, one was an organic trip-blank sample, and four were replicate samples. The field-blank sample contained concentrations of two inorganic constituents, one organic constituent, total organic carbon, and six radioactive constituents that were greater than the reporting levels. Concentrations of other constituents in the field-blank sample and those in the organic trip-blank sample were less than their respective reporting levels.

The 4 replicate samples and their respective primary samples generated 517 pairs of analytical results for a variety of chemical and radiochemical constituents. Of the 517 data pairs, 493 were statistically equivalent at the 95 percent confidence level; about 95 percent of the analytical results were in agreement.

Radiochemical and Chemical Constituents in Water from Selected Wells and Springs from the Southern Boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman Area, Idaho, 1998 **[Reference C-2]**

The USGS and the Idaho Department of Water Resources, in cooperation with DOE, sampled 18 sites as part of the fourth round of a long-term project to monitor water quality of the SRPA from the southern boundary of the INEEL to the Hagerman area. The samples were analyzed for selected radiochemical and chemical constituents. The samples were collected from 2 domestic wells, 12 irrigation wells, 2 stock wells, 1 spring, and 1 public supply well. Two quality assurance samples also were collected and analyzed.

None of the reported radiochemical or chemical constituent concentrations exceeded the established maximum contaminant levels for drinking water. Many of the radionuclide and inorganic constituent concentrations were greater than the respective reporting levels. Most of the organic-constituent concentrations were less than the reporting levels.

Chemical and Isotopic Composition and Gas Concentrations of Groundwater and Surface Water from Selected Sites at and Near the Idaho National Engineering and Environmental Laboratory, Idaho, 1994–97 **[Reference C-3]**

From May 1994 through May 1997, the USGS, in cooperation with the DOE, collected water samples from 86 wells completed in the SRPA at and near the INEEL. The samples were analyzed for a variety of chemical constituents including all major elements and 22 trace elements. Concentrations of scandium, yttrium, and

the lanthanide series were measured in samples from 11 wells and 1 hot spring. The data will be used to determine the fraction of young water in the groundwater. The fraction of young water must be known to calculate the ages of the groundwater using chlorofluorocarbons.

The concentrations of the isotopes deuterium, oxygen-18, carbon-13, carbon-14, and tritium were measured in many groundwater, surface water, and spring samples. The isotopic composition will provide clues to the origin and sources of water in the SRPA. Concentrations of helium-3, helium-4, total helium, and neon were measured in most groundwater samples, and the results will be used to determine the recharge temperature, and to date the groundwater.

A Transient Numerical Simulation of Perched Groundwater Flow at the Test Reactor Area, Idaho National Engineering and Environmental Laboratory, Idaho, 1952–94 **[Reference C-4]**

Perched groundwater zones have formed in the upper 200 ft of surficial alluvium, basalt, and sedimentary interbeds beneath wastewater infiltration ponds at the Test Reactor Area (TRA) of the INEEL. These zones are an integral part of the pathway for contaminants to move to the SRPA. Water moves rapidly through surficial sediments beneath the wastewater infiltration ponds as primarily vertical, unsaturated and saturated, intergranular flow. The extent of perched groundwater in the surficial sediments is limited to the vicinity of infiltration ponds. Water enters underlying basalt through fractures and interflow rubble zones and moves rapidly through the basalt as vertical flow in the fractures and as lateral flow in the rubble zones. Water enters the sedimentary interbeds from the overlying basalt and moves as saturated and unsaturated inter-granular flow. When the downward flux exceeds the vertical hydraulic conductivity of the interbeds, perched groundwater zones form and water moves laterally within and above the interbed unit. Vertical flow of water through the interbed unit enters the underlying basalts through fractures and moves as rapid fracture flow to the SRPA.

The approximate lateral dimensions of deep perched groundwater zones in 1988 as defined by monitoring wells were 1 mi by 0.5 mi for an area of about 14 million ft^2. The actual extent can only be approximated because of limited well information. This extent is controlled by the horizontal hydraulic conductivity of the unit in which perched water accumulates, by the rate at which downward flow is propagated through the perching layer, and by structural features that can direct or block lateral flow.

Perched water has been detected in the BC and DE1 basalt-flow groups and in a sedimentary interbed unit associated with the DE2, DE3, and DE3-4(W) flow groups. Water level data from paired wells in some areas indicated that multiple zones of perched water were separated by unsaturated basalt. Water level data from paired wells in other areas indicated that saturated flow was relatively continuous through the perched zones.

A four-layer numerical model was used to evaluate perched groundwater flow through the basalts and sediments in the upper 200 ft of the unsaturated zone beneath the TRA. This model treated perched flow as saturated flow and did not represent unsaturated flow properties related to changing moisture content. The first layer represented surficial sediments. The second and third layers represented basalt flow groups designated as the BC and DE1 flow groups, respectively. The fourth layer represented the sedimentary interbeds associated with the DE2, DE3, and DE3-4(W) basalt flow groups and designated as the interbed unit. Calibrated hydraulic conductivity values of 20 and 2 ft/d were uniformly assigned to cells in layers 2 and 3, respectively. Calibrated values of hydraulic conductivity of 0.05 ft/d and vertical hydraulic conductivity of 0.0028 ft/d were assigned to cells in layer 4 to represent fine-grained sediment in the

interbed unit. An effective porosity of 10 percent was assigned to all layers, and a confined storage coefficient of 0.0001, derived from the transient model calibration, was assigned to layers 2 through 4.

Until 1982, the extent of perched groundwater zones was controlled principally by wastewater infiltration from the warm waste ponds. In 1982, with the onset of wastewater disposal to the cold waste ponds, perched groundwater expanded to the south and water levels in deeper perched wells rose substantially. The simulated extent of perched groundwater zones approximated the known extent as determined from water levels in wells near the margins of perched groundwater zones. Comparison between simulated water levels and measured water levels showed that layer 2 poorly to moderately represented these transient hydrologic conditions in the BC flow group because of insufficient definition of the distribution of hydraulic properties. Layer 3 moderately to closely represented transient conditions in the DE1 flow group. The capability of layer 4 to represent transient conditions in the interbed unit was difficult to assess because most of the wells completed in the interbed were located at or outside the margins of perched water.

A simulation was run that assumed cessation of all wastewater recharge after 1994. This simulation showed that the perched groundwater zones drained approximately 4 years after cessation of recharge. All cells in layer 2 drained after approximately 6 months. All cells in layer 3 drained approximately 3.5 years after cessation. All cells in layer 4 drained approximately 4 years after cessation. The results of this transient simulation indicate that the BC and DE1 flow groups and the interbed unit will drain quickly in response to cessation of recharge from the TRA wastewater infiltration ponds.

Measured water levels in several wells completed in the perched zones were affected by leakage from intermittent streamflow exceeding 20,000 acre-ft per month. Because short-term streamflow infiltration fluctuations were not well approximated, simulated recharge peaks did not occur in cells representing wells known to be affected by streamflow infiltration. More precise simulation of the periodic commingling of perched groundwater zones underlying the TRA and recharge from the Big Lost River requires finer discretization of time and recharge from streamflow.

Chemical and Radiochemical Constituents in Water from Wells in the Vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho, 1997-98 **[Reference C-5]**

The USGS, in response to a request from the DOE Pittsburgh Naval Reactors Office, Idaho Branch Office, sampled water from 13 wells during 1997–1998 as part of a long-term project to monitor water quality of the SRPA in the vicinity of the Naval Reactors Facility, INEEL, Idaho.

Water samples were analyzed for naturally occurring constituents and human-made contaminants. A total of 91 samples were collected from the 13 monitoring wells. The routine samples contained detectable concentrations of total cations and dissolved anions and nitrite plus nitrate as nitrogen. Most of the samples also had detectable concentrations of gross alpha- and gross beta-particle radioactivity and tritium. Fourteen quality assurance samples also were collected and analyzed: seven were field-blank samples and seven were replicate samples. Most of the field blank samples contained less than detectable concentrations of target constituents; however, some blank samples did contain detectable concentrations of calcium, magnesium, barium, copper, manganese, nickel, zinc, nitrite plus nitrate, total organic halogens, tritium, and selected volatile organic compounds.

From May 1994 through May 1997, the USGS, in cooperation with the DOE, collected water samples from 86 wells

completed in the SRPA at and near the INEEL. The samples were analyzed for a variety of chemical constituents including all major elements and 22 trace elements. Concentrations of scandium, yttrium, and the lanthanide series were measured in samples from 11 wells and 1 hot spring. The data will be used to determine the fraction of young water in the groundwater. The fraction of young water must be known to calculate the ages of the groundwater using chlorofluorocarbons.

The concentrations of the isotopes deuterium, oxygen-18, carbon-13, carbon-14, and tritium were measured in many groundwater, surface water, and spring samples. The isotopic composition will provide clues to the origin and sources of water in the SRPA. Concentrations of helium-3, helium-4, total helium, and neon were measured in most groundwater samples, and the results will be used to determine the recharge temperature, and to date the groundwater.

Hydrologic Conditions and Distribution of Selected Constituents in Water, Snake River Plain Aquifer, Idaho National Engineering and Environmental Laboratory, Idaho, 1996 Through 1998 **[Reference 5-1]**

Radiochemical and chemical wastewater discharged since 1952 to infiltration ponds and disposal wells at the INEEL has affected water quality in the SRPA. The USGS, in cooperation with the DOE, maintains a monitoring network at the INEEL to determine hydrologic trends and to delineate the movement of radiochemical and chemical wastes in the aquifer. This report presents an analysis of water level and water quality data collected from the SRPA during 1996–1998.

Water in the SRPA moves principally through fractures and interflow zones in basalt, generally flows southwestward, and eventually discharges at springs along the Snake River. The aquifer is recharged principally from infiltration of irrigation water, infiltration of stream flow, and groundwater inflow from adjoining mountain drainage basins. Water levels in wells throughout the INEEL generally increased during 1996–1998.

Detectable concentrations of radiochemical constituents in water samples from wells in the SRPA at the INEEL decreased or remained constant during 1996–1998. Decreased concentrations are attributed to reduced rates of radioactive waste disposal, sorption processes, radioactive decay, and changes in waste disposal practices. Tritium concentrations in water samples decreased as much as 9.3 pCi/mL during 1996–1998 and ranged from 0.29 ± 0.06 to 18.7 ± 0.8 pCi/mL in 1998. Strontium-90 concentrations remained constant or decreased during 1996–1998 and ranged from 2.1 ± 0.6 to 41.1 ± 1.5 pCi/L in 1998. During 1996–1998, the concentrations of cobalt-60, cesium-137, americium-241, plutonium-238, and plutonium-239/240 (undivided) in water samples from all wells sampled at the INEEL were below the reporting level.

Detectable concentrations of chemical constituents in water from the SRPA at the INEEL were variable during 1996–1998. In 1998, water from one well south of the TRA contained 168 µg/L of dissolved chromium; other water samples contained from less than 14 to 26 µg/L. Sodium and chloride concentrations in the southern part of the INEEL increased slightly or remained constant during 1996–1998 because of long-term increased waste disposal rates. Nitrate concentrations remained relatively constant or decreased during 1996–1998 because of decreases in disposal rates and dilution by recharge water.

During 1996–1998, concentrations of 1 to 12 purgeable organic compounds were detected in water from wells at the INEEL. Concentrations of 1,1,1-trichloroethane were above the reporting level in all three wells sampled near the Idaho Nuclear Technology and Engineering Center (INTEC). Concentrations of several purgeable organic compounds exceeded their reporting levels in wells at or near the

Radioactive Waste Management Complex (RWMC) because of waste disposal practices.

Distribution of Selected Radiochemical and Chemical Constituents in Perched Groundwater, Idaho National Engineering and Environmental Laboratory, Idaho, 1996–98 **[Reference C-6]**

Radiochemical and chemical wastes generated at facilities at the INEEL have been discharged to infiltration ponds at the TRA and the INTEC and buried at the RWMC since 1952. Disposal of wastewater to ponds and infiltration of surface water at waste burial sites have resulted in formation of perched groundwater in basalts and in sedimentary interbeds above the SRPA. Perched groundwater is an integral part of the pathway for waste constituent migration to the aquifer.

The USGS, in cooperation with the DOE, maintains a continuous monitoring network at the INEEL to determine hydrologic trends and to monitor the movement of wastewater discharged from facilities. This report presents an analysis of water level and water quality data collected from perched groundwater at the INEEL during 1996–1998.

During 1996–1998, tritium concentrations in water from wells completed in deep-perched groundwater at the TRA generally decreased or were variable. During 1998, concentrations ranged from less than the reporting level to 116 ± 4 pCi/mL. Tritium concentrations in water from wells at the TRA were affected by distance of the well from the radioactive waste ponds, depth of the water below the ponds, the amount of tritium discharged to the radioactive waste ponds in the past, discontinued use of the radioactive waste ponds, radioactive decay, and dilution from nonradioactive water.

During 1996–1998, strontium-90 concentrations in water from wells completed in deep-perched groundwater at the TRA were variable. During October 1998, concentrations ranged from less than the reporting level to 59 ± 2 pCi/L. Cesium-137 and cobalt-60 were detected in water from a shallow well near the radioactive waste pond retention basin.

Dissolved chromium concentrations in perched groundwater at the TRA during 1998 ranged from less than 14 to 98 µg/L. The largest concentrations were in water from wells north and west of the radioactive waste ponds. Dissolved sodium concentrations ranged from 6.1 to 1,000 mg/L in 1998. Dissolved sulfate concentrations ranged from 18 to 3,200 mg/L. The largest concentrations of sodium and sulfate were in water from a well near the chemical waste pond.

During 1996–1998, tritium concentrations in water from wells completed in deep-perched groundwater near the INTEC infiltration ponds generally decreased because of decreased disposal; strontium-90 concentrations were variable. In October 1998, tritium concentrations ranged from less than the reporting level to 9.7 ± 0.5 pCi/mL; strontium-90 concentrations ranged from less than the reporting level to 2.8 ± 0.6 pCi/L.

During 1996–1998, concentrations of sodium, chloride, and sulfate in water from wells completed in perched groundwater near the INTEC infiltration ponds were similar to the concentrations of the constituents in the wastewater discharged.

During 1996–1998, concentrations of selected radiochemical constituents were below the reporting level in all samples from a well completed in perched groundwater at the RWMC. Samples contained concentrations greater than the reporting levels of 14 different purgeable organic compounds.

Radiochemical and Chemical Constituents in Water from Selected Wells and Springs from the Southern Boundary of the Idaho National Engineering and Environmental Laboratory to the Hagerman Area, Idaho, 1999 **[Reference C-7]**

The USGS and the Idaho Department of Water Resources, in cooperation with the DOE, sampled water from 19 sites as part of the fifth round of a long-term project to monitor water quality of the SRPA from the southern boundary of the INEEL to the Hagerman area. The samples were analyzed for selected radiochemical and chemical constituents. The samples were collected from four domestic wells, eight irrigation wells, two dairy wells, two springs, one commercial well, one stock well, and one observation well. Two quality assurance samples also were collected and analyzed.

None of the reported radiochemical or chemical constituent concentrations exceeded the established maximum contaminant levels for drinking water. Many of the radionuclide and inorganic constituent concentrations were greater than the respective minimum reporting levels. Most of the organic constituent concentrations were less than the minimum reporting levels.

In Situ Production of Chlorine-36 in the Eastern Snake River Plain Aquifer, Idaho: Implications for Describing Groundwater Contamination Near a Nuclear Facility **[Reference C-8]**

In situ chlorine-36 (^{36}Cl) production resulting from nuclear interactions between nonradioactive (stable) nuclides and particles given off during the radioactive transformation of uranium and thorium decay-series isotopes was determined for 25 whole-rock samples collected from 6 major water-bearing rock types in the Eastern SRPA. The rock types investigated were basalt, rhyolite, limestone, dolomite, shale, and quartzite. Calculated ratios of ^{36}Cl/Cl in these rocks, as a result of neutron activation of stable ^{35}Cl ranged from 1.4×10^{-15} (basalt) to 45×10^{-15} (rhyolite). The associated neutron production rates calculated for these rock types were 2.5 neutrons per gram of rock per year [(n/g)/yr] for the basalt and 29 (n/g)/yr for the rhyolite. The larger neutron production rate for the rhyolite is due to the larger uranium (11.5 parts per million) and thorium (22.2 parts per million) concentration of the rhyolite. For comparison, the uranium and thorium concentrations of the basalt were 0.8 and 2.23 ppm, respectively.

When the chloride concentration and rock porosity are considered with the calculated ^{36}Cl/Cl ratios, the estimated maximum corrected concentrations of ^{36}Cl in groundwater associated with the six rock types analyzed in this study ranged from 2.454×10^{5} atoms per liter for groundwater in the basalt to 7.68×10^{6} atoms per liter for groundwater in the rhyolite. These values are at least seven orders of magnitude smaller than concentrations measured in groundwater at and near the INEEL. A ^{36}Cl concentration of $15 \pm 0.1 \times 10^{12}$ atoms per liter has been reported for a groundwater sample collected near the INTEC, a nuclear waste processing facility at the INEEL. Additionally, in situ ^{36}Cl/Cl ratios in groundwater from rock with average compositions from this study ranged from 4.0×10^{-15} to 33.3×10^{-15}. For comparison, the range of ^{36}Cl/Cl for 254 groundwater samples collected from the SRPA at and near the INEEL was 31×10^{-15} to 2.9×10^{-9}.

Determining the contribution of in situ production to ^{36}Cl inventories in groundwater facilitated the identification of the source for this radionuclide in environmental samples. On the basis of calculations reported here, in situ production of ^{36}Cl was determined to be insignificant compared to concentrations measured in groundwater near buried and injected nuclear waste at the INEEL. Maximum estimated ^{36}Cl concentrations in groundwater from in situ production are on the same order of magnitude as natural concentrations in meteoric water.

Measurement of Hydraulic Properties of the B-C Interbed and their Influence on Contaminant Transport in the Unsaturated Zone at the Idaho National Engineering and Environmental Laboratory, Idaho **[Reference C-9]**

The intensely layered character of the 200-m thick unsaturated zone near the Radioactive Waste Management Complex (RWMC) Subsurface Disposal Area (SDA) at the INEEL critically affects both vertical and horizontal water fluxes. Because of the potential for radionuclide migration from the SDA to the SRPA, it is important to investigate the role of the unsaturated zone in contaminant transport processes. The unsaturated zone consists of thick layers of fractured basalts interbedded with thinner layers of sediment. These interbeds and basalts were deposited approximately 50,000 to 450,000 years ago during the late Pleistocene.

As a part of a drilling program to develop a standard methodology for subsurface characterization and risk assessment at INEEL, hydraulic properties of the 34-m deep sedimentary interbed (known as the B-C interbed) have been measured at one location in the vicinity of the SDA, including particle size distributions, water retention functions, saturated and unsaturated hydraulic conductivity, and related properties. In porous media, water flux is usually modeled in terms of Darcy's law for steady flow and Richards' equation for transient flow. Both of these formulations require knowledge of the unsaturated hydraulic conductivity (K) of the media. a property that is difficult to measure and highly sensitive to variations in water content. The transient case additionally requires knowledge of the water retention relation, which similarly varies to a high degree within the medium. The interbeds may play several critical roles in long-range transport processes: (a) retardation of downward-moving water as it encounters layer boundaries, (b) generation of perched water, (c) homogenization of preferential flow that has been focused by basalt fractures, and (d) the formation of long-range, highly conductive horizontal flow paths for contaminants. Within these sedimentary layers, there may be little or no impediment to lateral flow. Drastic differences in hydraulic properties between the basalt and interbeds, and within the interbeds themselves, are likely to promote such flow.

Hydrologic and Meteorological Data for an Unsaturated-Zone Study Area near the Radioactive Waste Management Complex, Idaho National Engineering and Environmental Laboratory, Idaho, 1997 to 1999 **[Reference C-10]**

The RWMC SDA at the INEEL has been used for burial of radioactive waste since 1952. In 1985, the USGS, in cooperation with DOE, began a multi-phase study of the geohydrology of the RWMC to provide a basis for estimating the extent of and the potential for migration of radionuclides in the unsaturated zone beneath the waste trenches and pits. This is the final phase in a study to provide hydrologic and meteorological data collected at a designated test trench area established by the USGS in 1985 adjacent to the northern boundary of the RWMC SDA.

Soil moisture content measurements were collected approximately monthly during the 1997-1999 period from 13 neutron-probe access holes with a neutron moisture gage. A meteorological station inside the test trench area provides data for the determination of evapotranspiration rates. This station measures soil surface temperature, net radiation, air temperature, relative humidity, wind speed, wind direction, soil heat flux, and precipitation and also calculates vapor pressure. Meteorological data for the test trench area are available for 1997 and part of 1998. The meteorological and soil moisture data are contained in files on a compact disk that is included with this report.