DOE/ID-12082(99) ISSN 1089-5469

Idaho National Engineering and Environmental Laboratory Site Environmental Report Calendar Year 1999

Environmental Surveillance, Education and Research Program

U.S. Department of Energy-Idaho Operations Office

July 2002

S. M. Stoller Corp.

This report was prepared for the
U. S. Department of Energy-Idaho Operations Office
under Contract DE-RP07-99ID13658
by the S. M. Stoller Corporation
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U.S. Department of Energy

Idaho National Engineering and Environmental Laboratory

It is the policy of the Department of Energy to conduct research, environmental remediation, and operations at the INEEL in a manner that protects human health and the environment and is in full compliance with environmental laws and regulations.

We achieve this by integrating environmental requirements and pollution prevention into our work planning and execution and by taking actions to minimize the environmental impacts of our operations. Through employee involvement and management commitment to environmental excellence, we 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. We do this by establishing and communicating environmental responsibilities, by providing environmental training to our workforce, and by implementing controls to mitigate environmental hazards.
- Conduct environmental remediation to address contamination from legacy activities and minimize impacts on human health and the environment.
- Develop and deploy new and enhanced environmental technologies and share this expertise with other DOE sites, the local community, and external customers.
- Integrate pollution prevention into project planning, design, and construction to minimize toxicity and volume of waste generated, conserve natural resources and energy, and minimize environmental impacts.
- Conserve natural resources by reusing and recycling materials, purchasing recycled materials, and using recyclable materials.
- Promptly identify noncompliant conditions and encourage full disclosure and open discussion regarding compliance issues. Aggressively work to resolve identified issues.
- Establish documented environmental objectives and milestones, and update them as necessary to reflect the changing needs, missions, and goals of the INEEL.
- Consider the input of our stakeholders when weighing options.
- Measure our environmental performance and monitor our impact on the environment, and communicate the results to our employees and stakeholders.
- Continuously improve our 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.

ACKNOWLEDGEMENTS

The following employees of S. M. Stoller Corporation, the current Environmental Surveillance, Education and Research Program (ESER) contractor, have provided primary authorship of this report: Aimee Anderson, Douglas Halford, Sue Majors, Christopher Martin and Ronald Warren.

The primary authors would like to thank all those who provided data and review time for the completion of this document. In particular, we wish to thank the following people for their assistance: Mark Arenaz, Barbara Beller, Brett Bowhan, Jack Depperschmidt, Greg Duggan, Brian Edgerton, Lori Fritz, Mark Gardner, Katie Hain, Rosemary Haines, Frank Holmes, Chelsea Hubbard, Talley Jenkins, Chuck Ljungberg, Stacey Madson, Mary McKnight, John Medema, Christian Natoni, R.D.E. Newbry, Kevin O'Neill, Kenny Osborne, Bill Owca, Don Rasch, Woody Russell, Bob Stark, Bob Stump, Dave Wessman, and Stephanie Woolf with the Idaho Operations Office of the U.S. Department of Energy (DOE); Roy Bartholomay, Brennon Orr, and Betty Tucker with the U.S. Geological Survey; W. Greg Bass with the Argonne West office of the DOE-Chicago Operations Office; Neil Hukari and Jerry Sagendorf of the National Oceanic and Atmospheric Administration; Tony Dull and Mark Hutchison of the DOE Pittsburgh Naval Reactors Office, Idaho Branch Office; Jerry Knowles and Bruce Olenick of Bechtel Bettis Inc.; Brad Andersen, Bob Bates, Ben Beus, Bryan Borsella, Teresa Brock, Doug French, John Gill, Teresa Meachum, Maria Miles, Jeffrey Mousseau, Joan Neff, Paul Ritter, Chris Staley, Leah Street, Karen Taylor, Jim Tkachyk, Dennis Walker, and Roger Wilhelmsen with Bechtel BWXT, Idaho; and Brian James of North Wind Environmental.

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

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

The third group includes a variety of exposures from human-made materials and devices such as medical x-rays, radiopharmaceuticals used to diagnose and treat disease, and consumer products containing minute quantities of radioactive materials. Exposures may also result from radioactive fallout from nuclear weapons testing, accidents at nuclear power plants, and other such 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 industries 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 1999 for the routine environmental surveillance programs conducted on and around the Idaho National Engineering and Environmental Laboratory (INEEL). The INEEL occupies approximately 2,300 km^2 (890 mi^2) of the upper Snake River Plain in southeastern Idaho. During 1999, the Environmental Science and Research Foundation (ESRF) conducted the offsite surveillance program as part of the Environmental, Surveillance, Education and Research (ESER) Program under contract with the DOE- Idaho Operations Office (DOE-ID). The term ESER contractor, as used in this report, refers to the ESRF. 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, North Wind Environmental, University of Idaho, and Washington State University. Stoller has prepared this report using the 1999 data collected by the ESRF. During 1999, the INEEL was operated by Lockheed Martin Idaho Technologies Company (LMITCO) from January 1st through September 30th and Bechtel BWXT Idaho,

LLC (BBWI) from October 1st through December 31st. LMITCO and BBWI are collectively referred to as the Management and Operating (M&O) contractor in this report. The M&O organization responsible for operating each facility conducted effluent and facility monitoring. The U.S. Geological Survey performed groundwater monitoring both onsite and offsite. The M&O contractor also conducted some facility and onsite groundwater monitoring. The National Oceanic and Atmospheric Administration collected meteorological data.

This report, prepared in accordance with the requirements in DOE Order 5400.1 [Reference P-2], is not intended to cover the numerous special environmental research programs conducted at the INEEL. Facilities operated under the Naval Nuclear Propulsion Program, such as the Naval Reactors Facility (NRF), are exempt from the provisions for preparation of an annual Site Environmental Report. The Naval Nuclear Propulsion Program maintains a separate environmental protection program to ensure compliance with all applicable environmental laws and regulations. Monitoring data and information specific to NRF are provided in a separate annual environmental report issued by NRF. For completeness, some information from onsite monitoring programs at NRF is included in this report.

EXECUTIVE SUMMARY

The results of the various monitoring programs for 1999 presented in this report indicated that radioactivity from the Idaho National Engineering and Environmental Laboratory (INEEL) operations could not be distinguished from worldwide fallout and natural radioactivity in the region surrounding INEEL. Radioactive material concentrations in the offsite environment and doses to the surrounding population were far below state of Idaho · and federal health protection guidelines.

Chapter 1 provides a description of the INEEL site, including the INEEL's mission, the history of the area, regional economic impacts of the INEEL, and major facilities located there.

Chapter 2 of this report summarizes INEEL activities related to compliance with environmental regulations and laws, describes various environmental issues and activities, and summarizes INEEL permit compliance for 1999.

A description of major activities and milestones in waste management, environmental restoration, and other environmental programs is provided in Chapter 3.

Chapter 4 discusses results from radiological environmental surveillance programs conducted in 1999 by both the Environmental Surveillance, Education and Research Program (ESER) contractor and the Management and Operating (M&O) contractor. Samples of air, water, foodstuffs and animal tissue were collected at distant, INEEL boundary and onsite locations. Environmental radiation measurements were also made at these locations.

Gross alpha and gross beta measurements, used as a screening echnique for air filters, were investigated by making statistical comparisons between onsite or boundary location concentrations and distant location concentrations. Gross alpha activities were found to be generally higher at distant locations than at boundary and onsite locations.

ESER contractor data indicated no statistically significant differences in monthly mean gross beta activity on air filters from onsite locations compared with distant group means. M&O contractor monthly mean gross beta activities did show statistically significant higher values for four of 144 comparisons of onsite versus distant locations. These higher values occurred in the Power Burst Facility/Auxiliary Reactor Area from June to September.

Air samples were also analyzed for specific radionuclides. Some radionuclides were detected at offsite locations, but most were near the minimum detectable concentration. At the levels measured, their origin is indistinguishable from natural sources, worldwide fallout, statistical variations in analytical results, or INEEL operations.

The annual concentrations of all specific nuclides detected at all locations were well below the U.S. Department of Energy's Derived Concentration Guides for radiation protection.

Tritium was measured in some atmospheric moisture and precipitation samples. Concentrations were similar at distant, boundary, and onsite locations, indicating that these detections were likely due to natural production in the upper atmosphere rather than to INEEL activities.

Gross alpha and gross beta activity were measured in offsite drinking and surface water samples. Concentrations were within the range expected for natural radioactivity. Four offsite drinking water and four offsite surface water samples contained tritium concentrations just above the minimum detectable concentration. The presence of tritium may be attributable to fallout sources, laboratory variability, or statistical variations in the analytical results.

Of the 161 milk samples collected in 1999, no samples contained detectable levels of iodine-131 (^{131}I). Tritium was not detected in any milk sample in 1999. Nine

milk samples contained detectable concentrations of strontium-90 (^{90}Sr). These concentrations were consistent with levels seen in samples nationwide, as reported by the U.S. Environmental Protection Agency (EPA). Some food samples (lettuce, wheat, and potatoes) contained small amounts of cesium-137 (^{137}Cs) and ^{90}Sr. These two radionuclides are present in soils as a result of worldwide fallout.

Low concentrations of ^{137}Cs were found in muscle tissue and liver of some game animals and sheep. These levels were consistent with background concentrations measured in animals sampled onsite and offsite in recent years. A liver and a muscle sample were taken from ten mule deer, four pronghorn, and two elk accidentally killed by vehicles on and around the INEEL. Nine of these samples contained detectable ^{137}Cs concentrations. Radionuclides above background concentrations were found in waterfowl and doves collected near the Test Reactor Area. The potential dose to a hunter consuming a game animal with the highest concentration of radionuclides was calculated to be approximately 0.02 mrem.

Ambient ionizing radiation measured simultaneously at the INEEL boundary and distant locations using environmental dosimeters were similar and showed only background levels.

Both the ESER and M&O contractors performed environmental surveillance for nonradiological substances. Chapter 5 presents a summary of air and storm water sampling results from the INEEL and offsite locations.

As in most previous years, concentrations in air of particulate matter less than 10 microns (PM_{10}) were generally higher at distant and boundary locations than at onsite locations. Agricultural activities are generally considered to be 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. Fine particulates ($PM_{2.5}$), nitrogen dioxide, and sulfur dioxide measured on and in the vicinity of the INEEL were all well within air quality standards.

Levels of one or more chemical parameters in storm water were above the corresponding EPA benchmarks at three monitoring points. However, no storm water discharge from INEEL facilities reached any regulated surface streams.

Groundwater monitoring was performed at the INEEL by the U.S. Geological Survey (USGS) using over 125 wells that tap the Snake River Plain Aquifer, as described in Chapter 6. Results of a number of special studies of the properties of the aquifer and the water within it were published during 1999. Several purgeable organic compounds (POCs) continue to be found in wells at the INEEL. Multiple wells used for drinking water contained POCs. Concentrations of organic compounds were below the EPA maximum contaminant levels (MCLs) for these compounds except for one monitoring well at the Radioactive Waste Management Complex where concentrations of carbon tetrachloride slightly exceed the MCL. (Throughout this report, measured concentrations of contaminants in groundwater and surface water are compared to the EPA drinking water standards as benchmarks. 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 on the INEEL. Neither of these radionuclides has been detected off of the INEEL since the mid 1980s. The calculated effective dose equivalent for workers at the INEEL of 0.6 mrem/yr is well below the EPA standard of 4 mrem/yr for community drinking water systems. This value was calculated using the location with the highest tritium concentration in drinking water (the Central Facilities Area).

Trichloroethylene concentrations in two

water samples from the backup well at Test Area North during 1999 remained slightly below the MCLs. In 1988, an aerating device was installed in the storage tank between the production wells and the point of entry to the Technical Support Facility (TSF) distribution system to remove volatile trichloroethylene from TSF drinking water. Results from water samples at this well and distribution systems indicate that the aeration system was efficiently treating trichloroethylene. In the third quarter of 1997, well TSF #1 was placed in standby and well TSF #2 was brought online as the primary production well. Trichloroethylene in well TSF #2 has not exceeded MCLs. As a result, the device in the tank is no longer operated unless well TSF #1 is being used.

Chapter 7 presents a description of the monitoring of airborne and liquid effluents released from INEEL facilities during 1999. An estimated total of 3,183 Ci of radioactivity, primarily in the form of short-lived noble gases, were released as airborne effluents. Approximately 91 Ci 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 at INEEL facilities. Nitrogen dioxide and sulfur dioxide concentrations were well below air quality regulatory limits. Monitoring results of liquid effluent streams indicated all were below applicable guidelines.

Chapter 8 describes the potential dose to members of the public from INEEL activities. The calculated hypothetical maximum individual effective dose equivalent of 0.003 mrem (3×10^{-5} mSv) was found to occur near Terreton, Idaho. This calculation was performed with MDIFF, a computer model developed to evaluate dispersion of pollutants from INEEL facilities. The calculation considered continuous submersion in, and inhalation of, radioactivity in air; ingestion of radioactivity in leafy vegetables and milk; and exposure to radioactive particulates deposited on the ground at that location on a continuous, year-round basis. This calculated dose is about 0.0008 percent of the background radiation dose in this area from all sources, including cosmic radiation, radioactive material in soil, natural radioactive potassium in the body, and exposure to radon.

The 1999 effective dose equivalent to the maximally exposed individual, calculated using the CAP-88 computer code and required for demonstration of compliance with EPA regulations, was 0.008 mrem or 0.002 percent of background. The model predicted the maximally exposed individual resided at Frenchman's Cabin, located at the INEEL's southern boundary. This location is currently inhabited only during portions of the year. Section 8.2, "Maximum Individual Dose - Airborne Emissions Pathway," includes a discussion of the two different computer models used. The maximum calculated dose to an individual by either of the methods was in compliance with the applicable radiation protection standard of 10 mrem/yr.

The maximum potential population dose from all evaluated pathways was estimated to be 0.037 person-rem (3.7×10^{-4} person-Sv) to the approximately 121,500 people residing within an 80-km (50-mi) radius from the geographical center of the INEEL. This value was calculated using the MDIFF air dispersion model and a food-chain model based on NUREG 1.109 [Reference ES-1]. This population dose was less than 0.0001 percent of the estimated 43,700 person-rem (437 person-Sv) population dose from background radioactivity and is lower than was calculated in 1997 and 1998.

In Chapter 9, the methods used to ensure the quality of data generated by contractors performing environmental monitoring at the INEEL are described. Data from quality control samples, including duplicate samples (two similar samples collected at the same time) and spiked samples (samples containing a known amount of a contaminant), are provided. Comparisons also are provided between data collected by the ESER contractor, M&O contractor, and the state of Idaho INEEL Oversight Program at locations where the three groups conduct similar sampling. No significant findings were made after data comparison.

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. A 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 ($1x10^{6}$)
centi-	c	1/100 ($1x10^{-2}$)
milli-	m	1/1,000 ($1x10^{-3}$)
micro-	µ	1/1,000,000 ($1x10^{-6}$)
nano-	n	1/1,000,000,000 ($1x10^{-9}$)
pico-	p	1/1,000,000,000,000 ($1x10^{-12}$)

Units of Radioactivity, Radiation Exposure, and Dose

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

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

The concentration of radioactivity in air samples and liquid samples, such as water and milk, is expressed in units of microcuries per milliliter (µCi/mL) of air or liquid. Radioactivity in foodstuffs 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 sievert 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 a 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 pre-established 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-125	^{125}Sb
Argon-41	^{41}Ar
Barium-140	^{140}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
Chlorine-36	^{36}Cl
Chromium-51	^{51}Cr
Cobalt-57	^{57}Co
Cobalt-58	^{58}Co
Cobalt-60	^{60}Co
Curium-244	^{244}Cm
Europium-152	^{152}Eu
Hafnium-181	^{181}Hf
Iodine-129	^{129}I
Iodine-131	^{131}I
Iodine-132	^{132}I
Iodine-133	^{133}I
Iron-55	^{55}Fe
Iron-59	^{59}Fe
Krypton-85	^{85}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
Potassium-40	^{40}K
Radium-226	^{226}Ra
Radium-228	^{228}Ra
Radon-222	^{222}Ra
Rubidium-88	^{88}Rb

Radionuclide	Symbol
Ruthenium-103	^{103}Ru
Ruthenium-106	^{106}Ru
Scandium-46	^{46}Sc
Sodium-24	^{24}Na
Strontium-90	^{90}Sr
Technetium-99	^{99}Tc
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

ACRONYMS

AEC	Atomic Energy Commission
AMWTF	Advanced Mixed Waste Treatment Facility
AMWTP	Advanced Mixed Waste Treatment Project
ANL-W	Argonne National Laboratory-West
ARA	Auxiliary Reactor Area
ATSDR	Agency for Toxic Substances and Disease Registry
BOD	Biological Oxygen Demand
BBWI	Bechtel BWXT Idaho, LLC
CEDE	Collective Effective Dose Equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDC	Centers for Disease Control and Prevention
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CFSGF	Coal Fired Steam Generating Facility
CI	Confidence Interval
CMS	Community Monitoring Station
COD	Chemical Oxygen Demand
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-CH	Department of Energy - Chicago Operations Office
DOE-HQ	U.S. Department of Energy - Headquarters
DOE-ID	U.S. Department of Energy - Idaho Operations Office
EA	Environmental Assessment
EAL	Environmental Assessment Laboratory
EBR-1	Experimental Breeder Reactor-I
EDE	Effective Dose Equivalent
EFS	Experimental Field Station
EIS	Environmental Impact Statement
EM	Environmental Management
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
ES&H	Environmental Safety and Health
ESER	Environmental, Surveillance, Education and Research Program
ESRF	Environmental Science and Research Foundation
FFA/CO	Federal Facility Agreement and Consent Order
FONSI	Finding of No Significant Impact
FY	Fiscal year
HLW	High-Level Waste

ICPP	Idaho Chemical Processing Plant (now INTEC)
IMPROVE	Interagency Monitoring of Protected Visual Environments
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center (formerly ICPP)
ISMS	Integrated Safety Management System
ISO	International Standards Organization
Kd	Distribution Coefficient
LMAES	Lockheed Martin Advanced Environmental Systems
LMITCO	Lockheed Martin Idaho Technologies Company
LSDDP	Large Scale Demonstration and Deployment Project
M&O	Management and Operating
MAPEP	Mixed Analyte Performance Evaluation Program
MCL	Maximum Contaminant Level
MDC	Minimum Detectable Concentration
MDIFF	Mesoscale Diffusion Model
MLLW	Mixed Low-Level Waste
MSC	(INEEL) Monitoring and Surveillance Committee
MSDS	Material Safety Data Sheet
MWFA	Mixed Waste Focus Area
NAGPRA	Native American Graves Protection and Repatriation Act
NAMP	National Analytical Management Program
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NERP	National Environmental Research Park
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIOSH	National Institute of Occupational Safety and Health
NIST	National Institute of Standards and Technology
NLLWMP	National Low-Level Waste Management Program
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
NRF	Naval Reactors Facility

NRTS	National Reactor Testing Station
NS	No Sample
NSNF	National Spent Nuclear Fuel Program
NTP	National Transportation Program
PACE	Paper, Allied-Industrial, Chemical and Energy Workers International Union
PBF	Power Burst Facility
PCBs	Polychlorinated Biphenyls
$PM_{2.5}$	Particulate Matter less than 2.5 microns
PM_{10}	Particulate Matter less than 10 microns
POCs	Purgeable Organic Compounds
QAP	Quality Assessment Program
RCRA	Resource Conservation and Recovery Act
RESL	Radiological and Environmental Sciences Laboratory
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision (CERCLA)
RWMC	Radioactive Waste Management Complex
RWMIS	Radioactive Waste Management Information System
SDA	Subsurface Disposal Area
SER 1999	Site Environmental Report 1999
SMC	Specific Manufacturing Capability
SNF	Spent Nuclear Fuel
SO_2	Sulfur Dioxide
SRPA	Snake River Plain Aquifer
STP	Site Treatment Plan
SWPPP	Storm Water Pollution Prevention Plan
TAN	Test Area North
TCE	Trichloroethylene
TLD	Thermoluminescent Dosimeter
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TNT	Trinitrotoluene
TRA	Test Reactor Area
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSF	Technical Support Facility
TSS	Total Suspended Solids
USGS	U.S. Geological Survey
WAG	Waste Area Group
WERF	Waste Experimental Reduction Facility
WIPP	Waste Isolation Pilot Plant

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	feet
g	gram
gal	gallon
ha	hectare
hr	hour
in	inch
kg	kilogram
L	liter
m	meter
mi	mile
mL	millliliter
mR	milliroengtgen
ng	nanogram
oz	ounce
pCi	picocurie
ppb	parts per billion
rem	roentgen equivalent man
R	roentgen
sec	second
Sv	Seivert
x^2	unit squared
x^3	unit cubed
yd	yard
yr	year
<	less than
>	greater than

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Chapter 1

Introduction

1. INTRODUCTION

1.1 LOCATION AND DESCRIPTION OF THE INEEL

The Idaho National Engineering and Environmental Laboratory (INEEL), also 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, extends 63 km (39 miles) from north to south, and is approximately 58 km (36 miles) wide at its broadest east-west portion (Figure 1-1). This area is mostly undisturbed expanse of the sagebrush-steppe ecosystem [Reference 1-1], with an average elevation of approximately 1,500 m (4,900 feet) above sea level. The INEEL is bordered on the north and west by mountain ranges and on the south by three volcanic buttes. Lands immediately beyond the boundaries of the INEEL are desert, foothills, and agricultural fields. Most of the nearby farming is concentrated northeast of the INEEL. Large areas of agricultural land are farmed adjacent to the Snake River, but these regions are more distant from the INEEL.

The altitude, intermountain setting, and latitude of the INEEL combine to produce a semi-arid climate [Reference 1-2]. 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 prior to 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, particularly fall through spring.

The climate of the cold desert environment of the INEEL is characterized by sparse precipitation (<8.6 in/yr), hot summers (average high temperature 70 °F), and cold winters (average low temperature 10 °F). The climate combined with mostly alkaline soils support plant communities and animal populations capable of coping with both arid conditions and temperature extremes. Basalt flows cover most of the plain, producing a rolling topography. 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 big game species. Published species counts include six fishes, two amphibians, 11 reptiles, 224 birds and 44 mammals [Reference 1-4]. Sixty percent of the INEEL is open to livestock grazing.

Figure 1-1. Location of the INEEL.

Rivers on the INEEL flow toward the northwest portion of the site, where they evaporate or soak into the subsurface. No surface water moves offsite. The fractured volcanic rocks under the INEEL, however, form a portion of the eastern Snake River Plain Aquifer, which stretches across 270 km (165 miles) 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-feet of water are stored in the aquifer's upper portions. The aquifer is primarily recharged from waters of the Henry's Fork and the South Fork of the Snake River, as well as the Big Lost River, the Little Lost River, and Birch Creek. In this century, irrigation recharge accounted for as much as 60 percent of the water in the aquifer. Beneath the INEEL, the aquifer moves to the southwest at a rate of 1.5 m to 6 m per day (5 to 20 feet per day). 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 for crop irrigation.

The INEEL consists of several primary facility areas located on an expanse of otherwise undeveloped terrain. Most buildings and structures on the INEEL are situated within facilities, leaving about 94 percent of the INEEL as open, undeveloped land [Reference 1-5].

1.2 INEEL'S MISSION

The present mission of the INEEL is "to develop, demonstrate, deploy, and transfer advanced engineering technology and systems to private industry to improve U.S. competitiveness and security, the efficient production and use of energy, and the quality of life and the environment worldwide." [Reference 1-6]

In addition to this stated mission, the DOE Idaho Operations Office (DOE-ID) is committed to providing a safe and healthy workplace for its employees, protecting public health and safety, and protecting the environment.

Currently about 60 percent of the INEEL's funding is devoted to environmental restoration and waste management activities. The INEEL's environmental program is laid out over the next 40 years by three key documents: the Idaho Settlement Agreement for spent nuclear fuel and radioactive waste; the Site Treatment Plan for waste that is both radioactive and hazardous (mixed waste); and the cleanup agreement with the DOE, the state of Idaho, and the Environmental Protection Agency (EPA). These legally enforceable agreements are geared toward assessing and remediating past contamination of the Site and putting wastes now stored at the INEEL in more stable forms that are ready for disposal as permanent repositories become available.

The remaining 40 percent of the INEEL budget funds ongoing programs like the Advanced Test Reactor and research into a wide range of fields, including energy efficiency, renewable energy, technology development, systems engineering, and other areas.

The INEEL was designated the second of seven National Environmental Research Parks (NERP) in 1975. NERPs were established as an outgrowth of the National Environmental Policy Act (NEPA) of 1969. The objectives of the NERPS are to "conduct research education activities that will:

- Develop methods for assessing and documenting the environmental consequences of human actions related to energy and weapons use;
- Develop methods for predicting the environmental consequences of ongoing and proposed energy development;
- Explore methods for eliminating or minimizing predicted adverse effects of various energy and weapons activities on the environment;
- Train people in ecological and environmental sciences; and
- Use the parks for educating the public on environmental and ecological issues." [Reference 1-1].

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 two million years [References 1-7 and 1-8]. The plain, which arcs across eastern Oregon and southern Idaho, marks the passage of the earth's crust over a plume of hot mantle material pressing upward. The resultant bimodal volcanism is oldest in the western portion of the Snake River Plain and youngest on the Yellowstone Plateau, which lies over the thermal plume today. The plain is a 650 km (400 mile) trail made by the passage of the continent over this "hot spot."

The following is a brief history taken from Plant Communities, Ethnoecology, and Flora of the Idaho National Engineering Laboratory [Reference 1-3]. For a more in-depth discussion of human use of the Upper Snake River Plain and especially of the lands of the INEEL, see Reference 1-3.

Humans first appeared on the Upper Snake River Plain 10,000 to 12,000 years ago. These peoples lived in socially fluid groups that traveled among the mountains, plains, and river bottoms as their seasonal needs changed. From the plain, game animals were taken in late summer. Archeological sites have revealed numerous large spear points associated with skeletal remains of mammoth, caribou, bison, and horse. The archeological record indicates a gradual reduction in projectile point size that corresponds roughly with local or complete extinction of large, relatively slow moving mammals and their replacement by the swifter-footed, smaller mammals, including deer, elk, and pronghorn, which still exist on the INEEL today [Reference 1-3].

The Shoshone and Bannock people eventually emerged in the region. These peoples used the plant and animal resources on the land as well. Rabbits, marmots, salmon, birds, camus, and cacti were often eaten. Sagebrush was used as fuel and bedding. Sap was collected from a variety of plant species and used as food.

The semi-nomadic nature of the Shoshone/Bannock and the practice among members of the present day Fort Hall Reservation population of gathering seasonally available resources from distant locations (e.g., piñon nuts and bitterroot, neither of which grows on or near the Reservation) imply a breadth of Shoshone/Bannock ecological knowledge that is in keeping with the region's environmental diversity [Reference 1-3].

Obsidian and other useful stones were quarried at Big Southern Butte and the high quality obsidian from this source was traded widely across the northern plains. A prime route between the Fort Hall area and the Camas prairie passed across the plain near the three buttes and across what later became the INEEL.

The earliest exploratory visits by European descendants came in the 1810s, '20s, and '30s. Trappers and fur traders were some of the first to make their way across the plain. Trappers ranged over the plain seeking new populations of beavers for pelts. Their descriptions discouraged potential settlers and encouraged those using the Oregon Trail to avoid lingering in the high desert. In 1834 when the original Fort Hall was built, there were numerous bison and beaver, but with the influx of European trappers, numbers of both species dwindled rapidly.

By 1840 the fur trade was essentially over. Between 1810 and 1840, game traditionally hunted by native human populations experienced significant declines. The second half of the 1800s saw valuable ores mined in the surrounding mountains, the beginning of cattle and sheep grazing in the valleys, and settlers from the Church of Jesus Christ of Latter-day Saints moving northward into the area. As the population grew, more lines of transportation — stock trails and stage routes — emerged across the plain. By 1857, an estimated 240,000 immigrants and their 1.5 million grazing animals passed through southern Idaho on the Oregon Trail. Native plant communities suffered greatly from this, as did the Northern Shoshones,

Bannocks, and their livestock, who traditionally depended upon those communities. By 1868, treaties had been signed forcing the native populations onto the reservation at Fort Hall. By the 1870s, miners had entered the Salmon River country, providing the impetus for farmers and others to follow.

A railroad opened between Blackfoot and Arco in 1901. There was, by then, sufficient enticement for homesteaders to attempt to win a section of land on the plain. The Carey Land Act of 1894 and the Desert Reclamation Act of 1902 set the stage for Idaho's irrigation-based farming economy, but the heart of the plain remained immune to irrigation because the porosity of its soils could not be overcome, and water drained from newly built canals faster than it could be carried to crops and stock.

World War II brought the U.S. Naval Ordnance Station to Pocatello, Idaho. This station, one of just two such installations in the U.S., retooled large guns from U.S. Navy ships. The facility was located inland to avoid the threat of enemy bomb attacks along the coast. The retooled guns needed to be tested, and the nearby, uninhabited plain was put to use as a gunnery range, called the Naval Proving Ground. In the aftermath of the war, as the nation worked to tame atomic power, the Atomic Energy Commission (AEC), predecessor to the DOE, became interested in the Naval Proving Ground and developed plans for an isolated facility with an ample water supply to build, test, and perfect nuclear power reactors. The Snake River Plain was chosen as the best location.

The Naval Proving Ground became the National Reactor Testing Station (NRTS) in 1949 under the AEC. The NRTS technological mission required both of the defining characteristics of the Snake River Plain, desert land and ample groundwater. The NRTS administrative offices were situated about 71 km (44 miles) to the east in Idaho Falls, then a city of less than 20,000 (Figure 1-2). 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. Only two reactors are routinely operated today. The NRTS was renamed the Idaho National Engineering Laboratory in 1974 and Idaho National Engineering and Environmental Laboratory in 1997 [Reference 1-9].

According to 1990 census figures some 121,500 people live within 80 km (50 miles) of the INEEL's operational center [Reference 1-10]. The communities closest to the INEEL are Atomic City (population 25), Arco (population 1,106), Howe (population 20), Monteview (population 10), Mud Lake (population 179), and Terreton (population 100). The larger population centers of Idaho Falls (population 49,928), Blackfoot (population 10,769), and Pocatello (population 50,588) are at least 35 km (22 miles) from the nearest INEEL boundary.

1.4 REGIONAL ECONOMIC IMPACT

Approximately 7,900 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 7,500 employees work for the prime contractor at the INEEL, which has been Bechtel BWXT, Idaho, LLC (BBWI) since October 1999. Other employees work for contractors, such as Bechtel Bettis, Inc. and the University of Chicago's Argonne National Laboratory.

The INEEL has a tremendous economic impact on eastern Idaho. The following statistics for 1999 demonstrate why the INEEL is an integral component of Idaho's economy and society [Reference 1-11].

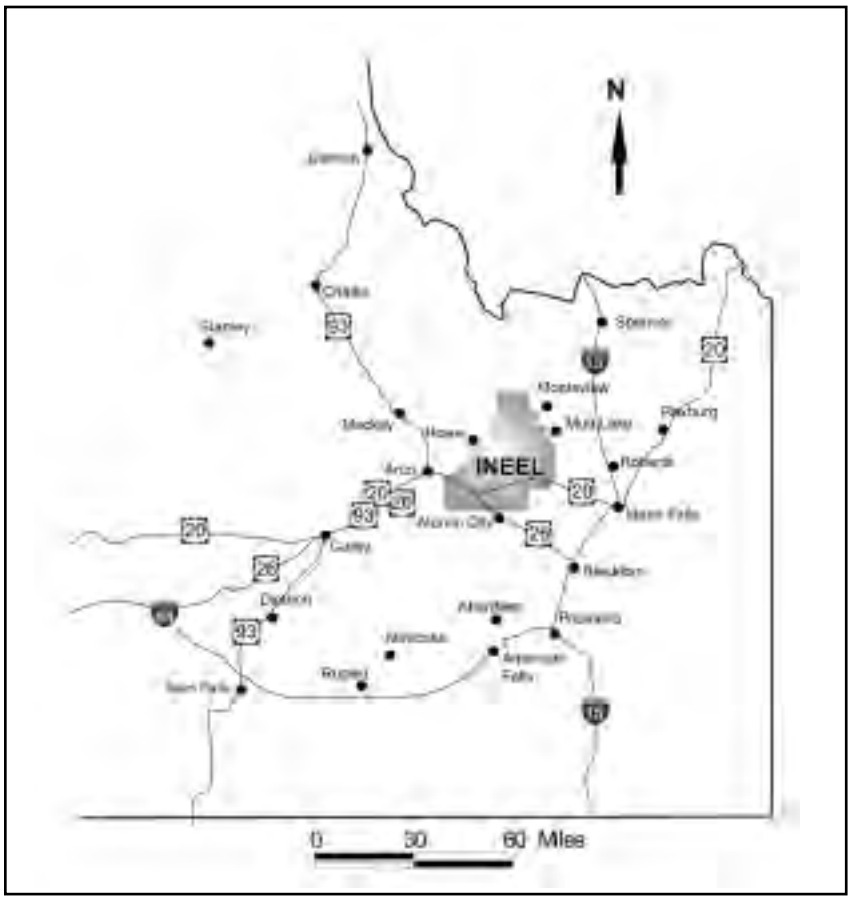

Figure 1-2. INEEL Vicinity.

- The INEEL directly and indirectly maintained over 15,000 jobs and accounted for almost half a billion dollars in economic activity for Idaho.
- About $132 million worth of goods and services was purchased by the INEEL from vendors in Idaho and surrounding states.
- Altogether, INEEL families paid $133.8 million in taxes.
- DOE and INEEL contractors consistently give their time and income to the community through various civic activities. In 1999, INEEL employees gave $21.2 million to charitable causes in their communities. INEEL employees and their households also contributed 1,386,949 volunteer hours to community concerns, church affiliations, educational activities, political and issue-related causes, youth, and other areas of interest.

1.5 FACILITIES

In 1999, the INEEL was operated for the DOE by Lockheed Martin Idaho Technologies Company (LMITCO) from January through September, and by BBWI from September through December. Bechtel Bettis, Inc. and the University of Chicago's Argonne National Laboratory operate additional facilities. Facilities are located in the city of Idaho Falls and at eight operating areas on the INEEL (Figure 1-3). Major facilities and their current missions are listed in the following sections.

Argonne National Laboratory-West

The University of Chicago's Argonne National Laboratory under contract to the DOE-Chicago Operations Office (DOE-CH) operates Argonne National Laboratory-West (ANL-W). The present mission of the laboratory is research into spent nuclear fuel, nuclear proliferation, and waste reduction and cleanup technologies.

Idaho Nuclear Technology and Engineering Center

The Idaho Nuclear Technology and Engineering Center (INTEC), formerly the Idaho Chemical Processing Plant (ICPP), receives and stores nuclear fuels from the U.S. Navy and other agencies. Technologies for treatment and disposal of high-level waste are being developed at the facility. High-level wastes are being treated and will ultimately be prepared for disposal in a permanent repository.

Figure 1-3. INEEL Facilities.

Test Area North

Located at the north end of the INEEL, Test Area North (TAN) was built to house the program to develop a nuclear-powered airplane during the 1950s. Facilities include one of the world's largest "hot shops," which, from 1986 to 1990, also supported research into the Three Mile Island accident. The largest program currently at TAN, the Specific Manufacturing Capability (SMC) project, produces armor for the M1A2 Abrams tank for the U.S. Army.

Test Reactor Area

The Test Reactor Area (TRA) has studied the effects of radiation on materials, fuels, and equipment for over 40 years. The Advanced Test Reactor at TRA is currently used for the production of important isotopes used in medicine, research, and industry and to test nuclear fuels.

Waste Reduction Operations Complex/ Power Burst Facility

The Power Burst Facility (PBF) area contains the Waste Experimental Reduction Facility (WERF), which processes low-level waste to reduce waste volume through sizing of metallic waste, compaction, and incineration.

Naval Reactors Facility

Bechtel Bettis, Inc. operates the Naval Reactors Facility (NRF) for DOE's Pittsburgh Naval Reactors Office. From 1953 through May 1995, NRF prototypes were used to train Navy personnel before serving aboard nuclear-powered submarines and warships. At the Expended Core Facility, NRF tests and examines naval reactor fuel components to improve current designs and to monitor the performance of existing reactors.

Radioactive Waste Management Complex

The mission of the Radioactive Waste Management Complex (RWMC) is to manage the disposal of low-level radioactive waste and to temporarily store transuranic waste. The facility studies various strategies for storing, processing, and disposing of radioactive wastes. The Stored Waste Examination Pilot Plant is used to non-destructively examine waste before it can be sent to the Waste Isolation Pilot Plant (WIPP) in New Mexico.

Central Facilities Area

The Central Facilities Area (CFA) is the headquarters for services at the INEEL. The area contains environmental monitoring, radiochemistry, radiation protection, quality assurance, and calibration laboratories; vehicle and equipment pools; a cafeteria; fire and emergency medical facilities; warehouses; various craft shops; and a security facility.

Idaho Falls Facilities

Idaho Falls facilities include the INEEL Research Center, which features programs in materials science, physical science, biotechnology, environmental science, and geotechnology. Additional personnel that provide support for the facilities at the INEEL are housed at the Engineering Research Office Building, Willow Creek Building, two DOE office buildings, and other office buildings.

Chapter 2

Environmental Compliance Summary

2. ENVIRONMENTAL COMPLIANCE SUMMARY

A large number of the current environmental statutes and regulations are applicable, in whole or in part, to the Idaho National Engineering and Environmental Laboratory (INEEL) or at the INEEL boundary. These are listed in Appendix A. A brief summary of the INEEL's status with those 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 the specific procedures to assess and remediate areas where the release of hazardous substances has occurred. 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 Department of Energy – Idaho Operations Office (DOE-ID), the state of Idaho, and the Environmental Protection Agency (EPA) Region 10.

During 1999, investigations under the processes outlined in the FFA/CO continued to be streamlined. Limited field investigations, termed either Track 1 or Track 2, were used to aid in evaluation of many potential release sites. A Track 1 designation is used for potential release sites where existing data are expected to support that a site needs no further action. A Track 2 investigation involves limited field data collection as necessary. After each limited investigation is completed, a determination is made by the CERCLA Project Managers whether a no further action listing is possible, or that either proceeding with an interim cleanup action or further investigation under a remedial investigation/feasibility study is appropriate. Most currently scheduled Track 1 and Track 2 field investigations have been completed.

Cleanup milestones scheduled in the FFA/CO were all met during 1999. Waste Area Groups (WAGs) identified in the FFA/CO have initiated a Comprehensive Remedial Investigation/Feasibility Study (RI/FS), which was intended as the last major investigation at each WAG. WAGs 1, 2, 3, 5, 8, and 9 had completed their respective RI/FS by 1999.

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 12856, "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 to local emergency planning committees, the State Emergency Response Commission, and to local fire departments for each quarter in calendar year 1999. These quarterly reports satisfied the 90-day notice requirement for new chemicals brought onsite.

312 Report. The Emergency and Hazardous Chemical Inventory (Tier II) Report for 1999 was transmitted to the planning and response agencies by March 1, 2000. This report identified the types, quantities, and locations of hazardous and extremely hazardous chemicals stored at INEEL facilities that exceed CERCLA and Threshold Planning Quantities within EPCRA.

313 Report. The Toxic Chemical Release Inventory Report was transmitted to the EPA and the state of Idaho by July 1, 1999. The report identified quantities of toxic chemicals released to the environment by the INEEL during calendar year 1998. Reports were prepared for three toxic chemicals in 1999: lead, nitric acid, and nitrate compounds.

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 potential natural resource trustees with possible jurisdiction over trust resources are the state of Idaho, 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 is attempting to coordinate 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.

In April 1995, the M&O contractor and the Environmental Surveillance, Education, and Research (ESER) contractor wrote a guidance manual for conducting screening level ecological risk assessments (Reference 2-1). The manual was developed to streamline and standardize the ecological assessment process at the INEEL. It supports DOE schedules and milestones in the FFA/CO for carrying out RI/FS activities at the INEEL.

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 many natural resource issues among trustees as well. The regulation allows for this substitution (Reference 2-2).

Clean Air Act

The Clean Air Act set standards for ambient air quality and for emission of hazardous air pollutants. 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:

- Self-certification that emissions are below any trigger level necessitating action by a regulatory agency;
- Request for a permit applicability determination from the regulatory agency;
- Request for a Permit to Construct; and
- Request for a Permit to Construct for sources of significant emissions through a Prevention of Significant Deterioration analysis.

Permitting actions for potential sources of air pollutants at the INEEL are listed in Section 2.3.

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

approval of the Idaho Title V Operating Permit program.

The INEEL Title V Air Operating Permit Application was submitted to the Idaho Division of Environmental Quality (DEQ) on July 28, 1995. The permit application was declared "administratively complete" on December 22, 1995. It is anticipated that an updated application is to be submitted in the spring of 2001. A regulatory technical review of the application is not anticipated to begin until summer of 2001. An emission inventory of sources of air pollutants is conducted annually and submitted to the regulatory agency.

National Emission Standards for Hazardous Air Pollutants. In June 2000, DOE-ID submitted the 1999 INEEL National Emission Standards for Hazardous Air Pollutants — Radionuclides report to EPA, DOE-Headquarters, and state of Idaho officials. 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 1999 calculations for this code are discussed further in Chapter 8, Dose to the Public.

Clean Water Act

The Clean Water Act, passed in 1972, established goals to control pollutants discharged to U.S. surface waters. Among the main elements of the Act are effluent limitations set by the EPA for specific industry categories and water quality standards set by states. The Clean Water Act also provided for the National Pollutant Discharge Elimination System (NPDES) permit program, requiring permits for discharges from a point source into surface waters. DOE was issued NPDES storm water general permits for the discharge of storm water from industrial and construction activities at the INEEL in 1993.

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 material in Spreading Area B. Borrow activities have ceased in this area since then.

Spill Prevention, Control, and Countermeasure Plans. Only the Test Area North (TAN), the Idaho Nuclear Technology and Engineering Center (INTEC), and the Radioactive Waste Management Complex (RWMC) require Spill Prevention, Control, and Countermeasure Plans. These INEEL facilities were evaluated in 1999 in accordance with 40 CFR 112.

National Pollutant Discharge Elimination System Point Source Discharge Permits. A NPDES permit application is on file with EPA Region 10 for minor discharges from INTEC production wells to the Big Lost River. INTEC is required to comply with Idaho water quality standards for these discharges.

Storm Water Discharge Permits for Industrial Activity. A modified NPDES Storm Water Multi-sector General Permit for industrial activities was published in 1998. The INEEL Storm Water Pollution Prevention Plan (SWPPP) for Industrial Activities (DOE/ID-10431) was implemented in 1993. The Plan provides for baseline and tailored controls and measures to prevent pollution of storm water. The SWPPP team conducts annual evaluations to determine compliance with the Plan and the need for revision. The Environmental Monitoring Unit of the M&O contractor monitors storm water in accordance with the permit requirements and with DOE Orders. Results from this monitoring in 1999 are provided in Chapters 4 and 5.

The National Oceanic and Atmospheric Administration Air Resources Laboratory 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. 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.

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 non-regulated 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 Test Reactor Area Chemical Waste and Cold Waste Ponds, the Naval Reactors Facility (NRF) Waste Ditch, and the Argonne National Laboratory-West (ANL-W) industrial and sanitary waste ponds.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) establishes regulatory standards for generation, transportation, storage, treatment, and disposal of hazardous waste. The Idaho DEQ is authorized by EPA to regulate hazardous waste and the hazardous component of mixed waste at the INEEL. Mixed waste contains both radioactive and hazardous materials. Radioactive wastes not containing hazardous materials are regulated by the Atomic Energy Act as administered through DOE Orders.

Notice of Violation. On May 6, 1999, a Consent Order to resolve the August 1997 Notice of Violation (NOV) was implemented. DOE agreed to a $500,000 penalty to resolve the 89 alleged violations, of which a Supplemental Environmental Project was established to contribute $114,906 to GEMStar Programs. On May 26, 1999, DOE received another NOV from 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. A Consent Order to resolve this NOV is expected to be implemented in 2000.

Closure Plans. The state of Idaho approved the closure plan of the Waste Calciner Facility in November 1999 for removal from the Part A permit.

Reports. As required by the state of Idaho, INEEL submitted the Idaho Hazardous Waste Generator Annual Report for 1999. The report contains information on waste generation, treatment, recycling, and disposal activities at INEEL facilities.

DOE-ID submitted the INEEL 1999 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, 1999.

A 45-day Notification for 1999 Treatability Studies was submitted to DEQ in October 1998. This report was submitted in lieu of the notification normally provided in the DOE Annual Report on Treatability Studies. Treatability Studies, as defined by the regulation [Reference 2-3], 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, which amends RCRA, 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 3.3.

In November 1999, the annual STP report was submitted to the State for review and final approval and the State approved the report in January 2000. In 1999, the INEEL treated 52 cubic meters (1836 ft^3) of mixed waste from offsite sources.

National Environmental Policy Act

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 Internal Scoping Procedures, Quality Program Plan, and Public Participation Plan. The DOE-ID NEPA Compliance Officer and NEPA Planning Board implement the process.

Advanced Mixed Waste Treatment Project Environmental Impact Statement. The Draft Environmental Impact Statement (EIS) was published on July 14, 1998. Three public meetings were held — one in Idaho Falls on August 18, 1998 and two in Twin Falls on August 20 and 21, 1998. The Final EIS was published in February 1999 and the Record of Decision was issued in March 1999. Refer to Section 3.3 for more information on this project.

High-Level Waste Treatment and Facilities Disposition EIS. A Notice of Intent was published and public scoping was conducted in 1997. Work continued on a Draft EIS in 1999, which is expected to be issued in early 2000. Refer to Section 3.3 for more information on this project.

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 non-transient non-community or transient non-community systems. The INEEL operates 12 active public water systems, two of which serve the NRF and ANL-W. All INEEL facilities performed sampling of drinking water as required by the State and EPA. See Chapter 6 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 environment. TSCA supplements sections of the Clean Air Act,

the Clean Water Act, 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. DOE-ID continues to store radioactively contaminated PCBs at the INEEL. Negotiations between the Headquarters offices of DOE and EPA resulted in a complex-wide 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 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 when 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.

DOE-ID, the M&O contractor, and Shoshone-Bannock Tribes began twice-a-year monitoring of the Waste Experimental Reduction Facility (WERF) Human Remains site in accordance with the Disposition Plan for WERF Human Remains (June 1998). Human remains were reburied at the site in 1998 after discovery in 1996.

Endangered Species Act

The Environmental Surveillance, Education, and Research (ESER) Program conducts ecological research, field surveys, and NEPA evaluations regarding ecological resources. Particular emphasis is given to threatened and endangered species and species of special concern identified by the U.S. Fish and Wildlife Service. Although sightings of wolves (*Canis lupus,* an endangered species) on the INEEL have been sporadically reported since 1993, none were reported during 1999. Nor were any Ute's ladies tresses *(Spiranthes diluvialis)* reported. It is 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 (*Speotyto cunicuilaria*), sage grouse (*Centrocercus urophasianus),* elk (*Cervus elaphus*), and pronghorn antelope (*Antilocapra americana*).

2.2 OTHER MAJOR ENVIRONMENTAL ISSUES AND ACTIVITIES

Groundwater Monitoring Program Activities

The INEEL Groundwater Monitoring Plan establishes 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 United States 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 (ARA), Special Training Facility, Power Burst Facility (PBF), 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 on an as-needed basis.

In 1999, 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 6), 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, and workers are concerned about previous exposures and are interested in a 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.

NIOSH Workforce Restructuring Investigation. Researchers from the Boston University School of Public Health, in cooperation with NIOSH, are investigating the effects of workforce restructuring (downsizing) in the nuclear industry. The health of displaced workers will also be studied. This investigation was started in 1999 and is expected to conclude in 2000.

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 comprised 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 continued in 1999.

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 complex-wide 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 2000.

Environmental Occurrences

Several small spills occurred at the INEEL during 1999 that were not reportable to external agencies under environmental regulations. The spills generally consisted of petroleum products and antifreeze. Five 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, over one pound of F002 RCRA hazardous waste was released to the soil from a tank and a combined total of 20—22 gallons of hydraulic fluid were released to the soil during two separate spills. At TAN, 4,000—5,000 gallons of fuel oil were spilled to the soil from a tank and an undetermined amount of jet fuel was released to the soil during a historical leak from an old fuel line. At CFA, stained soil discovered around an abandoned fuel tank was estimated to be a diesel fuel leak of approximately 200 gallons.

Environmental Oversight and Monitoring Agreement

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

- Assess the potential impacts of present and future DOE activities in Idaho;
- Assure citizens of Idaho that all present and future DOE activities in Idaho are protective of the health and safety of Idahoans and the environment; and
- Communicate the findings to the citizens of Idaho in a manner that provides them the opportunity to evaluate potential impacts of present and future DOE activities in Idaho.

Oversight Program activities produced many accomplishments in 1999, due in large part to a well-coordinated working relationship with DOE, INEEL contractors, the Shoshone-Bannock Tribes, USGS, National Oceanic and Atmospheric Administration, 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, ANL-W, Shoshone-Bannock Tribes, 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 is intended to verify and supplement 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 which have been or potentially could be contaminated by INEEL activities, including air, external gamma radiation, soil, milk, surface water, and groundwater. Results are reported in the 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 64 recommendations to date. In 1999, 11 recommendations were made including:

- Programmatic EIS for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States;
- Draft EIS of Sodium-Bonded Spent Nuclear Fuel;
- Recommendation on Groundwater Remediation Standards at the INEEL;
- Proposed Plan for Operable Unit 4-13a Interim Action, Waste Area Group 4 (WAG 4), CFA, INEEL;
- Stakeholder Statements from the Transportation Workshop May 20 – 22, 1999, Cincinnati, Ohio;
- Supplement to the Surplus Plutonium Disposition Draft EIS;
- Draft Final Proposal Plan for Waste Area Group 5 (WAG 5) – PBF/ARA at the INEEL;
- DOE's Notice of Intent to Prepare an EIS for Electrometallurgical Treatment of Sodium-Bonded Spent Nuclear Fuel in the Fuel Conditioning Facility at ANL-W, INEEL;
- Position on the Potential Violation of the April 30th Milestone Under the Idaho Settlement Agreement;
- Technical Comments on the Revised Draft RCRA Part B Permit for the WIPP; and
- Proposed Plan for TAN (Waste Area Group 1).

2.3 Permits

Table 2-1 summarizes permits applied for, and granted to, the INEEL through year-end 1999.

Table 2.1 Permit Summary for the INEEL (1999).

Media/Permit Type	Issuing Agency	Granted	Pending
Air			
Self-Certify	None	35	0
Permit to Construct	State of Idaho	1	0
Exempt/PAD[a]	State of Idaho	6	1
NESHAPs[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			
NPDES - Point Source	EPA Region 10	0	1
NPDES - Storm Water	EPA Region 10	2	0
Wastewater Land Application	State of Idaho	4	2
404 Permit	Corps of Engineers	1	0
Industrial Waste Acceptance	City of Idaho Falls	15	0
RCRA			
Part A	State of Idaho	1	0
Part B[c]	State of Idaho	8[c]	36[c]

[a] PAD represents Permit Applicability Determination.
[b] NESHAPs represents National Emissions Standards for Hazardous Air Pollutants.
[c] Part B permit is a single permit composed of several volumes.

Chapter 3

Environmental Program Information

3. ENVIRONMENTAL PROGRAM INFORMATION

3.1 ENVIRONMENTAL MANAGEMENT SYSTEM

The Department of Energy (DOE) Idaho Operations Office (DOE-ID) and the Idaho National Engineering and Environmental Laboratory (INEEL) management and operating (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 1999, 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 company documents to ensure full integration of environmental requirements flow-down into the work planning processes used at the INEEL;
- Development of a communication plan for ISO 14001 registration;
- Consolidation of functional Environmental Safety and Health (ES&H) 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. 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/EMS systems. However, linkages 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.

3.2 ENVIRONMENTAL RESTORATION PROGRAM

Overview

A common perception of environmental restoration investigative and remedial activities at DOE and other government sites is that all parts of the process are expensive and time consuming. However, during recent years, streamlining environmental restoration activities at the INEEL by DOE, the Environmental Protection Agency (EPA), and the state of Idaho has saved millions of dollars. This streamlining was possible due to the flexibility and management principles established under the Federal Facility Agreement and Consent Order (FFA/CO). This streamlining includes such activities as:

- Making clean-up 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.

The FFA/CO was signed in December 1991, and since then the INEEL has cleaned up sites containing asbestos, petroleum products, acids and bases, radionuclides, unexploded ordnance and explosive residues, polychlorinated biphenyls (PCBs), heavy metals, and other hazardous wastes. The INEEL Environmental Restoration Program has maintained significant progress in accomplishing its goals. As of December 1999, a tally of environmental restoration activities at the INEEL showed:

- 26 areas for conducting environmental investigations have been identified;
- 21 investigations have been completed;
- 19 Records of Decision have been signed;
- 9 areas have cleanup underway; and
- 10 areas have completed cleanup.

Comprehensive remedial investigation/ feasibility studies (RI/FS) are under way in Waste Area Groups 4, 7, and 10. The comprehensive investigations, which take an average of forty months to complete, accomplish the following:

- Determine the cumulative risks for an entire Waste Area Group 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/FS, and interim actions;
- Identify data gaps and recommend actions such as field sampling or historical document research to resolve questions;
- Perform a feasibility study to evaluate remedial alternatives for the entire Waste Area Group;
- Develop a proposed plan presenting the alternatives and recommending a preferred alternative;
- Develop a Record of Decision (ROD) 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 five investigations remain to be completed:

- Central Facilities Area comprehensive investigation;
- Buried waste at the Radioactive Waste Management Complex;
- Soil contamination at the Idaho Nuclear Technology and Engineering Center Tank Farm;
- Miscellaneous sites, including Experimental Breeder Reactor-I/Boiling Water Reactor Experiment-I; and
- Sitewide groundwater and Snake River Plain Aquifer contamination.

Waste Area Group 1 – Test Area North

Groundwater Remediation. Cleanup of the Test Area North (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 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 water is not accessible to workers or the public.

The final RI/FS addressing the entire contamination plume was completed in 1994. 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 and has since treated over 120.5 million liters (31.7 million gallons) of water. The remedy selected under the ROD calls for containing the contaminated groundwater and reducing contamination levels to below maximum contaminant levels within 100 years.

The decision also calls for the evaluation of new, innovative technologies, such as in-situ bioremediation and in-situ chemical oxidation, as enhancements to the current pump and treat operation.

A field test of bioremediation using a native microbe present in the subsurface was completed in 1999. Lactate was injected into the ground as a nutrient enhancement to the microbes that break down trichloroethylene (TCE). The test revealed the microbes were successful in significantly reducing the amount of TCE present.

Waste Area Group 1 – Comprehensive RI/FS. The comprehensive RI/FS was begun in 1995. Eleven operable units and 94 potential release sites, including tanks containing hazardous, PCBs, and radioactive wastes (the V-tanks) were evaluated during the final investigation. The RI/FS was finalized on November 14, 1997. A ROD for the comprehensive investigation was issued at the end of 1999. The ROD describes how eight contaminated sites will be remediated, including underground storage tanks, contaminated soil areas, a disposal pond, burn pits, and a fuel leak. A Proposed Plan for a new groundwater remedial action alternative is anticipated to be issued in 2000.

Waste Area Group 2 – Test Reactor Area

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 meters (330 feet) above the Snake River Plain Aquifer. It was formed over time by percolation from the TRA wastewater disposal ponds. Routine compliance monitoring has been conducted since 1993 to aid regulatory agencies in comparison of predicted and actual contaminant concentrations in the perched water.

Waste Area Group 2 – Comprehensive RI/FS. The comprehensive RI/FS and ROD were signed December 1997, documenting remedial action to be taken at eight of the 55 potential release sites at TRA, including four disposal ponds, three subsurface contaminant release sites, and one area of surficial windblown contamination. Major contaminants of concern are metals, radionuclides, and organic chemicals such as PCBs. The statement of work and work plan for Remedial Design/Remedial Action were approved by the regulatory agencies in 1998. Cleanup actions at the eight release sites began in 1999. Cleanup actions will consist of covering contaminated soil at three sites, excavating and disposing soil at one site, and implementing institutional controls and monitoring at all eight sites.

Waste Area Group 3 – Idaho Nuclear Technology and Engineering Center

Tank Farm. In 1999, DOE, EPA, and the state of Idaho finalized the Scope of Work to investigate contaminated soil at the INTEC tank farm and set the initial schedule for the

RI/FS. The tank farm consists of 20 tanks containing liquid wastes of varying quantities and associated equipment for waste transfer, monitoring, and control. This investigation will result in a separate ROD. An interim action of institutional controls will commence to minimize contaminant exposures and limit effects on soil and groundwater until a cleanup action is completed.

Waste Area Group 3 – Comprehensive RI/FS. The major source of contamination at INTEC is from underground storage tanks that contain high-level waste generated from past spent nuclear fuel reprocessing activities. 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.

Waste Area Group 4 – Central Facilities Area

Simulated Calcine/ Mercury-Contaminated Soil Removal Action. The materials associated with this project were excavated from a dry pond used in the 1950s and 1960s to dispose of materials from the Chemical Engineering Laboratory during development of a nuclear waste calcining process. The removal action summary report was issued in 1998.

Waste Area Group 4 – Comprehensive RI/FS. A total of 13 operable units and 52 potential release sites are being examined during this investigation. The main sources of contamination are landfills, a waste disposal pond, a wastewater drainfield, and underground storage tanks. Major contaminants are metals, radionuclides, and nitrates. The Remedial Investigation/Baseline Risk Assessment was submitted for review by the regulatory agencies in May 1998 and the draft RI/FS was submitted in September 1998. 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. Because the investigation of surface contamination was nearly complete, the Agencies decided to address surface contamination and groundwater contamination separately. As a result, an interim action Proposed Plan was released to address surface contamination at three sites, including a waste disposal pond, a sewage treatment plant drainfield, and a transformer yard. Completion of the comprehensive RI/FS will be delayed until 2002 to gather more information on groundwater contamination.

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

Stationary Low-Power Reactor-1/Boiling Water Reactor Experiment-I. Although these two reactor burial sites are located in different Waste Area Groups, similarities led to combining them for the investigative and remedial processes.

The Stationary Low-Power Reactor-1 facility was a small nuclear power plant designed for the military to generate electric power and heat for remote installations. An accidental critical reaction on January 3, 1961, resulted in a steam explosion that destroyed the reactor and killed the three operators on duty. To minimize radiation exposure to site workers and the public, a reactor burial ground was built for the contaminated debris near the original reactor site. Disposing of the material onsite was preferable to transporting the radioactive debris over 26 km (16 miles) of public highway to the Radioactive Waste Management Complex (RWMC).

The Boiling Water Reactor Experiment-I facility was a small reactor for testing boiling water reactor technology. It was intentionally destroyed in 1954 after completion of its mission. The destruction of the reactor contaminated about 2 acres (0.8 hectares) of

surrounding terrain. Much of the reactor debris was buried in place, and the area was covered with about 15 cm (6 in) of gravel to reduce radioactivity levels.

Capping of these sites was completed in 1996. The Remedial Action Report was completed in September 1997. The caps receive routine inspection, maintenance, and periodic radiological surveys.

Waste Area Group 5 – Comprehensive RI/FS. This investigation began in February 1995. Waste Area Group 5 has 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 RI/FS report was published in 1999. 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. The preferred alternative for contaminated soil sites was removal, ex-situ sorting, and onsite disposal. Under this alternative, the radioactively contaminated soil would be sorted to minimize the volume requiring disposal. A treatability study using the Segmented Gate System, a soil sorting technology, was performed in 1999 to evaluate the potential for volume reduction. Results of this treatability study are reported in "Summary Report for the Segmented Gate System Treatability Study, INEEL/EXT-99-00733" dated October 1999.

Waste Area Group 6 – Boiling Water Reactor Experiment

Boiling Water Reactor Experiment-I. Remediation of this reactor burial site is included under Waste Area Group 5 with the Stationary Low-Power Reactor-1 discussion.

Waste Area Group 6 – Comprehensive RI/FS. This comprehensive investigation is being conducted in combination with the Waste Area Group 10 comprehensive RI/FS.

Waste Area Group 7 – Radioactive Waste Management Complex

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 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 into which organic vapors were released when 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 1999, over 63,000 pounds of total volatile organic compounds have been removed from the vadose zone. The system will continue to extract and treat organics from the Subsurface Disposal Area (SDA) in 2000.

Pit 9 Interim Action. In 1993, a ROD was signed for Pit 9 that identified an interim action consisting of limited retrieval and treatment of waste from the pit. A subcontractor, Lockheed Martin Advanced Environmental Systems (LMAES), was selected to perform the interim action. LMAES experienced problems in performing the interim action, as a result DOE failed to meet two enforceable regulatory milestones. In March 1997, the agencies developed an Agreement to Resolve Disputes [Reference 3-1].

As a result of the Agreement to Resolve Disputes, DOE-ID developed a revised Remedial Design/Remedial Action Scope of

Work and Remedial Design Work Plan [Reference 3-2]. The revised Work Plan included a new schedule for implementation of the Pit 9 ROD by the subcontractor and a schedule for a contingent path that would be implemented in the event the subcontractor failed to perform the subcontract. DOE-ID, EPA, and the state of Idaho jointly developed this contingency plan. The agencies agreed to proceed with the contingency planning in order to ensure future schedules would be met. In addition, there was a need to obtain information to support the Waste Area Group 7 decision process, including characterization and treatability information.

On June 1, 1998, the M&O contractor terminated its Pit 9 subcontract with LMAES, citing failure to perform its obligations in a timely manner ("default"). In response to this action, DOE-ID notified EPA and the state of Idaho of its decision to pursue the jointly developed contingency plan, referred to as the Staged Interim Action.

The Staged Interim Action, a three-stage approach agreed to by the Agencies, will satisfy the requirements of the ROD and has the same objectives as the original Pit 9 interim action:

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

The Staged Interim Action consists of three stages. Stage I began in 1998 and will provide early 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 Waste Area Group 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 1999, geophysical mapping of Pit 9 was completed and three probes were installed in non-waste areas to determine moisture content of soils. An Independent Technical Review Panel was convened to address employee concerns associated with drilling into Pit 9. Additionally, the Stage II 30 percent design was completed and submitted to the Agencies for review. Stage I probing and Stage II design will continue 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 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 1999, an analysis of the in-situ vitrification of buried transuranic (TRU) waste in Maralinga, Australia, was completed. Work plans for in-situ grouting and in-situ vitrification treatability studies were completed and test pits containing simulated waste were excavated.

Pad A was revegetated to ensure integrity of the cap over the pad. Groundwater and perched water samples continue to be collected on a quarterly basis in and around RWMC to assess potential migration of contaminants from the site. In addition, a report was prepared and submitted to Congress that addresses the status of cleanup and assessment activities at Waste Area Group 7 and associated issues.

Waste Area Group 8 — Naval Reactors Facility

Naval Reactors Facility Remediation. DOE, EPA, and the state of Idaho signed a ROD for 10 sites at the Naval Reactors Facility (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. During 1999, monitoring and maintenance continued at the landfills.

Waste Area Group 8 – Comprehensive RI/FS. DOE, EPA, and the state of Idaho completed the comprehensive RI/FS for Waste Area Group 8 in September 1997. The RI/FS identified nine inactive waste sites with potential unacceptable risk to human health or the environment. The Agencies recommended limited excavation, disposal, and containment as the preferred remedy for the nine sites of concern. The Proposed Plan was issued for public comment in January 1998. A ROD for the comprehensive investigation of the NRF was signed in September 1998. It addressed 64 remaining sites, including the nine sites of concern. The remaining 55 sites do not require additional actions. Cleanup work began in the summer of 1999 on three of the nine inactive sites.

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 Argonne National Laboratory-West (ANL-W), which identified 5 sites requiring cleanup. The ROD identified phytoremediation 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 and therefore approximately 76 cubic meters (100 cubic yards) of soil from these sites will be excavated and disposed of at an appropriate facility.

Phytoremediation is the use of selected plants to extract contaminants through their root systems. The plants are periodically harvested, dried, packaged, and disposed at an appropriate facility. The phytoremediation project began in 1999 and is expected to continue through 2003.

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

Unexploded Ordnance Removal Actions. Prior to the inception of the INEEL in 1949, the U.S. Navy conducted aerial bombing practice, naval artillery testing, explosives storage bunker testing, and ordnance disposal at the site. These activities resulted in the unexploded ordnance areas that are being addressed in these removal actions. Unexploded ordnance and explosive residues found to date include artillery shells, partially exploded bombs, anti-tank mines, anti-personnel mines, depth charges, smokeless powder, and dummy bombs with spotting charges.

Removal actions began in 1993. During these actions, unexploded ordnance and ordnance explosive wastes were removed from various sites at the INEEL. Remaining ordnance areas will be evaluated in the Operable Unit 10-04 RI/FS to determine if additional remedial alternatives should be performed. A Treatability Study began in 1999 to test a new technique to break down soil contaminated with trinitrotoluene (TNT), including chunks of the explosive agent. The soil was pretreated with acetone to dissolve the TNT chunks then composted with wood chips, cow and chicken manure, alfalfa, and potatoes to allow microorganisms naturally found in the compost to feed on the TNT and reduce the ingredients to nitrogen-rich soil. Preliminary sampling results show the composting process degraded the TNT in the soil. A report summarizing the treatability study results is expected in 2000.

Radionuclide-Contaminated Soils Removal Action. The INEEL removed, consolidated, and contained over 7,600 m^3 (10,000 cubic yards) of contaminated soils from seven locations across the site between 1995 and 1997. These areas were contaminated as a result of spills, storage of surface-contaminated materials, and windblown contamination. Soil was consolidated in the TRA Warm Waste Pond to reduce the number of INEEL contaminated soil areas and final disposition of the soil was evaluated

in the TRA Operable Unit 2-13 Record of Decision. The Operable Unit 10-04 RI/FS will evaluate whether any additional soil consolidation will be needed to further reduce the risks.

Waste Area Group 10 – Comprehensive RI/FS. The comprehensive investigation to address Waste Area Group 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, began in 1999, with the ROD scheduled for completion in 2002. 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. A draft RI/FS for Operable Unit 10-08 is expected in 2004.

3.3 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. Waste Management continues to promote openness with stakeholders in regard to these issues and works closely with the INEEL State Oversight Program and the congressional delegation. Stakeholders were also notified of the timeframes for regulatory required public comment periods and where the subject 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. This Act requires the preparation of site treatment plans for the cleanup of mixed wastes, those containing both radioactive and non-radioactive 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 and provided a preliminary analysis of potential offsite mixed low-level waste treatment capabilities.

The INEEL Proposed Site Treatment Plan formed the basis for negotiations between the state of Idaho and DOE-ID on the consent order for mixed waste treatment at the INEEL. The FFA/CO 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: DOE reserved its right to challenge the approval authority of the State over offsite wastes, and 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.

Storage and treatment of the majority of the offsite waste will be performed at the Waste Reduction Operations Complex using incineration, stabilization, neutralization, macroencapsulation, and carbon absorption technologies. Additional offsite mixed wastes will be treated at the Advanced Mixed Waste Treatment Facility (AMWTF) planned to begin construction at the INEEL in 2000.

Advanced Mixed Waste Treatment Project. The overall goal of the Advanced Mixed Waste Treatment Project (AMWTP) is the treatment of alpha low-level mixed and transuranic 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 British Nuclear Fuels Limited, Inc. in December 1996. The contract was awarded in three phases:

- Phase I — licensing, permitting and environmental compliance to be completed in April 2000;
- Phase II — construction and process demonstration to be completed in December 2002;
- Phase III — treatment operations to begin by March 2003.

AMWTP completed several major milestones in 1999:

- ROD on Environmental Impact Statement issued in March 1999;
- Site mobilization activities began June 1999;
- Preliminary Safety Analysis Review approved by DOE in June 1999; and
- Draft HWMA/TSCA Permit issued by the state of Idaho and EPA on November 10, 1999, for public review and comment.

The facility will operate until 2015 with the possibility of continued operations until 2033.

High-Level Waste Treatment and Facilities Disposition. High-level waste (HLW) is a product of reprocessing spent nuclear fuel and is highly radioactive. HLW includes liquid waste produced directly from reprocessing and any solid waste (i.e., calcine) derived from the liquid. At the INEEL, HLW exists in both liquid and solid forms and is stored in underground tanks and in bins at the INTEC. The INEEL completed calcining of all liquid non-sodium bearing HLW on February 20, 1998, four months ahead of the June 30, 1998 Idaho Settlement Agreement milestone. Calcining of sodium-bearing liquid waste began on February 20, 1998, more than three years ahead of the Settlement Agreement milestone. All of this waste is required to be calcined by the end of the year 2012. By the end of 1999, approximately 4.9-million liters (1.3-million gallons) of sodium-bearing liquid waste and 4,300 cubic meters (~56,000 cubic yards) of high-level calcine waste remained in storage at the INEEL. During 1999, 380,000 liters (100,000 gallons) of liquid sodium-bearing waste were calcined. The sodium-bearing calcine waste will be stored in accordance with the DOE Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement Record of Decision, expected to be issued in 2001.

Low-Level Radioactive Waste. Significant accomplishments were achieved during fiscal year 1999 in the disposal of the legacy backlog of low-level radioactive waste (LLW) stored at the INEEL. Activities at the RWMC SDA were highlighted by the disposal of over

4,660 cubic meters (6,100 cubic yards) of legacy and newly generated LLW in fiscal year 1999. LLW volume reduction (compaction and sizing) accomplishments at the Waste Experimental Reduction Facility (WERF) totaled 2,836 cubic meters (3,710 cubic yards).

The goals for fiscal year 2000 include disposal of up to 4,000 cubic meters (5,232 cubic yards) of stored and newly generated LLW at the SDA and volume reduction (compaction and sizing) of 2,500 cubic meters (3,270 cubic yards) of LLW at WERF.

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, the Resource Conservation and Recovery Act, 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 3.1]. It functions as an important preventive mechanism in that reduced waste generation reduces waste management costs, compliance vulnerabilities, and the potential for environmental insult. 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 1999, the INEEL reported 23 pollution prevention projects, which resulted in a waste reduction of 8,500 cubic meters (~11,000 cubic yards) and decreased the cost of operations by $26.9 million. Noteworthy pollution prevention accomplishments in 1999 include:

- INEEL Environmental Restoration deactivated and decommissioned buildings and equipment and reused or recycled the resulting concrete, steel, wood materials, etc., reducing sanitary waste by approximately 6,467 metric tons and saving $11 million.
- Total volume of office paper used at INEEL was reduced by 50 percent due to the use of electronic documents, electronic drawings, and electronic mail, reducing sanitary waste by 148 metric tons and saving $4.1 million.

In September 1999, the INEEL shut down the Coal Fired Steam Generating Facility (CFSGF) because an analysis indicated the facility was unnecessary as an energy-producing source. The pelletizer system was also closed and was transferred to the DOE Savannah River Site in South Carolina as part of a technology exchange. The pelletizer converted office waste materials into paper cubes that supplemented the coal used to fuel the CFSGF. The waste materials formerly slated for the pelletizer will now be recycled or disposed of in landfills.

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 and volumetric survey for free release); and
- Provide the means for generators to disposition mixed waste lead.

The INEEL Site Treatment Plan backlog schedule for treatment of mixed waste lead-shielded casks was established in January 1996. The backlog schedule identified 136.7 cubic meters (179 cubic yards) of waste lead and lead-shielded casks. To date, 80.57 cubic meters (104.74 cubic yards) of waste were processed through the cask dismantlement activity: 9.27 cubic meters (12.1 cubic yards) in fiscal year (FY) 1996; 61 cubic meters (80 cubic yards) in FY 1997; and 10.3 cubic meters (13.4 cubic yards) in FY 1998. The combined percentage of the backlog processed as of September 1998 was 58.9 percent. Therefore, the established milestones to process 25 percent of the backlog by March 31, 1998, and to process 50 percent by March 31, 1999, have both been completed ahead of schedule. By December 1999, 75 percent of the backlog had been processed.

Mixed Low-Level Waste Treatment. The WERF was utilized to treat mixed low-level waste (MLLW) at the INEEL throughout 1999. The WERF incinerator processed over 200 cubic meters (260 cubic yards) of MLLW during 1999. The INEEL is marketing the capacity to treat DOE MLLW by incineration at WERF. Under provisions proposed in the INEEL Site Treatment Plan, any offsite waste received at the INEEL must be treated within six months of receipt, and all treatment residue must be sent out of Idaho within six months of treatment.

Since the first offsite waste treatment campaign in 1996, shipments of MLLW have been received and incinerated from the Naval Nuclear Propulsion Program (Mare Island, Charleston, Puget Sound, Pearl Harbor, and Norfolk Naval Shipyards), Bettis and Knolls Atomic Power Laboratories, and other DOE sites (Los Alamos, Hanford, Pantex, Sandia, and Paducah).

Idaho Settlement Agreement. On October 16, 1995, DOE, the U. S. Navy, and the state of Idaho entered into an agreement that will guide management of spent nuclear fuel and radioactive waste at the INEEL for the next 40 years. The agreement makes Idaho the only State with a federal court-ordered agreement limiting shipments of DOE and Naval spent nuclear fuel into the State and setting milestones for shipments of spent nuclear fuel and radioactive waste out of the State. All Settlement Agreement milestones scheduled for 1999 were met as follows:

- Begin moving Three Mile Island fuel into dry storage. Due 3/31/99 and was met 3/31/99.
- Issue DOE and Navy RODs on NEPA Analyses for preparing spent fuel for shipment using canisters. Due 4/30/99 and met by the Navy and DOE on 1/8/97 and 4/27/97, respectively, approximately two years ahead of schedule.
- First shipment of INEEL transuranic waste out of Idaho. Due 4/30/99 and was met 4/27/99.
- Negotiate plan and schedule for calcine waste treatment. Due 12/31/99, negotiation began 9/10/99, 3 months ahead of schedule.
- Commence negotiations to schedule spent fuel transfers out of wet storage. Due 12/31/99 and commenced on 5/13/99, 7 months ahead of schedule.
- Receive no more than 20 Naval spent fuel shipments per year (1997 - 2000). 20 shipments were received in 1999.

As part of the Settlement Agreement, the state of Idaho received its fourth installment of $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 created over 2,000 jobs.

Transuranic Waste. The TRU Program accomplished several major goals in 1999. In February 1999, the TRU Waste Program received certification from the EPA for its quality assurance program. The certification stated the INEEL has properly executed a quality assurance program in accordance with the requirements for contact-handled debris waste. On April 27, 1999, INEEL made its first shipment of TRU waste to the Waste

Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, less than five weeks after WIPP opened for receipt of non-mixed TRU waste. This shipment met the 1995 Idaho Settlement Agreement milestone to begin shipment by April 30, 1999. Three successive shipments to WIPP were completed in August and September. A total of 126 drums containing 26 cubic meters (34 cubic yards) of TRU waste were shipped to WIPP in 1999.

3.4 ENVIRONMENTAL RISK REDUCTION

Decontamination & Decommissioning / Demolition Activities

Decontamination and decommissioning (D&D) and demolition activities at the INEEL are primarily concerned with the safe and compliant decontamination and decommissioning of inactive facilities. These facilities fall under two broad categories: structures potentially suitable for reuse, and structures not suitable for reuse. Since 1975, 215 surplus buildings and structures have been removed as part of cleanup activities. Specific projects at various facilities are described below.

Test Reactor Area. The INEEL's Test Reactor Area building 660 (TRA-660), 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 environmental impact statement 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 are expected to be released in 2000, after which the reactors will be dismantled and disposed.

Idaho Nuclear Technologies and Engineering Center. The final two phases of a three-phase innovative closure project for the Waste Calcining Facility were completed in 1999. The first phase, completed in 1998, involved filling three basement levels of the facility, including rooms, hallways, pipes, and vessels, with more than 3,192 cubic meters (4,200 cubic yards) of grout. The grout created an underground monolith that encapsulates and prevents migration of any contaminants. Phases II and III involved demolition, grouting of above-surface structures, and capping the site with concrete. Total project costs were $11 million compared with an estimated $150 million for another traditional D&D technique.

Test Area North. Dismantlement of the Initial Engine Test Facility began in 1999. 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 Experimental Breeder Reactor-I facility.

Radioactive Waste Management Complex. The Certification and Segregation Building was dismantled in 1999. Until 1997, the Building stored thousands of drums of transuranic waste that were destined for WIPP. The drums are now stored in regulatory-compliant storage buildings at the RWMC. Future plans for the area involve construction of the AMWTF.

INEEL Large Scale Demonstration and Deployment Project. The INEEL Large Scale Demonstration and Deployment Project (LSDDP) 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 17 technologies are planned to be demonstrated or have been demonstrated during the INEEL LSDDP:

- Remote Underwater Characterization Systems – demonstrated August 1998.
- Soft-sided Containers – demonstrated August 1998 through January 1999.

- Lead Paint Analyzer – demonstrated February 1999.
- Automatic Locking Scaffold System – demonstrated January through April 1999.
- Electromagnetic Radiography – demonstrated June 1999.
- Alloy Analyzer – demonstrated June 1999.
- PCB Analyzer – demonstrated June 1999.
- Paint Scaler Technology – demonstrated September 1999.
- Global Positioning Radiometric Scanner – demonstrated September 1999.
- Copper Wire Recycle System – demonstrated November 1999.
- En-Vac Robotic Climber with Scabbler – planned for demonstration in 2000.
- Portable Safety Monitor – planned for demonstration in 2000.
- In Situ Object Counting System – planned for demonstration in 2000.
- Electro-Chemical Decontamination System – planned for demonstration in 2000.
- Three-Dimensional Surface Mapping System – planned for demonstration in 2000.
- Roughing Filter Technology – planned for demonstration in 2000.
- Integrated Vertical and Overhead Decontamination System – planned for demonstration in 2000.

3.5 NATIONAL PROGRAMS MANAGED BY DOE-ID

Environmental Management Lead Laboratory

The Secretary of Energy designated the INEEL as the Environmental Management (EM) Lead Laboratory for the DOE complex in 1999. This status makes INEEL responsible to facilitate and integrate EM planning, resources, and implementation activities across the complex to help reduce barriers and develop effective solutions. Specifically, the INEEL will facilitate and lead activities to:

- Initiate an assessment of capabilities required to complete the EM mission;
- Reduce cleanup risks, cost, and time by encouraging consideration of alternative and innovative technologies;
- Lead development of a science and technology program for long-term stewardship;
- Champion complex-wide integration and planning;
- Provide unbiased, open, and expert technical assistance on key issues;
- Improve the defensibility of program decision-making;
- Manage national programs assigned to the INEEL; and
- Provide infrastructure and technical leadership for EM's Subsurface Science program.

As a basic operating principle, the EM Lead Laboratory will perform outreach to other DOE laboratories to ensure their involvement in key science and technology issues.

National Analytical Management Program

The National Analytical Management Program (NAMP) is managed by DOE-ID. Its mission is to promote quality in the planning, management, and performance of sampling and analysis activities that generate characterization and monitoring data in support of DOE environmental quality initiatives. The NAMP provides national leadership to the DOE Office of Environmental Management through:

- Establishment of national policy;
- Development of complex-wide technical guidance;
- Serving as a national clearinghouse for resolution of EM analytical services issues; and
- Providing forums for collection, discussion, and dissemination of information on DOE analytical services.

NAMP is the focal point for technical and managerial excellence in EM analytical services. It ensures that EM receives quality analytical data through traceability to the National Institute of Standards and Technology, accreditation and audit consolidation, and performance evaluation programs. NAMP projects cover diverse areas and are directly responsive to EM customer requirements. The core NAMP project areas are program and resource management, information systems, data handling, accreditation, quality assurance and control, technical development, and interagency cooperation.

An exemplary NAMP project, the Mixed Analyte Performance Evaluation Program (MAPEP), is a major laboratory performance evaluation program implemented through the DOE-ID Radiological and Environmental Sciences Laboratory. MAPEP distributes samples containing known quantities of specific analytes to participating laboratories for analyses.

Nuclear Materials Focus Area

In 1999, the Plutonium Focus Area in the DOE Office of Science and Technology and the Nuclear Materials Stewardship Technology Development Program in the DOE Office of Nuclear Materials and Facility Disposition were merged to form the Nuclear Materials Focus Area (NMFA). The new Focus Area 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, complex-wide 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 1999 include:

- Developing chemically bonded phosphate ceramics for stabilizing and encapsulating actinide residues;
- Testing sensors for use in nuclear material vaults to detect gas generation, pressurization, and tampering;
- Collaborating on Russian stabilization technologies for problematic actinide solutions; and
- Continuing complex-wide integration functions.

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. Managed by DOE-ID, the Mixed Waste Focus Area (MWFA) 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.

In 1999 many of the MWFA earlier investments were reaping dividends in terms of deployments and technologies ready for implementation. Nine Innovative Technology Summary Reports were completed, signifying nine technologies were ready for implementation. Included were three mercury stabilization technologies, two mercury amalgamation technologies, three salt and ash stabilization technologies, and an alternative organic destruction technology. In addition, nine technologies were deployed, including surrogates used as part of the Non-Destructive Assay System Performance Demonstration Program, an innovative off-gas sampling system, chemical denitrification, an innovative non-destructive assay system, and another stabilization technology. In maintaining a balanced portfolio of investments, including basic science through deployment, the MWFA facilitated the initiation of 22 new basic science activities through the EM Science Program, and initiated four new deployment projects

through the Accelerated Site Technology Deployment Program.

Lastly, some longer-term investments were continued, including the HANDSS-55 project, to provide a remote modular waste conditioning system for the DOE Savannah River Site. Remote drum and liner opening systems were demonstrated this year. Another longer term activity for the MWFA included Transuranic Waste package payload enhancement, which stretched the envelope for TRU waste shipment by evaluating matrix depletion effects on hydrogen generation. Analysis was completed that will be included in an application to the Nuclear Regulatory Commission.

National Low-Level Waste Management Program

The National Low-Level Waste Management Program (NLLWMP) at INEEL assists DOE in fulfilling its responsibilities under the Low-Level Radioactive Waste Policy Amendments Act of 1985 (the Act). The objective of the NLLWMP is to provide technical expertise, information, and other resources to states and compact regions in support of the development of their LLW management facilities. The NLLWMP maintains contact with State and compact region officials to identify and provide general and specific assistance. Principal areas of activity include providing workshops, fulfilling state-specific requests, developing technical documents, distributing general information on LLW, providing information management, providing technical coordination of organizations, LLW management projects, and supplying other assistance.

In 1999, the NLLWMP completed 12 workshops for over 300 attendees in California, Texas, Utah, Florida, Arizona, and Pennsylvania. Topics included mixed waste, radiation fundamentals, transportation, and uniform manifesting. The NLLWMP also published 14 reports ranging from technical studies on closure of disposal facilities to reports to Congress on State status in providing for LLW disposal. The program continued to maintain the nation's only source of commercial LLW disposal data and acted as a clearinghouse for information by distributing 1,789 documents to 1,044 requestors.

National Spent Nuclear Fuel Program

The DOE-ID manages the National Spent Nuclear Fuel (NSNF) Program. Its mission is to safely and efficiently manage DOE-owned spent nuclear fuel (SNF) and prepare it for disposal. In completing this mission, the DOE Environmental Restoration and Waste Management Programs, 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 scope of the NSNF Program to which these requirements applies is defined by what constitutes DOE-owned SNF as well as the DOE programs and facilities needed to satisfactorily complete the mission.

DOE will manage material as spent nuclear fuel if it is irradiated fuel or targets that are permanently withdrawn from a nuclear reactor or other neutron irradiation facility following irradiation, the constituent elements of which have not been separated by reprocessing. Such materials include essentially intact fuel elements and disassembled or damaged units and pieces, and other materials. A large number of different SNF types are stored within the DOE complex. Of the different types, several categories of DOE-owned SNF may be defined. DOE facilities include those conditioning and storage facilities within which DOE-owned SNF currently resides and new facilities that are brought on-line to effect the mission of providing safe, interim storage.

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 non-classified shipments of hazardous materials, including radioactive and mixed wastes, and other commodities such as coal,

other fuels, maintenance materials, supplies, etc.

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 composed of personnel from the DOE Headquarters, Idaho, and Albuquerque offices manages the NTP. NTP Idaho is uniquely responsible for transportation planning and integration activities in support of EM 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 Experimental Breeder Reactor-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 BORAX-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. INEEL has extensive expertise in light water and gas-cooled nuclear systems, design, development, and testing. 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 non-proliferation.

Sagebrush Steppe Ecosystem Reserve

In 1999, DOE entered into an 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 utilized by 270 species of animals and 400 plant species and comprise one of the last undisturbed sagebrush steppe ecosystems in the United States. It is part of a complex-wide effort by DOE to identify, protect, and conserve environmentally significant parcels of land in partnership with federal and state agencies. The agreement charters the Bureau of Land Management to develop a management plan that will continue to protect this unique habitat.

National Vadose Zone Program

In August 1999, the INEEL was charged with leading development of a comprehensive vadose zone program that will foster technically grounded decision-making throughout the DOE complex in the characterization, assessment, and remediation of contaminated groundwater. The Program will include five distinctly different areas:

- A road mapping effort that will guide the national agenda for funding vadose zone science and technology development;
- Targeted fundamental research at the INEEL and partner universities;

- Vadose zone monitoring technology development;
- Land-use planning; and
- Developing a management infrastructure.

The INEEL has been involved in subsurface science and vadose zone investigations for 50 years and is already recognized as a leader in vadose zone research within the DOE complex.

Center for Ion Mobility Spectrometry

INEEL established the Center for Ion Mobility Spectrometry in March 1999 with a $1.7 million funding infusion. The Center is a collaborative effort by researchers from the INEEL, Washington State University, New Mexico State University, and Montana State University. The researchers will contribute expertise, equipment, and personnel to better understand the fundamental basis of ion mobility spectrometry and to develop new applications to further exploit this technology. The Center is developing an affiliation with the Center for Process Analytical Chemistry based at the University of Washington, which is a consortium of industrial sponsors, several national laboratories and government agencies that addresses challenges in the application of process analytical chemistry.

3.6 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 1999 included:

- Publishing three *INEEL Reporters;*
- Publishing one *INEEL Reporter Progress Report Supplement;*
- Holding four Town Hall meetings in Idaho Falls, Pocatello, Blackfoot, and Arco;
- Providing more than a dozen briefings to the INEEL Citizens Advisory Board;
- Holding several briefings with the Shoshone-Bannock Tribes;
- Hosting 178 tours with a combined attendance of over 2,600 people; and
- Holding seven public meetings on Waste Area Groups 4 and 5, and the RWMC RCRA permit modification.

INEEL celebrated its 50th anniversary in 1999 by holding several events including an anniversary open house at the INEEL site. The open house attracted more than 5,700 visitors to the INEEL and INEEL Research Center in Idaho Falls.

The INEEL also opened a new office in Jackson, Wyoming, in December 1999. The office provides Jackson-area residents a convenient location to obtain information about current INEEL programs, projects and issues, and future missions of the laboratory. Residents can also arrange site visits, INEEL Speakers Bureau presentations, and receive timely responses to questions about the INEEL.

American Indian Program

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 10,000 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 (DOE-HQ) Office of Environmental Management, intended to enhance tribal awareness, capabilities, and participation in INEEL activities. The core program addresses environmental management activities including National Environmental Policy Act, transportation, environmental monitoring and training, cultural resources management, and emergency response and management.

DOE also funded the operation of an Emergency Operations Center and a Community Monitoring Station at Fort Hall. The Center is equipped with state-of-the-art communications and tracking equipment and is manned by a fully trained emergency management staff. The Community Monitoring Station provides environmental data to the public and Tribal officials for the purposes of outreach, environmental and emergency management. All INEEL air, radiation, and meteorological data collected by the state of Idaho and the National Oceanic Atmospheric Administration (NOAA) is accessible to the Tribes via this system. An educational program is being fostered that will include the Fort Hall schools. This is the only monitoring station of its kind in the DOE system operated by an American Indian Tribe. DOE-ID played a key role in determining and ensuring funding, establishing interactions between the Tribes, State, and NOAA, and coaching this project through fruition.

INEEL-Sponsored Academic Programs

INEEL and DOE-ID provide paid research and work opportunities for students from Idaho and regional institutions. In 1999, over 200 college students, high school students, and teachers were involved.

3.7 ENVIRONMENTAL MONITORING

Purpose and Organization of Monitoring Programs

Routine operation of INEEL facilities release materials into the environment, some of which may include both radioactive and non-radioactive contaminants. 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. A variety of exposure pathways can transport contaminants away from INEEL facilities, where they could potentially impact the surrounding environment and the population living there (Figure 3-1).

The primary purposes of the various environmental monitoring programs conducted at the INEEL are 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.

The term environmental monitoring is used to describe two separate activities. Effluent monitoring is the measurement of the waste stream prior to 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.

At the INEEL, environmental monitoring is a collective effort involving a number of different organizations and groups. The remainder of this section provides a summary of the various environmental monitoring activities currently being conducted by both the M&O and Environmental Surveillance, Education, and Research (ESER) contractors.

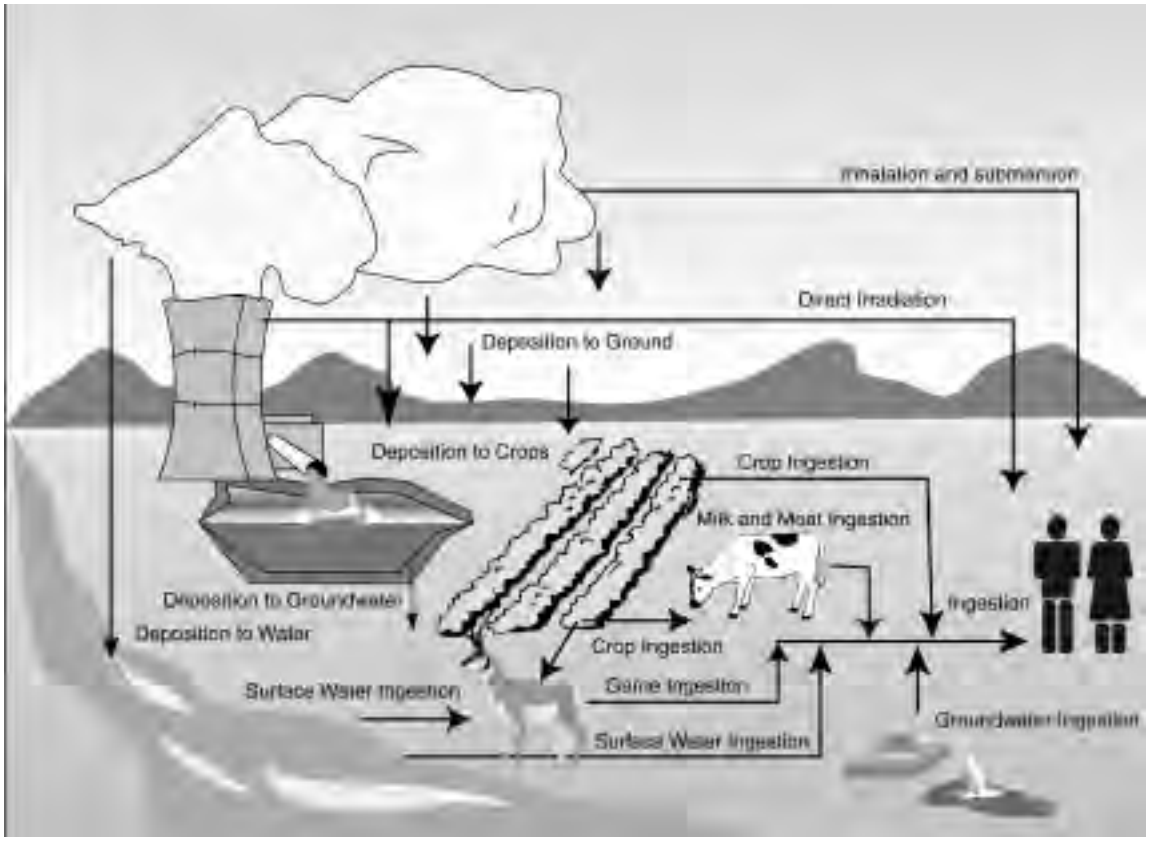

Figure 3-1. Potential Pathways from the INEEL to Humans.

Effluent Monitoring Programs

Radiological Effluents. Each INEEL facility is responsible for monitoring radionuclides in airborne effluents released to the environment. There are currently six airborne emission points for which continuous monitoring for radionuclides is required under the National Emission Standards for Hazardous Air Pollutants (NESHAP). Of these six points, two are at ANL-W, two are at INTEC, and two are at WERF. Other emission points are monitored to verify that they remain below the threshold at which continuous monitoring is required, or for general facility information.

Data from each of these release points are reported monthly to a centralized database, the Radioactive Waste Management Information System (RWMIS), operated by the M&O contractor. An annual report of the results of the effluent monitoring organizes the data by month, facility, and radionuclide.

Radioactive liquid effluents are also monitored at release points and compiled in the RWMIS. Most liquid radioactive effluents are discharged into lined ponds. No radioactive liquids are released to offsite surface waters or to streams on the INEEL.

Nonradiological Effluents. Nonradiological airborne effluents originate from the following primary sources at the INEEL:

- Calcination of high-level radioactive liquid waste at the New Waste Calcining Facility;
- Combustion of fuel oil used for heating INEEL facilities;
- Combustion of fuel in engines operating generators;
- Motor vehicle exhaust; and
- Fugitive dusts from a number of activities, including construction and waste burial.

Emissions of nitrogen dioxide are routinely monitored at the New Waste Calcining Facility

when the Calciner is operating. Monitoring data for these sources are published in the INEEL Non-radiological Waste Management Information System annual reports. Sulfur dioxide emissions from heating oil usage are calculated from the sulfur content and the quantity of fuel used. Emissions of nitrogen dioxide from fuel oil are calculated using EPA emission factors [Reference 3-3] and the amount and type of oil used at each facility. Motor vehicle exhausts and fugitive dusts are not monitored at the source.

At ANL-W, the Experimental Breeder Reactor-II auxiliary boilers are monitored monthly, both as an efficiency check and to ensure that emissions of nitrogen oxides and sulfur dioxide remain below the state of Idaho's emission limits. A portable stack emission monitor provides a direct printout of ambient and stack temperature, carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxides, and oxygen.

Routine direct disposal of wastes to the Snake River Plain Aquifer ceased in 1984. Liquid wastes are now disposed to sewage lagoons, seepage ponds, industrial waste ponds, industrial waste ditches, and sewage treatment facilities. The M&O contractor operates the liquid effluent monitoring program for effluent streams at CFA, INTEC, Idaho Falls, TAN, and TRA. A total of 13 discharge points were routinely monitored for various non-radiological parameters in 1999.

ANL-W monitors its Industrial Waste Pond and Secondary Sanitary Lagoon monthly for non-radiological constituents and water quality parameters (i.e., pH, temperature, specific conductance, and dissolved oxygen).

Facility Monitoring Programs

Several INEEL facilities conduct environmental surveillance within and around the perimeters of their facilities. The scope of each of these programs varies with the nature of the facility being monitored. One such program, the Waste Management Surveillance Program, monitors M&O contractor waste management facilities including RWMC and WERF in compliance with DOE Order 435.1. Samples of air, water, soil, and vegetation are collected. Environmental radiation measurements are also made, and visual inspections of the facilities are conducted. Other monitoring programs are in place at ANL-W, INTEC, and the Specific Manufacturing Capability facility located at TAN.

Drinking Water Programs

The M&O contractor Drinking Water Program monitors production and drinking water wells for radiological, chemical, and bacteriological contaminants at all INEEL facilities operated by the M&O contractor. Currently, 17 wells and 10 distribution systems are routinely 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 and ANL-W maintain separate programs for sampling drinking water at their facilities. Radiological and bacteriological samples from ANL-W are sent to M&O contractor laboratories for analysis.

Radiological Monitoring. Onsite drinking water samples are collected quarterly for radiological analysis from production wells and distribution systems in use at active M&O contractor facilities. Each water sample is submitted for gross analyses for alpha- and beta-emitting radionuclides. Tritium analyses are also performed on all drinking water samples. Since water quality monitoring data indicates drinking-water wells at the INTEC facility may contain water with elevated levels of ^{90}Sr, quarterly samples are collected for ^{90}Sr analysis.

Bacteriological Monitoring. The M&O contractor monitors 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.

Chemical Monitoring. The M&O contractor routinely samples drinking water from wells and distribution systems at facilities at the INEEL for volatile organic compounds. A program to monitor lead and copper in drinking water in accordance with EPA regulations was started in 1992. The year 1995 concluded three successive years of monitoring lead and copper levels in drinking water. Since regulatory values were not exceeded and were in accordance with regulations, this monitoring was reduced to once every three years beginning in 1998. Chlorinated drinking-water systems are also monitored for total trihalomethanes (bromoform, bromo -dichloromethane, chloroform, and dibromochloromethane). Additional sampling is conducted for a variety of inorganic constituents, including metals, nitrates, and dissolved solids.

Storm Water Monitoring Program

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. A storm water monitoring program was implemented in 1993. In 1999, 24 sites at five INEEL areas were designated storm water monitoring locations. Samples are collected from storms of at least 0.25 cm (0.1 in) of precipitation preceded by a minimum of 72 hours without precipitation. Collection, preservation, and analysis of storm water samples are performed in accordance with the National Pollutant Discharge Elimination System Storm Water Sampling Guidance Document and 40 CFR 136.

The general permit does not contain numeric limitations for analytical parameters, except for the runoff from coal piles at INTEC. Runoff from this area is required to have a pH within the range of 6 to 9. Other parameters are compared to benchmark concentrations listed in Reference 3-4 to help evaluate the quality of storm water discharges.

Site Environmental Surveillance Program

General Information. The M&O contractor has conducted the Site Environmental Surveillance Program since January 1994. The program has overall responsibility for sampling of air and soil and measurement of environmental radiation at onsite locations. For comparison purposes, some sampling is also performed at distant locations. A summary of the program in 1999 is provided in Table 3-1.

The Radiological Measurement Laboratory located at TRA performed most analyses for the Site Environmental Surveillance Program. The M&O contractor, through the computer support group, maintains a database containing sampling and analytical information.

Low-Volume Air Samplers. Airborne particulate radioactivity is monitored continuously on the INEEL by the M&O contractor using a network of low-volume air samplers (Figure 3-2). Air is sampled at 12 locations onsite and at four offsite locations for comparison purposes. Locations of onsite samplers provide coverage of each of the major INEEL facilities. Each low-volume air sampler maintains an average airflow of about 50 L/min (2 ft^3/min) through a set of filters consisting of a 1.2-μm pore membrane filter followed by a charcoal cartridge. The filters are 99 percent efficient for airborne particulate radioactivity and iodides.

The particulate filters from the low-volume air samplers are collected and analyzed weekly.

All the charcoal cartridges are evaluated individually each week for ^{131}I by gamma spectrometry. Particulate filters are analyzed after waiting a minimum of four days to allow the naturally occurring, short-lived radon and thoron daughters to decay. Analyses for gross (nonspecific) alpha and gross beta activity are performed on a proportional counter.

Specific radionuclide analyses are more sensitive than gross alpha and gross beta analyses for detecting concentrations of

Table 3-1. M&O Contractor Site Environmental Surveillance Radiological Program Summary (1999).

		Locations and Frequency		
Medium Sampled	**Analysis**	**Onsite**	**Offsite**	**Approximate Minimum Detectable Concentration**
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	1 to 10×10^{-15} µCi/mL
	Pu isotopes	12 quarterly	4 quarterly	2×10^{-18} µCi/mL
	^{241}Am	12 quarterly	4 quarterly	2×10^{-18} µCi/mL
	^{90}Sr	12 quarterly	4 quarterly	3.5×10^{-17} µCi/mL
	Particulate matter	12 quarterly	4 quarterly	10 µg/m^3
Atmospheric Moisture	^{3}H	1 to 2 per quarter	1 to 2 per quarter	1×10^{-11} µCi/mL
Soil	Specific gamma	Varies annually[a]	-----[b]	3×10^{-9} µCi/g
	^{90}Sr	Varies annually	-----[b]	3×10^{-9} µCi /g
	Pu isotopes	Varies annually	-----[b]	6×10^{-8} µCi/g
	Am	Varies annually	-----[b]	1×10^{-7} µCi/g
Direct Radiation Exposure (TLDs)	Ionizing Radiation	135 semiannually	13 semiannually	5 mR
Direct Radiation Exposure (Radiation Surveys)	Gamma Radiation	Facilities[c]	-----[b]	Not Applicable
		INEEL Roads[d]	-----[b]	Not Applicable

[a] Onsite soil sampling is performed each year at different onsite facilities on a rotating seven-year schedule.

[b] No samples collected or survey done in 1999.

[c] Surveys are performed each year at different onsite facilities on a rotating three-year schedule.

[d] All INEEL roadways over which waste is transported are surveyed annually.

man-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 (^{238}Pu, $^{239/240}$Pu, and ^{241}Am) and ^{90}Sr. The analyses for alpha-emitting nuclides use chemical separation techniques followed by alpha spectrometry. For ^{90}Sr, beta counting follows the chemical separation.

Atmospheric Moisture Samplers. Samplers for tritium in water vapor in the atmosphere are located on the INEEL at the Experimental Field Station (EFS) and on Van Buren Boulevard. In these samplers, air is passed through a column of molecular sieve material ($CaSO_4$) at a rate of approximately 0.5 L/min (1 ft^3/hr). The molecular sieve material in the column absorbs water vapor in the air; columns are changed when the molecular

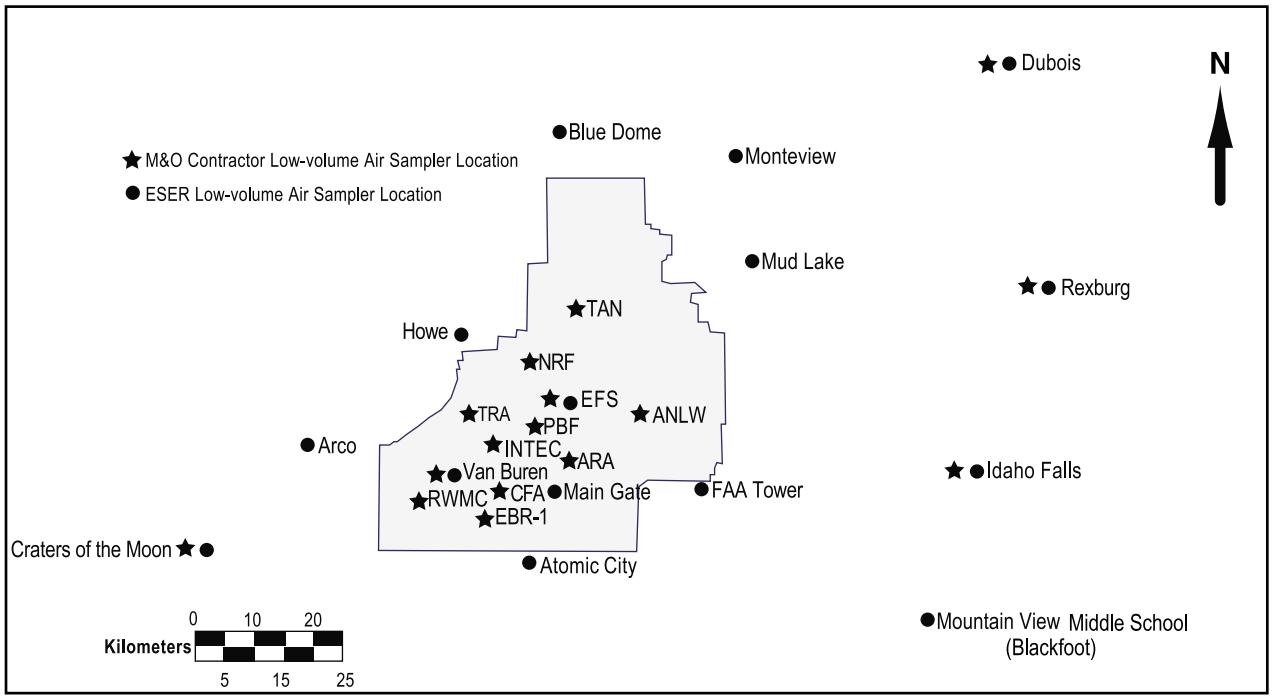

Figure 3-2. Low-Volume Air Sampler Locations.

sieve material absorbs sufficient moisture to obtain a sample (typically from one to three times per quarter). Tritium concentrations are then determined by liquid scintillation counting of the water extracted from the molecular sieve columns.

Nitrogen Dioxide/Sulfur Dioxide Monitoring. To fulfill one of the conditions specified in the Permit to Construct, Idaho Chemical Processing Plant Nitrogen Oxide Sources, two nitrogen oxide monitoring stations (which measure NO and NO_2, collectively called NO_x) are operated by the M&O contractor. These are located near the intersection of U.S. Highway 20/26 and Van Buren Boulevard and at EFS. The analyzers used are designated as EPA-equivalent methods. One EPA-equivalent method sulfur dioxide analyzer is operated at the Van Buren Boulevard location in addition to the nitrogen dioxide analyzer.

Environmental Dosimeters. Environmental dosimeters, known as thermoluminescent dosimeters (TLDs), are used to measure ionizing radiation exposures. The TLDs measure ionizing radiation exposures from 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 card containing five individual chips is placed 1 m (3 ft) above ground level. The M&O contractor maintained dosimeters at 13 offsite locations and 135 locations on the INEEL. The dosimeter card at each location is changed twice a year, and the M&O contractor Dosimetry Unit measures cumulative gamma radiation.

INEEL Offsite Environmental Surveillance Program

General Information. The offsite environmental surveillance program is conducted under the ESER contract. In 1999 the ESER contractor was the Environmental Science and Research Foundation. The purpose of this program is to conduct environmental monitoring, ecological research, and environmental services independent of the M&O contractor at the INEEL. Work under the ESER contract has

been conducted since it was privatized in April 1994. Table 3-2 lists the Offsite Environmental Surveillance activities conducted under the ESER contract.

During 1999, as in all years, the ESER contractor used independent offsite laboratories to perform analyses for the environmental surveillance program. The Idaho State University Environmental Assessment Laboratory conducted the majority of radiological analyses, including gross alpha/gross beta, tritium, and gamma spectrometry analyses. Radiochemical analyses, such as ^{90}Sr and transuranics, were performed at Quanterra Inc., an independent commercial laboratory. Analyses for the Interagency Monitoring of Protected Visual Environments (IMPROVE) program are performed at the University of California, Davis, Crocker Nuclear Laboratory.

Low-Volume Air Samplers. The ESER contractor maintains a network of low-volume air samplers (Figure 3-2) to monitor for airborne radioactivity. Twelve samplers are located at offsite locations. In addition, three samplers are operated at locations on the INEEL for comparison purposes. Each low-volume air sampler maintains an average airflow of about 50 L/min (2 ft^3/min) through a set of filters consisting of a 1.2-μm pore membrane filter followed by a charcoal cartridge. The filters are 99 percent efficient for airborne particulate radioactivity and iodides.

The particulate filters from the low-volume air samplers are collected and analyzed weekly. Charcoal cartridges are evaluated in batches of up to eight cartridges for ^{131}I using gamma spectrometry. If any activity is noted in a batch, each filter in the batch can then be recounted individually.

Particulate filters are analyzed weekly for gross alpha and beta concentrations using a proportional counting system. Filters are analyzed after waiting a minimum of four days to allow short-lived radionuclides to decay. Gross alpha and beta analyses are used as a screening technique to provide timely information on levels of radioactivity in the environment.

The particulate filters from the low-volume samplers are composited by location at the end of each quarter and analyzed for specific radionuclides. All composites are analyzed for specific gamma-emitting nuclides by gamma spectrometry. Selected composites are then submitted for analyses for transuranic radionuclides (^{238}Pu, $^{239/240}$Pu, and ^{241}Am) and ^{90}Sr. The analyses for transuranic nuclides use chemical separation techniques followed by alpha spectrometry. For ^{90}Sr, beta counting follows the chemical separation.

Measurements of total suspended particulates are performed on the particulate filters from the low-volume filters. Clean filters are weighed at the beginning of each quarter and filter composites are weighed at the end of the quarter. 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 though the filters.

Atmospheric Moisture. Samplers to collect atmospheric water vapor for tritium analyses are located in Idaho Falls, Blackfoot, Atomic City, and Rexburg. In these samplers, air is passed through a column of silica gel at a rate of approximately 0.3 L/min (0.01 ft^3/min). The gel in the column absorbs water vapor from the air. Columns are changed when the gel absorbs sufficient moisture to obtain a sample (typically from one to three times per quarter). Tritium concentrations are then determined by liquid scintillation counting of the water extracted from the silica gel columns.

Precipitation. Monthly precipitation samples are collected on the INEEL at CFA and at the offsite location of Idaho Falls. In addition, weekly samples are collected at EFS when available. A portion of each precipitation sample is submitted for tritium analysis by liquid scintillation counting.

Table 3-2. ESER – Surveillance Program Summary (1999).

Medium Sampled	Type of Analysis	Number of Locations and Frequency		Minimum Detectable Concentration
		Onsite	Offsite	
Air (Low Volume) (particulate filter)	Gross alpha	3 weekly	12 weekly	1×10^{-15} µCi/mL
	Gross beta	3 weekly	12 weekly	3×10^{-15} µCi/mL
	Specific gamma	3 quarterly	4 quarterly	3×10^{-16} µCi/mL
	^{238}Pu	1-2 quarterly	4 quarterly	2×10^{-18} µCi/mL
	$^{239/240}$Pu	1-2 quarterly	4 quarterly	3×10^{-18} µCi/mL
	^{241}Am	1-2 quarterly	4 quarterly	2×10^{-18} µCi/mL
	^{90}Sr	1-2 quarterly	12 quarterly	3×10^{-17} µCi/mL
	Particulate matter	3 quarterly	12 quarterly	10 µg/m^3
Air (Charcoal Cartridge)	^{131}I	3 weekly	12 weekly	4×10^{-15} µCi/mL
Air (PM_{10})		None	3 weekly	
Air (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	1×10^{-7} µCi/mL
Drinking Water	Gross alpha	None	13 semiannually	3×10^{-9} µCi/mL
	Gross beta	None	13 semiannually	2×10^{-9} µCi/mL
	^{3}H	None	13 semiannually	1×10^{-7} µCi/mL
Surface Water	Gross alpha	None	5 semiannually	3×10^{-9} µCi/mL
	Gross beta	None	5 quarterly	2×10^{-9} µCi/mL
	^{3}H	None	5 quarterly	1×10^{-7} µCi/mL
Animal Tissue (Sheep)[a]	Specific gamma	4 annually	2 annually	5×10^{-9} µCi/g
Animal Tissue (Game)	Specific gamma	Varies annually[b]	----	5×10^{-9} µCi/g
Foodstuffs (Milk)	^{131}I	None	1 weekly	2×10^{-9} µCi/mL
	^{131}I	None	9 monthly	2×10^{-9} µCi/mL
	^{90}Sr	None	9 annually	3×10^{-10} µCi/mL
	^{3}H	None	9 annually	1×10^{-7} µCi/mL
Foodstuffs (Potatoes)	Specific gamma	None	8 annually	4×10^{-9} µCi/g
	^{90}Sr	None	8 annually	5×10^{-9} µCi/g
Foodstuffs (Wheat)	Specific gamma	None	11 annually	4×10^{-9} µCi/g
	^{90}Sr	None	11 annually	5×10^{-9} µCi/g
Foodstuffs (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	4×10^{-8} µCi/g
	Pu	None	12 biennially	2×10^{-9} µCi/g
	Am	None	12 biennially	3×10^{-9} µCi/g
	^{90}Sr	None	12 biennially	9×10^{-8} µCi/g
Direct Radiation Exposure (Thermoluminescent Dosimeters)	Ionizing Radiation	None	14 semiannually	5 mR

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

[b] Only road-killed game animals are sampled onsite. No controls are generally collected except for specific ecological studies.

Fine Particulates. The ESER contractor established samplers, which selectively measure the concentration of fine particulates less than 10 μm in aerodynamic diameter, known as PM_{10} samplers, as part of the Community Monitoring Stations in Rexburg and Blackfoot. Sampling at these stations began in 1996. An additional sampler began operation in Atomic City in March 1997. Fine particulate samplers operate for 24 hours, midnight to midnight, every sixth day. Clean quartz fiber filters are weighed before and after sampling to determine the amount of material collected.

IMPROVE Samplers. The National Park Service, in cooperation with other federal land management agencies (U.S. Forest Service, U.S. Fish & Wildlife Service, Bureau of Land Management) began the IMPROVE program in 1985. This program was an extension of an earlier EPA program to measure fine (<2.5 μm) particles, 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. The two samplers each collect two 24-hour samples weekly of fine particulates <2.5 μm in diameter. Analyses are performed for mass, optical absorption, hydrogen, carbon, nitrogen, and oxygen plus elements from sodium through lead on the periodic table.

Water. In 1999 the ESER contractor collected semiannual drinking water samples from boundary and distant communities, and additional surface water samples from the Magic Valley area and the Snake River at Idaho Falls. Each water sample collected was submitted for gross analyses for alpha and beta emitting radionuclides, as well as for tritium analysis using liquid scintillation.

Milk. Milk samples were collected from both commercial and single-family dairies (Figure 3-3). A 4-L (1-gal) sample was obtained from each location monthly, except in Idaho Falls where a sample was collected weekly. Milk from each location was analyzed for ^{131}I, and one analysis for ^{90}Sr and tritium at each location was performed during the year.

Lettuce. Lettuce samples were 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 were analyzed for ^{90}Sr and gamma-emitting radionuclides.

Wheat. 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.

Potatoes. Potato samples were collected from storage warehouses in the INEEL vicinity. The samples, with cleaned skins included, were processed and weighed. All potato samples were analyzed for ^{90}Sr and gamma-emitting radionuclides.

Sheep. 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.

Game Animals. Selected tissues (muscle, liver, and thyroid) are collected from game animals accidentally killed on INEEL roads or from animals that die of natural causes (e.g., starvation). 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 prior to gamma spectrometry analysis.

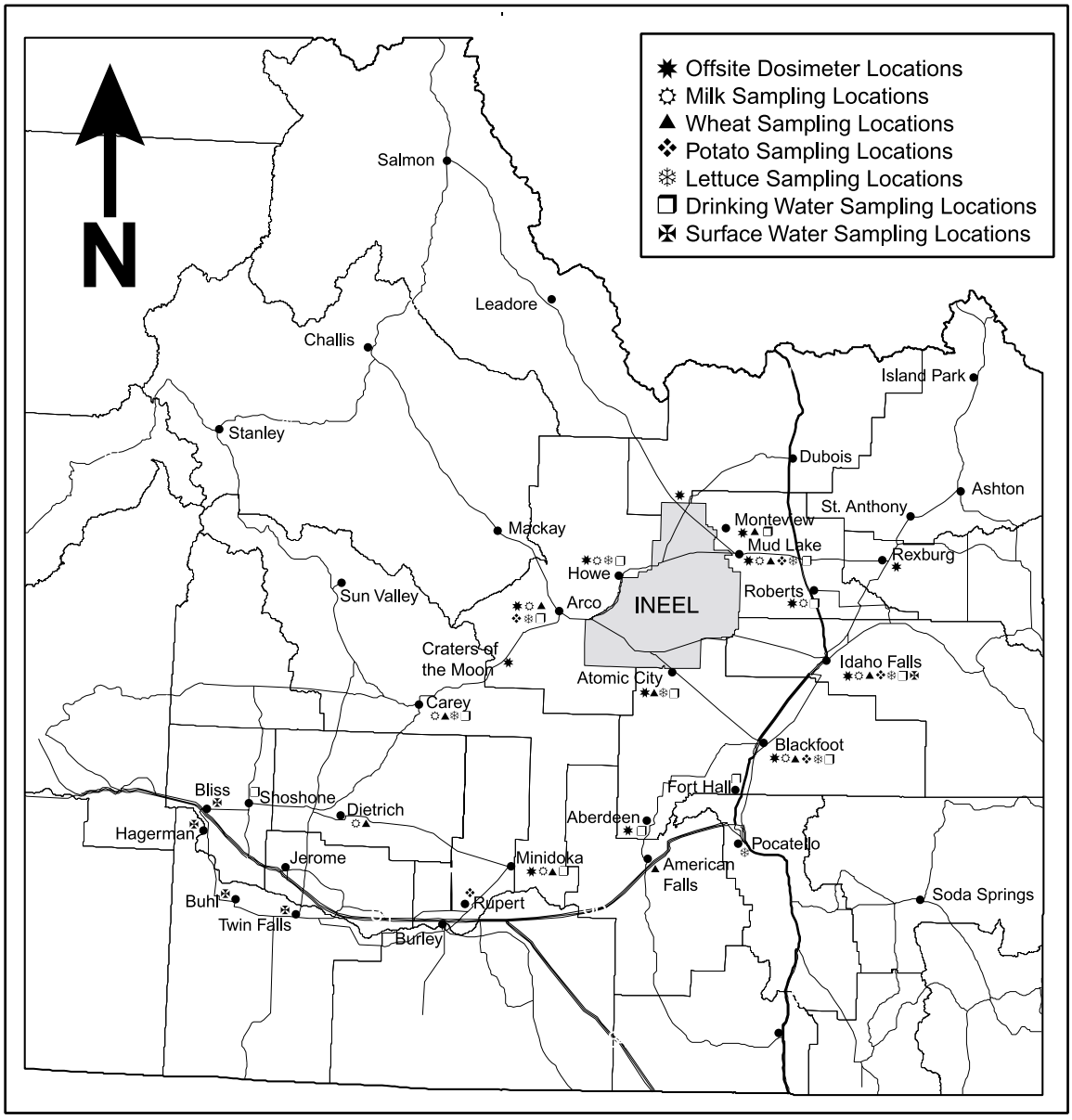

Figure 3-3. Offsite Foodstuff Sampling and Environmental Dosimeter Locations.

Waterfowl samples are collected from waste disposal ponds at four facilities on the INEEL to evaluate the potential for exposure to members of the public who might consume these game animals. 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.

Soil. To establish background levels of natural and fallout radioactivity in surface soil and to assess any potential buildup of radioactivity from INEEL operations, soil samples are collected from distant and boundary locations in each even-numbered year. Soil samples were last collected in 1998 from 12 locations.

Environmental Dosimeters. Environmental dosimeters, commonly called thermoluminescent dosimeters (TLDs), are used to measure ionizing radiation exposures at offsite locations. The TLDs measure ionizing radiation exposures from all sources,

including natural radioactivity, cosmic radiation, 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 card containing five individual chips is placed 1 m (3 ft) above ground level. Dosimeters are changed twice per year at each of the 13 sampling locations (Figure 3-3).

USGS Groundwater Monitoring Program

The USGS INEEL Project Office has conducted groundwater and surface water monitoring at the Site since 1949. 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 6).

The USGS monitors water levels in wells and radiological and non-radiological substances in water from their observation wells and auger holes on schedules ranging from monthly to annually (Table 3-3). The USGS also conducts special studies of the groundwater of the Snake River Plain. A summary of these studies is provided in Chapter 6 of this report. These special studies provide more specific geological and hydrological information on the flow and recharge of the aquifer and the movements of radioactive and non-radioactive substances in the groundwater.

Chemical Monitoring. USGS personnel collected water samples from selected onsite production wells and groundwater monitoring wells on schedules ranging from monthly to annually. These samples are submitted to the USGS National Water Quality Laboratory in Arvada, 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.

Meteorological Monitoring Program

Meteorological monitoring began at the INEEL in 1949. The NOAA Air Resources Laboratory Federal Research Division, located in Idaho Falls, currently maintains a network of 30 meteorological stations in the vicinity of the INEEL. These stations provide continuous measurement of a variety of parameters, including temperature at two or three levels, wind speed and direction, relative humidity, and precipitation. In addition, continuous measurements are made 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.

INEEL Oversight Program

Since 1990, the state of Idaho has operated an environmental surveillance program as part of the INEEL Oversight Program. This program includes the collection and analysis of air, precipitation, atmospheric moisture, water, soil and milk samples on and around the INEEL. In addition, the program has a network of pressurized ion chambers, electret ion chambers, and environmental dosimeters.

Many of these samples are taken simultaneously with other organizations performing environmental surveillance or are at sites collocated with other organizations. The Idaho State University Environmental Monitoring Laboratory performs all radiological analyses. The Oversight Program recently completed a report detailing results obtained by the program. [Reference 3-5].

Table 3-3. U.S. Geological Survey Groundwater Monitoring Program Summary (1999).

		Groundwater		Surface Water		
Constituent	Frequency	Number of Sites	Number of Samples	Number of Sites	Number of Samples	Minimum Detectable Concentration[a]
Gross alpha	Semiannually	44	88	4	8	5×10^{-9}
Gross beta	Semiannually	44	88	4	8	4×10^{-9}
Tritium	Quarterly	29	116	---	---	4×10^{-7}
	Semiannually	94	188	7	14	
	Annually	37	39	---	---	
Specific gamma	Quarterly	6	24	---	---	1 to 10×10^{-9} [b]
	Semiannually	56	116	4	8	
	Annually	26	26	---	---	
^{90}Sr	Quarterly	25	100	---	---	5×10^{-9}
	Semiannually	59	118	---	---	
	Annually	34	34	---	---	
Americium	Quarterly	6	24	---	---	5×10^{-11}
	Semiannually	13	26	---	---	
	Annually	3	3	---	---	
Plutonium	Quarterly	6	24	---	---	4×10^{-11}
	Semiannually	13	26	---	---	
	Annually	3	3	---	---	
Conductance	Quarterly	37	148	---	---	Not applicable
	Semiannually	96	192	7	14	
	Annually	37	39	---	---	
Sodium ion	Quarterly	2	8	---	---	0.1
	Semiannually	46	92	---	---	
	Annually	9S	98	---	---	
Chloride ion	Quarterly	27	116	---	---	0.1
	Semiannually	77	154	7	14	
	Annually	57	56	---	---	
Nitrates (as nitrogen)	Semiannually	42	84	---	---	0.05
	Annually	67	67	---	---	
Sulfate	Quarterly	2	8	---	---	0.1
	Triennially	3	9	---	---	
	Semiannually	10	20	---	---	
	Annually	103	103	---	---	
Chromium (dissolved)	Quarterly	4	16	---	---	0.005
	Semiannually	71	142	---	---	
	Annually	18	16	---	---	
Purgeable Organic Compounds[c]	Monthly	1	12	---	---	0.0002
	Quarterly	5	20	---	---	
	Semiannually	17	34	---	---	
	Annually	7	7	---	---	
Total Organic Carbon	Annually	42	42	---	---	0.1
Trace elements	Annually	1	1			
	Semiannually	10	20	---	---	Varies

[a] MDCs are given in µCi/mL for radiological parameters and mg/L for non-radiological parameters.
[b] MDC for gamma spectroscopic analyses varies depending on radionuclide.
[c] Each volatile organic water sample is analyzed for 60 purgeable organic compounds.

Chapter 4

Environmental Radiological Program Results

4. ENVIRONMENTAL RADIOLOGICAL PROGRAM RESULTS

4.1 AIR SAMPLING

Low-Volume Charcoal Cartridges

Both the Environmental Science, Education, and Research (ESER) contractor and the Management and Operating (M&O) contractor collected charcoal cartridges weekly and analyzed them for gamma-emitting radionuclides. If traces of any anthropogenic radionuclides are detected, the filters are individually analyzed. During 1999, the M&O contractor analyzed a total of 971 cartridges, looking specifically for Iodine-131 (^{131}I). The ESER contractor also analyzed 936 cartridges for ^{131}I. Iodine-131 was not detected in samples of 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 25 locations total (M&O and ESER) on a weekly basis. All were analyzed for gross alpha activity. Gross alpha concentrations found in ESER contractor samples, both onsite and offsite, were consistent with those found in M&O contractor samples at common locations (Table 4-1).

ESER contractor annual mean gross alpha concentrations ranged from (1.1 ± 0.2) x 10^{-15} µCi/mL at Craters of the Moon to (2.0 ± 0.3) x l0^{-15} µCi/mL at Blackfoot (Table 4-1). M&O contractor data indicated an annual mean range of (0.4 ± 0.3) x 10^{-15} µCi/mL at Argonne National Laboratory-West (ANL-W) to (2.1 ± 1.0) x 10^{-15} µCi/mL at Rexburg (Table 4-1).

Reasons for differences in concentrations measured in 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.

Low-Volume Gross Beta

As with gross alpha, gross beta concentrations in ESER contractor samples were consistent with those found in M&O contractor samples (Table 4-2). Chapter 9 includes a comparison table of weekly gross beta concentrations obtained by the M&O contractor and the ESER contractor at common locations, and a more in depth comparison is summarized by the Oversight Program [Reference 4-1].

Weekly gross beta concentrations in ESER contractor samples ranged from a low of (0.4 ± 1.0) x 10^{-15}µCi/mL during August at Rexburg to a high of (74 ± 3.0) x 10^{-15} µCi/mL at Mud Lake in October. Concentrations measured by the M&O contractor ranged from a low of (0.4 ± 4.0) x 10^{-15} µCi/mL at Van Buren Boulevard during February to a high of (73 ± 12) x 10^{-15} µCi/mL at the Experimental Field Station (EFS) during October.

ESER contractor annual mean gross beta concentrations ranged from (21 ± 2) x 10^{-15} µCi/mL at Craters of the Moon to 26 ± 3 x l0^{-15} µCi/mL at Idaho Falls and Howe (Table 4-2). M&O contractor data indicated an annual mean range of (17 ± 2) x 10^{-15} µCi/mL at Radioactive Waste Management Complex (RWMC) to (25 ± 3) x 10^{-15} µCi/mL at Test Reactor Area (TRA) (Table 4-2).

Figure 4-1 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.

In general, the levels of airborne radioactivity for the three groups track each other closely throughout the year. This is an indication that the pattern of fluctuations occurred over the entire sampling network

Table 4-1. Gross Alpha Activity in Air (1999).

ESER Contractor Data

Group	Location	No. of Samples	Concentration (x 10^{-15} µCi/mL) Range of Samples	Concentration (x 10^{-15} µCi/mL) Annual Mean ± 95% C.I. [a]
Distant	Blackfoot	52	0.2 – 4.5	2.0 ± 0.3
	Mountain View	52	0.4 – 4.3	2.0 ± 0.2
	Craters of the Moon	52	-0.06 – 3.4	1.1 ± 0.2
	Idaho Falls	52	0.3 – 4.7	1.8 ± 0.3
	Rexburg	52	0.3 – 4.5	1.8 ± 0.3
			Grand Mean	**1.7 ± 0.1**
Boundary	Arco	52	0.2 – 3.3	1.4 ± 0.2
	Atomic City	52	0.2 – 4.1	1.3 ± 0.2
	FAA Tower	52	-0.2 – 3.6	1.2 ± 0.2
	Howe	52	-0.8 – 8.7	1.8 ± 0.2
	Monteview	52	0.003 – 3.2	1.6 ± 0.2
	Mud Lake	52	0.4 – 3.9	1.7 ± 0.2
	Reno Ranch	52	0.07 – 3.2	1.3 ± 0.2
			Grand Mean	**1.5 ± 0.1**
INEEL	EFS	52	0.1 – 3.3	1.3 ± 0.2
	Main Gate	52	0.1 – 2.7	1.2 ± 0.2
	Van Buren	51	0.2 – 3.4	1.5 ± 0.2
			Grand Mean	**1.3± 0.1**

M&O Contractor Data

Group	Location	No. of Samples	Concentration (x 10^{-15} µCi/mL) Range of Samples	Concentration (x 10^{-15} µCi/mL) Annual Mean ± 95% C.I. [a]
Distant	Blackfoot	49	-1.0 – 4.9	1.1 ± 0.4
	Craters of the Moon	50	-1.5 – 3.6	0.7 ± 0.4
	Idaho Falls	50	-2.0 – 3.4	0.9 ± 0.4
	Rexburg	51	-0.7 – 2.3	2.1 ± 1.0
			Grand Mean	**1.2 ± 0.3**
INEEL	ANL-W	51	-1.9 – 2.7	0.4 ± 0.3
	ARA	50	-1.4 – 3.4	0.7 ± 0.3
	CFA	48	-2.4 – 2.3	0.4 ± 0.3
	EBR-1	48	-2.1 – 3.1	0.6 ± 0.4
	EFS	49	-7.0 – 3.5	0.7 ± 0.4
	INTEC	49	-1.6 – 2.0	0.5 ± 0.3
	NRF	45	-1.2 – 3.5	0.8 ± 0.3
	PBF	46	-3.0 – 5.0	0.5 ± 0.4
	RWMC	49	-1.4 – 2.4	0.5 ± 0.2
	TAN	50	-1.5 – 2.8	0.6 ± 0.3
	TRA	49	-2.5 – 2.9	0.7 ± 0.3
	Van Buren	50	-0.7 – 4.3	1.2 ± 0.3
			Grand Mean	**0.6 ± 0.1**

[a] Confidence Interval.

Table 4-2. Gross Beta Activity in Air (1999).

ESER Contractor Data

Group	Location	No. of Samples	Concentration (x 10^{-15} µCi/mL) Range of Samples	Annual Mean ± 95% C.I.[a]
Distant	Blackfoot	52	9 – 55	24 ± 3
	Mountain View M.S.	52	7 – 62	23 ± 3
	Craters of the Moon	52	7 – 37	21 ± 2
	Idaho Falls	52	9 – 64	26 ± 3
	Rexburg	52	0.4 – 46	22 ± 2
			Grand Mean	**23 ± 1**
Boundary	Arco	52	8 – 41	22 ± 2
	Atomic City	52	8 – 45	23 ± 2
	FAA Tower	52	4 – 49	22 ± 3
	Howe	52	4 – 71	26 ± 3
	Monteview	52	7 – 61	25 ± 3
	Mud Lake	52	8 – 74	25 ± 3
	Reno Ranch	52	8 – 47	23 ± 2
			Grand Mean	**24 ± 1**
INEEL	EFS	52	8 – 63	25 ± 3
	Main Gate	52	8 – 48	23 ± 2
	Van Buren	51	8 – 52	24 ± 3
			Grand Mean	**24 ± 1**

M&O Contractor Data

Group	Location	No. of Samples	Concentration (x 10^{-15} µCi/mL) Range of Samples	Annual Mean ± 95% C.I. [a]
Distant	Blackfoot	49	8 – 51	24 ± 3
	Craters of the Moon	50	3 – 40	20 ± 2
	Idaho Falls	50	5 – 49	24 ± 3
	Rexburg	51	6 – 50	22 ± 3
			Grand Mean	**22 ± 1**
INEEL	ANL-W	51	4 – 47	22 ± 2
	ARA	50	5 – 54	23 ± 3
	CFA	48	7 – 51	21 ± 2
	EBR-1	48	5 – 53	23 ± 2
	EFS	49	7 – 73	24 ± 3
	INTEC	49	3 – 58	23 ± 3
	NRF	45	8 – 49	22 ± 3
	PBF	45	6 – 54	24 ± 3
	RWMC	49	5 – 40	17 ± 2
	TAN	50	7 – 42	20 ± 2
	TRA	49	4 – 46	25 ± 3
	Van Buren	50	0.4 – 55	23 ± 3
			Grand Mean	**22 ± 1**

[a] Confidence Interval.

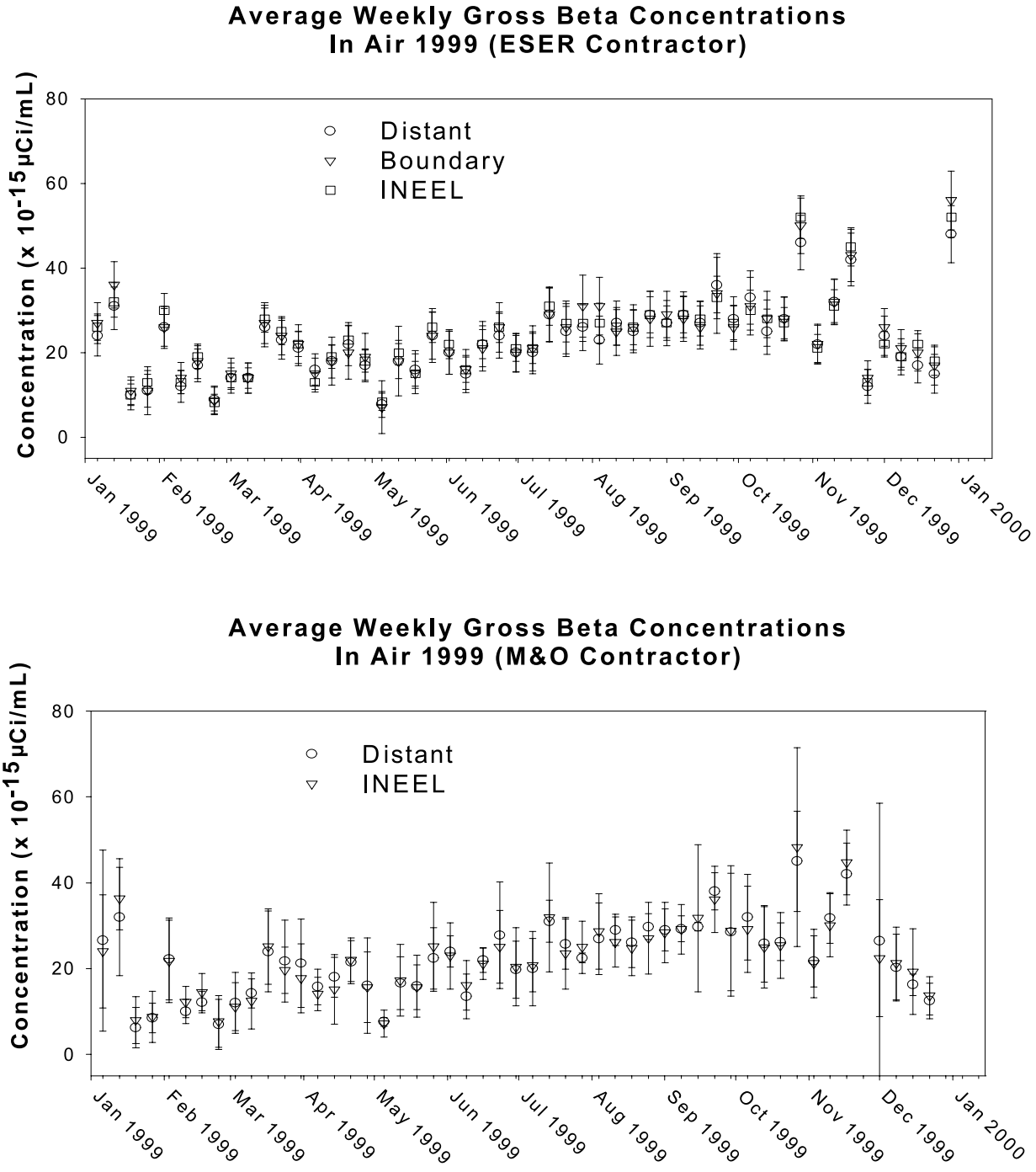

Figure 4-1. Average Weekly Gross Beta Concentrations in Air (1999).

and therefore was not caused by a localized source such as a facility or activity at the INEEL.

Statistical Comparisons

Statistical comparisons were made 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 INEEL and boundary station concentrations were not significantly different from distant stations for the numbers of samples collected (Table 4-3). For M&O contractor samples, radioactivities near INEEL were significantly higher than distant stations for four of 144 comparisons (<3 percent). INEEL radioactivities were statistically higher than the distant group during June at Auxiliary Reactor Area (ARA) and from July to September at Power Burst Facility (PBF) (Table 4-3). Because there were 169 comparisons and there is an approximate five percent rate at which a false positive may occur, there were actually fewer significant differences than might be expected by chance. (See Appendix B)

Statistical comparisons were also made between the annual gross beta mean radioactivities 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 radioactivities for individual stations were statistically greater than the distant mean annual gross beta radioactivity.

The few statistically significant differences in radioactivities detected may be due to INEEL operations at the onsite locations. 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 identity a possible INEEL cause, if any, for the differences.

Specific Radionuclides in Air Samples

Anthropogenic radionuclides were observed in ESER contractor samples (Table 4-4), although most were in the range of concentrations where detection is questionable (see Appendix B).

The ESER contractor has detected Americium-241 (^{241}Am) in air samples since mid-1995. No particular location has consistently exhibited detectable ^{241}Am concentrations; detections remain scattered across the network. A laboratory oversight was found to be the cause of most of these detections. The ESER contractor instituted a corrective action with the laboratory in mid 1999, and detections of ^{241}Am returned to the expected frequency (approximately ± 30 percent). Detections of ^{241}Am fell approximately 15 percent in 1999 from 1998 as a result of the laboratory corrective action. Positive detections of specific human-made radionuclides reported by the M&O and ESER contractors can also be found in Table 4-4 (see Appendix B for a discussion of the relative confidence in the presence of constituents at a reported value).

Atmospheric Moisture

During 1999, the ESER contractor collected a total of 16 atmospheric moisture samples from four locations, including Atomic City, Blackfoot, Idaho Falls, and Rexburg. Tritium was detected in seven of the samples. During the first quarter, Rexburg and Atomic City samples displayed the same tritium radioactivities of (1.2 ± 0.9) x 10^{-13} µCi/cubic-centimeter (cm^3) in air. Samples from Atomic City, Idaho Falls, and Blackfoot had measurable radioactivities of (6.2 ± 3.4) x 10^{-14} µCi/cm^3, (4.4 ± 4.4) x 10^{-15} µCi/cm^3, and (3.5 ± 2.9) x 10^{-14} µCi/cm^3 respectively, in the second quarter. A Rexburg sample contained (5.8 ± 5.6) x 10^{-14} µCi/cm^3 tritium in air

Table 4-3. Statistical Comparison of Gross Beta Concentrations in Air at Distant, Boundary and INEEL Locations (1999).

ESER Contractor Data

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Arco													
Atomic City													
FAA Tower													
Howe													
Monteview													
Mud Lake													
Reno Ranch													
Boundary													
EFS													
Main Gate													
Van Buren													
INEEL													

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
ANL-W													
ARA													
CFA													
EBR-1													
EFS													
INTEC													
NRF													
PBF													
RWMC													
TAN													
TRA													
Van Buren													
INEEL													

Shaded area indicates the mean gross beta concentration for that location was 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.

Table 4-4. Human-Made Radionuclides in ESER and M&O Contractor Air Samples (1999).

Location	^{241}Am (x 10^{-18} µCi/mL)	^{238}Pu (x 10^{-18} µCi/mL)	$^{239/240}Pu$ (x 10^{-18} µCi/mL]	^{90}Sr (x 10^{-17} µCi/mL)
ESER CONTRACTOR SAMPLES				
First Quarter 1999				
Arco	3.6 ± 2.2	No Detections	No Detections	No Detections
Atomic City	No Detections	No Detections	No Detections	10.4 ± 4.0
Blackfoot	5.8 ± 4.4	No Detections	No Detections	No Detections
Craters of the Moon	0.9 ± 0.5	No Detections	No Detections	No Detections
EFS	No Detections	No Detections	No Detections	22.8 ± 7.0
Main Gate	0.8 ± 0.8	No Detections	No Detections	No Detections
Monteview	1.8 ± 1.4	No Detections	No Detections	No Detections
Mud Lake	No Detections	No Detections	No Detections	6.4 ± 3.4
Second Quarter 1999				
Atomic City	1.5 ± 1.3	No Detections	No Detections	No Detections
Craters of the Moon	1.1 ± 1.0	No Detections	No Detections	No Detections
EFS	1.4 ± 1.2	No Detections	No Detections	No Detections
FAA Tower	No Detections	No Detections	No Detections	1.5 ± 1.4
Idaho Falls	2.3 ± 1.8	No Detections	4.4 ± 3.4	No Detections
Main Gate	No Detections	No Detections	No Detections	6.0 ± 2.8
Monteview	2.0 ± 1.4	No Detections	No Detections	8.9 ± 3.8
Mud Lake	1.6 ± 1.4	No Detections	No Detections	No Detections
Third Quarter 1999				
Arco	2.8 ± 2.0	No Detections	No Detections	No Detections
Atomic City	No Detections	No Detections	No Detections	4.7 ± 3.6
EFS	No Detections	No Detections	No Detections	12.7 ± 6.2
Idaho Falls	No Detections	No Detections	No Detections	5.6 ± 5.4
Monteview	1.6 ± 1.4	No Detections	No Detections	No Detections
Mud Lake	No Detections	No Detections	No Detections	6.9 ± 4.2
Rexburg	No Detections	No Detections	No Detections	7.6 ± 4.2
Fourth Quarter 1999				
EFS	1.3 ± 1.2	No Detections	No Detections	No Detections
Idaho Falls	2.1 ± 2.0	No Detections	No Detections	No Detections
Monteview	No Detections	No Detections	No Detections	2.6 ± 3.4
Mud Lake	No Detections		2.4 ± 2.2	No Detections
M&O CONTRACTOR SAMPLES				
First Quarter 1999				
All sites	No Detections	No Detections	No Detections	No Detections
Second Quarter 1999				
All sites	No Detections	No Detections	No Detections	No Detections
Third Quarter 1999				
All sites	No Detections	No Detections	No Detections	No Detections
Fourth Quarter 1999				
EFS	No Detections	No Detections	No Detections	11.9 ± 6.2
TRA	No Detections	No Detections	No Detections	15.3 ± 8.6
PBF	No Detections	No Detections	No Detections	17.9 ± 7.8

All values are written as measured concentration ± 2 standard deviations.

during the third quarter. Rexburg also had a measurable tritium radioactivity of (9.7 ± 7.2) x 10^{-13} µCi/cm^3 in the fourth quarter. These detected radioactivities were all very low, and radioactivities were similar at distant and boundary locations. This similarity suggests the detections probably represent tritium formed naturally in the upper atmosphere by cosmic ray bombardment, from residual weapons testing fallout, and possible analytical variations. The highest observed radioactivity (from Rexburg) represents approximately 0.001 percent of the Department of Energy (DOE) Derived Concentration Guide of 1 x 10^{-7} µCi/cm^3.

The M&O contractor also collected atmospheric moisture samples at the EFS and at Van Buren Boulevard on the INEEL. They collected from one to three samples at each location each quarter. Laboratory analyses indicated that all samples were below detection limits (see Table 3-1 for detection limits).

Precipitation

When precipitation occurred, the ESER contractor collected precipitation samples weekly at the EFS (on the INEEL), monthly at the Central Facility Area (CFA) (on the INEEL), and offsite in Idaho Falls. A total of 31 precipitation samples were collected during 1999 from the three sites. Tritium was detected in four of the samples at radioactivities ranging from (1.1 ± 0.9) x 10^{-7} µCi/mL to (2.7 ± 1.0) x 10^{-7} µCi/mL. The highest radioactivity was from EFS. The radioactivities are well within the normal range observed worldwide in recent years and are likely due to the worldwide inventory of tritium from natural production and also to expected variability in laboratory analyses.

4.2 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 (Figure 3-3). The ESER contractor collected 40 offsite water samples, 12 from surface water locations and 28 from drinking water locations. In addition, the M&O contractor's storm water monitoring results are also presented here. Radiological results from onsite production well sampling may be found in Chapter 6, "Groundwater," together with results from additional sampling conducted by the M&O contractor Drinking Water Program.

Offsite Water Sampling – Gross Alpha

In 1999, one surface water sample and two drinking water samples contained detectable radioactivities of gross alpha at (1.4 ± 1.0) pCi/L, (1.3 ± 1.0) pCi/L and (1.8 ± 1.7) pCi/L, respectively. The highest radioactivity is well below the Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) of 15 pCi/L for drinking water.

Offsite Water Sampling – Gross Beta

Gross beta activity above the MDC was present in 31 of the 40 offsite water samples. Detectable radioactivities ranged from (1.9 ± 1.8) pCi/L to (12.0 ± 2.8) pCi/L. The EPA has not established a numerical MCL for gross beta in drinking water. However, the measured radioactivities are within the range that would be expected from natural decay products of thorium and uranium that dissolve into water as the water passes through the basalt of the Snake River Plain.

Offsite Water Sampling – Tritium

Tritium was detected in four drinking water and four surface water samples during 1999. Drinking water radioactivities ranged from (0.9 ± 0.8) x 10^{-7} µCi/mL to (1.5 ± 0.4) x 10^{-7} µCi/mL with the highest value coming from Blackfoot. Surface water sample radioactivities ranged from (1.4 ± 0.8) x 10^{-7} µCi/mL to (3.4 ± 1.0) x 10^{-7} µCi/mL with the highest radioactivities coming from Twin Falls. The maximum levels are below the DOE Derived Concentration Guide (DCG) of 0.002 µCi/mL for tritium in water. These levels can be explained by natural and laboratory variability.

Storm Water Sampling

During 1999 three storm water samples were analyzed for gross alpha, gross beta, radium-226, antimony-125, tritium, and strontium-89/90. Benchmarks have been established for radionuclides in storm water runoff at the INEEL based on the DCG's in DOE Order 5400.5. One sample from the Idaho Nuclear Technology and Engineering Center (INTEC) had a measurable gross alpha activity of (4.2 ± 2.0 pCi/L). Gross beta activity was found in a sample from INTEC (16.6 ± 3.1 pCi/L) and two samples from PBF with radioactivities of 4.24 ± 0.85 pCi/L and 4.16 ± 0.84 pCi/L, respectively. The specific radionuclides $^{89/90}$Sr and tritium were not detected in storm water samples. Radium-226 was detected in both PBF samples at 1.02 ± 0.46 pCi/L and 0.78 ± 0.42 pCi/L, respectively. Antimony-125 was also detected in one of the PBF samples at a level of 11.0 ± 10.0 pCi/L.

More detailed information and data on storm water monitoring was included in the 1999 Environmental Monitoring Program Report [Reference 4-2].

4.3 FOODSTUFF SAMPLING

Milk

During 1999, 161 milk samples were collected. All of the samples were analyzed for ^{131}I. During the first and third quarters, selected samples were analyzed for tritium. During the second and fourth quarters, selected samples were analyzed for ^{90}Sr.

No ^{131}I was detected in any milk samples. Tritium was not detected in any 1999 milk samples. Strontium-90 was detected in nine samples ranging from (4.4 ± 1.8) x 10^{-4} pCi/mL at Arco to (1.1 ± 0.3) x 10^{-3} pCi/mL in a sample from Carey. All levels of ^{90}Sr in milk were 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 4-3]. There is no indication that activities at the INEEL are contributing to ^{90}Sr in milk.

Lettuce

Nine lettuce samples, including one duplicate, were collected from regional private gardens. Cesium-137 (^{137}Cs) was detected in samples from Blackfoot and Idaho Falls at concentrations of (2.8 ± 2.4) x 10^{-7} and (5.5 ± 2.7) x 10^{-7} µCi/g, respectively. Strontium-90 was detected in all nine of the lettuce samples (Table 4-5). Both ^{137}Cs and ^{90}Sr are present in soil from above-ground nuclear weapons testing which took place between 1945 and 1980.

Wheat

None of the 11 wheat samples collected during 1999 contained detectable ^{137}Cs. Measurable concentrations of ^{90}Sr were seen in 10 samples from both distant and boundary locations (Table 4-6). The concentrations of ^{90}Sr were similar to those detected in recent years and are attributed to historic aboveground nuclear weapons testing (1945 –1980).

Potatoes

Seventeen potato samples, including one duplicate, were collected during 1999. Fourteen samples from 11 distant locations and three from boundary locations (Figure 4-2). Strontium-90 was detected in four samples (Rupert; Arco; Klamath, Oregon; and Center, Colorado) at concentrations ranging from (2.9 ± 2.6) x 10^{-3} pCi/g from Arco, Idaho, to (8.3 ± 5.0) x 10^{-3} pCi/g from Rupert, Idaho. These concentrations are consistent with past results seen in potatoes and are likely due to historic worldwide fallout from nuclear weapons testing and the Chernobyl reactor accident in 1986. Samples collected in Idaho from Idaho Falls, Blackfoot, Mud Lake, Tabor, and from Palmer, Alaska; Fairbanks, Alaska; Quincy, Washington; Fillmore City, Minnesota; Bend, Oregon; and Bridgemont, Michigan, did not exhibit detectable ^{90}Sr levels. Two of the three samples collected from Center, Colorado, did not exhibit detectable levels of ^{90}Sr. There was no significant difference between mean ^{90}Sr concentrations for potatoes collected near the INEEL boundary compared with those collected in southeast

Table 4-5. Strontium-90 Concentrations in Garden Lettuce (1994–1999).

	(10^{-9} µCi/g dry weight)					
Location	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Distant Group						
Blackfoot	160 ± 80	740 ± 200	270 ± 240	90 ± 70	100 ± 80	130 ± 60
Carey	130 ± 40	-50 ± 180	NS [a]	70 ± 50	200 ± 50	120 ±80
Idaho Falls	120 ± 40	60 ± 30	NS	50 ± 30	70 ± 40	60 ± 40
Mean	140 ± 50	140 ± 50	270 ± 240	60 ± 40	120 ± 60	103 ± 60
Boundary Group						
Arco	50 ± 40	140 ± 50	200 ± 200	70 ± 70	200 ± 100	120 ± 40
Atomic City	200 ± 60	300 ± 120	120 ± 100	160 ± 60	100 ± 70	90 ± 40
Howe	NS	NS	100 ± 160	80 ± 80	100 ± 90	60 ± 70
Monteview	110 ± 40	100 ± 90	NS	90 ± 40	100 ± 50	225 ± 200
Mud Lake	70 ± 60	80 ± 40	160 ± 360	170 ± 80	100 ± 80	160 ± 80
Mean	110 ± 100	160 ± 160	140 ± 70	130 ± 60	120 ± 80	130 ± 90

[a] NS indicates no sample collected.

Table 4-6. Strontium-90 Concentrations in Wheat (1994–1999).

	(10^{-9} µCi/g dry weight)					
Location	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Distant Group						
American Falls	7 ± 2	8 ± 4	7 ± 5	9 ± 5	6 ± 4	6 ± 5
Blackfoot	7 ± 2	4 ± 4	6 ± 6	14 ± 6	8 ± 4	5 ± 5
Carey	2 ± 2	11 ± 7	5 ± 6	5 ± 4	NS	8 ± 3
Dietrich	3 ± 2	NS [a]	5 ± 5	4 ± 4	4 ± 3	5 ± 4
Idaho Falls	6 ± 2	9 ± 5	9 ± 18	4 ± 4	7 ± 3	8 ± 6
Minidoka	6 ± 2	3 ± 5	8 ± 5	5 ± 4	6 ± 3	4 ± 3
Mean	5 ± 2	7 ± 4	7 ± 2	7 ± 4	6 ± 3	6 ± 4
Boundary Group						
Arco	4 ± 2	3 ± 5	16 ± 40	4 ± 3	6 ± 3	5 ± 3
Monteview	7 ± 3	4 ± 4	3 ± 4	5 ± 5	9 ± 4	6 ± 5
Mud Lake	5 ± 2	4 ± 5	5 ± 5	4 ± 4	8 ± 4	3 ± 3
Taber	8 ± 2	12 ± 6	10 ± 6	5 ± 5	6 ± 3	8 ± 6
Terreton	5 ± 2	7 ± 5	8 ± 6	6 ± 4	7 ± 3	5 ± 4
Mean	6 ± 2	6 ± 5	8 ± 6	5 ± 1	7 ± 3	5 ± 4

[a] NS indicates no sample collected.

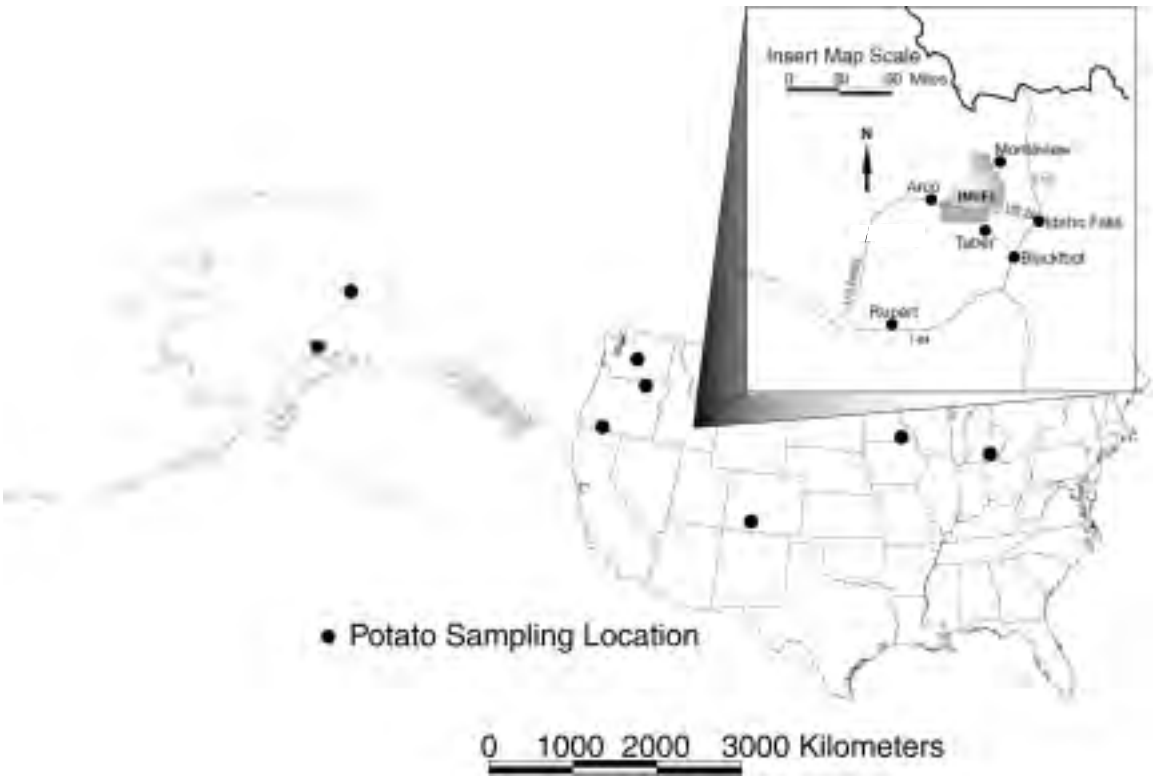

Figure 4-2. Locations of Potato Samples Taken during 1999.

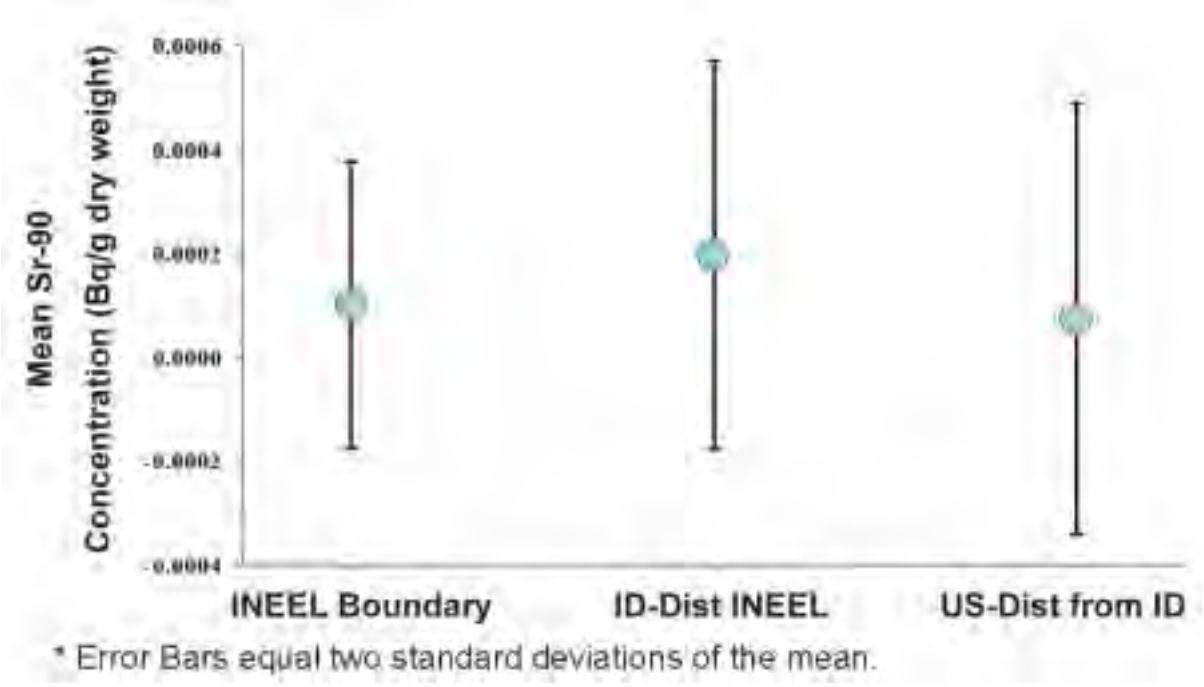

Figure 4-3. Average Strontium-90 Concentrations in Potatoes.

Idaho distant from the INEEL or with those collected across the United States (Figure 4-3).

Sheep

Six sheep were sampled during the second quarter of 1999. Four were taken from INEEL land, and two were taken from Blackfoot to serve as control samples. Cesium-137 was detected in the muscle tissue of both control samples averaging $(3.6 \pm 2.6) \times 10^{-9}$ µCi/g and in one of the liver tissue samples at $(2.6 \pm 2.1) \times 10^{-9}$ µCi/g. Cesium-137 was found in three of the four onsite muscle samples ranging from $(5.6 \pm 3.0) \times 10^{-9}$ µCi/g to $(6.0 \pm 2.4) \times 10^{-9}$ µCi/g. It was also detected in livers of three samples ranging from $(3.7 \pm 2.2) \times 10^{-9}$ µCi/g to $(7.0 \pm 3.0) \times 10^{-9}$ µCi/g. All ^{137}Cs concentrations were similar to those found in both onsite and offsite sheep samples during recent years. Iodine-131 was not detected in any of the sheep.

Game Animals

Ten mule deer, four pronghorn, and two elk, which had been accidentally killed on INEEL roads, were sampled. Four pronghorn, five elk, and eight mule deer muscle samples were collected as background samples from hunters across the Western United States: three from central Idaho, three from Wyoming, three from Montana, four from Utah, and one each from New Mexico, Colorado, Nevada, and Oregon. Each background sample had small, but detectable, ^{137}Cs in their muscle ranging from $(2.0 \pm 2.0) \times 10^{-9}$ µCi/g to $(1.5 \pm 0.2) \times 10^{-7}$ µCi/g. There was detectable ^{137}Cs in nine liver/muscle samples taken from animals on or near the INEEL, ranging from $(2.6 \pm 2.0) \times 10^{-9}$ µCi/g to $(13.5 \pm 3.2) \times 10^{-9}$ µCi/g (mule deer muscle). All of these low concentrations are within the range of historical values and can be attributed to the ingestion of radionuclides from worldwide fallout from above-ground nuclear weapons testing. No ^{131}I was detected in any of the thyroid glands.

A total of 16 mourning doves were collected: seven from TRA, five from INTEC, and four controls from south of Idaho Falls. Due to the small sample size of muscle tissue from an individual dove, all doves from each location were composited into two or three samples (Table 4-7). Samples were analyzed for gamma emitting radionuclides, ^{90}Sr, Plutonium-238 (^{238}Pu), Plutonium-239/240 ($^{239/240}$Pu), and Americium-241 (^{241}Am). A total of three human-made radionuclides were detected in dove muscle samples, one in the control dove sample (^{137}Cs) and two in the TRA doves (Cobalt-60 [^{60}Co], ^{241}Am). No radionuclides were detected in the INTEC samples (Table 4-7).

No waterfowl were collected during 1999. From 1994-1998, a total of 68 waterfowl were collected: 17 from TRA, 10 from INTEC, 9 from Test Area North (TAN), 8 from Argonne National Laboratory-West (ANL-W), and 24 from locations distant from the INEEL. All were analyzed for gamma emitting radionuclides with a subset analyzed for ^{90}Sr, ^{238}Pu, $^{239/240}$Pu, and ^{241}Am. Total radionuclide concentrations are summarized in Table 4-8. Potential dose from consuming these ducks are discussed in Chapter 8, Section 8.3.

Marmots were not collected in 1999. During 1998 a total of nine yellow-bellied marmots were collected: six from the RWMC and three controls (43 km southeast of the INEEL). All were analyzed for gamma emitting radionuclides with one randomly selected control sample and three randomly selected RWMC samples analyzed for ^{90}Sr, ^{238}Pu, $^{239/240}$Pu, and ^{241}Am. A total of nine human-made radionuclides were detected in those samples with eight found in marmots taken from the RWMC (Table 4-9). Calculated hypothetical doses to humans from marmot consumption can be found in Chapter 8, Section 8.3.

4.4 SOIL SAMPLING

Biennial soil sampling was conducted during 1998 with no collections made in 1999. See the 1998 Site Environmental

Report for Calendar Year 1998 (DOE/ID-12082 [98]) for information on results from 1998 [Reference 4-4]. Soil will be sampled again in 2000 and results of radioanalysis reported in the Site Environmental Report for 2000.

4.5 ENVIRONMENTAL DOSIMETERS

The measured cumulative radiation exposure for offsite locations from November 1998 to November 1999 is shown in Table 4-10 for the duplicate set of dosimeters maintained by the ESER contractor and the M&O contractor. For purposes of comparison, annual exposures from 1996–1999 are also included for each location.

The mean annual exposures from distant locations in 1999 were 121 ± 9 mR, as measured by ESER contractor dosimeters, and 116 ± 10 mR, as measured by the M&O contractor's dosimeters. For boundary locations, the mean annual exposures were 121 ± 9 mR as measured by ESER contractor dosimeters and 120 ± 11 mR as measured by M&O contractor dosimeters. Using both sets of data, the average exposure of the distant group was equivalent to 122 mrem when a dose equivalent conversion factor of 1.03 was used to convert from mR to mrem in tissue. [Reference 4-5] The average exposure for the boundary group was 124 mrem.

Table 4-11 summarizes the calculated effective dose equivalent an individual receives on the Snake River Plain from various background radiation sources. The terrestrial portion of this value 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. These are very long-lived radionuclides and soil concentrations remain, on the average, constant over millions of years. 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 1999, this resulted in a 4-mrem/yr reduction to 72 mrem/yr due to the shielding effect of snow cover. Snow cover ranged from 2.54 to 25.4 cm (1 to 10 in) in depth with an average of 10.5 cm (4 in) over 74 days with recorded snow cover.

The cosmic component varies primarily with altitude, increasing from about 26 mrem at sea level to about 48 mrem at the elevation of the INEEL at approximately 1,500 m (4,900 ft) [Reference 4-6]. This may vary slightly due to solar cycle fluctuations and other factors.

The estimated sum of the terrestrial and cosmic components for 1999 was 120 mrem. This is essentially equal to the value of 122 mrem measured at distant locations by thermoluminescent dosimeters (TLDs), after conversion from mR to mrem in 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. There is also variation 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 4-11 for this component of the total background dose because no specific estimate for southeastern Idaho has been made and few specific measurements have been made of radon in homes in this area. Therefore, the effective dose equivalent

Table 4-7. Human-Made Radionuclides Detected in Breast Meat of Mourning Doves Collected on the INEEL (1999).

Location	Radionuclide(s) Detected	Concentration (x 10^{-6} μCi/g)[a]
Control 4 doves composited into 2 samples of 2 doves each	^{137}Cs detected in one sample	0.059 ± 0.058
INTEC 5 doves composited into 2 samples; one with 3 doves the other with 2	No radionuclides detected	---
TRA 7 doves composited into 3 samples; two with 2 doves the other with 3	^{60}Co ^{241}Am (both radionuclides detected in the same sample)	0.083 ± 0.078 0.007 ± 0.005

[a] Concentration ± 2 standard deviations.

Table 4-8. Human-Made Radionuclides Detected in Edible Portions of Waterfowl (1994–1998).

		Muscle (pCi/g)
Controls	Maximum:	2.945
N = 24	Median:	0.009
	Average:	0.291
	Standard deviation:	3.681
TRA	Maximum:	288.077
N = 17	Median:	0.456
	Average:	24.414
	Standard deviation:	18.534
TAN	Maximum:	1.797
N = 9	Median:	0.190
	Average:	0.460
	Standard deviation:	1.388
ANL-W	Maximum:	0.128
N = 8	Median:	0.060
	Average:	0.061
	Standard deviation:	1.233
INTEC	Maximum:	1.170
N = 10	Median:	0.055
	Average:	0.237
	Standard deviation:	1.338

N = sample size.

Table 4-9. Human-Made Radionuclides Detected in Edible Portions of Yellow-Bellied Marmots (1998)[a].

		Concentration (x 10^6 µCi/g)		
Location	**Radionuclide**	**Minimum[b]**	**Maximum[b]**	**Mean**
Control (N = 3)[c]	^{90}Sr	0.157 ± 0.070		NA[d]
	^{137}Cs	<mdc[e]	0.018 ± 0.010	0.015 ± 0.030[f]
	^{144}Ce	<mdc	0.124 ± 0.108	0.007 ± 0.444
RWMC (N = 6)[f]	^{60}Co	<mdc	0.013 ± 0.008	0.008 ± 0.050
	^{65}Zn	<mdc	0.070 ± 0.052	0.023 ± 0.208
	^{90}Sr	0.078 ± 0.052	0.122 ± 0.064	0.096 ± 0.124
	^{95}Nb	<mdc	1.395 ± 0.922	0.284 ± 6.986
	^{134}Cs	<mdc	0.015 ± 0.014	0.009 ± 0.064
	^{137}Cs	<mdc	0.016 ± 0.012	0.009 ± 0.056
	^{141}Ce	<mdc	16.100 ± 10.700	4.404 ± 22.850
	^{238}Pu	<mdc	0.001 ± 0.001	0.001 ± 0.002

[a] Marmots were not collected in 1999. Therefore, the 1998 data are included here.
[b] Values are measured concentration ± 2 standard deviations.
[c] N = sample size
[d] NA indicates not applicable.
[e] <mdc indicates less than minimum detectable concentration.
[f] Mean ± 2 standard deviations of the mean with errors of individual estimates propagated.

Table 4-10. Environmental Exposures (1996 –1999).

	Annual Exposure (mR)[a]							
	1996		1997		1998		1999	
Distant Group	**ESER**	**M&O**	**ESER**	**M&O**	**ESER**	**M&O**	**ESER**	**M&O[b]**
Aberdeen	NS[c]	NS	137 ± 8	134 ± 4	128 ± 8	157 ± 18	130 ± 9	124 ± 7
Blackfoot	120 ± 8	132 ± 7	129 ± 6	116 ± 4	130 ± 6	134 ± 7	111 ± 4	111 ± 6
Blackfoot (MVMS)[d]	NS	NS	122 ± 5	NS	113 ± 4	NS	113 ±14	NS
Craters of the Moon	117 ± 4	122 ± 6	122 ± 7	119 ± 6	122 ± 6	121 ± 8	115 ± 12	120 ± 13
Idaho Falls	120 ± 5	120 ± 6	132 ± 7	119 ± 7	124 ± 6	115 ± 6	124 ± 13	108 ± 10
Minidoka	118 ± 5	121 ± 4	110 ± 5	113 ± 8	116 ± 7	113 ± 6	112 ± 7	113 ± 12
Rexburg	122 ± 4	125 ± 11	144 ± 8	120 ± 5	144 ± 7	116 ± 4	129 ± 5	110 ± 11
Roberts	140 ± 9	141 ± 9	140 ± 11	140 ± 7	130 ± 6	137 ± 8	131 ± 9	129 ± 10
Mean	127 ± 9	130 ± 8	123 ± 9	123 ± 9	126 ± 6	128 ± 11	121 ± 9	116 ± 10
Boundary Group								
Arco	131 ± 6	130 ± 4	125 ± 9	125 ± 9	128 ± 7	117 ± 6	128 ± 12	124 ± 7
Atomic City	136 ± 6	144 ± 14	134 ± 10	137 ± 11	132 ± 6	124 ± 5	124 ± 8	133 ± 6
Howe	117 ± 8	122 ± 6	125 ± 6	122 ± 9	125 ± 5	116 ± 7	118 ± 6	116 ± 10
Monteview	122 ± 4	108 ± 4	127 ± 8	108 ± 4	124 ± 4	113 ± 8	114 ± 6	108 ± 14
Mud Lake	129 ± 6	139 ± 9	127 ± 9	125 ± 9	137 ± 7	130 ± 4	129 ± 9	128 ± 13
Reno Ranch	110 ± 4	109 ± 6	126 ± 8	111 ± 8	117 ± 6	105 ± 6	113 ± 10	113 ± 18
Mean	124 ± 10	125 ± 16	127 ± 3	121 ± 11	127 ± 5	118 ± 6	121 ± 9	120 ± 11

[a] Annual exposure ± 2s.
[b] BBWI took over the INEEL M&O contract and associated sampling responsibilities from LMITCO in October 1999.
[c] NS indicates no sample due to the dosimeter being damaged or missing.
[d] Mountain View Middle School (MVMS) site was established Oct. 1996. The M&O contractor does not sample at this location.

Table 4-11. Estimated Natural Background Effective Dose Equivalent in mrem for a Person Residing on the Snake River Plain (1999).

Source of Radiation Dose Equivalent		Total Average Annual (mrem) Estimated	Measured
External			
	Terrestrial	72	N/A
	Cosmic	48	N/A
	Subtotal	**120**	**122**
Internal			
	Cosmogenic	1	
	Inhaled Radionuclides	200	
	^{40}K and others	39	
	Subtotal	**240**	
Total		**360**	

N/A indicates radiation parameters not measured individually.

from natural background radiation for residents in the INEEL vicinity may actually be higher or lower than the total estimated background dose of about 360 mrem shown in Table 4-11 and will vary from one location to another.

Onsite TLDs representing the same exposure period as the offsite dosimeters are shown in Figures 4-4 through 4-12. The results are expressed in mR ± two standard deviations (± 2s). Onsite dosimeters were placed on facility perimeters, concentrated in areas likely to show the highest gamma radiation readings. Other onsite dosimeters are located in the vicinity of radioactive materials storage areas. At some facilities, slightly elevated exposures result from areas of soil contamination around the perimeter of these facilities.

Location	Exposure ± 2s (mR)
ANL 7	135 ± 10
ANL 8	131 ± 15
ANL 9	146 ± 17
ANL 10	136 ± 6
ANL 11	123 ± 10
ANL 12	127 ± 6
ANL 13	119 ± 6
ANL 14	124 ± 10
ANL 15	158 ± 14
ANL 16	159 ± 9
ANL 17	135 ± 12
ANL 18	130 ± 9

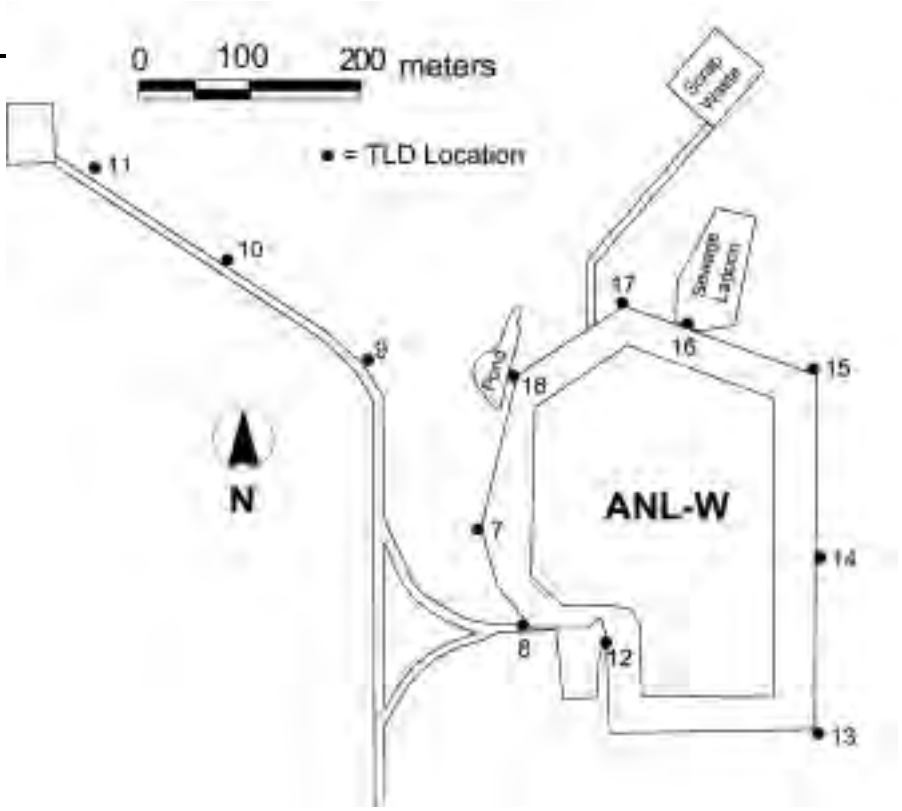

Figure 4-4. Environmental Dosimeter Locations and Measurements at ANL-W (1999).

Location	Exposure ± 2s (mR)
ARA 1	154 ± 16
ARA 2	151 ± 11
ARA 3	188 ± 11
ARA 4	163 ± 10

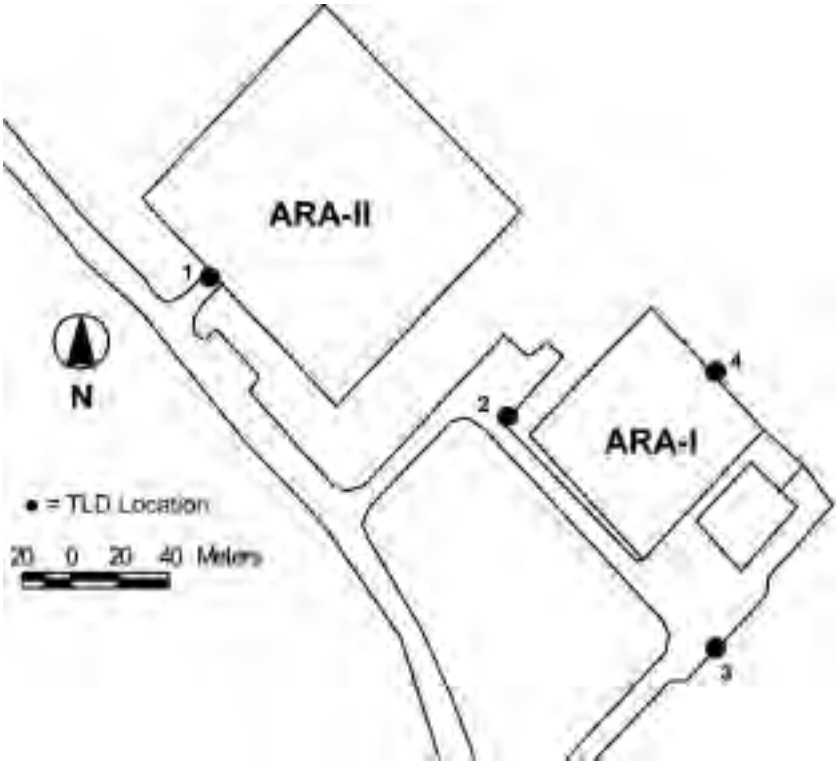

Figure 4-5. Environmental Dosimeter Locations and Measurements at ARA (1999).

Location	Exposure ± 2s (mR)
CFA 1	125 ± 9
CFA 2	126 ± 13
CFA 3	127 ± 6
CFA 4	128 ± 8

Figure 4-6. Environmental Dosimeter Locations and Measurements at CFA (1999).

Location	Exposure ± 2s (mR)
INTEC 1	148 ± 7
INTEC 9	172 ± 11
INTEC 14	132 ± 6
INTEC 15	139 ± 12
INTEC 16	133 ± 16
INTEC 17	129 ± 9
INTEC 18	132 ± 7
INTEC 19	141 ± 12
INTEC 20	229 ± 16
INTEC 21	168 ± 22
INTEC 22	173 ± 7
INTEC 23	147 ± 11
INTEC 24	132 ± 13
INTEC 25	124 ± 7
INTEC 26	124 ± 6
TREE FARM 1	163 ± 9
TREE FARM 2	149 ± 9
TREE FARM 3	165 ± 9
TREE FARM 4	181 ± 12

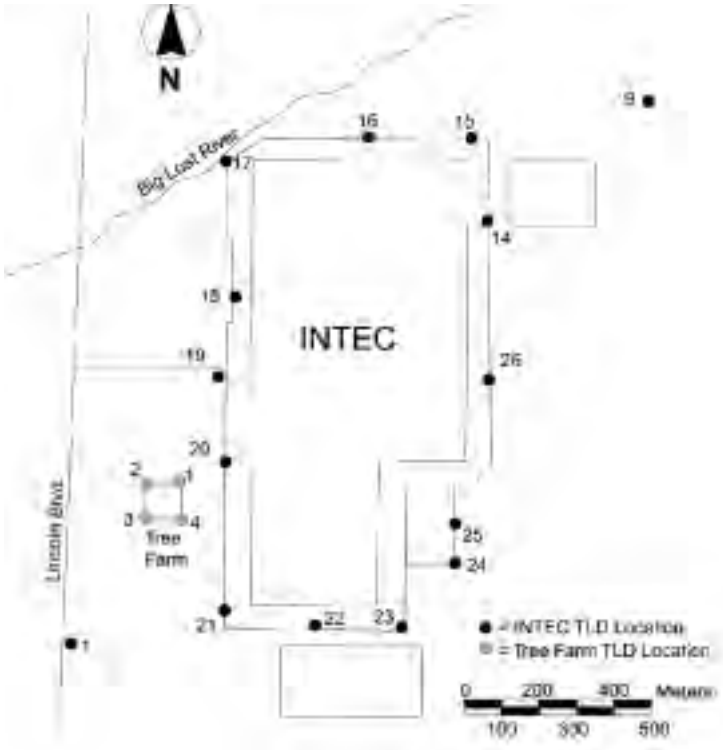

Figure 4-7. Environmental Dosimeter Locations and Measurements at INTEC (1999).

Location	Exposure ± 2s (mR)
NRF 4	129 ± 12
NRF 5	150 ± 6
NRF 11	129 ± 9
NRF 12	137 ± 11
NRF 13	128 ± 9
NRF 16	132 ± 10
NRF 17	128 ± 11
NRF 18	143 ± 5
NRF 19	125 ± 9
NRF 20	139 ± 9
NRF 21	125 ± 11

Figure 4-8. Environmental Dosimeter Locations and Measurements at NRF (1999).

Location	Exposure ± 2s (mR)
PBF/SPERT 1	200 ± 10
PBF/SPERT 2	120 ± 9
PBF/SPERT 3	124 ± 8
PBF/SPERT 4	140 ± 9
PBF/SPERT 5	125 ± 10
PBF/SPERT 6	143 ± 9
PBF/WERF 1	129 ± 12
PBF/WERF 2	122 ± 13
PBF/WERF 3	127 ± 10
PBF/WERF 4	136 ± 10
PBF/WERF 5	123 ± 12
PBF/WERF 6	127 ± 10
PBF/WERF 7	133 ± 11

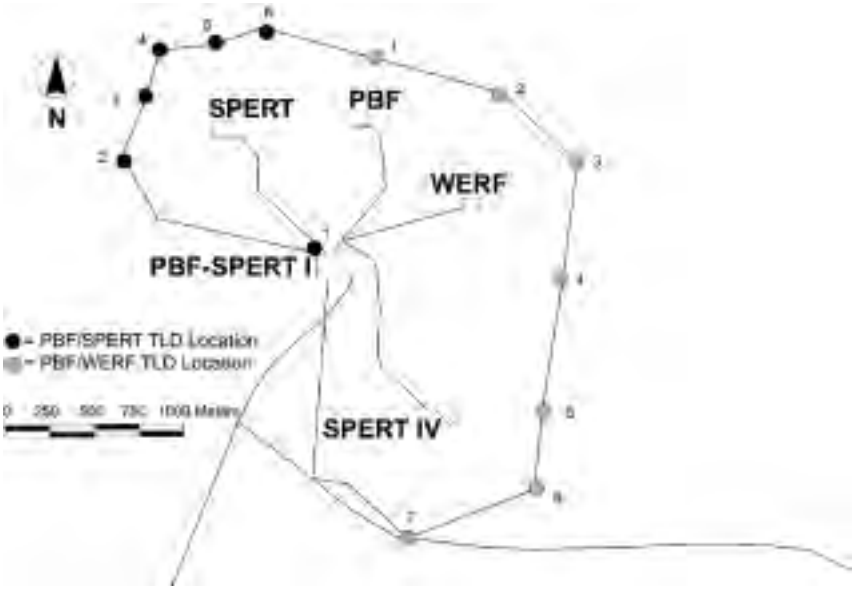

Figure 4-9. Environmental Dosimeter Locations and Measurements at PBF (1999).

Location	Exposure ± 2s (mR)
RWMC 3a	127 ± 8
RWMC 5a	122 ± 9
RWMC 7a	142 ± 10
RWMC 9a	130 ± 9
RWMC 11a	122 ± 4
RWMC 13a	125 ± 9
RWMC 15a	126 ± 11
RWMC 17a	128 ± 12
RWMC 19a	111 ± 4
RWMC 21a	121 ± 7
RWMC 23a	122 ± 8
RWMC 25a	118 ± 6
RWMC 27a	152 ± 12
RWMC 29a	141 ± 8
RWMC 31a	135 ± 9
RWMC 37a	110 ± 7
RWMC 39	178 ± 6
RWMC 40	137 ± 8
RWMC 41	261 ± 11
RWMC 42	128 ± 12
RWMC 43	123 ± 7
RWMC 45	126 ± 13
RWMC 46	115 ± 4
RWMC 47	114 ± 9

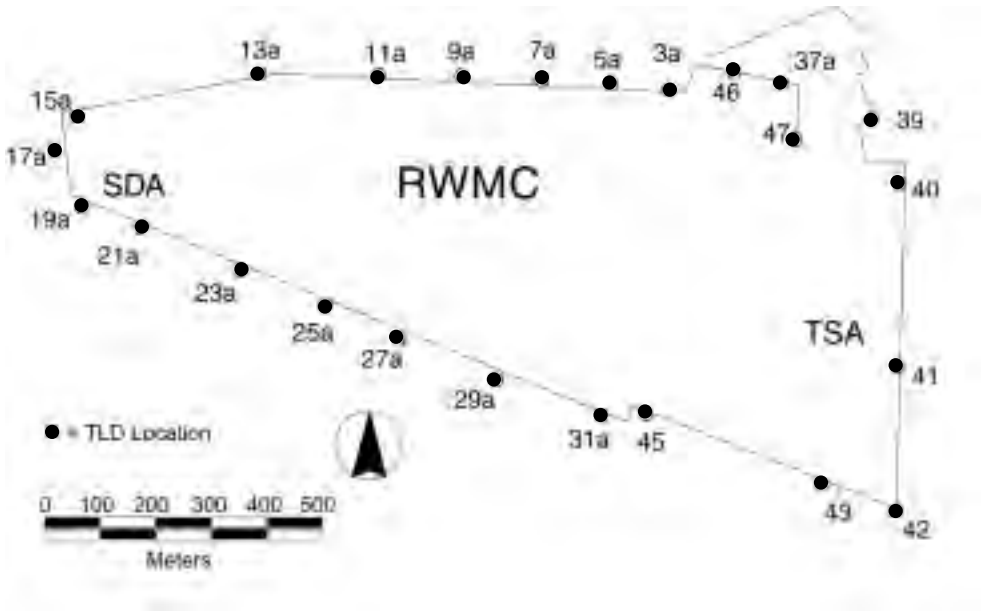

Figure 4-10. Environmental Dosimeter Locations and Measurements at RWMC (1999).

Location	Exposure ± 2s (mR)
TAN/TSF 1	120 ± 13
TAN/TSF 2	126 ± 12
TAN/TSF 3	111 ± 9
TAN/TSF 4	128 ± 10
TAN/LOFT 1	128 ± 7
TAN/LOFT 2	128 ± 7
TAN/LOFT 3	110 ± 9
TAN/LOFT 4	113 ± 10
TAN/LOFT 5	116 ± 8
TAN/LOFT 6	118 ± 7
TAN/LOFT 7	138 ± 12
TAN/WRRTF 1	106 ± 3
TAN/WRRTF 2	117 ± 13
TAN/WRRTF 3	114 ± 6
TAN/WRRTF 4	125 ± 5

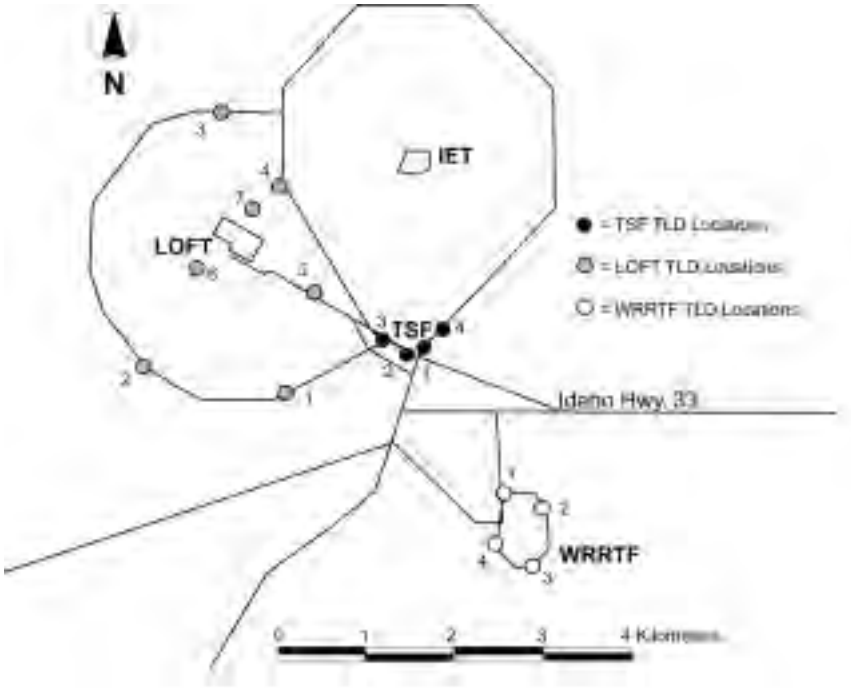

Figure 4-11. Environmental Dosimeter Locations and Measurements at TAN (1999).

Location	Exposure ± 2s (mR)
TRA 1	130 ± 4
TRA 2	254 ± 16
TRA 3	468 ± 21
TRA 4	215 ± 11
TRA 5	144 ± 8
TRA 6	125 ± 7
TRA 7	143 ± 6
TRA 8	158 ± 11
TRA 9	124 ± 6
TRA10	131 ± 6
TRA11	127 ± 4
TRA12	124 ± 5
TRA13	129 ± 8

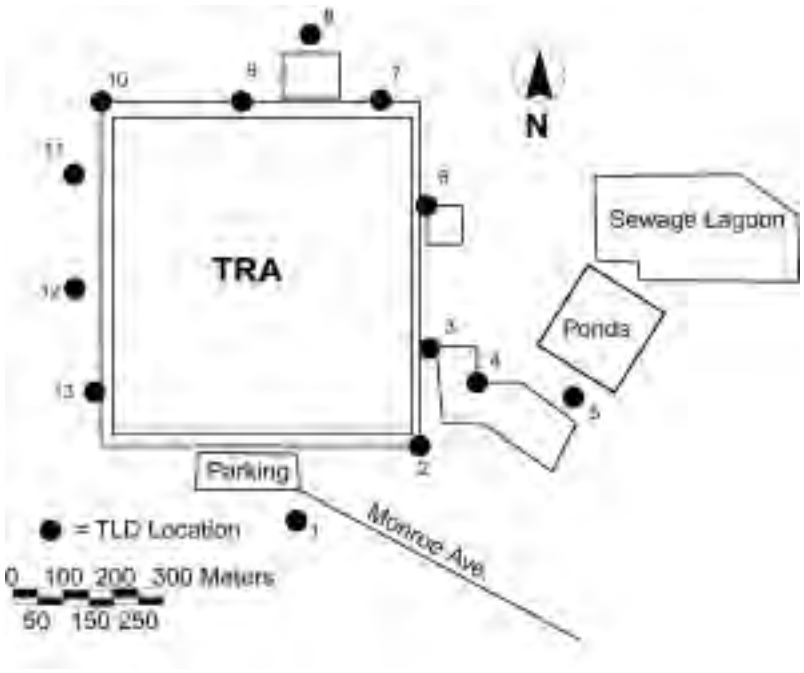

Figure 4-12. Environmental Dosimeter Locations and Measurements at TRA (1999).

Location	Exposure ± 2s (mR)
LINCOLN BLVD 1	115 ± 7
LINCOLN BLVD 3	129 ± 8
LINCOLN BLVD 5	116 ± 4
LINCOLN BLVD 7	127 ± 9
LINCOLN BLVD 9	133 ± 11
LINCOLN BLVD 11	132 ± 11
LINCOLN BLVD 13	126 ± 5
LINCOLN BLVD 15	132 ± 12
LINCOLN BLVD 17	128 ± 8
LINCOLN BLVD 19	125 ± 10
LINCOLN BLVD 21	112 ± 3
LINCOLN BLVD 23	119 ± 9
LINCOLN BLVD 25	119 ± 8
HWY 26-266	112 ± 4
HWY 26-268	115 ± 8
HWY 26-270	117 ± 7
HWY 20-264	119 ± 9
HWY 20-266	104 ± 5
HWY 20-268	113 ± 7
HWY 20-270	117 ± 8
HWY 20-272	112 ± 11
HWY 20-274	102 ± 6
HWY 20-276	112 ± 6
EBR 1	118 ± 6

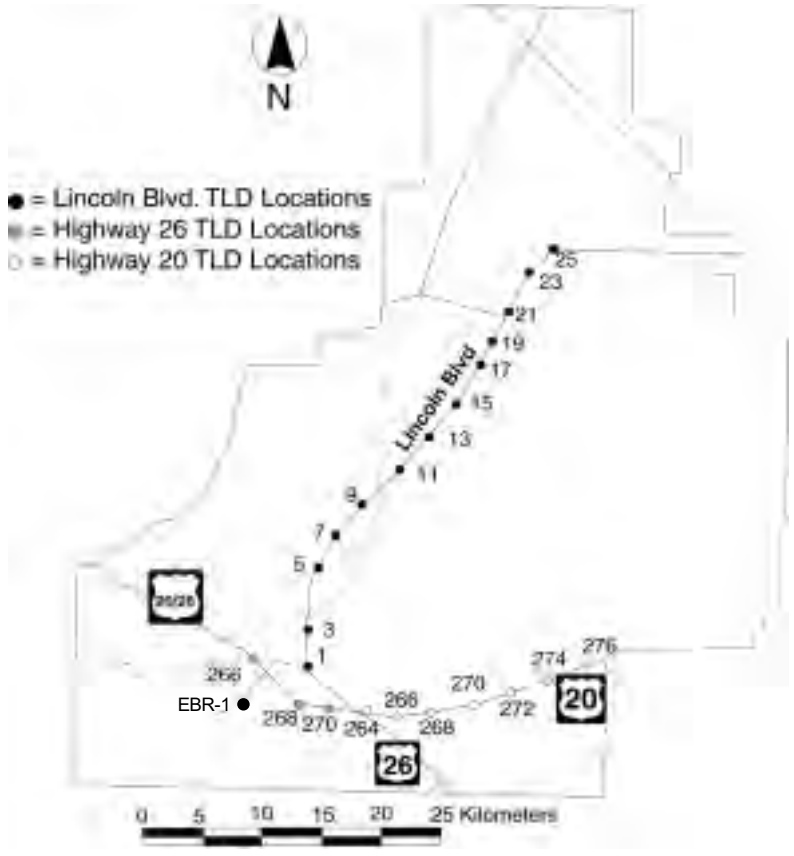

Figure 4-13. Environmental Dosimeter Locations and Measurements Lincoln Boulevard and U.S. Highway 20 (1999).

Chapter 5

Nonradiological Environmental Monitoring Results

5. NONRADIOLOGICAL ENVIRONMENTAL MONITORING RESULTS

5.1 TOTAL SUSPENDED PARTICULATES

In 1999, the Department of Energy (DOE) Environmental Surveillance, Education, and Research (ESER) contractor and the Management and Operating (M&O) contractor measured concentrations of total suspended particulates using filters 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 5.2, these samplers do not selectively filter out particles of a certain size range, so they measure the total amount of particulate matter.

The annual means of total suspended particulate concentrations ranged from 8 µg/m^3 at Experiment Field Station (EFS) on the Idaho National Engineering and Environmental Laboratory (INEEL) to 57 µg/m^3 at Arco (Table 5-1).

Particulate concentrations were generally higher at distant and boundary locations than at the INEEL stations. This is mostly due to agricultural activities in offsite areas. Particulate concentrations increased from 1998 to 1999 at most locations, which is consistent with drier years. Overall, however, concentrations were commensurate with those observed in the past 10 years (Figure 5-1).

5.2 FINE PARTICULATES

The 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 micrometers" [Reference 5-1]. Particles of this size can reach the lungs and are considered to be responsible for most of the adverse health effects associated with airborne particulate

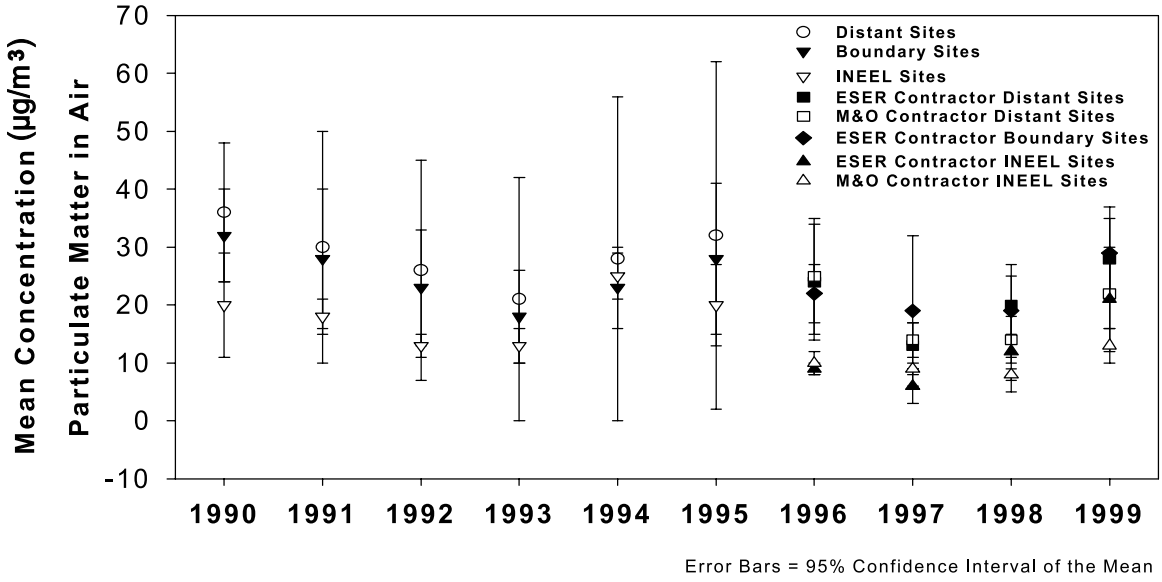

Figure 5-1. Ten-Year Summary of Total Particulate Matter Concentrations (1990–1999).

Table 5-1. Particulate Concentrations in Air (1999).

ESER Contractor Data

		Concentration (µg/m^3)	
Group	**Location**	**Range**	**Mean ± 95% C.I.[a]**
Distant	Blackfoot	7 – 45	22 ± 14
	Craters of the Moon	11 – 25	18 ± 5
	Idaho Falls	12 – 67	34 ± 21
	Mountain View	14 – 48	30 ± 15
	Rexburg	13 – 51	37 ± 14
	Distant Mean		28 ± 7
Boundary	Arco	26 – 85	57 ± 24
	Atomic City	15 – 35	25 ± 8
	FAA Tower	-0.3 – 34	16 ± 13
	Howe	9 – 50	27 ± 15
	Monteview	13 – 49	32 ± 13
	Mud Lake	10 – 48	25 ± 15
	Reno Ranch	8 – 37	22 ± 10
	Boundary Mean		29 ± 8
INEEL	EFS	-22 – 30	8 ± 19
	Main Gate	6 – 32	16 ± 10
	Van Buren	18 – 58	40 ± 17
	INEEL Mean		21 ± 9

M&O Contractor Data

		Concentration (µg/m^3)	
Group	**Location**	**Range**	**Mean ± 95% C.I.[a]**
Distant	Blackfoot	11 – 46	28 ± 18
	Craters of the Moon	7 – 19	11 ± 5
	Idaho Falls	12 – 33	22 ± 11
	Rexburg	15 – 39	27 ± 10
	Distant Mean		22 ± 6
INEEL	ANL-W	6 – 21	14 ± 6
	ARA	4 – 17	12 ± 6
	CFA	4 – 15	9 ± 5
	EBR1	6 – 17	10 ± 5
	EFS	5 – 18	10 ± 5
	CPP	5 – 16	10 ± 6
	NRF	4 – 19	12 ± 7
	PBF	5 – 19	10 ± 6
	RWMC	5 – 18	11 ± 7
	TAN	5 – 19	12 ± 7
	TRA	7 – 22	14 ± 7
	VANB	12 – 64	31 ± 23
	INEEL Mean		13 ± 3

[a] Confidence interval.

pollution. The air quality standards for fine particulates, generally referred to as PM_{10}, are an annual average of 50 µg/m^3, with a maximum 24-hour concentration of 150 µg/m^3.

The ESER contractor collected 57 valid samples at Rexburg from January through December 1999. The concentration of fine particulates ranged from 0.3 µg/m^3 to 54 µg/m^3, with a mean of 19 ± 2 µg/m^3 (± 95 percent confidence interval of mean). At Mountain View Middle School in Blackfoot, 58 valid samples were collected from January through December. Concentrations ranged from 2 µg/m^3 to 64 µg/m^3. The mean concentration at this location was 18 ± 3 µg/m^3. At Atomic City, 54 valid samples were collected from January through December. Concentrations ranged from 1.0 to 130 µg/m^3, with a mean of 18 ± 5 µg/m^3.

Particulate concentrations from all distance groupings and in samples taken by different organizations generally track each other very well and have overlapping error bars meaning they are not significantly different.

5.3 NITROGEN DIOXIDE

Nitrogen dioxide was monitored continuously and averaged on an hourly basis by the M&O contractor at Van Buren Boulevard and the EFS (Figure 5-2) throughout 1999. At Van Buren Boulevard, quarterly mean concentrations ranged from 1.9 µg/m^3 to 2.8 µg/m^3, with an annual mean of 2.4 µg/m^3. This annual concentration is about 3 percent of the EPA air quality standard of 100 µg/m^3 for nitrogen dioxide. The maximum 24-hour concentration measured was 7.3 µg/m^3 on December 23. Data were successfully obtained at the Van Buren Boulevard station for 88 percent of the hours in 1999.

Quarterly means at EFS ranged from 2.8 µg/m^3 during the fourth quarter to 4.1 µg/m^3 during the first quarter. For the year, the mean concentration was 3.2 µg/m^3, or about 3 percent of the EPA standard. The maximum 24-hour average concentration occurred on February 14, when a value of 7.9 µg/m^3 was recorded. Data were obtained at the EFS location for 92 percent of the hours during 1999.

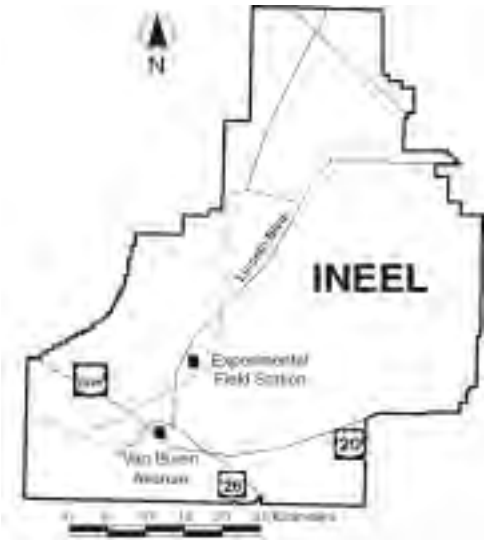

Figure 5-2. Nitrogen Oxides and Sulfur Dioxide Monitoring Locations.

When operating, the New Waste Calcining Facility at the Idaho Nuclear Technology and Engineering Center (INTEC) is the largest single source of nitrogen dioxide at the INEEL. A graph of nitrogen dioxide concentrations observed at the two sampling locations is shown in Figure 5–3. The EFS sampler is located approximately 5 km (3 miles) in the prevailing wind direction from INTEC. All quarterly concentrations have remained below 50 percent of the annual standard throughout the time period of monitoring. Further information on airborne nitrogen dioxide effluents released during 1999 is provided in Chapter 7.

5.4 SULFUR DIOXIDE

Sulfur dioxide was measured at the Van Buren Boulevard monitoring location, and the analyzer operated satisfactorily for 96 percent of the year. For sulfur dioxide, there are three separate EPA standards [Reference 5-2]. The mean sulfur dioxide concentration for 1999 was 3.7 µg/m^3, or about 3 percent of the annual primary air

quality standard of 80 µg/m^3. There is a second primary air quality standard for the maximum 24-hour concentration, not to be exceeded more than once per year, of 365 mg/m^3.

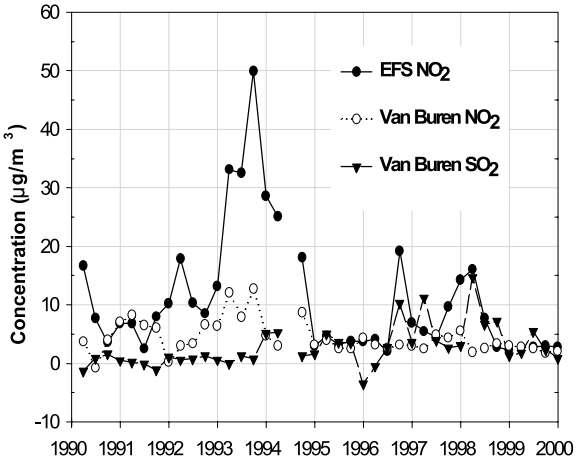

Figure 5-3. Quarterly Mean Nitrogen Dioxide and Sulfur Dioxide Concentrations at the INEEL (1990–1999).

In 1999 the maximum recorded 24-hour SO_2 concentration at Van Buren Boulevard was 6.0 µg/m^3 (3.2 ppb), much lower than the standard of 365 µg/m^3.

In addition to the primary standards, there is also a secondary ambient air quality standard. The secondary standard refers to the maximum 3-hour concentration, which cannot exceed 1300 µg/m^3 more than once per year. The highest 3-hour concentration was 11.3 µg/m^3 (6.0 ppb); this is approximately 0.9 percent of this secondary standard.

5.5 IMPROVE SAMPLERS

Interagency Monitoring of Protected Visual Environment (IMPROVE) samplers have operated continuously at Craters of the Moon National Monument and the Central Facilities Area (CFA) since the spring of 1992. The most recent data available are through August 1999 [Reference 5-3]. Summaries of the data for hydrogen and elements sodium through lead on the periodic table are shown in Table 5-2. 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 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

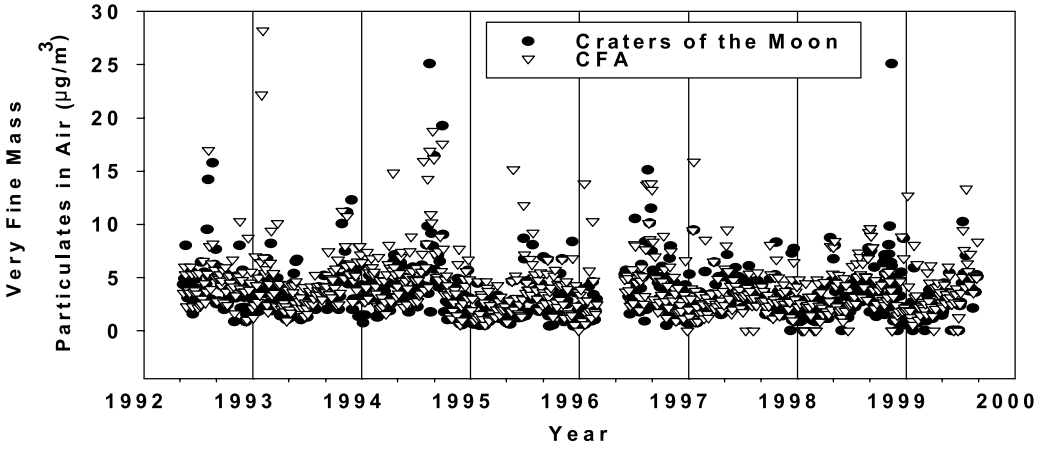

Figure 5-4. Very Fine Mass ($PM_{2.5}$) at Craters of the Moon and CFA (1992 – 1999) .

Table 5-2. Data for IMPROVE Samplers at CFA and Craters of the Moon (January–August 1999).

	Percent 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	40 – 623	33 – 439	147 ± 22	118 ± 16
Sodium	24	25	<dl – 83	<dl – 104	16 ± 3	17 ± 3.9
Magnesium	16	9.0	<dl – 66	<dl – 49	10 ± 2.8	8.1 ± 1.7
Aluminum	66	83	<dl – 390	<dl – 232	45 ± 14	46 ± 9.8
Silicon	100	100	16 – 1171	13 – 709	158 ± 40	129 ± 26
Phosphorus	1.0	2.0	<dl – 3.3	<dl – 6.2	3.0 ± 0.2	2.7 ± 0.2
Sulfur	100	100	27 – 410	24 – 372	167 ± 20	149 ± 20
Chlorine	7.0	8.0	<dl – 7.8	<dl – 34	2.9 ± 0.3	3.0 ± 1.0
Potassium	100	100	7.1 – 377	4.6 – 126	43 ± 12	33 ± 6.5
Calcium	100	99	3.3 – 346	<dl – 197	58 ± 15	47 ± 8.7
Titanium	96	89	<dl – 25	<dl – 16	5.7 ± 0.8	5.3 ± 0.7
Vanadium	29	42	<dl – 3.9	<dl – 3.3	1.6 ± 0.2	1.5 ± 0.1
Chromium	40	40	<dl – 4.2	<dl – 4.5	1.4 ± 0.2	1.3 ± 0.2
Manganese	57	62	<dl – 7.4	<dl – 4.5	2.0 ± 0.3	1.7 ± 0.2
Iron	100	100	1.8 – 243	0.6 – 148	36 ± 8.5	31 ± 6.1
Nickel	10	5.0	<dl – 0.2	<dl – 0.1	0.08 ± 0.04	0.07 ± 0.003
Copper	72	62	<dl – 3.0	<dl – 0.7	0.3 ± 0.09	0.2 ± 0.04
Zinc	100	100	0.4 – 4.6	0.4 – 5.9	1.6 ± 0.2	1.6 ± 0.2
Arsenic	43	62	<dl – 0.3	<dl – 0.5	0.09 ± 0.02	0.1 ± 0.03
Lead	91	94	<dl – 2.5	<dl – 2.9	0.7 ± 0.1	0.7 ± 0.1
Selenium	69	32	<dl – 0.6	<dl – 0.3	0.2 ± 0.03	0.07 ± 0.01
Bromine	100	100	0.2 – 4.1	0.2 – 4.2	1.7 ± 0.2	1.5 ± 0.2

[a] Percent Detected indicates percent of samples analyzed greater than the detection limit.
[b] ng = Nanograms (x 10^{-9}).
[c] Confidence interval.
[d] <dl indicates at least one value was below the detection limit for that parameter.

6 nanograms (ng)/m^3, or up to 10 times higher than at the two southeast Idaho sites. Selenium, in the range of 0.3 ng/m^3 at Craters of the Moon and 0.6 ng/m^3 at CFA, is a tracer of emissions from coal-fired plants (Table 5-2). 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 micrometers, $PM_{2.5}$, are the size fraction most commonly associated with visibility impairment. At Craters of the Moon, $PM_{2.5}$ has ranged over the period of sampler operation from 0 to 25 µg/m^3 with a mean of 3.5 µg/m^3 (Figure 5-4).

Concentrations at CFA during the same time period varied from 0 to 28 µg/m^3, with a mean of 4.2 µg/m^3. In general, the highest levels of very fine mass 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.

5.6 STORM WATER MONITORING

The National Pollutant Discharge Elimination System (NPDES) General Permit sets monitoring requirements for three types of facilities that are directly applicable to the INEEL: (1) EPCRA Section 313 facilities, (2) coal piles, and (3) land disposal units, incinerators, boilers, and industrial furnaces. Additional monitoring locations are sampled for characterization purposes to evaluate the effectiveness of pollution abatement programs.

The INTEC qualifies as an Emergency Planning Community Right-to-Know Act (EPCRA) Section 313 Facility because of the quantity of nitric acid used at the plant. For INTEC, the water priority chemical is nitric acid, and the monitoring parameters are pH, nitrate plus nitrite, oil and grease, biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total Kjeldahl nitrogen (TKN), total phosphorous, and acute whole effluent toxicity.

An industrial coal pile for use at the Coal Fired Steam Generation Facility is also located at the INTEC. The NPDES General Permit lists parameters that must be monitored in storm water discharges from coal piles as oil and grease, pH, TSS, copper, nickel, and zinc.

The CFA Landfill III, the Subsurface Disposal Area at the Radioactive Waste Management Complex (RWMC), and the Waste Experimental Reduction Facility (WERF) incinerator all require monitoring. Land disposal units and incinerators require monitoring for oil and grease, pH, COD, acute whole effluent toxicity, TKN, total and dissolved magnesium, TSS, total organic carbon, arsenic, barium, cadmium, chromium, cyanide, lead, mercury, selenium, and silver.

In 1999, the INEEL Storm Water Monitoring program collected eight samples from three points at RWMC, two samples from the T-28 gravel pit (TAN-GP-1/1), three samples from two of the injection wells at the Power Burst Facility (PBF), and one sample from one of the the three INTEC locations. All 14 samples were tested. Those locations for which the average exceeded benchmarks for storm water monitoring parameters specified in the NPDES General Permit are listed in Table 5-3.

The composite samples collected at RWMC exhibited average concentrations of one or more of the measured parameters exceeding the corresponding benchmarks. The samples collected at RWMC-MP-2/1 contained average concentrations of TSS, aluminum, and iron in excess of the benchmarks. RWMC-MP-1/2 samples contained concentrations of aluminum, iron, and total nitrogen (nitrate plus nitrite) exceeding the respective benchmarks. The samples collected at RWMC-MP-4/1 contained concentrations of COD, TSS, aluminum, iron, nitrogen (nitrate plus nitrite), and zinc. Samples collected at PBF-MP-3/2, PBF-MP-4/2, and TAN-GP-1/1 exhibited no

concentrations in excess of the NPDES benchmarks.

While Table 5-3 lists several analyses in which the sample concentrations exceeded the respective benchmarks, the only permit required limit at the INEEL is for pH in runoff from the coal piles at the INTEC. In 1999 the samples collected at INTEC had values within the specified limits for pH of 6 to 9. The benchmarks in Table 5-3, according to the 1995 NPDES General Permit [Reference 5-4], are not effluent limits, but rather performance targets above which there is a level of concern. The level of concern is a concentration at which a storm water discharge might impair water quality or affect human health from ingestion of water or fish. These levels have been set by the EPA to determine whether a storm water discharge from a given facility merits further monitoring. Exceeding the benchmarks does not necessarily imply water quality violations in the receiving water body, especially in cases like the INEEL, where the only natural permanent surface stream is the Big Lost River. The NPDES General Permit is concerned with "waters of the U.S.," i.e., water bodies used for purposes that could affect interstate commerce or recreation. In this case, water quality in the Big Lost River was not affected because the discharge infiltrated while in a manmade surface channel within a short distance of the discharge point.

Table 5-3. Nonradiological Storm Water Monitoring Data that Exceeded the Associated Benchmark in 1999.

Location	Parameter	Units	Avg[a]	Min	Max	Benchmark
RWMC-MP-1/2	Aluminum	mg/L	3.105	0.965	6.61	0.750
	Iron	mg/L	3.478	0.954	7.48	1.0
	Nitrogen, Nitrate+Nitrite	mg/L	0.875	0.19	1.56	0.680
RWMC-MP-2/1	Total Suspended Solids	mg/L	107	107	107	100
	Aluminum	mg/L	4.11	4.11	4.11	0.750
	Iron	mg/L	4.19	3.96	4.41	1.0
RWMC-MP-4/1	Chemical oxygen demand	mg/L	285.5	49	522	120
	Total suspended solids	mg/L	309.5	65	554	100
	Aluminum	mg/L	12.95	3.57	28.9	0.750
	Iron	mg/L	14.72	3.52	33.3	1.0
	Nitrogen, Nitrate+Nitrite	mg/L	2.52	0.42	4.62	0.680
	Zinc	mg/L	1.039	0.188	2.68	0.117

[a] One-half the detection limit is used in the yearly average calculation, where applicable.

Chapter 6

Groundwater

6. GROUNDWATER

6.1 PROGRAM SUMMARIES

The U.S. Geological Survey

The U.S. Geological Survey (USGS) is responsible for conducting groundwater monitoring, analyses, and studies of the Snake River Plain Aquifer (SRPA) under and adjacent to the Idaho National Engineering and Environmental Laboratory (INEEL). This is done through an extensive network of strategically placed observation wells on and near the INEEL (Figures 6-1 and 6-2).

The SRPA, which underlies the INEEL, serves as the primary source for drinking water and crop irrigation for the Eastern Snake River Basin. A brief description of the hydrogeology of the INEEL and the movement of water in the SRPA can be found in Section 1.1. Further information may be found in various USGS publications.

The USGS has investigated hydrologic conditions at the INEEL since 1949 and currently conducts an extensive monitoring program for the SRPA and perched water bodies above it. This program includes the collection of samples on the INEEL and at locations beyond the southern and western boundaries. The USGS routine groundwater surveillance program is summarized in Section 3.7. In 1999, the routine program included collection of 346 samples for radionuclides and inorganic constituents including trace elements, and 53 samples for purgeable organic compounds. In addition, as part of the 1999 NRF sampling program, the USGS collected quarterly samples from 13 Naval Reactors Facility (NRF) wells. A total of 60 samples were collected and analyzed for radioactivity, inorganic constituents and purgeable organic compounds. Various USGS reports contain maps showing the frequency of water level measurements and water sample collections. Recent information has also been published on the extent and distribution of various contaminants in the water of the SRPA and perched water from INEEL facilities between 1992 and 1995 [Reference 6-1]. A summary of this information is presented in Sections 6.2 and 6.3.

The USGS also conducts special studies of the groundwater resources of the Snake River Plain. A summary of the studies published in 1999 is provided in Appendix C. These special studies provide more specific geological, chemical, and hydrological information on the flow and recharge of the Aquifer and the movements of radiochemical and chemical substances in the groundwater. One important special USGS investigation is an ongoing annual sampling effort in the area between the southern boundary of the INEEL and Hagerman 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. This study is summarized in Appendix C and has been described in a special Fact Sheet from the USGS INEEL Project Office.

Abstracts from USGS documents published in 1999 are provided in the Appendix C. The USGS INEEL Project Office can assist in obtaining copies of their publications.

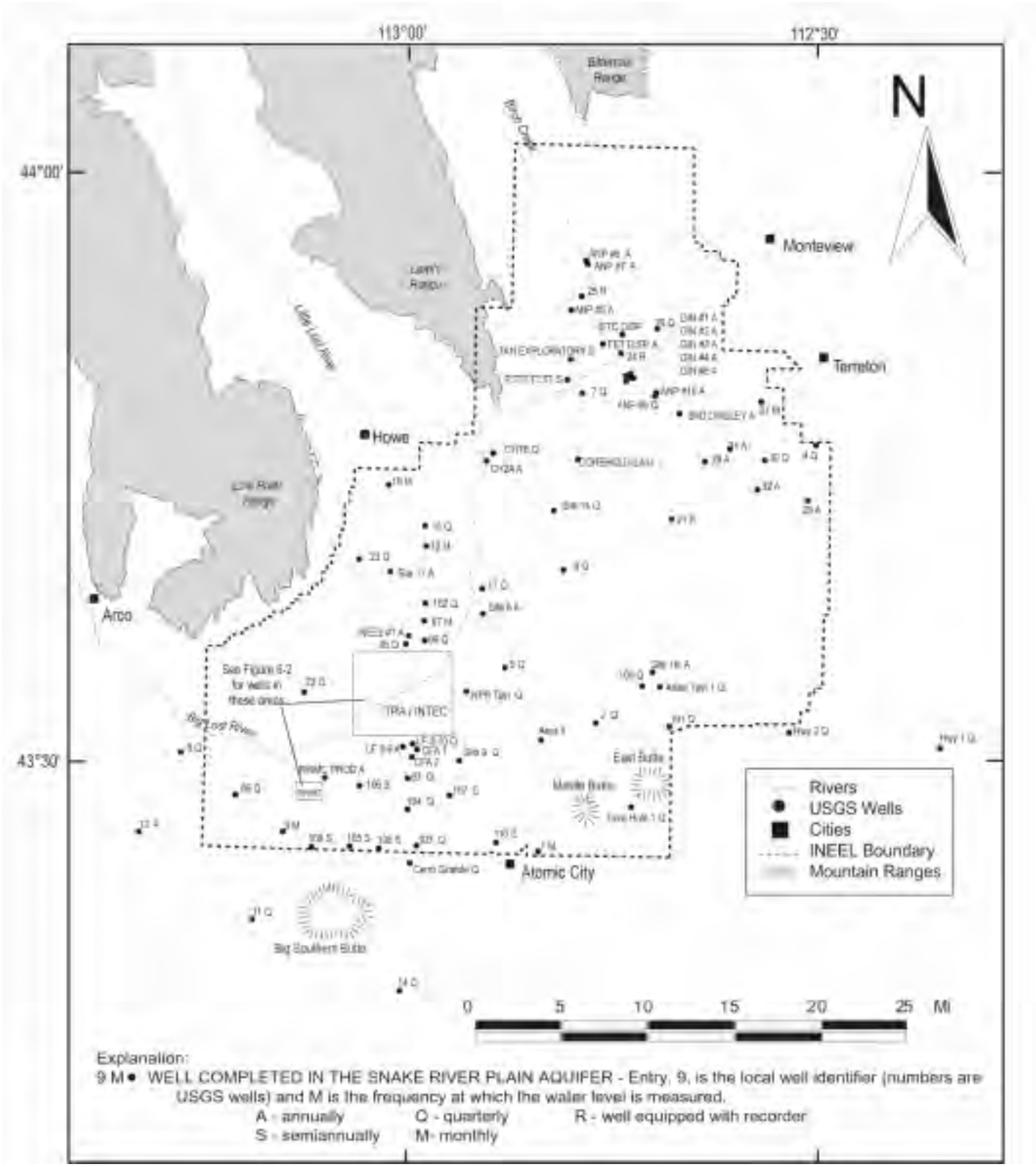

Figure 6-1. USGS Well Locations.

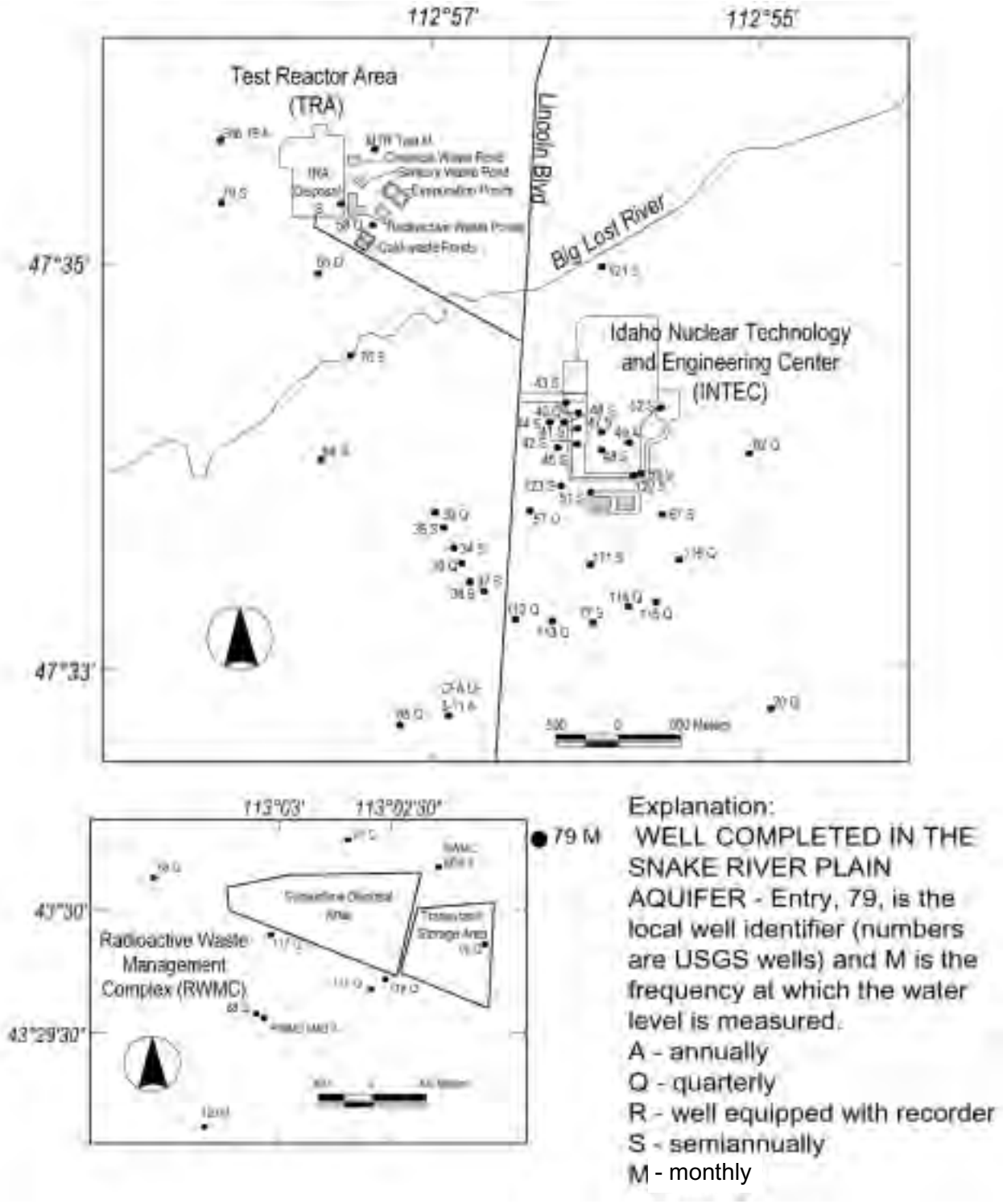

Figure 6-2. USGS Well Locations at INTEC, TRA, and RWMC [Reference 6-1].

Management and Operating (M&O) Contractor

The M&O contractor conducts groundwater monitoring in support of Wastewater Land Application Permit requirements, Remedial Investigation/ Feasibility Studies, and various Records of Decision for INEEL facilities, as well as surveillance monitoring. More detailed information and data are included in the 1999 *Environmental Monitoring Program Report* (INEEL/EXT-2000-00318).

6.2 NONRADIOLOGICAL MONITORING

USGS

Sampling for purgeable (volatile) organic compounds in groundwater was conducted by the USGS at the INEEL during 1999. Water samples from one onsite production well and 10 groundwater monitoring wells were collected and submitted to the USGS National Water Quality Laboratory in Arvada, 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 6-2]. Concentrations above the laboratory reporting level of 0.2 µg/L were detected for five purgeable organic compounds: carbon tetrachloride; chloroform; chloroethane; tetrachloroethylene; and ethylene (Table 6-1). The Radioactive Waste Management Complex (RWMC) production well contained detectable concentrations of purgeable organic compounds. Annual average concentrations of these compounds in this well remained about the same as those observed in 1998. Carbon tetrachloride concentrations remained at levels at or just above the Maximum Contaminant Level (MCL) of 5 µg/L at the end of 1999 (Table 6-1).

M&O Contractor

The M&O contractor Environmental Monitoring Unit routinely samples drinking water from wells and distribution systems at INEEL facilities for volatile organic compounds. At the Test Area North (TAN) Technical Support Facility (TSF), the production wells and distribution systems have been sampled more frequently since the discovery in 1987 that trichloroethylene concentrations in samples collected from TSF Well #1 exceeded the Environmental Protection Agency (EPA) MCL. The concentration of trichloroethylene in this well remained slightly below the MCL in the two samples collected in 1999 (Table 6-2).

In 1988, an aerating device (air sparger system) was installed in the storage tank between the production wells and the point of entry to the TSF distribution system to remove volatile trichloroethylene from TSF drinking water. Results from water samples at this well and distribution system indicate that the aeration system was efficiently treating trichloroethylene. In the third quarter of 1997 well TSF #1 was placed in standby and well TSF #2 was brought online as the primary production well. Well TSF #2 has not had trichloroethylene exceeded MCLs. As a result the sparger in the tank is no longer operated unless well TSF #1 is being used.

Chlorinated drinking water systems are also monitored for total trihalomethanes (bromo-dichloromethane, bromoform, chloroform, and dibromochloromethane). All drinking water systems at the INEEL were well below the EPA MCL of 100 µg/L. Concentrations of total trihalomethanes in 1999, ranged from 0.1 µg/L at the Gun Range to 6.3 µg/L in the PBF distribution system.

From 1992 through 1995, the INEEL M&O contractor conducted a semiannual monitoring program for lead and copper levels in drinking water in accordance with EPA regulations (40 CFR 141.80-141.91). Maximum contaminant levels for copper and lead were not exceeded during this period.

Monitoring for these constituents was repeated in 1999 in accordance with regulations. Water from the production and established potable wells at INEEL facilities were sampled and analyzed at least once in

Table 6-1. Purgeable Organic Compounds in USGS Well Samples (1999) [a].

Well ID	Date	Carbon Tetra-chloride	Chloroform	Tetrachloro-ethylene	Chloroethane Total	Ethylene Total
34	4/1	< dl[b]	< dl	< dl	0.2	< dl
	10/14	< dl	< dl	< dl	0.2	< dl
38	4/20	< dl	< dl	< dl	0.2	< dl
	10/19	< dl	< dl	< dl	0.2	< dl
65	4/20	< dl	< dl	< dl	0.3	< dl
	10/27	< dl	< dl	< dl	0.3	0.1
77	4/14	< dl	< dl	< dl	0.2	< dl
	10/5	< dl	< dl	< dl	0.2	< dl
84	4/20	< dl	< dl	< dl	0.1	< dl
	10/5	< dl	< dl	< dl	0.1	< dl
87	1/14	2.4	0.1	0.2	0.2	0.6
	4/15	2.3	0.1	0.1	0.2	0.6
	7/6	2.8	0.2	< dl	0.2	0.7
	10/14	3.0	0.2	< dl	0.2	0.7
88	1/13	1.6	0.5	0.4	0.2	0.7
	4/17	1.7	0.5	< dl	0.2	0.7
	7/27	2.0	0.5	0.1	0.2	0.8
	10/13	1.7	0.5	< dl	0.2	0.7
90	1/13	3.1	0.5	0.3	0.4	1.47
	4/21	3.2	0.5	0.2	0.4	1.5
92	3/30	13.6	284.6	22.86	28.72	178.8
120	1/14	4.0	0.8	0.3	0.4	1.6
	4/15	3.0	0.6	0.1	0.3	1.2
	7/6	4.2	0.8	0.1	0.4	1.6
	10/14	7.0	1.3	0.2	0.6	2.3
RWMC PROD	1/14	4.6	0.8	0.4	0.6	2.2
	2/17	4.3	0.8	0.2	0.5	2.1
	3/15	4.8	0.8	0.3	0.6	2.3
	4/15	4.7	0.8	0.3	0.5	2.2
	5/13	5.9	1.0	0.3	0.7	2.7
	6/15	5.3	0.9	0.3	0.6	2.5
	7/14	5.2	0.9	0.2	0.6	2.4
	8/16	5.8	0.8	0.3	0.6	2.7
	9/13	3.6	0.7	0.3	0.5	2.3
	10/14	5.5	0.8	0.2	0.6	2.3
	11/15	5.0	0.7	0.2	0.5	2.1
	12/20	5.1	0.9	0.3	0.6	2.5

[a] all measurements are in µg/ml.
[b] <dl means concentration is less than the reporting limit for the analysis.

Table 6-2. Purgeable Organic Compounds in INEEL Drinking Water (1999).[a]

Well	FEB	MAR	APR	JUN	JUL	AUG	SEP	OCT	NOV
Total Trihalomethanes (MCL = 100 µg/L)									
TSF DIST.	--[b]	1.2	--	1.7	--	--	2.6	--	1.5
CFA DIST.	--	6.5	--	2.0	--	--	2.8	--	4.7
CTF DIST.	--	4.3	--	3.6	--	--	3.7	--	5.5
TRA DIST.	--	0.1	--	0.1	--	--	2.6	--	0.4
PBF DIST.	--	4.4	--	5.7	--	--	6.7	--	8.2
GUN RANGE DIST.	--	0.2	--	0.1	--	--	0.1	--	--
INTEC DIST.	--	2.4	--	0.4	--	--	4.1	--	1.6
Trichloroethylene (MCL = 5 µg/L)									
CFA #1 WELL	--	--	0.2	--	--	--	--	--	--
CFA #2 WELL	--	--	0.9	--	--	--	--	--	--
TSF #1 WELL	--	--	--	--	--	--	--	4.2	4.5
TSF #2 WELL	1.6	--	1.1	--	--	3.6	--	--	1.7
TSF DIST.	1.0	--	0.8	--	--	2.0	--	--	1.0
RWMC WELL	2.2	--	2.0	--	--	2.0	--	--	1.7
CFA DIST.	--	--	0.2	--	--	--	--	--	--
RWMC DIST.	1.4	--	1.3	--	--	1.4	--	--	1.3
1,1,1-Trichloroethane (MCL = 200 µg/L)									
CFA #1 WELL	--	--	0.3	--	--	--	--	--	--
CFA #2 WELL	--	--	0.3	--	--	--	--	--	--
CFA DIST.	--	--	0.3	--	--	--	--	--	--
MAIN GATE DIST.	--	--	1.1	--	--	--	--	--	--
RWMC WELL	0.5	--	0.5	--	--	0.5	--	--	0.5
RWMC DIST.	0.3	--	0.3	--	--	0.3	--	--	0.3
Tetrachloroethylene (MCL = 5 µg/L)									
TSF #1 WELL	--	--	--	--	--	--	--	1.2	1.1
TSF #2 WELL	0.6	--	0.3	--	--	1.0	--	--	0.4
TSF DIST.	0.3	--	0.2	--	--	0.5	--	--	0.2
RWMC WELL	0.3	--	--	--	--	--	--	--	--
Carbon tetrachloride (MCL = 5 µg/L)									
RWMC WELL	5.2	--	4.5	--	--	4.7	--	--	4.2
RWMC DIST.	2.8	--	2.7	--	--	2.9	--	--	2.4
Ethylbenzene (MCL = 700 µg/L)									
TSF DIST.	0.2	--	0.3	--	--	0.4	--	--	0.3
CFA DIST.	--	--	0.2	--	--	--	--	--	--
CTF DIST.	--	--	0.5	--	--	--	--	--	--
PBF DIST.	--	--	0.3	--	--	--	--	--	--
Toluene (MCL = 1000 µg/L)									
TSF DIST.	4.0	--	6.0	--	--	6.1	--	--	3.7
CTF DIST.	--	--	12.0	--	--	--	--	--	--
Xylenes (total) (MCL = 10,000 µg/L)									
TSF DIST.	1.3	--	1.9	--	--	2.3	--	--	1.6
CFA DIST.	--	--	1.5	--	--	--	--	--	--
CTF DIST.	--	--	2.6	--	--	--	--	--	--
PBF DIST.	--	--	2.5	--	--	--	--	--	--
p-Dichlorobenzene (MCL = 75 µg/L)									
GUN RANGE DIST.	--	--	0.1	--	--	--	--	--	--
RWMC DIST.	0.3	--	0.7	--	--	--	--	--	0.2
1,2-Xylene									
TSF DIST.	--	--	--	--	--	0.6	--	--	--
1,3-Xylene									
TSF DIST.	--	--	--	--	--	1.6	--	--	--

[a] All values are in µg/L.

[b] A double dash (--) means the system was not sampled.

1999 for copper, lead, and also nitrate as nitrogen (Table 6-3). None of these constituents were above MCLs or state of Idaho drinking water limits in 1999. More detailed information and data is included in the *1999 Environmental Monitoring Program Report*, INEEL/EXT-2000-00318.

ANL-W

The drinking water system at ANL-W was sampled in 1999 in accordance with Safe Drinking Water Act implementing regulations for organics, inorganics, gross alpha and gross beta radioactivity, uranium, and radium. All parameters were well below applicable standards.

NRF

Drinking water samples were collected prior to entering the distribution system and monitored for volatile organic compounds, inorganic constituents, and water quality parameters. Samples were drawn from a sampling port immediately downstream from the NRF water softening treatment system and prior to entering the distribution system. No volatile organic compounds were detected above minimum detection levels established for the analyses of these compounds. Concentrations of inorganic analytes and water quality parameters were all below regulatory limits. With the assistance of USGS, groundwater monitoring continued around NRF (Figure 6-3). Specifics regarding this monitoring program are published in the 1999 Environmental Monitoring Report for

Figure 6-3. Monitoring Wells Around NRF.

the Naval Reactor Facility, NRF EA-780 [Reference 6-3].

6.3 RADIOCHEMICAL MONITORING

Historic waste disposal practices have produced localized areas of radiochemical contaminants in the SRPA at the INEEL. The INTEC facility used direct injection as a routine disposal method up to 1984. This wastewater contained high concentrations of both tritium and strontium-90 (^{90}Sr). TRA also discharged contaminated wastewater, but to a shallow percolation pond. Injection at

Table 6-3. Inorganic Chemicals in INEEL Potable Production Wells (1999).

Well	Date	Parameter	Concentration (mg/L)	MCL (mg/L)
TSF DIST.	5/25/99	Nitrogen, as Nitrate	1.000	10
CFA DIST.	5/25/99	Nitrogen, as Nitrate	3.100	10
CTF DIST.	5/25/99	Nitrogen, as Nitrate	1.000	10
TRA DIST.	5/25/99	Nitrogen, as Nitrate	1.100	10
PBF DIST.	5/25/99	Nitrogen, as Nitrate	1.100	10
MAIN GATE DIST.	5/18/99	Nitrogen, as Nitrate	0.700	10
EBR-I DIST.	5/18/99	Nitrogen, as Nitrate	0.500	10
GUN RANGE DIST.	5/25/99	Nitrogen, as Nitrate	1.100	10
RWMC DIST.	5/18/99	Nitrogen, as Nitrate	0.900	10
INTEC DIST.	5/18/99	Nitrogen, as Nitrate	1.200	10
CFA DIST.	6/24/99	Lead	0.002	0.015
RWMC WELL	6/24/99	Lead	0.001	0.015
PBF DIST.	6/24/99	Lead	0.001	0.015
MAIN GATE WELL	6/28/99	Lead	0.002	0.015
EBR-I DIST.	6/28/99	Lead	0.001	0.015
TSF DIST.	6/22/99	Lead	0.001	0.015
CTF DIST.	6/22/99	Lead	0.001	0.015
TRA DIST.	6/23/99	Lead	0.001	0.015
INTEC DIST.	6/23/99	Lead	0.001	0.015
GUN RANGE WELL	6/29/99	Lead	0.001	0.015
CFA DIST.	6/24/99	Copper	0.005	1.3
RWMC WELL	6/24/99	Copper	0.001	1.3
PBF DIST.	6/24/99	Copper	0.001	1.3
MAIN GATE WELL	6/28/99	Copper	0.001	1.3
EBR-I DIST.	6/28/99	Copper	0.002	1.3
TSF DIST.	6/22/99	Copper	0.001	1.3
CTF DIST.	6/22/99	Copper	0.002	1.3
TRA DIST.	6/23/99	Copper	0.002	1.3
INTEC DIST.	6/23/99	Copper	0.004	1.3
GUN RANGE WELL	6/29/99	Copper	0.002	1.3

the INTEC was discontinued in 1986 and the injection well sealed in 1990. 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 1952-83 was 910 Ci/yr; during 1984-91, 280 Ci/yr; and during 1992-95, 107 Ci/yr. Between 1952 and 1995, the INEEL disposed of about 93 Ci of ^{90}Sr at TRA and about 57 Ci at INTEC. 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 1992-1995, the INEEL disposed of about 0.1 Ci of ^{90}Sr to the TRA infiltration ponds.

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

USGS Monitoring

Tritium

The configuration and extent of the tritium contamination area, based on the latest data, are shown in Figure 6-4

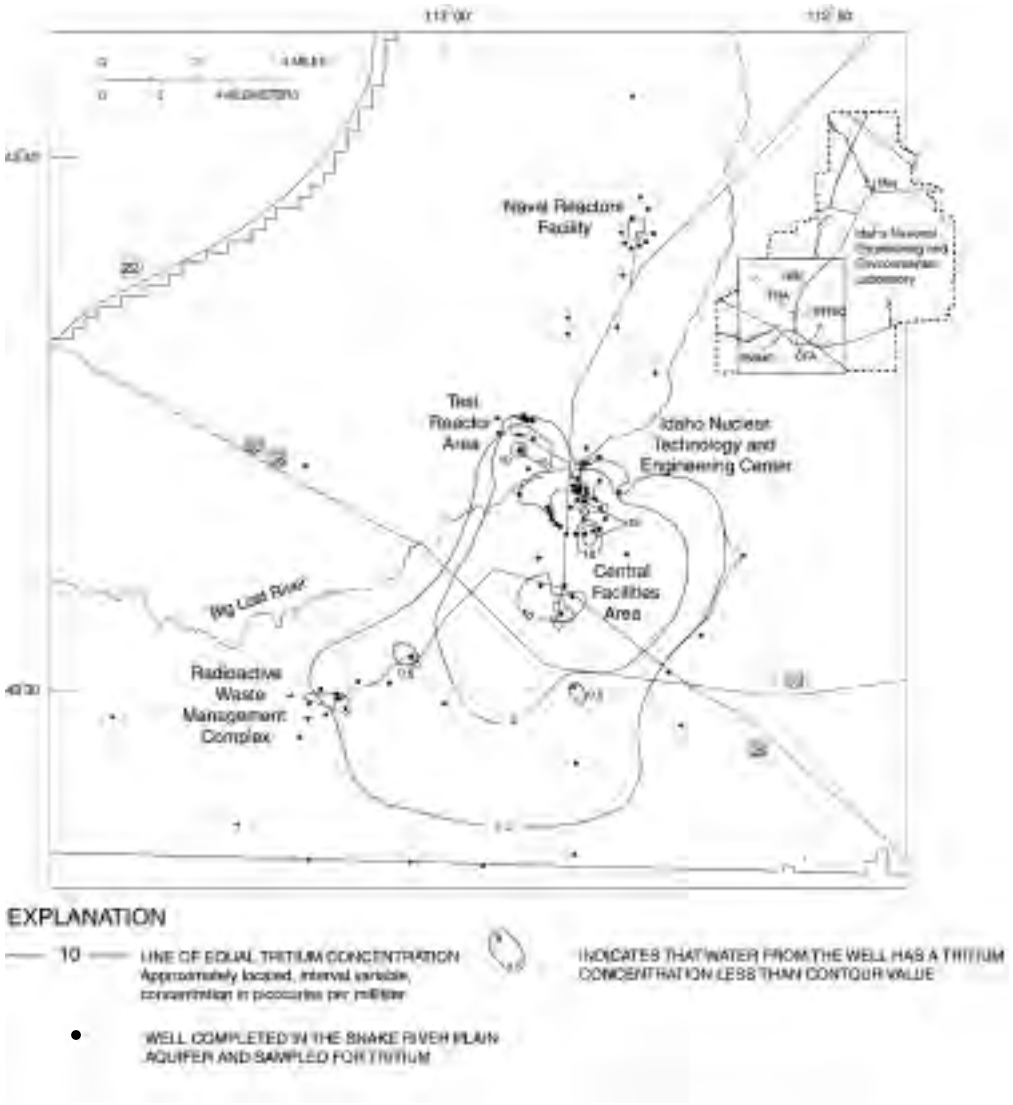

Figure 6-4. Distribution of Tritium in the SRPA on the INEEL (1998).

[Reference 6-1]. The area of contamination within the 0.5 pCi/mL contour line decreased from about 115 km^2 (45 mi^2) in 1988 to about 100 km^2 (40 mi^2) in 1991. Concentrations of tritium in the contamination area have generally decreased. Since there is no known source of tritium contamination of groundwater at CFA, the area of elevated concentrations near CFA most likely represent water originating at INTEC prior to 1986 when direct injection of tritium containing wastewater were disposed.

The tritium concentration in Well 65 near TRA (Figure 6-2) decreased from 21.2 ± 0.9 pCi/mL in 1995 to 15.9 ± 0.7 pCi/mL in 1998; the tritium concentration in Well 77 south of INTEC (Figure 6-2) decreased from 25.1 ± 1.0 pCi/mL in 1995 to 18.2 ± 0.7 pCi/mL in 1998. The decreasing trend exhibited in these wells is representative of tritium concentrations throughout the area of contamination at the INEEL.

The EPA MCL for tritium in drinking water is 20 pCi/mL, and the values in both well 65 and well 77 have dropped below this limit. The decreased tritium

concentrations over the long term are due to 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 6-5 [Reference 6-1]. The contamination originates from the INTEC. 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 probably is retained in surficial sedimentary deposits and in interbeds, but has not reached 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 1991. The concentrations during 1992-95 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.

Prior to 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

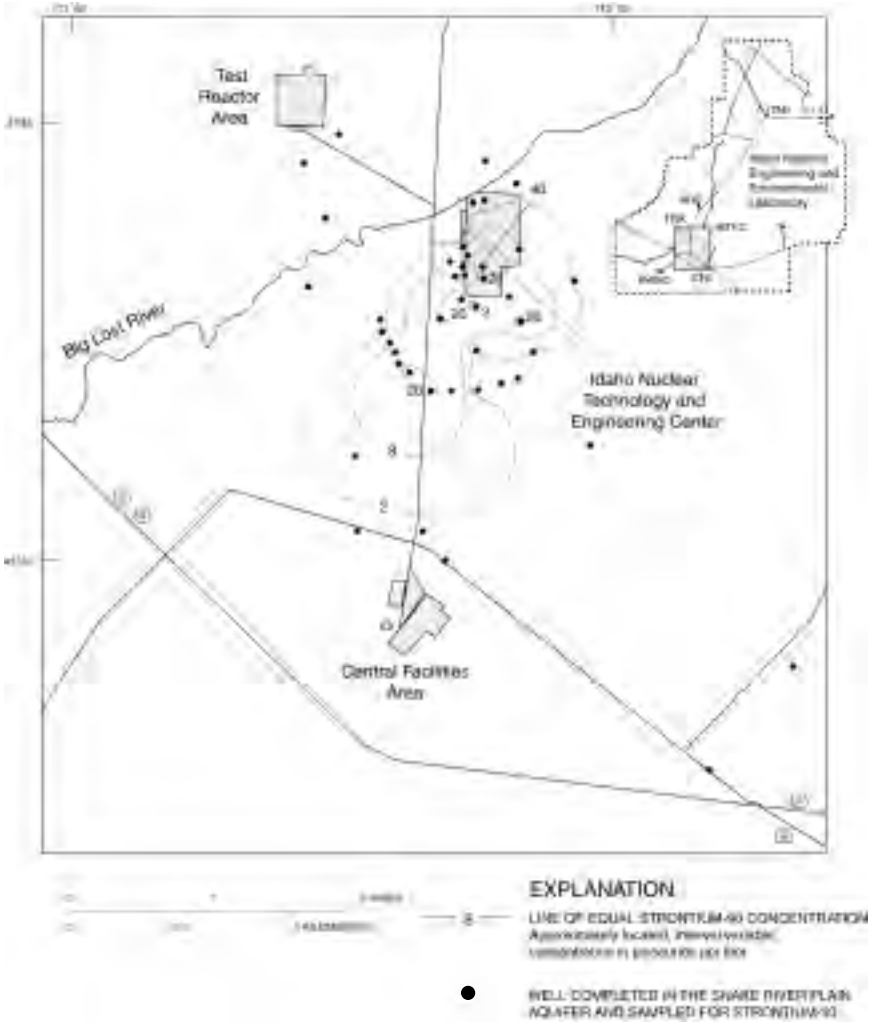

Figure 6-5. Distribution of ^{90}Sr in the SRPA on the INEEL (1998).

wells sampled from 1992 to 1995 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 decreased the sorption, via ion-exchange, of ^{90}Sr on soil and rock surfaces, allowing more ^{90}Sr to exist in the liquid phase [Reference 6-1].

M&O Contractor Monitoring

Gross Alpha

Of the 60 onsite production well and distribution system samples analyzed for gross alpha in 1999, a total of 51 samples contained activities above the minimum detectable concentration. The highest concentration observed was 5 ± 1 x 10^{-9} µCi/mL in a sample collected on October 19 from the INTEC Well # 5. This value is 33 percent of the EPA MCL of 15 x 10^{-9} µCi/mL for gross alpha in drinking water.

According to USGS reports, alpha-emitting radionuclides (^{238}Pu, $^{239/240}Pu$, and ^{241}Am) from INEEL operations have not migrated far from their entrance into the SRPA near INTEC. All onsite drinking water wells lie outside the migration areas for these anthropogenic alpha-emitting nuclides.

Gross Beta

Of the 59 onsite production well samples analyzed for gross beta, six 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 ± 1) x 10^{-9} µCi/mL in a sample from the CFA distribution system on October 10. This value is 15 percent of the EPA MCL of 50 x 10^{-9} µCi/mL for gross beta in drinking water.

Tritium

Samples from five of the onsite production wells and three drinking water distribution systems that were routinely sampled in 1999 showed detectable concentrations of tritium in one or more samples (Table 6-4). Figure 6-6 shows 12 years of tritium data for two of the production wells and two distribution systems.

Strontium-90

Because of the presence of the localized area 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 1999 samples exhibited detectable concentrations of ^{90}Sr (the minimum detectable concentration was approximately 0.3 x 10^{-9} µCi/mL).

CFA Worker Dose

Because of the potential impacts to downgradient workers at the 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 1999 calculation was based on:

- Mean tritium concentration for the CFA distribution system in 1999 as shown in Table 6-4.
- Data from a 1990-91 USGS study for ^{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) x 10^{-9} µCi/mL (the average of two samples) and water from CFA # 2 had a concentration of (0.14 ± 0.03) x 10^{-9} µCi/mL (also the average of two samples). For perspective, the proposed EPA drinking water standard

Table 6-4. Tritium Concentrations in INEEL Production Wells and Distribution Systems (1999).

		Tritium Concentration ($x10^{-6}$ µCi/mL)			
Well Code	# of Samples[a]	Minimum	Maximum	Mean	Mean % of the MCL[b]
CFA Dist.	4	11.4 ± 0.8	14.1 ± 0.8	12.9 ± 0.9	64
CFA # 1	4	12.9 ± 0.9	14.4 ± 0.9	13.3 ± 0.9	66
CFA # 2	3	10.2 ± 1.3	11.2 ± 1.3	10.7 ± 1.1	53
EBR-1 Dist.	4	-0.02 ± 0.1	.07 ± 0.1	-0.061 ± 0.1	--
Rifle Range	4	2.2 ± 0.4	2.3 ± 0.2	2.3 ± 0.3	11
RWMC Dist.	4	1.2 ± 0.3	1.4 ± 0.1	1.3 ± 0.2	6
RWMC Well	4	1.2 ± 0.1	1.4 ± 0.1	1.3 ± 0.1	6
INTEC Dist.	4	0.02 ± 0.1	0.09 ± 0.1	0.05 ± 0.9	0.25
INTEC Well # 4	4	-0.04 ± 0.1	0.09 ± 0.1	0.01 ± 0.1	--
INTEC Well # 5	4	-0.07 ± 0.1	0.002 ± 0.01	-0.003 ± 0.01	--
Main Gate Dist.	4	-0.2 ± 0.1	-0.02 ± 0.1	-0.08 ± 0.1	--
PBF Dist.	4	-0.2 ± 0.1	0.06 ± 0.1	-0.1 ± 0.07	--
TAN/CTF Dist.	4	-0.08 ± 0.1	0.07 ± 0.1	-0.02 ± 0.08	--
TAN/TSF	4	-0.1 ± 0.2	-0.03 ± 0.1	-0.06 ± 0.1	--
TRA Dist.	4	-0.07 ± 0.1	0.05 ± 0.1	-0.02 ± 0.8	--

[a] Samples taken only from wells in use at collection time.
[b] EPA drinking water MCL (Maximum Contaminant Level) for Tritium is 20 x 10^{-6} µCi/ml.

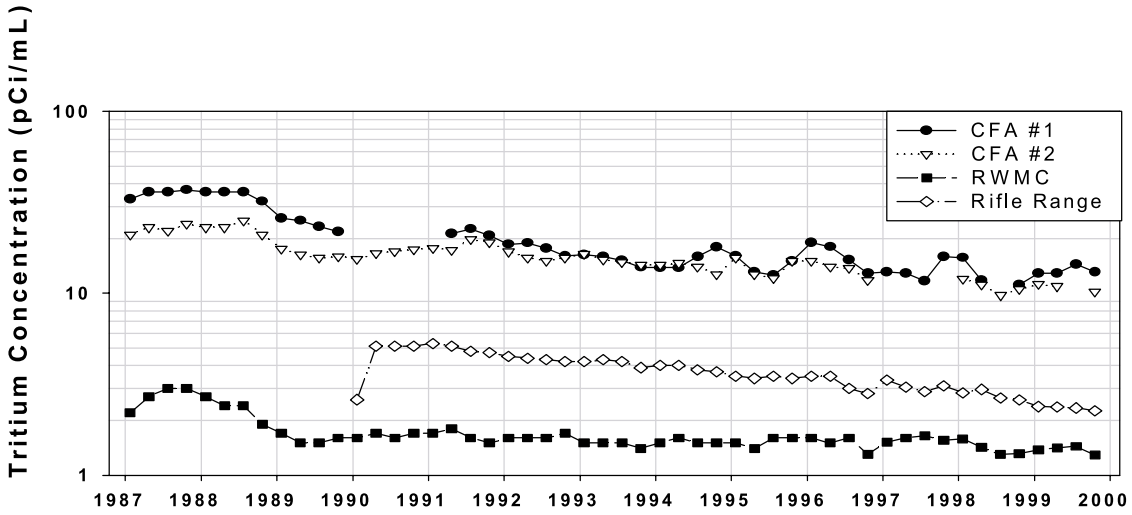

Figure 6-6. Tritium Concentrations in four INEEL Wells (1987–1999).

for ^{129}I in drinking water is 21 x 10^{-9} µCi/mL.

- Water usage information for 1999 showing CFA #1 was used for approximately 44 percent of the drinking water and CFA #2 for 56 percent of the drinking water.

For the 1999 dose calculation, the assumption was made that each worker's total water intake came from the CFA drinking water distribution system. This assumption overestimates the dose because workers typically consume only about half their total intake during working hours and typically work only 240 days rather than 365 days per year. The estimated effective dose equivalent to a worker from consuming all drinking water at CFA during 1999 was 0.6 mrem, well below the EPA standard of 4 mrem for community drinking water systems.

ANL-W

During 1999, ANL-W analyzed one sample for gross alpha, gross beta, and tritium from the entrance to the drinking water distribution system in accordance with the Safe Drinking Water Act. The gross alpha concentration was 1.6 pCi/L (11 percent of the MCL of 15 pCi/L); the gross beta concentration was 5.3 pCi/L (below the MCL of 8 for the beta emitter ^{90}Sr). No detectable concentration of tritium was reported.

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 were gross beta activity in samples from the secondary sanitary lagoon (average = 4.2 x 10^{-8} µCi/mL, 95 percent confidence interval = 4 x 10^{-9} µCi/mL).

NRF

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 1999 Naval Reactors Environmental Report [Reference 6-3].

6.4 BACTERIOLOGICAL MONITORING

M&O Contractor

Potable water at the INEEL was monitored for coliform bacteria monthly or quarterly by contractor personnel and analyzed by the M&O contractor Environmental Hygiene Laboratory. A total of 514 samples were collected at 12 INEEL facilities during 1999. Twenty samples had positive bacteria detection: 3 of 76 samples taken at INTEC, 15 of 129 samples taken at NRF, and 2 of 38 samples taken at TRA. All systems that tested positive were chlorinated and retested. This process was repeated until two consecutive samples show negative results.

Chapter 7

Effluent Monitoring

7. EFFLUENT MONITORING

7.1 RADIOACTIVE EFFLUENTS

General Information

Radionuclides released to the environment via airborne and liquid effluents were monitored during 1999 at potentially significant release sites as required by applicable regulations. These sites included stacks and liquid effluent streams at the relevant facilities monitored by Idaho National Engineering and Environmental Laboratory (INEEL) contractors. Monitoring results were reported to the Radioactive Waste Management Information System (RWMIS) administered by the Management and Operating (M&O) contractor. Effluent information from the RWMIS is used to produce annual reports summarizing effluent monitoring by month, facility, and radionuclide.

Airborne Effluents

During 1999, an estimated 3,183 curies (Ci) of radioactivity were released to the atmosphere from all INEEL sources [Reference 7-1]. Argonne National Laboratory-West (ANL-W) accounted for 59 percent of the total, with the Test Reactor Area (TRA) contributing 39 percent (Table 7-1). Over 98 percent of the radioactive effluent was in the form of noble gases, elements from Group 8 on the periodic table of the elements. The primary exposure concern for noble gases is external, as these are generally not transported through food chains and do not concentrate in biological tissues [Reference 7-2].

Year-to-year fluctuations in airborne radioactive effluent releases are dependent on which processes are active at INEEL facilities. During 1997 and 1998, totals were higher than the annual totals for 1994 - 1996 and 1999 (Figure 7-1). This is due primarily to an increase in releases of Krypton-85 (^{85}Kr) from ANL-W as part of a spent fuel treatment project, the Electrometallurgical Treatment Research and Demonstration Project in the Fuel Conditioning Facility.

Liquid Effluents

Table 7-2 summarizes the radioactive liquid effluents released onsite during 1999. 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. No radioactive liquid effluent was released to the offsite environment from INEEL facilities during 1999. Injections of radioactive liquid effluents into the Snake River Plain Aquifer ceased in 1984.

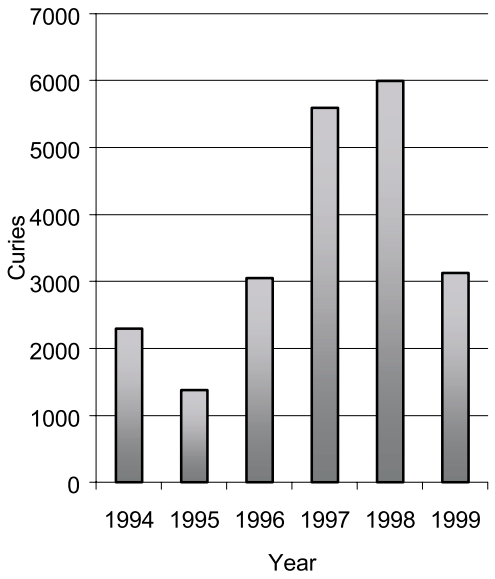

Figure 7-1. INEEL Airborne Radioactive Effluent.

Table 7-1. Radionuclide Composition of INEEL Airborne Effluents from Point Sources (1999)[a].

		Airborne Effluent (Ci)					
Effluent Type	**Radionuclide [b]**	**Half-Life**	**ANL-W**	**INTEC**	**NRF**	**TRA**	**Total**
Noble gases	^{85}Kr	10.7 yr	1,862	--	4.7×10^{-2}	--	1,863
	^{41}Ar	1.83 h	3.365	--	--	1,216	1,219
	^{135}Xe	9.10 h	--	--	--	14.66	14.66
	^{133}Xe	5.25 d	--	--	--	10.47	10.47
Particulates	^{88}Rb	17.7 min	--	--	--	0.42	0.42
	^{234}U	2.5×10^{5} yr	--	--	--	--	4.82×10^{-2}
	^{138}Cs	32.2 min	--	--	--	2.10×10^{-2}	2.10×10^{-2}
	^{51}Cr	27.8 d	--	--	--	2.47×10^{-3}	2.47×10^{-3}
	^{99m}Tc	6.01 h	--	--	--	1.12×10^{-3}	1.12×10^{-3}
	^{137}Cs	30.2 yr	--	5.61×10^{-4}	--	3.47×10^{-5}	5.96×10^{-4}
	^{24}Na	15.0 h	--	--	--	5.49×10^{-4}	5.49×10^{-4}
	$^{90}Sr+D$[c]	29.1 yr	--	1.21×10^{-4}	--	6.28×10^{-6}	1.27×10^{-4}
	^{125}Sb	2.73 yr	--	7.71×10^{-5}	--	1.31×10^{-7}	7.71×10^{-5}
	^{238}Pu	87.7 yr	--	2.17×10^{-6}	--	--	2.17×10^{-6}
	^{239}Pu	2.4×10^{4} yr	--	2.05×10^{-7}	--	--	2.05×10^{-7}
Tritium, ^{14}C,	^{3}H	12.3 yr	11.32	8.9	2.9×10^{-2}	--	75.35[d]
and Iodine	^{14}C	5,700 yr	--	--	0.64	--	0.63
Isotopes	^{129}I	1.6×10^{7} yr	--	2.61×10^{-3}	--	--	2.61×10^{-3}
	^{131}I	8.04 d	--	--	5.0×10^{-6}	8.88×10^{-4}	8.91×10^{-4}
	^{132}I	2.3 h	--	--	--	1.47×10^{-3}	1.47×10^{-3}
	^{133}I	20.8 h	--	--	--	2.91×10^{-3}	2.91×10^{-3}
	^{134}I	53 min	--	--	--	2.22×10^{-3}	2.22×10^{-3}
	^{135}I	6.57 h	--	--	--	3.62×10^{-3}	3.62×10^{-3}
All others		-	6.89×10^{-5}	7.7×10^{-6}	2.5×10^{-4}	0.0	3.3×10^{-4}
Total[e]		**-**	**1,878**	**8.9**	**0.72**	**1,241**	**3,183**

[a] Radioactive release information provided by the report *1999 INEEL National Emission Standards for Hazardous Air Pollutants – Radionuclides Report,* DOE/ID-10342 (99), June 2000.
[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, ^{90}Sr, ^{137}Cs, and Pu) are also included.
[c] "+D" indicates parent-daughter equilibrium assumed.
[d] Total includes 55.1 Ci from the Waste Experimental Reduction Facility (WERF).
[e] Rounded totals include small amounts from facilities not listed.

7.2 NONRADIOACTIVE EFFLUENTS

Airborne Effluents

Sitewide Air Emission Inventory. The M&O contractor publishes the Air Emission Inventory for the INEEL annually. This document provides a compilation of emissions from sources at all facilities [Reference 7-3].

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

Table 7-2. Radionuclide Composition of Liquid Effluents Released Onsite (1999)[a].

		Liquid Effluent (Ci)		
Radionuclide[b]	**Half-Life**	**INTEC**	**TRA**	**Total**
^{3}H	12.3 yr	--	87.2	87.2
^{60}Co	5.27 yr	--	1.76	1.76
^{51}Cr	27.8 d	--	0.76	0.76
^{24}Na	15.0 hr	--	0.24	0.24
^{152}Eu	13.4 yr	--	0.11	0.11
^{154}Eu	8.5 yr	--	0.14	0.14
^{155}Eu	4.73 yr	--	5.75×10^{-2}	5.75×10^{-2}
^{181}Hf	42.4 d	--	5.42×10^{-2}	5.42×10^{-2}
^{124}Sb	60.4 d	--	3.87×10^{-2}	3.87×10^{-2}
^{40}K	1.26×10^{9} yr	2.76×10^{-2}	--	2.76×10^{-2}
^{65}Zn	245 d	--	1.72×10^{-2}	1.72×10^{-2}
^{89}Sr	50.5 d	--	1.19×10^{-2}	1.19×10^{-2}
^{127M}Te	109 d	--	0.55	0.55
All others	--	4.32×10^{-4}	6.38×10^{-3}	6.81×10^{-3}
Totals		**2.80×10^{-2}**	**90.94**	**90.97**

[a] Preliminary radioactive release data provided by the 1999 Radioactive Waste Management Information System.
[b] Table includes all radionuclides with total releases greater than 1×10^{-2} Ci.

PM_{10} (particulates less than 10 microns in diameter). The constituents monitored include those released by boilers at facilities.

ANL-W. Emissions from the Experimental Breeder Reactor II Auxiliary boilers do not require continuous monitoring because they are below the state of Idaho's 250 million Btu/hr emission limit. Monitoring occurs monthly with a portable stack emission monitor as an efficiency check and to ensure NO_x and SO_2 emissions are below State-imposed standards. Emission rates have been calculated using tons per year instead of hourly emission rates to increase accuracy of results. During 1999, the total annual NO_x was 6,985 kg/yr (7.7 ton/yr), and SO_2 emissions were 2,268 kg/yr (2.5 ton/yr) for significant sources at ANL-W.

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 Naval Reactors Facility (NRF); lined sewage lagoons at the ANL-W, Central Facilities Area, Specific Manufacturing Capability Facility, TRA, and Idaho Nuclear Technology and Engineering Center (INTEC); and industrial waste ponds at the ANL-W, INTEC, and Technical Support Facility. Injection wells and the Big Lost River are not used as repositories for any liquid wastes. Some storm water runoff is directed to the Big Lost River Channel.

ANL-W. During 1999, the Industrial Waste Pond at ANL-W was monitored for iron, sodium, mercury, chloride, fluoride, sulfate, phosphate, temperature, dissolved oxygen, specific conductance, turbidity, and pH. The Secondary Sanitary Lagoon was monitored for biological oxygen demand, total suspended solids, dissolved oxygen, specific conductance, turbidity, temperature, iron, sodium, chloride, fluoride, sulfate, and pH. All parameters for both ponds were well below applicable standards.

INTEC. 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 7-3.

During 1999, measured concentrations for each parameter were below levels that would define the effluent as a hazardous waste stream [Reference 7-4].

TRA. Nonradioactive liquid effluents are discharged from TRA into three types of ponds: the Cold Waste Pond, the Chemical

Table 7-3. INTEC-797 Effluent Monitoring Data (1999).

	Concentration												
Parameter[a]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Toxicity Limit[b]
Aluminum	0.0288	0.0158	0.0158	0.0189	0.0067	0.0151	0.0059	0.0402	0.0055	0.0093	0.0093	0.0082	--
Arsenic	0.0032	0.0032	0.0032	0.0045	0.0045	0.0045	0.0045	0.0039	0.0035	0.0039	0.0039	0.0042	5
Barium	0.0573	0.0864	0.0934	0.0524	0.0913	0.0923	0.067	0.0947	0.11	0.0573	0.069	0.0812	100
Cadmium	0.0025	0.0021	0.0021	0.0004	0.0004	0.0004	0.0006	0.0137	0.0004	0.0004	0.0004	0.0005	1
Chromium	0.0053	0.0053	0.0037	0.0048	0.0047	0.0044	0.0044	0.0064	0.0057	0.0049	0.0051	0.0052	5
Copper	0.0095	0.0048	0.0063	0.0062	0.0024	0.0010	0.0029	0.0024	0.0029	0.0091	0.0041	0.0059	--
Mercury	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.2
Selenium	0.0034	0.0034	0.0034	0.0049	0.0049	0.0060	0.0049	0.0043	0.0051	0.0043	0.0043	0.0032	1
Silver	0.0071	0.0062	0.0062	0.0015	0.0015	0.0015	0.0015	0.0012	0.0012	0.0012	0.0012	0.0017	5
Sodium	150	124	129	105	124	102	96.5	123	180	148	133	110	--
Chloride	112	198	215	117	187	199	145	218	304	256	183	186	--
Fluoride	0.350	0.350	.032	0.36	0.210	0.170	0.200	0.220	0.200	0.200	0.240	0.200	--
Iron	0.0543	0.0268	0.0176	0.0261	0.0133	0.0160	0.0203	0.0583	0.0125	0.0142	0.0139	0.0174	--
Manganese	0.0022	0.0016	0.0009	0.0012	0.0005	0.0007	0.0006	0.0008	0.0013	0.001	0.0009	0.0006	--
Phosphate	0.140	0.170	0.170	0.170	0.170	0.170	0.170	0.31	0.31	0.31	0.31	0.31	--
TDS[c]	410	532	574	417	547	568	479	576	708	631	516	519	--
pH	8.21	8.48	8.23	8.29	8.25	8.15	8.27	8.2	8.59	8.25	8.47	8.42	< 2 or > 12.5
Conductivity	636	1030	1109	7.1	974	1100	879	1100	1400	1200	963	936	--
Nitrate	0.970	0.92	0.94	0.91	0.87	0.96	0.92	0.90	0.93	0.87	0.99	0.89	--
Nitrite	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	--
Antimony		0.022	0.022	0.0033	0.0033	0.0033	0.0033	0.034	0.0038	0.0034	0.0078	0.0042	--
Beryllium		0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	--
Calcium		52.2	62	34.7	54.7	54.8	41.4	57.9	64.9	33.3	43.3	48.9	--
Cobalt		0.0022	0.0022	0.0008	0.0012	0.0008	0.0008	0.0009	0.001	0.0009	0.0009	0.0013	--
Lead	0.0186	0.0202	0.0202	0.0052	0.0052	0.0052	0.0052	0.0049	0.0041	0.0049	0.0049	0.0043	5
Magnesium		15.3	17.4	10.2	15.3	18.3	14	17.7	19.3	8.98	12.	15.6	--
Nickel		0.0047	0.0047	0.0011	0.0011	0.0011	0.0011	0.0008	0.0013	0.0008	0.0008	0.0017	--
Potassium		2026	3.04	1.87	2.44	2.32	2.29	2.87	2.99	1.94	2.07	3.13	--
Sulfate	36.3	36.3	38	37.5	29.8	29.9	50.6	32.2	26.4	25.9	30	33.8	--
Thallium		0.0284	0.0284	0.0016	0.0016	0.0016	0.0016	0.00085	0.0012	0.0009	0.0022	0.0012	--
Vanadium		0.0087	0.0046	0.0042	0.0042	0.0051	0.0056	0.0053	0.0044	0.0035	0.0045	0.0046	--
Zinc		0.0051	0.0032	0.0072	0.0033	0.0039	0.0126	0.0243	0.0089	0.0076	0.0135	0.0028	--
TKN[d]	0.22	0.21	0.77	0.11	0.11	0.11	0.13	0.15	0.15	0.15	0.25	0.15	--

[a] Concentration reported in mg/L except conductivity (µS) and pH (standard units).
[b] Toxicity Limit is the EPA maximum concentration of contaminants for the toxicity characteristics is from 40 CFR 261.24.
[c] TDS = Total dissolved solids.
[d] TKN = Total Kjeldahl Nitrogen.

Cold Waste Pond and two sewage lagoons. Table 7-4 summarizes the nonradiological monitoring data for effluents released into the Cold Waste Pond from TRA during 1999. The Chemical Waste Pond was closed and covered with a protective cap during 1999.

NRF. Liquid effluent monitoring confirmed all discharges in 1999 were controlled in accordance with applicable federal and State laws. Specifics regarding this monitoring are published in the 1999 Environmental Monitoring Report for the Naval Reactor Facility, NRF EA-780.

Table 7-4. TRA-764 Effluent Monitoring Data (1999).

	Concentration				
Parameter	**January**	**April**	**August**	**October**	**Toxicity Limit[a]**
Conductivity	1,069[b]	270	1,036	985.4	--[c]
pH	7.87	7.45	7.81	7.14	2 to 12.5
Total dissolved solids	770	253	862	797	--
Aluminum	0.200	0.200	0.0113	0.0148	--
Antimony	0.200	0.200	0.00160	0.0022	--
Arsenic	0.00618	0.00500	0.0162	0.0040	5
Barium	0.113	0.0477	0.129	0.119	100
Beryllium	0.00100	0.00100	0.0000500	0.000057	--
Calcium	125	47.9			--
Cadmium	0.00100	0.00100	0.000150	0.0017	1
Chloride Ion	33.4	11.2	29.4	32.7	--
Cobalt	0.0200	0.0200			--
Chromium	0.0200	0.0200	0.00940	0.0128	5
Copper	0.0200	0.0200	0.00550	0.0100	--
Fluoride Ion	0.35	0.16	0.41	0.49	--
Iron	0.0536	0.0500	0.126	0.0973	--
Lead	0.00300	0.00300	0.000500	0.00050	5
Manganese	0.00500	0.00500	0.00180	0.0022	--
Magnesium	45	17.9	45	45	--
Mercury	0.000200	0.000200	0.000200	0.000200	0.2
Nickel	0.0500	0.0500	0.00720	0.0074	--
Total Nitrogen	2.81	1.02	2.678	2.45	--
Sodium	25.2	9.25	27.7	25.7	--
Potassium	9.02	2.00			--
Selenium	0.00500	0.00500	0.00170	0.0011	1
Silver	0.0150	0.0150	0.00210	0.0021	5
Sulfate	347	25.22	353	384	--
Thallium	0.200	0.200	0.00140	0.0015	--
Vanadium	0.0200	0.200	0.0109	0.0099	--
Zinc	0.0500	0.0500	0.0106	0.0096	--

[a] EPA maximum concentration of contaminants for the toxicity characteristics is from 40 CFR 261.24.
[b] All concentrations in mg/L except conductivity (μS) and pH (standard units).
[c] A double dash (--) in this column means no limit has been established.

Chapter 8

Dose to the Public

8. DOSE TO THE PUBLIC

8.1 GENERAL INFORMATION

It is the policy of 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 P-2]. 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 8-1]. The purpose of this chapter is to describe dose to public and the environment surrounding the INEEL in terms of radionuclide contaminants during the calendar year 1999.

During 1999 no significant differences were detected in samples taken at locations distant from the INEEL compared with those taken near the boundaries (see Chapter 4). Therefore, there was no measured increase in exposure to radionuclides from the INEEL in the offsite environment during 1999. Because potential 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 7) and appropriate air dispersion models. During 1999, this was accomplished for the radionuclides summarized in Table 7-1 (pg. 7-4).

The following estimates were calculated:

- The effective dose equivalent to the maximally exposed individual residing offsite using the CAP-88 model [Reference 8-2];
- The effective dose equivalent to the maximally exposed individual residing offsite using dispersion calculations from the MDIFF (mesoscale diffusion) model [Reference 8-3]; and
- The collective effective dose equivalent (population dose) within an 80-km (50-mi) radius of the operations center of the Site (the Test Reactor Area [TRA] and the Idaho Nuclear Technology and Engineering Center [INTEC]). The estimated population dose was based on the effective dose equivalent calculated with the MDIFF air dispersion model for the maximally-exposed individual.

In this chapter, the term "dose" will refer to effective dose equivalent (EDE) unless another term is specifically stated. Dose was calculated by summing the committed dose equivalents to organs, each multiplied by a weighting factor proportional to each organ's sensitivity to radiation. 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 for internally deposited radionuclides [Reference 8-4] and for radionuclides deposited on the ground surface [Reference 8-5] in calculations with both air dispersion models. 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 was less than year-round occupancy time in the community. The CAP-88 model includes a factor to allow for shielding from radioactivity on the ground surface by surface soil contours.

Of the potential exposure pathways by which radioactive materials from INEEL operations could be transported offsite (see Figure 3-1), 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 quickly carry airborne radioactive materials offsite. 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.

8.2 MAXIMUM INDIVIDUAL DOSE – AIRBORNE EMISSIONS PATHWAY

Summary of Models

The National Emission Standards for Hazardous Air Pollutants (NESHAPs) as detailed 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 per year. This includes releases from stacks and diffuse sources. The Environmental Protection Agency (EPA) requires the use of either the CAP-88 or AIRDOS model to demonstrate compliance with 40 CFR Part 61.

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., 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 8-6]. 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 8-6, 8-7, and 8-8].

There are differences in the atmospheric dispersion portions of the MDIFF and CAP-88 air dispersion codes. CAP-88 makes its calculations based on the joint frequency of wind conditions from a single wind station located near the source. MDIFF calculates the individual trajectories using winds from about 30 towers in the Upper Snake River Plain. This allows for more accurate movement of a release plume using prevailing wind conditions over the total travel time of the release. For this reason the two models may not agree on the location of the maximum dose.

CAP-88 Model

Dose from INEEL airborne releases of radionuclides calculated to demonstrate compliance with NESHAPS are published in the *1999 National Emissions Standards for Hazardous Air Pollutants – Radionuclides Report*. [Reference 7-1] 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. Although this location is only inhabited during portions of the year, it meets the EPA definition of a residence. At Frenchman's Cabin, a hypothetical dose of 0.008 mrem (8×10^{-5} mSv) was calculated. The facilities making the largest contributions to this dose were the Test Reactor Area at 39 percent, diffuse sources of radioactivity at the Radioactive Waste Management Complex (RWMC) with 49 percent, and the Naval Reactors Facility (NRF) accounting for about 11 percent. The dose of 0.008 mrem

is well below the whole body dose limit of 10 mrem, set in 40 CFR 61.

MDIFF Model

Using data gathered continuously at meteorological stations on and around the INEEL and the MDIFF model, the NOAA-ARL-FRD prepares a mesoscale map (Figure 8-1) showing the calculated 1999 concentrations normalized to a unit release rate from the Test Reactor Area/Idaho Nuclear Technology and Engineering Center (TRA/INTEC) midpoint. To obtain the average air concentration (Ci/m^3) for a radionuclide released from this point along any dispersion coefficient isopleth (line of equal air concentration) in Figure 8-1, the value of the dispersion coefficient is multiplied by the number of curies of the radionuclide released during the year and divided by the square of the number of hours in a year ($[8{,}760 \text{ hours}]^2$ or 7.67×10^7).

The MDIFF model predicted that the highest concentration of radionuclides in air at an inhabited area during 1999 would have occurred about 2 miles southeast of Terreton, 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, ingestion of milk, and exposure due to deposition of radioactive particles on the ground. The calculation was based on data presented in Table 7-1 and in Figure 8-1.

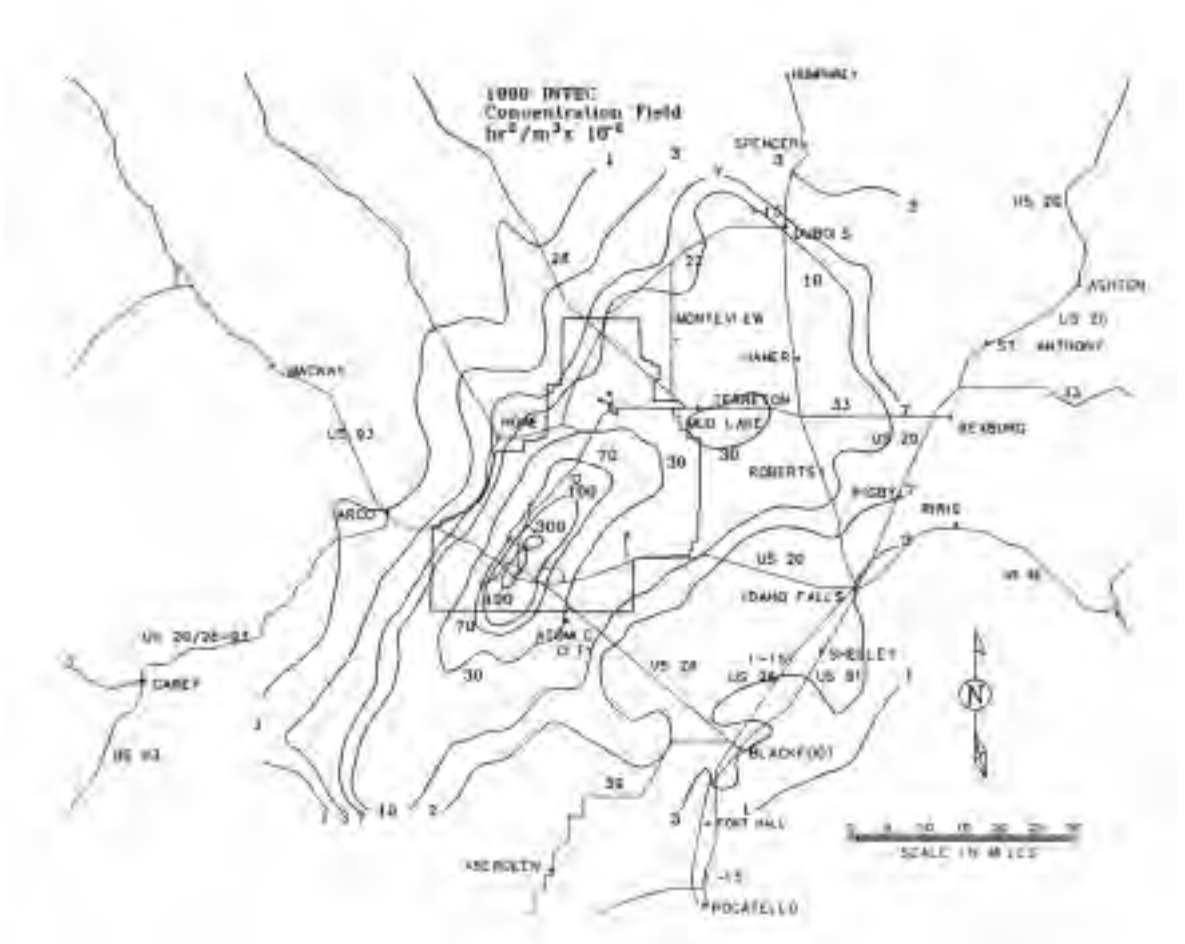

Figure 8-1. Average Mesoscale Dispersion Isopleths of Air Concentrations at Ground Level, Normalized to Unit Release Rate for TRA/INTEC.

Using the calculated dispersion coefficient of 31.8 x 10^{-9}, the largest dispersion coefficient value from TRA/INTEC at a location inhabited by a full-time resident, and allowing for radioactive decay during the 54-km (34-mi) transit of the radionuclides from TRA/INTEC to the area southeast of Terreton, the potential effective dose equivalent from all radionuclides released was calculated to be approximately 0.003 mrem (3 x 10^{-5} mSv) (Table 8-1). This dose is 0.03 percent of the whole body dose limits set in 40 CFR 61 for airborne releases of radionuclides.

Of this calculated dose, immersion accounted for 65 percent of the total, contributed primarily by the noble gas Argon-41 (^{41}Ar). Iodine-129 via the ingestion pathway accounted for 32 percent. The remaining 3 percent was contributed by a combination of other radionuclides (Figure 8-2).

The calculated maximum dose resulting from INEEL operations is a small fraction of the average dose received by individuals in southeastern Idaho from cosmic and terrestrial sources of naturally occurring radiation found in the environment. The total annual dose from all natural sources is estimated at approximately 360 mrem (Table 4-11).

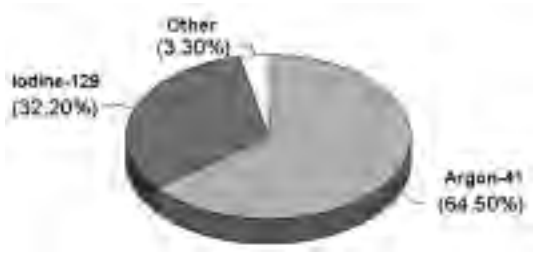

Figure 8-2. Radionuclides Contributing to Maximum Individual Dose (as calculated by the MDIFF model) (1999).

8.3 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

Table 8-1. Maximum Individual Effective Dose Equivalent (as calculated by the MDIFF Model) (1999).

Radionuclide[a]	Radionuclide Concentration (µCi/mL) at Maximum Offsite Location[b]	Maximum Effective Dose Equivalent	
		mrem	mSv
^{41}Ar	2.65 x 10^{-13}	1.76 x 10^{-3}	1.76 x 10^{-5}
^{129}I	1.08 x 10^{-18}	8.76 x 10^{-4}	8.76 x 10^{-6}
^{90}Sr + D[c]	5.26 x 10^{-20}	1.91 x 10^{-5}	1.91 x 10^{-7}
^{3}H	3.12 x 10^{-14}	1.65 x 10^{-5}	1.65 x 10^{-7}
^{137}Cs + D[c]	2.48 x 10^{-19}	1.21 x 10^{-5}	1.21 x 10^{-7}
^{85}Kr	7.71 x 10^{-13}	8.64 x 10^{-6}	8.64 x 10^{-8}
^{60}Co	8.33 x 10^{-20}	8.25 x 10^{-6}	8.25 x 10^{-8}
^{131}I	3.68 x 10^{-19}	6.84 x 10^{-6}	6.84 x 10^{-8}
^{135}Xe	5.33 x 10^{-15}	6.67 x 10^{-6}	6.67 x 10^{-8}
^{14}C (organic)	2.65 x 10^{-16}	4.68 x 10^{-6}	4.68 x 10^{-8}
^{238}Pu	8.98 x 10^{-22}	3.47 x 10^{-6}	3.47 x 10^{-8}
TOTAL		**2.72 x 10^{-3}**	**2.72 x 10^{-5}**

[a] Table includes only radionuclides that contribute a dose of 1.0 x 10^{-6} mrem or more.
[b] Estimate of radioactive decay is based on a 1.7-hour transport time using the distance to Terreton (34 miles) and the average wind speed (20 mi/hr).
[c] When indicated (+D), the contribution of progeny decay products was also included in the dose calculations.

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

A study was initiated in 1994 to obtain data on potential doses from waterfowl using the ponds. This study focuses on two hypalon-lined ponds that formerly were used for waste disposal.

Although no waterfowl were collected in 1999, from 1994 to 1998, a total of 68 ducks were collected (24 from control locations, 17 from the lined ponds at TRA, 10 from INTEC, 9 from a pond at the Test Area North, and 8 from ponds at the Argonne National Laboratory-West facility). The potential dose from eating 225 g (8 oz) of meat from those ducks collected is displayed in Figure 8-3. Radionuclide concentrations driving these doses are reported in Table 4-8. Doses from consuming waterfowl are based on the assumption that ducks are killed and eaten immediately after leaving the ponds.

A lower dose would be more realistic due to the biological elimination of the radioactivity. For example, a significant contributor to the dose, Cesium-137 (^{137}Cs), has an effective half-life in mallard ducks of 11.2 days [Reference 8-9]. This means that half of the ^{137}Cs present in the muscle tissue of the duck would be eliminated in 11.2 days. At the end of the next 11.2 days, half of the remaining radioactivity (or one-fourth of the original activity) would be remaining, and so forth.

The potential doses from waterfowl samples are substantially reduced from 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 8-10], and from the 4.0 mrem estimated for the most contaminated duck taken from the percolation pond in 1984 to 1986 [Reference 8-11].

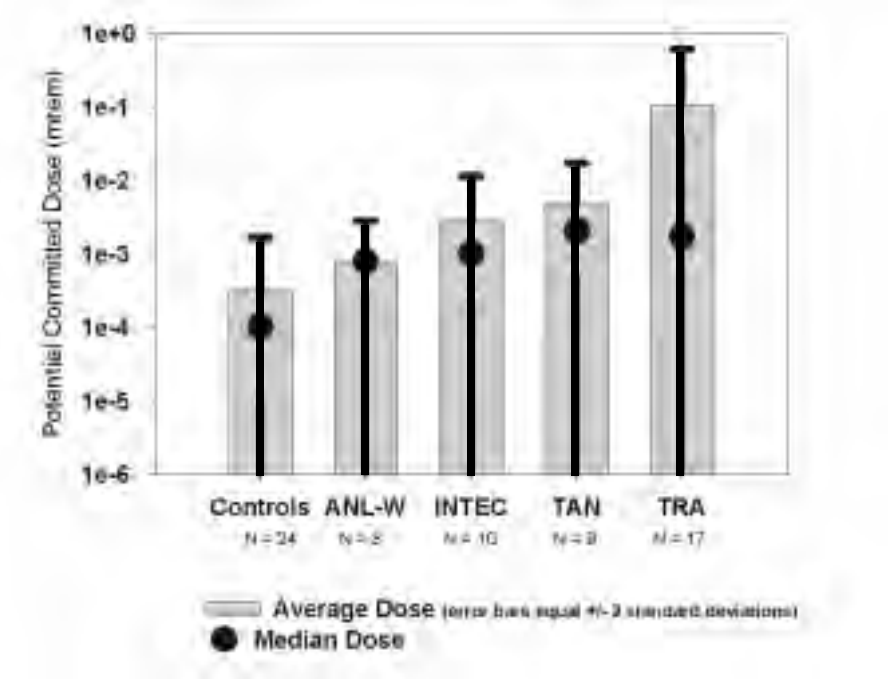

Figure 8-3. Potential Committed (50 yr) Effective Dose Equivalents from Ingesting 225 g of Muscle Tissue from Waterfowl using INEEL Disposal Ponds (1994-1998).

Mourning Doves

During 1999, a total of 16 mourning doves were collected, 7 from the evaporation ponds at TRA, 5 from INTEC, and 4 control samples collected approximately five miles southeast of Idaho Falls, Idaho. Manmade radionuclide concentrations in the edible portion of the doves reported in Table 4-7 were used to estimate the potential dose resulting from the ingestion of 30 g (1 oz) of the edible portion of the mourning doves (Table 8-2). The potential dose from a dove at TRA was calculated to be 0.0002 mrem, compared with <0.00009 mrem in the control doves. The largest anthropogenic contributors to the dose from doves from TRA were Americium-241 (^{241}Am) and Cobalt-60 (^{60}Co). The highest estimated potential whole-body dose equivalent to a person eating the entire muscle mass of a mourning dove from the former TRA percolation pond was 0.3 mrem in 1974-1977 [Reference 8-12].

Table 8-2. Maximum Potential Committed (50 yr) Effective Dose Equivalents from Ingestion of Muscle Tissue of Mourning Doves Using INEEL Waste Ponds (1999).

Radio-nuclide	Control (N = 4) (mrem)	TRA Evap. Ponds (N = 7) (mrem)	INTEC Perc. Ponds (N = 5) (mrem)
^{60}Co	0	3.1×10^{-5}	0
^{137}Cs	8.5×10^{-5}	0	0
^{241}Am	0	1.6×10^{-4}	0
Total	**8.5×10^{-5}**	**1.9×10^{-4}**	**0**

Assumes the consumption of 30 g (1 oz) of muscle tissue containing the observed concentrations of detected radionuclides (see Table 4-7).
N = sample size

Big Game Animals

Based on the highest concentration of radionuclides found in a game animals collected from 1977 to 1996, the potential dose was estimated at approximately 0.03 mrem [Reference 8-13]. An estimate of the potential whole-body dose for 1999 that could be received from an individual eating the entire muscle mass (~27 kg [60 lbs]) of a large game animal with the highest levels of radioactivity was 0.02 mrem.

Yellow-Bellied Marmots

No marmots were sampled during 1999. Marmots will be sampled again in 2000. During 1998 a total of nine yellow-bellied marmots were collected, six from the RWMC and three from a control location 27 miles (43 km) southeast of the INEEL. The maximum potential dose was calculated from consuming 225 g (8 oz) of marmot meat. For 1998, this potential dose was 0.014 mrem from RWMC marmots, primarily from cerium-141. For control marmots, a potential dose of 0.004 mrem was calculated, primarily from ^{90}Sr.

8.4 80-KILOMETER POPULATION DOSE

An estimate was made of the collective effective dose equivalent (CEDE), 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 the TRA/INTEC facilities. The population dose was calculated by a computer program that multiplies the population number in each square mile by the dispersion coefficient at that point (h^2/m^3) and the normalized dose received at the location of the maximally exposed individual ($rem/yr/h^2/m^3$). 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 CEDE by the population in that particular census division. This calculation overestimates dose because the model does not account for radioactive decay of the isotopes during transport over distances greater than the 54-km (34-mi) distance from the TRA/INTEC facilities to the residence of the maximally exposed individual located near Terreton. Idaho Falls, for example, is about 66 km (41 mi) from TRA/INTEC. Neither residence time nor shielding by housing was considered when calculating the MDIFF dose on which the CEDE 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 1999 MDIFF population dose within each census division was obtained by summing the results from appropriate areas contained within those divisions (Table 8-3). The total 80-km (50-mi) population dose was the sum of the population doses for the various census divisions. The estimated potential population dose was 0.037 person-rem (0.00037 person-Sv) to a population of about 121,500. 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 0.0001 percent. The dose of 0.037 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

Table 8-3. Dose to Population within 80 Kilometers (50 miles) of INEEL Center (1999).

		Population Dose	
Census Division	**Population[a]**	**Person-rem**	**Person-Sv**
Aberdeen	2,760	8.82×10^{-4}	8.82×10^{-6}
Alridge (part)	192	7.13×10^{-5}	7.13×10^{-7}
American Falls (part)	200	2.50×10^{-5}	2.50×10^{-7}
Arco	2,600	2.77×10^{-4}	2.77×10^{-6}
Atomic City (city)	25	4.32×10^{-5}	4.32×10^{-7}
Atomic City (division)	2,300	1.31×10^{-4}	1.31×10^{-6}
Blackfoot	12,450	2.59×10^{-3}	2.59×10^{-5}
Carey (part)	120	6.14×10^{-7}	6.14×10^{-9}
Challis (part)	10	8.43×10^{-8}	8.43×10^{-10}
Firth	3,018	1.12×10^{-3}	1.12×10^{-5}
Fort Hall (part)	3,920	2.73×10^{-4}	2.73×10^{-6}
Hamer	2,400	4.85×10^{-3}	4.85×10^{-5}
Howe	325	2.86×10^{-4}	2.86×10^{-6}
Idaho Falls	63,500	1.47×10^{-2}	1.47×10^{-4}
Idaho Falls, west	1,750	1.55×10^{-4}	1.55×10^{-6}
Leadore (part)	15	3.20×10^{-6}	3.20×10^{-8}
Lewisville-Menan (part)	2,700	1.09×10^{-3}	1.09×10^{-5}
Mackay	1,200	7.31×10^{-7}	7.31×10^{-9}
Moreland	8,150	2.94×10^{-3}	2.94×10^{-5}
Rigby	998	4.02×10^{-4}	4.02×10^{-6}
Roberts	1,430	1.85×10^{-3}	1.85×10^{-5}
Shelley	6,400	2.37×10^{-3}	2.37×10^{-5}
Ucon	4,902	1.98×10^{-3}	1.98×10^{-5}
West Clark	90	2.21×10^{-4}	2.21×10^{-6}
Totals	**121,455**	**3.67×10^{-2}**	**3.67×10^{-4}**

[a] Population based on 1990 Census Report for Idaho.

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

8.5 SUMMARY

Table 8-4 summarizes the calculated annual effective dose equivalents from 1999 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 to the estimated dose from natural background. The difference between the MDIFF and CAP-88 dose is related to differences in the dispersion coefficient at the different MEI locations. This value is used to calculate the dose.

The contribution of game animal consumption to the population dose has not been calculated because only a 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 8-10). The total population dose contribution from this ingestion pathway 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.

Table 8-4. Summary of Annual Effective Dose Equivalents Due to INEEL Operations (1999).

	Maximum Dose to an Individual[a]		Population Dose
	MDIFF[b]	CAP-88[c]	MDIFF
Dose	0.003 mrem 3×10^{-5} mSv	0.008 mrem 8×10^{-5} mSv	0.037 person-rem 3.7×10^{-4} person-Sv
Location	~2 mi. SE of Terreton	Frenchman's Cabin	Area within an 80-km circle
Applicable radiation protection standard[d]	10 mrem (0.1 mSv)	10 mrem (0.1 mSv)	----
Percentage of standard	0.03%	0.08%	----
Natural background	360 mrem (3.6 mSv)	360 mrem (3.6 mSv)	43,700 person-rem (437 person-Sv)
Percentage of background	0.0008%	0.002%	0.00008%

[a] Hypothetical dose to the maximally exposed individual residing near the INEEL.
[b] Effective dose equivalent calculated using the MDIFF air dispersion model. MDIFF calculations do not consider occupancy time or shielding by buildings.
[c] Effective dose equivalent calculated using the CAP-88 code.
[d] Although the DOE standard for all exposure models 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.

Chapter 9

Quality Assurance

9. QUALITY ASSURANCE

9.1 QUALITY ASSURANCE PROGRAMS

Quality control and assurance programs were maintained by contractors conducting environmental monitoring and by laboratories performing environmental analyses to ensure precise, accurate, representative, and reliable results and to 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 that occurs during analysis;
- Analysis of blind spike samples (a sample 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.

9.2 LABORATORY INTERCOMPARISON PROGRAMS

General Information

Radiological data reported in this document were obtained from several commercial, university, government, and government contractor laboratories, including the Idaho State University Environmental Assessment Laboratory (EAL), the Idaho National Engineering and Environmental Laboratory (INEEL) Management and Operating (M&O) contractor's Radiological Measurements Laboratory, Paragon Analytics, Inc., the Department of Energy (DOE) Radiological and Environmental Sciences Laboratory (RESL), and Quanterra, Inc. These laboratories participate in a variety of programs to ensure the quality of their analytical data.

Quality Assessment Program

DOE's Environmental Measurements Laboratory (EML) in New York administers the Quality Assessment Program (QAP). EML prepares quality control samples containing various alpha-, beta-, and gamma-emitting radionuclides in water, soil, air filter, vegetation, and tissue media and distributes them to numerous DOE contractor laboratories throughout the country. The program is a laboratory intercomparison in that results from the participants are compared with the experimentally determined results of the EML. EML issues QAP Reports twice per year in which the identities of participating laboratories, their results, and comparison to EML results are presented. Results from the QAP are presented in Tables 9-1 to 9-5 for laboratories used during 1999.

National Institute of Standards and Technology

RESL participates in a traceability program administered through National Institute of Standards and Technology (NIST). NIST prepares several alpha-,

beta-, and gamma-emitting standards, generally in liquid media, for analysis by RESL.

Environmental Protection Agency Intercomparison Studies Program

The Environmental Protection Agency's (EPA) Environmental Monitoring Systems Laboratory in Las Vegas, Nevada, coordinates an intercomparison program for radionuclides in water. The laboratories used by contractors performing environmental monitoring at the INEEL participate in this program.

Dosimetry

To verify the quality of the environmental dosimetry program conducted by the M&O contractor, the Operational Dosimetry Unit has participated in 11 International Environmental Dosimeter Intercomparison Studies. The Operational Dosimetry Unit's results were 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.

Blind Spikes

The Environmental Surveillance, Education, and Research Program (ESER) contractor purchases samples spiked with various radionuclides from Analytics, Inc. and submits these spikes, disguised as samples, to the laboratories performing analyses for the ESER contractor. The analytical results are expected to compare to the known value to within ± 20 percent or three standard deviations.

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.

9.3 DATA PRECISION AND VERIFICATION

As a measure of the quality of data collected, the ESER contractor, the INEEL M&O contractor, the U. S. Geological Survey (USGS), and other contractors performing monitoring used a variety of quality control samples of different media. Quality control samples include duplicate samples (separate samples taken at the same time), split samples (two portions of a sample that are analyzed separately), and spike samples (samples to which a known amount of a contaminant is added).

Duplicate Sampling within Organizations

Both the ESER contractor and the INEEL M&O contractor maintained duplicate air samplers at two locations during 1999 (Table 9-6). The ESER contractor operated duplicate samplers at Mountain View Middle School (Blackfoot) and at Atomic City (Figure 3-2). The M&O contractor duplicate samplers were 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.

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 INEEL Oversight Program collected air monitoring data throughout 1999 at three shared 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 (see Figure 3-2). Data from these three sampling locations for gross alpha and gross beta are shown in Tables 9-7 and 9-8, respectively.

The ESER contractor also collects semiannual samples of drinking and surface water jointly with the Oversight Program at five locations in the Magic Valley area. Table 9-9 contains results from analysis of

1999 samples from these locations. In addition, the USGS collects groundwater samples simultaneously with the Oversight Program. A more thorough comparison of interorganization duplicate sampling data can be found in Reference 4-1.

Table 9-1. EML Quality Assessment Program Results for Idaho State University (ISU) Environmental Assessment Laboratory (EAL) (1999).

Media	Units	Radionuclide	ISU EAL Value	ISU EAL Error	EML Value	EML Error	Reported/EML Ratio
			March 1999				
Air	Bq/filter	^{57}Co	3.0	0.1	3.01	0.14	0.997
		^{60}Co	5.2	0.1	4.96	0.28	1.048
		^{137}Cs	6.2	0.1	6.05	0.3	1.025
		Gross Alpha	1.68	0.02	1.61	0.16	1.043
		Gross Beta	0.74	0.01	1.56	0.16	0.474
Soil	Bq/kg	^{125}Sb	3.8	0.1	3.59	0.31	1.058
		^{228}Ac	55.4	3.7	47.15	2.989	1.175
		^{214}Bi	74.0	3.2	69.9	5.66	1.059
		^{137}Cs	643.9	10.6	659.5	24.95	0.976
		^{40}K	356.7	36.4	362.75	20.156	0.983
		^{212}Pb	44.0	2.4	47.925	2.572	0.918
		^{214}Pb	74.0	3.2	71.0	7.035	1.042
Vegetation	Bq/kg	^{60}Co	21.8	1.5	21.45	1.0	1.016
		^{137}Cs	483.5	8.6	467.0	20.0	1.035
		^{40}K	747.3	50.0	656.5	20.0	1.138
Water	Bq/L	^{60}Co	56.8	0.6	51.1	3.0	1.112
		^{137}Cs	43.6	0.5	39.375	2.4047	1.107
		Gross Alpha	1140.4	18.8	1090.0	20.0	1.046
		Gross Beta	550.5	9.3	1100.0	40.0	0.5
			September 1999				
Air	Bq/filter	^{54}Mn	8.7	0.2	7.91	0.45	1.100
		^{57}Co	8.0	0.1	7.73	0.033	1.035
		^{60}Co	6.8	0.1	6.35	0.41	1.071
		^{106}Ru	6.3	0.4	5.5	1.76	1.145
		^{137}Cs	7.2	0.1	6.43	0.42	1.120
		Gross Alpha	2.46	0.03	2.77	0.26	0.888
		Gross Beta	2.51	0.03	2.66	0.26	0.944
Soil	Bq/kg	^{40}K	795.6	49.0	780.0	27.0	1.020
		^{137}Cs	204.2	3.8	204.0	5.0	1.001
		^{212}Bi	110.2	9.4	140.0	14.0	0.787
		^{212}Pb	121.0	1.8	127.0	4.8	0.953
		^{214}Bi	133.4	4.9	69.5	1.8	1.919
		^{214}Pb	133.4	4.9	72.0	0.42	1.853
		^{228}Ac	148.7	3.6	124.0	4.8	1.199
Vegetation	Bq/kg	^{40}K	507.2	46.1	513.0	20.0	0.989
		^{60}Co	14.1	0.8	17.6	1.0	0.801
		^{137}Cs	429.9	5.3	440.0	20.0	0.977
Water	Bq/L	^{60}Co	53.9	0.5	52.4	2.2	1.029
		^{137}Cs	78.8	1.1	76.0	3.4	1.037
		Gross Alpha	1199.8	13.9	1580.0	20.0	0.759
		Gross Beta	610.2	8.9	740.0	40.0	0.825

The EML value is the mean of replicate determinations for each radionuclide.
The EML error is the standard error of the mean.
The Reported/EML value is the ratio of the laboratory reported value to the EML value.

Table 9-2. EML Quality Assessment Program Results for General Engineering Labs (GEL) (1999).

Media	Units	Radionuclide	GEL		EML		Reported/EML Ratio
			Value	Error	Value	Error	
			September 1999				
Air	Bq/filter	^{241}Am	0.105	0.021	0.127	0.0099	0.827
		^{57}Co	7.79	0.802	7.73	0.033	1.008
		^{60}Co	6.81	0.862	6.35	0.41	1.072
		^{137}Cs	7.06	0.803	6.43	0.42	1.098
		Gross Alpha	2.72	0.032	2.77	0.26	0.982
		Gross Beta	2.71	0.027	2.66	0.26	1.019
		^{54}Mn	8.81	1.13	7.91	0.45	1.114
		^{238}Pu	0.082	0.014	0.0968	0.0065	0.847
		^{239}Pu	0.145	0.021	0.136	0.011	1.066
		^{106}Ru	7.01	3.15	5.5	1.76	1.275
		^{90}Sr	0.338	0.037	0.336	0.0141	1.006
		^{234}U	0.069	0.012	0.0658	0.0034	1.049
		^{238}U	0.075	0.012	0.0646	0.0048	1.161
	µg/filter	U	5.84	0.062	5.23	0.29	1.117
Soil	Bq/kg	^{241}Am	1.69	0.311	1.44	0.19	1.174
		^{228}Ac	131.0	20.4	124.0	4.8	1.056
		^{212}Bi	82.9	14.2	140.0	14.0	0.592
		^{214}Bi	88.5	11.3	69.5	1.8	1.273
		^{244}Cm	47.5	5.143	[a]	[a]	[a]
		^{137}Cs	217.0	24.2	204.0	5.0	1.064
		^{40}K	914.0	97.3	780.0	27.0	1.172
		^{212}Pb	142.0	16.1	127.0	4.8	1.118
		^{214}Pb	102.0	12.6	72.0	0.42	1.417
		^{239}Pu	2.75	0.419	3.2	0.5	0.859
		^{90}Sr	9.8	1.07	13.0	0.47	0.754
		^{234}Th	188.0	45.0	198.0	5.6	0.949
		^{234}U	183.0	23.5	190.0	5.2	0.963
		^{238}U	197.0	25.1	202.0	7.2	0.975
	µg/filter	U	15.1	0.16	16.3	0.3	0.926
Vegetation	Bq/kg	^{241}Am	3.13	0.488	2.88	0.22	1.087
		^{244}Cm	1.85	0.361	1.61	0.36	1.149
		^{60}Co	18.4	2.49	17.6	1.0	1.045
		^{137}Cs	459.0	52.6	440.0	20.0	1.043
		^{40}K	579.0	64.0	513.0	20.0	1.129
		^{239}Pu	4.48	0.675	4.3	0.46	1.042
		^{90}Sr	586.0	5.45	595.0	29.0	0.985
Water	Bq/L	^{241}Am	0.984	0.139	0.85	0.1	1.158
		^{60}Co	54.8	5.91	52.4	2.2	1.046
		^{137}Cs	77.6	8.24	76.0	3.4	1.021
		^{55}Fe	45.8	10.6	53.0	2.0	0.864
		Gross Alpha	1790.0	43.9	1580.0	20.0	1.133
		Gross Beta	969.0	24.7	740.0	40.0	1.309
		^{3}H	84.2	9.3	80.7	3.7	1.043
		^{63}Ni	115.0	2.65	114.0	10.0	1.009
		^{238}Pu	0.857	0.144	0.79	0.08	1.085
		^{239}Pu	0.934	0.155	0.87	0.1	1.074
		^{90}Sr	1.77	0.066	1.72	0.1	1.029
		^{234}U	0.386	0.063	0.37	0.02	1.043
		^{238}U	0.39	0.063	0.36	0.02	1.083
	µg/filter	U	0.032	0.001	0.03	0.01	1.067

[a] EML activity value not available at this time.

Table 9-3. EML Quality Assessment Program Results for INEEL M&O Contractor (1999).

Media	Units	Radionuclide	M&O		EML		Reported/EML Ratio
			Reported Value	Reported Error	EML Value	EML Error	
			March 1999				
Air	Bq/filter	^{241}Am	0.151	0.012	0.1337	0.0012	1.129
		^{57}Co	3.2	0.2	3.01	0.14	1.063
		^{60}Co	5.2	0.4	4.96	0.28	1.048
		^{137}Cs	6.3	0.5	6.05	0.3	1.041
		^{238}Pu	0.266	0.023	0.2722	0.0009	0.977
		^{239}Pu	0.14	0.013	0.1243	0.0028	1.126
		^{125}Sb	4.1	0.3	3.59	0.31	1.142
		^{90}Sr	0.64	0.05	0.644	0.0145	0.994
		^{234}U	0.07	0.009	0.05996	0.0019	1.167
		^{238}U	0.066	0.01	0.06124	0.0028	1.078
Soil	Bq/kg	^{241}Am	4.63	0.45	4.8943	0.969	0.946
		^{137}Cs	750.0	60.0	659.5	24.95	1.137
		^{40}K	420.0	70.0	362.75	20.156	1.158
		^{238}Pu	0.32	0.06	0.3637	0.0854	0.88
		^{239}Pu	7.67	0.68	8.1117	1.0683	0.946
		^{90}Sr	34.9	1.8	32.4	0.5292	1.077
		^{234}U	147.0	15.0	140.667	1.155	1.045
		^{238}U	144.0	17.0	145.0	1.732	0.993
Vegetation	Bq/kg	^{241}Am	3.22	0.23	3.522	0.5898	0.914
		^{244}Cm	1.8	0.19	1.6707	0.5415	1.077
		^{60}Co	23.0	3.0	21.45	1.0	1.072
		^{137}Cs	480.0	40.0	467.0	20.0	1.028
		^{40}K	720.0	90.0	656.5	20.0	1.097
		^{238}Pu	0.33	0.07	0.4185	0.0105	0.789
		^{239}Pu	5.02	0.49	5.2043	0.4278	0.965
		^{90}Sr	816.0	24.0	736.1	7.7	1.109
Water	Bq/L	^{241}Am	1.15	0.08	1.146	0.0505	1.003
		^{60}Co	52.0	4.0	51.1	3.0	1.018
		^{137}Cs	40.0	3.0	39.375	2.4047	1.016
		^{55}Fe	73.0	23.0	97.4	1.65	0.749
		Gross Alpha	880.0	50.0	1090.0	20.0	0.807
		Gross Beta	1240.0	30.0	1100.0	40.0	1.127
		^{238}Pu	0.816	0.079	0.7716	0.0366	1.058
		^{239}Pu	1.01	0.091	1.0093	0.0579	1.001
		^{90}Sr	4.2	0.3	4.104	0.0453	1.023
		^{234}U	0.291	0.05	0.2685	0.0155	1.084
		^{238}U	0.311	0.06	0.2619	0.0163	1.187

Table 9-3. EML Quality Assessment Program Results for INEEL M&O Contractor (1999). (Cont.)

Media	Units	Radionuclide	M&O Reported Value	M&O Reported Error	EML EML Value	EML EML Error	Reported/EML Ratio
			September 1999				
Air	Bq/filter	^{57}Co	7.7	0.6	7.73	0.033	0.996
		^{60}Co	6.6	0.5	6.35	0.41	1.039
		^{54}Mn	8.6	0.6	7.91	0.45	1.087
		^{90}Sr	0.36	0.02	0.336	0.0141	1.071
		^{106}Ru	5.5	0.5	5.5	1.76	1.000
Air	Bq/filter	^{241}Am	0.103	0.009	0.127	0.0099	0.811
		^{241}Am (rep 2)	0.11	0.03	0.127	0.0099	0.866
		^{137}Cs	6.7	0.5	6.43	0.42	1.042
		^{238}Pu	0.087	0.004	0.0968	0.0065	0.899
		^{239}Pu	0.129	0.006	0.136	0.011	0.949
		^{234}U	0.071	0.01	0.0658	0.0034	1.079
		^{238}U	0.067	0.011	0.0646	0.0048	1.037
Soil	Bq/kg	^{241}Am	1.56	0.15	1.44	0.19	1.083
		^{244}Cm	37.3	2.3	[a]	[a]	[a]
		^{137}Cs	226.0	17.0	204.0	5.0	1.108
		^{40}K	787.0	67.0	780.0	27.0	1.009
		^{238}Pu	0.275	0.04	0.32	0.13	0.859
		^{239}Pu	2.8	0.14	3.2	0.5	0.875
		^{90}Sr	13.0	1.7	13.0	0.47	1.000
		^{234}U	196.0	16.0	190.0	5.2	1.032
		^{238}U	204.0	16.0	202.0	7.2	1.010
Vegetation	Bq/kg	^{241}Am	3.03	0.3	2.88	0.22	1.052
		^{40}K	465.0	80.0	513.0	20.0	0.906
		^{244}Cm	1.92	0.19	1.61	0.36	1.193
		^{60}Co	14.0	2.0	17.6	1.0	0.795
		^{137}Cs	434.0	30.0	440.0	20.0	0.986
		^{90}Sr	665.0	46.0	595.0	29.0	1.118
		^{238}Pu	0.273	0.027	0.5	0.1	0.546
		^{239}Pu	4.26	0.21	4.3	0.46	0.991
Water	Bq/L	^{241}Am	0.932	0.038	0.85	0.1	1.096
		^{60}Co	54.0	4.0	52.4	2.2	1.031
		^{137}Cs	80.0	6.0	76.0	3.4	1.053
		^{55}Fe	33.3	1.9	53.0	2.0	0.628
		Gross Alpha	1364.0	74.0	1580.0	20.0	0.863
		Gross Beta	1090.0	70.0	740.0	40.0	1.473
		^{3}H	76.4	5.3	80.7	3.7	0.947
		^{63}Ni	110.0	6.0	114.0	10.0	0.965
		^{238}Pu	0.8	0.032	0.79	0.08	1.013
		^{239}Pu	0.887	0.035	0.87	0.1	1.020
		^{90}Sr	1.56	0.19	1.72	0.1	0.907
		^{234}U	0.455	0.046	0.37	0.02	1.230
		^{238}U	0.441	0.046	0.36	0.02	1.225

[a] EML activity value not available at this time.

Table 9-4. EML Quality Assessment Program Results for Paragon Analytics, Inc. (1999).

Media	Units	Radionuclide	Paragon		EML		Reported/EML Ratio
			Reported Value	Reported Error	EML Value	EML Error	
			March 1999				
Air	Bq/filter	^{241}Am	0.141	0.025	0.1337	0.0012	1.055
		^{57}Co	2.7	0.47	3.01	0.14	0.897
		^{60}Co	4.74	0.81	4.96	0.28	0.956
		^{137}Cs	6.1	1.0	6.05	0.3	1.008
		^{238}Pu	0.278	0.04	0.2722	0.0009	1.021
		^{239}Pu	0.126	0.022	0.1243	0.0028	1.014
		^{125}Sb	4.09	0.74	3.59	0.31	1.139
		^{90}Sr	0.58	0.11	0.644	0.0145	0.901
		^{234}U	0.07	0.015	0.05996	0.0019	1.167
		^{238}U	0.071	0.017	0.06124	0.0028	1.159
	µg/filter	U	5.6	1.3	4.945	0.2266	1.132
	Bq	U	0.146	0.023	0.1231	0.0036	1.186
Soil	Bq/kg	^{228}Ac	53.0	10.0	47.15	2.989	1.124
		^{241}Am	5.4	1.0	4.8943	0.969	1.103
		^{214}Bi	64.0	12.0	69.9	5.66	0.916
		^{137}Cs	770.0	130.0	659.5	24.95	1.168
		^{40}K	392.0	70.0	362.75	20.156	1.081
		^{212}Pb	51.1	9.0	47.925	2.572	1.066
		^{214}Pb	74.0	13.0	71.0	7.035	1.042
		^{239}Pu	8.3	1.5	8.1117	1.0683	1.023
		^{90}Sr	30.7	6.3	32.4	0.5292	0.948
		^{234}Th	128.0	31.0	138.0	4.08	0.928
		^{234}U	145.0	18.0	140.667	1.155	1.031
		^{238}U	155.0	19.0	145.0	1.732	1.069
Vegetation	Bq/kg	^{241}Am	3.4	0.5	3.522	0.5898	0.965
		^{244}Cm	2.22	0.26	1.6707	0.5415	1.329
		^{60}Co	23.1	4.1	21.45	1.0	1.077
		^{137}Cs	556.0	92.0	467.0	20.0	1.191
		^{40}K	710.0	120.0	656.5	20.0	1.081
		^{239}Pu	4.97	0.67	5.2043	0.4278	0.955
		^{90}Sr	636.0	118.0	736.1	7.7	0.864
Water	Bq/L	^{241}Am	1.21	0.17	1.146	0.0505	1.056
		^{60}Co	51.4	8.6	51.1	3.0	1.006
		^{137}Cs	42.0	7.2	39.375	2.4047	1.067
		^{3}H	124.0	19.0	121.08	6.78	1.024
		^{63}Ni	106.0	14.0	114.0	10.0	0.93
		^{238}Pu	0.73	0.11	0.7716	0.0366	0.946
		^{239}Pu	0.99	0.14	1.0093	0.0579	0.981
		^{90}Sr	3.31	0.63	4.104	0.0453	0.807
		^{234}U	0.31	0.059	0.2685	0.0155	1.155
		^{238}U	0.285	0.051	0.2619	0.0163	1.088
	µg/filter	U	0.0242	0.0057	0.0212	0.001	1.142
	Bq	U	0.63	0.076	0.541	0.0246	1.165

Table 9-4. EML Quality Assessment Program Results for Paragon Analytics, Inc. (1999). (cont.)

Media	Units	Radionuclide	Paragon Reported Value	Paragon Reported Error	EML EML Value	EML EML Error	Reported/EML Ratio
			September 1999				
Air	Bq/filter	^{241}Am	0.112	0.02	0.127	0.0099	0.882
		^{57}Co	7.5	1.2	7.73	0.033	0.970
		^{57}Co (rep2)	7.4	1.2	7.73	0.033	0.957
		^{60}Co	6.2	1.0	6.35	0.41	0.976
		^{60}Co (rep2)	6.5	1.1	6.35	0.41	1.024
		^{137}Cs	6.2	1.0	6.43	0.42	0.964
		^{137}Cs (rep2)	6.8	1.1	6.43	0.42	1.058
		^{54}Mn	7.8	1.3	7.91	0.45	0.986
		^{54}Mn (rep2)	8.4	1.4	7.91	0.45	1.062
		^{238}Pu	0.099	0.019	0.0968	0.0065	1.023
		^{239}Pu	0.136	0.023	0.136	0.011	1.000
		^{90}Sr	0.346	0.07	0.336	0.0141	1.030
		^{106}Ru	5.4	1.3	5.5	1.76	0.982
		^{106}Ru (rep2)	5.5	1.6	5.5	1.76	1.000
		^{234}U	0.079	0.015	0.0658	0.0034	1.201
	Bq	U	0.153	0.021	0.133	0.0081	1.150
Soil	Bq/kg	^{228}Ac	159.0	27.0	124.0	4.8	1.282
		^{241}Am	2.46	0.72	1.44	0.19	1.708
		^{212}Bi	158.0	31.0	140.0	14.0	1.129
		^{214}Bi	87.0	15.0	69.5	1.8	1.252
		^{137}Cs	271.0	45.0	204.0	5.0	1.328
		^{40}K	1000.0	170.0	780.0	27.0	1.282
		^{212}Pb	173.0	29.0	127.0	4.8	1.362
		^{214}Pb	99.0	17.0	72.0	0.42	1.375
		^{239}Pu	3.5	0.76	3.2	0.5	1.094
		^{90}Sr	13.5	3.9	13.0	0.47	1.038
		^{234}Th	318.0	79.0	198.0	5.6	1.606
		^{208}Tl	54.9	9.3	[a]	[a]	[a]
		^{234}U	207.0	25.0	190.0	5.2	1.089
		^{238}U	209.0	25.0	202.0	7.2	1.035
	Bq	U	424.0	35.0	401.0	8.7	1.057
Vegetation	Bq/kg	^{241}Am	3.38	0.63	2.88	0.22	1.174
		^{244}Cm	1.85	0.35	1.61	0.36	1.149
		^{60}Co	18.4	3.4	17.6	1.0	1.045
		^{137}Cs	478.0	79.0	440.0	20.0	1.086
		^{40}K	514.0	95.0	513.0	20.0	1.002
		^{239}Pu	3.87	0.68	4.3	0.46	0.900
		^{90}Sr	614.0	111.0	595.0	29.0	1.032
Water	Bq/L	^{241}Am	0.98	0.13	0.85	0.1	1.153
		^{60}Co	50.8	8.4	52.4	2.2	0.969
		^{137}Cs	80.0	14.0	76.0	3.4	1.053
		^{55}Fe	39.1	8.3	53.0	2.0	0.738
		^{3}H	78.0	11.0	80.7	3.7	0.967
		^{63}Ni	113.0	16.1	114.0	10.0	0.991
		^{90}Sr	1.71	0.31	1.72	0.1	0.994
		^{238}Pu	0.83	0.12	0.79	0.08	1.051
		^{239}Pu	0.93	0.13	0.87	0.1	1.069
		^{234}U	0.469	0.083	0.37	0.02	1.268
		^{238}U	0.377	0.071	0.36	0.02	1.047
	Bq	U	0.86	0.11	0.76	0.04	1.132

[a] EML activity value not available at this time.

Table 9-5. EML Quality Assessment Program Results for Quanterra, Inc. (1999).

Media	Units	Radionuclide	Quanterra		EML		Reported/EML Ratio
			Reported Value	Reported Error	EML Value	EML Error	
			March 1999				
Air	Bq/filter	^{241}Am	0.122	0.011	0.1337	0.0012	0.912
		^{57}Co	3.53	0.28	3.01	0.14	1.173
		^{60}Co	5.13	0.07	4.96	0.28	1.034
		^{137}Cs	6.11	0.09	6.05	0.3	1.01
		Gross Alpha	1.95	0.06	1.61	0.16	1.211
		Gross Beta	1.67	0.07	1.56	0.16	1.071
		^{238}Pu	0.266	0.034	0.2722	0.0009	0.977
		^{239}Pu	0.12	0.016	0.1243	0.0028	0.965
		^{125}Sb	3.9	0.25	3.59	0.31	1.086
		^{90}Sr	0.66	0.07	0.644	0.0145	1.025
		^{234}U	0.062	0.001	0.05996	0.0019	1.034
		^{238}U	0.066	0.001	0.06124	0.0028	1.078
	µg/filter	U	5.44	0.36	4.945	0.2266	1.1
Soil	Bq/kg	^{228}Ac	53.0	7.0	47.15	2.989	1.124
		^{241}Am	4.58	0.23	4.8943	0.969	0.936
		^{214}Bi	77.0	3.0	69.9	5.66	1.102
		^{137}Cs	760.0	54.0	659.5	24.95	1.152
		^{40}K	407.0	76.0	362.75	20.156	1.122
		^{212}Pb	52.0	2.0	47.925	2.572	1.085
		^{214}Pb	88.0	14.0	71.0	7.035	1.239
		^{238}Pu	0.43	0.16	0.3637	0.0854	1.182
		^{239}Pu	7.92	0.33	8.1117	1.0683	0.976
		^{90}Sr	28.5	5.0	32.4	0.5292	0.88
		^{234}Th	235.0	89.0	138.0	4.08	1.703
		^{234}U	125.0	3.0	140.667	1.155	0.889
		^{238}U	130.0	3.0	145.0	1.732	0.897
	µg/filter	U	10.9	0.16	11.8	0.3	0.924
Vegetation	Bq/kg	^{241}Am	2.97	0.07	3.522	0.5898	0.843
		^{244}Cm	1.65	0.03	1.6707	0.5415	0.988
		^{60}Co	26.6	2.3	21.45	1.0	1.24
		^{137}Cs	572.0	11.0	467.0	20.0	1.225
		^{40}K	807.0	18.0	656.5	20.0	1.229
		^{239}Pu	4.53	0.15	5.2043	0.4278	0.87
		^{90}Sr	577.0	43.0	736.1	7.7	0.784
Water	Bq/L	^{241}Am	1.03	0.12	1.146	0.0505	0.899
		^{60}Co	59.0	2.0	51.1	3.0	1.155
		^{137}Cs	47.0	2.0	39.375	2.4047	1.194
		Gross Alpha	692.0	88.0	1090.0	20.0	0.635
		Gross Beta	754.0	150.0	1100.0	40.0	0.685
		^{3}H	126.0	3.0	121.08	6.78	1.041
		^{63}Ni	115.0	3.0	114.0	10.0	1.009
		^{238}Pu	0.8	0.06	0.7716	0.0366	1.037
		^{239}Pu	0.99	0.03	1.0093	0.0579	0.981
		^{90}Sr	3.71	0.09	4.104	0.0453	0.904
		^{234}U	0.26	0.04	0.2685	0.0155	0.968
		^{238}U	0.34	0.08	0.2619	0.0163	1.298
	µg/filter	U	0.0223	0.0001	0.0212	0.001	1.052

Table 9-5. EML Quality Assessment Program Results for Quanterra, Inc. (1999). (cont.)

Media	Units	Radionuclide	Quanterra		EML		Reported/EML Ratio
			Reported Value	Reported Error	EML Value	EML Error	
			September 1999				
Air	Bq/filter	^{241}Am	0.115	0.013	0.127	0.0099	0.906
		^{57}Co	8.1	0.54	7.73	0.033	1.048
		^{60}Co	6.7	0.36	6.35	0.41	1.055
		^{137}Cs	6.6	0.35	6.43	0.42	1.026
		Gross Alpha	3.29	0.33	2.77	0.26	1.188
		Gross Beta	3.02	0.24	2.66	0.26	1.135
		^{54}Mn	8.6	0.45	7.91	0.45	1.087
		^{238}Pu	0.096	0.012	0.0968	0.0065	0.992
		^{239}Pu	0.137	0.015	0.136	0.011	1.007
		^{106}Ru	5.9	0.76	5.5	1.76	1.073
		^{90}Sr	0.38	0.06	0.336	0.0141	1.131
		^{238}U	0.063	0.007	0.0646	0.0048	0.975
		^{234}U	0.068	0.008	0.0658	0.0034	1.033
	µg/filter	U	5.69	0.39	5.23	0.29	1.088
Soil	Bq/kg	^{228}Ac	160.0	10.0	124.0	4.8	1.290
		^{241}Am	2.13	0.23	1.44	0.19	1.479
		^{214}Bi	83.0	5.0	69.5	1.8	1.194
		^{137}Cs	250.0	13.0	204.0	5.0	1.225
		^{40}K	954.0	52.0	780.0	27.0	1.223
		^{212}Pb	166.0	9.0	127.0	4.8	1.307
		^{214}Pb	89.0	5.0	72.0	0.42	1.236
		^{239}Pu	2.47	0.3	3.2	0.5	0.772
		^{90}Sr	11.5	1.6	13.0	0.47	0.885
		^{234}Th	372.0	99.0	198.0	5.6	1.879
		^{234}U	151.0	12.0	190.0	5.2	0.795
		^{238}U	159.0	12.0	202.0	7.2	0.787
	µg/filter	U	15.7	1.7	16.3	0.3	0.963
Vegetation	Bq/kg	^{241}Am	2.85	0.24	2.88	0.22	0.990
		^{60}Co	18.3	2.3	17.6	1.0	1.040
		^{244}Cm	1.62	0.14	1.61	0.36	1.006
		^{137}Cs	494.0	25.0	440.0	20.0	1.123
		^{40}K	570.0	37.0	513.0	20.0	1.111
		^{239}Pu	4.65	0.39	4.3	0.46	1.081
		^{90}Sr	571.0	77.0	595.0	29.0	0.960
Water	Bq/L	^{241}Am	0.822	0.076	0.85	0.1	0.967
		^{60}Co	55.2	3.2	52.4	2.2	1.053
		^{137}Cs	79.5	4.3	76.0	3.4	1.046
		Gross Alpha	1440.0	147.0	1580.0	20.0	0.911
		Gross Beta	716.0	52.0	740.0	40.0	0.968
		^{3}H	76.3	2.77	80.7	3.7	0.945
		^{63}Ni	120.0	5.0	114.0	10.0	1.053
		^{238}Pu	0.787	0.074	0.79	0.08	0.996
		^{239}Pu	0.906	0.083	0.87	0.1	1.041
		^{90}Sr	1.56	0.25	1.72	0.1	0.907
		^{234}U	0.335	0.038	0.37	0.02	0.905
		^{238}U	0.395	0.043	0.36	0.02	1.097
	µg/filter	U	0.0335	0.004	0.03	0.01	1.117

Table 9-6. Comparison of Duplicate Air Monitoring Results (1999).

Environmental Surveillance, Education and Research Program Data

	Gross Alpha (10^{-15} µCi/mL)				Gross Beta (10^{-15} µCi/mL)			
	Atomic City		MVMS[a]		Atomic City		MVMS	
Month	Sampler	Duplicate	Sampler	Duplicate	Sampler	Duplicate	Sampler	Duplicate
January	1.0 ± 0.9[b]	1.0 ± 0.5	1.4 ± 1.3	0.9 ± 0.9	21 ± 21	15 ± 9	16 ± 16	18 ± 19
February	0.4 ± 0.1	1.3 ± 0.9	1.2 ± 0.6	0.5 ± 0.4	16 ± 12	16 ±13	14 ± 12	15 ± 15
March	1.1 ± 0.2	2.3 ± 0.9	2.3 ± 0.9	1.2 ± 0.5	20 ± 8	20 ± 7	18 ± 6	19 ± 8
April	0.9 ± 0.6	1.6 ± 0.4	2.1 ± 0.6	1.2 ± 1.1	18 ± 5	17 ± 5	17 ± 6	18 ± 7
May	1.1 ± 1.0	1.7 ± 1.5	1.2 ± 1.0	1.2 ± 1.3	17 ± 11	17 ± 9	15 ± 10	17 ± 11
June	1.3 ± 0.3	1.9 ± 1.0	1.8 ± 1.0	1.3 ± 0.3	20 ± 6	20 ± 5	20 ± 6	20 ± 4
July	2.5 ± 1.8	2.2 ± 2.0	2.1 ± 1.1	2.1 ± 1.0	26 ± 11	26 ± 6	24 ± 6	27 ± 6
August	2.0 ± 0.5	2.0 ± 0.7	2.3 ± 0.8	1.8 ± 0.7	24 ± 1	27 ± 4	26 ± 3	29 ± 6
September	1.8 ± 0.6	2.3 ± 0.5	2.3 ± 1.0	1.5 ± 1.3	27 ± 4	29 ± 4	28 ± 5	25 ±18
October	1.8 ± 1.1	2.7 ± 2.0	3.0 ± 1.7	1.7 ± 1.4	31 ± 17	34 ±19	34 ±17	31 ±15
November	1.3 ± 1.0	2.0 ± 1.5	2.2 ± 1.7	1.8 ± 0.8	26 ± 21	27 ±13	29 ±22	26 ±21
December	0.9 ± 0.7	1.2 ± 1.1	1.7 ± 0.8	1.1 ± 1.1	25 ±17	26 ±24	29 ±24	25 ± 19
Annual	**1.3 ± 0.3**	**1.9 ± 0.3**	**2.0 ± 0.3**	**1.4 ± 0.2**	**23 ± 3**	**23 ± 3**	**23 ± 4**	**23 ± 3**

INEEL M&O Contractor Data

	Gross Alpha (10^{-15} µCi/mL)				Gross Beta (10^{-15} µCi/mL)			
	CFA		TAN		CFA		TAN	
Month	Sampler	Duplicate	Sampler	Duplicate	Sampler	Duplicate	Sampler	Duplicate
January	-0.4 ± 2.5	-0.3 ± 0.9	0.4 ± 1.6	1.2 ± 4.0	20 ± 22	15 ± 42	21 ± 23	19 ± 44
February	-1.0 ± 10	0.8 ± 0.6	-0.6 ± 0.3	-0.3 ± 1.8	13 ± 70	15 ±13	13 ±10	17 ± 13
March	0.5 ± 1.1	1.3 ± 0.6	0.4 ± 0.6	0.6 ± 0.7	15 ± 7	16 ± 6	14 ± 7	17 ± 7
April	0.3 ± 1.5	0.8 ± 1.1	1.0 ± 0.7	0.8 ± 1.1	15 ± 9	17 ± 6	16 ± 6	18 ± 7
May	0.4 ± 0.6	0.1 ± 1.2	0.4 ± 0.8	0.5 ± 0.5	14 ± 11	16 ± 9	14 ± 9	16 ± 10
June	0.7 ± 1.1	0.9 ± 1.0	1.3 ± 0.4	0.8 ± 1.2	21 ± 4	18 ± 5	20 ± 5	19 ± 5
July	0.3 ± 0.6	1.5 ± 1.2	1.3 ± 1.0	1.0 ± 0.0	24 ± 8	21 ± 5	20 ± 4	26 ± 57
August	1.4 ± 1.5	1.2 ± 1.2	0.9 ± 0.6	0.6 ± 1.2	24 ± 5	24 ± 4	24 ± 4	26 ± 2
September	0.9 ± 1.2	1.2 ± 1.1	0.9 ± 1.1	-0.2 ± 1.4	29 ± 7	28 ± 4	28 ± 5	30 ± 7
October	0.3 ± 1.6	0.7 ± 1.1	0.7 ± 0.9	-0.3 ± 2.5	29 ± 6	33 ± 40	29 ± 14	33 ± 22
November	0.3 ± 2.2	1.3 ± 2.2	0.7 ± 5.0	1.7 ± 6.0	33 ± 41	32 ±27	30 ± 26	37 ±25
December	-0.1 ± 2.6	0.4 ± 0.8	-0.3 ± 2.4	0.9 ± 0.6	17 ± 7	18 ± 5	18 ± 12	22 ± 4
Annual	**0.3 ± 0.3**	**0.8 ± 0.3**	**0.6 ± 0.3**	**0.6 ± 0.3**	**21 ± 4**	**21 ± 4**	**21 ± 3**	**23 ± 4**

[a] MVMS = Mountain View Middle School.
[b] Monthly mean ± 95 percent confidence interval of the mean.

Table 9-7. Comparison of ESER, INEEL M&O, and State of Idaho Air Monitoring Results - Gross Alpha (1999).

	Gross Alpha (10^{-15} µCi/mL)								
Week	Craters of the Moon			EFS			Van Buren		
Ending	ESER	M&O	State	ESER	M&O	State	ESER	M&O	State
1/08	0.8 ± 0.4[a]	0.9 ± 0.8	0.6 ± 0.3	0.6 ± 0.4	0.7 ± 0.7	0.9 ± 0.3	1.5 ± 0.5	0.5 ± 0.8	0.6 ± 0.3
1/15	1.2 ± 0.5	0.5 ± 1.1	0.5 ± 0.2	0.9 ± 0.4	-0.3 ± 1.1	0.9 ± 0.3	2.3 ± 0.6	-0.5 ± 1.2	0.8 ± 0.3
1/22	0.4 ± 0.3	0.3 ± 1.3	-0.1 ± 0.2	0.9 ± 0.6	1.1 ± 1.3	0.0 ± 0.3	0.4 ± 0.3	2.1 ± 1.5	-0.2 ± 0.2
1/29	0.6 ± 0.3	-0.7 ± 1.1	0.1 ± 0.3	0.5 ± 0.5	1.3 ± 1.2	0.1 ± 0.3	0.3 ± 0.3	-0.2 ± 1.2	0.1 ± 0.3
2/05	0.4 ± 0.3	-1.5 ± 1.1	0.7 ± 0.3	0.4 ± 0.7	-0.3 ± 1.1	1.0 ± 0.3	1.0 ± 0.5	0.4 ± 1.5	0.6 ± 0.2
2/12	0.3 ± 0.3	-0.3 ± 1.5	0.1 ± 0.3	0.8 ± 0.6	1.7 ± 1.3	0.4 ± 0.2	0.8 ± 0.4	-0.5 ± 1.3	0.2 ± 0.2
2/19	0.1 ± 0.2	-1.4 ± 1.0	0.3 ± 0.2	0.2 ± 0.3	-1.4 ± 1.0	0.6 ± 0.3	0.8 ± 0.4	1.8 ± 1.4	0.4 ± 0.3
2/26	0.2 ± 0.2	-1.4 ± 1.1	0.1 ± 0.2	0.1 ± 0.3	0.9 ± 1.2	0.4 ± 0.2	0.2 ± 0.3	-0.7 ± 1.2	0.2 ± 0.2
3/05	1.2 ± 0.4	-0.2 ± 1.1	0.3 ± 0.2	0.8 ± 0.5	0.7 ± 1.2	0.4 ± 0.2	1.0 ± 0.5	1.1 ± 1.5	0.4 ± 0.2
3/12	0.5 ± 0.3	0.4 ± 1.2	0.3 ± 0.3	0.3 ± 0.3	2.4 ± 1.3	0.4 ± 0.3	0.8 ± 0.4	1.5 ± 1.4	0.2 ± 0.3
3/19	1.3 ± 0.5	0.0 ± 1.0	0.5 ± 0.4	1.3 ± 0.6	1.1 ± 1.1	1.0 ± 0.4	1.0 ± 0.5	1.2 ± 1.3	0.5 ± 0.4
3/26	1.7 ± 0.6	0.0 ± 1.2	1.0 ± 0.3	0.8 ± 0.5	0.4 ± 1.2	1.4 ± 0.4	1.6 ± 0.5	1.0 ± 1.3	1.0 ± 0.3
4/02	1.0 ± 0.4	3.5 ± 1.3	0.6 ± 0.3	1.2 ± 0.5	0.0 ± 1.1	1.2 ± 0.4	1.3 ± 0.5	0.6 ± 1.4	0.6 ± 0.3
4/09	0.7 ± 0.4	0.9 ± 1.3	0.7 ± 0.2	0.5 ± 0.6	0.0 ± 1.2	0.9 ± 0.3	0.8 ± 0.4	-0.7 ± 1.3	0.9 ± 0.3
4/16	0.9 ± 0.4	2.0 ± 1.2	0.7 ± 0.3	0.8 ± 0.5	1.4 ± 1.5	0.5 ± 0.2	0.7 ± 0.4	3.0 ± 1.5	0.8 ± 0.3
4/23	1.5 ± 0.8	0.4 ± 1.1	1.6 ± 0.4	1.9 ± 0.9	2.3 ± 0.9	1.1 ± 0.3	1.7 ± 0.9	2.8 ± 1.4	1.6 ± 0.4
4/30	1.5 ± 0.5	0.3 ± 1.2	0.8 ± 0.3	1.2 ± 0.5	NS[b]	0.7 ± 0.3	0.8 ± 0.4	0.5 ± 1.4	0.5 ± 0.2
5/07	-0.0 ± 0.2	-0.8 ± 1.0	0.4 ± 0.2	0.3 ± 0.4	-0.5 ± 0.7	0.4 ± 0.2	0.3 ± 0.3	1.3 ± 1.3	0.6 ± 0.2
5/14	0.9 ± 0.5	0.5 ± 1.1	0.9 ± 0.3	0.9 ± 0.5	1.4 ± 0.8	0.9 ± 0.3	1.0 ± 0.5	0.8 ± 1.3	0.8 ± 0.3
5/21	1.1 ± 0.7	0.0 ± 1.1	1.3 ± 0.3	1.2 ± 0.8	1.0 ± 0.8	1.1 ± 0.3	1.5 ± 0.8	1.0 ± 1.2	1.0 ± 0.3
5/28	1.1 ± 0.8	0.7 ± 1.0	0.8 ± 0.3	1.9 ± 1.0	0.0 ± 0.6	1.5 ± 0.4	2.1 ± 1.0	1.0 ± 1.1	1.2 ± 0.4
6/04	1.5 ± 0.8	2.5 ± 1.0	0.6 ± 0.3	2.0 ± 1.0	1.4 ± 0.7	0.5 ± 0.3	1.3 ± 0.8	1.6 ± 1.0	0.5 ± 0.3
6/11	0.9 ± 0.7	1.2 ± 0.9	0.4 ± 0.3	0.5 ± 0.8	0.6 ± 0.6	0.7 ± 0.3	1.3 ± 0.8	0.6 ± 1.0	0.8 ± 0.3
6/18	2.1 ± 0.8	2.5 ± 1.1	0.8 ± 0.3	0.9 ± 0.9	0.2 ± 0.7	0.6 ± 0.3	1.0 ± 0.8	0.9 ± 1.1	0.9 ± 0.3
6/25	1.2 ± 0.8	0.3 ± 0.9	0.5 ± 0.3	2.1 ± 1.0	0.8 ± 0.7	0.8 ± 0.3	2.0 ± 0.9	0.2 ± 1.1	1.2 ± 0.4
7/02	0.7 ± 0.4	2.4 ± 1.0	0.7 ± 0.3	1.2 ± 0.6	-0.4 ± 0.6	0.8 ± 0.3	1.4 ± 0.6	0.8 ± 1.0	1.1 ± 0.3
7/09	1.6 ± 0.9	2.0 ± 1.0	0.8 ± 0.3	1.6 ± 1.0	0.2 ± 0.6	0.7 ± 0.3	2.2 ± 1.1	2.8 ± 1.3	1.2 ± 0.3
7/16	3.0 ± 1.1	2.7 ± 1.1	1.7 ± 0.4	2.5 ± 1.3	3.5 ± 1.1	2.0 ± 0.5	3.3 ± 1.2	1.6 ± 1.0	1.9 ± 0.4
7/23	0.4 ± 1.2	1.8 ± 1.0	4.3 ± 0.7	1.4 ± 1.2	0.5 ± 0.7	5.4 ± 0.8	2.9 ± 1.6	4.3 ± 1.6	5.1 ± 0.7
7/30	0.8 ± 0.7	1.4 ± 1.1	4.7 ± 0.7	1.8 ± 0.9	1.0 ± 0.8	6.1 ± 0.7	1.7 ± 0.9	1.2 ± 1.2	5.6 ± 0.7
8/06	3.1 ± 1.2	-0.6 ± 0.8	2.1 ± 0.5	1.9 ± 1.2	1.8 ± 0.8	2.6 ± 0.5	2.0 ± 1.2	1.5 ± 1.2	2.6 ± 0.5
8/13	1.6 ± 0.7	0.5 ± 0.9	1.4 ± 0.4	2.4 ± 1.0	0.9 ± 0.7	1.9 ± 0.5	1.2 ± 0.9	1.7 ± 1.1	2.5 ± 0.6
8/20	1.1 ± 0.7	0.5 ± 0.9	NS	2.3 ± 1.0	0.0 ± 0.6	1.2 ± 0.4	1.7 ± 0.9	1.8 ± 1.2	1.4 ± 0.4
8/27	2.0 ± 0.7	2.9 ± 1.1	NS	2.4 ± 0.9	1.7 ± 0.8	2.0 ± 0.5	2.5 ± 0.9	0.8 ± 1.1	NS
9/03	0.8 ± 0.6	1.7 ± 1.0	1.5 ± 0.5	1.3 ± 0.9	2.4 ± 0.8	2.2 ± 0.5	1.8 ± 0.9	0.9 ± 1.1	NS
9/10	1.3 ± 0.7	0.0 ± 0.9	1.2 ± 0.5	1.4 ± 0.9	1.8 ± 0.8	1.2 ± 0.5	2.0 ± 0.9	-0.2 ± 1.0	NS
9/17	1.0 ± 0.6	-0.3 ± 0.8	0.9 ± 0.5	1.1 ± 0.8	0.2 ± 0.7	1.1 ± 0.5	2.3 ± 1.0	2.4 ± 1.3	NS
9/24	3.4 ± 1.1	1.2 ± 0.9	2.6 ± 0.5	2.4 ± 1.4	1.0 ± 0.8	2.7 ± 0.6	2.5 ± 1.5	1.5 ± 1.2	NS
10/1	1.5 ± 0.7	0.0 ± 1.1	1.4 ± 0.4	0.8 ± 0.8	0.9 ± 0.8	1.3 ± 0.4	1.9 ± 1.1	1.8 ± 1.7	1.1 ± 0.4
10/8	0.4 ± 0.8	1.1 ± 1.3	NS	1.9 ± 1.3	1.3 ± 1.0	5.9 ± 0.8	3.1 ± 1.5	1.0 ± 1.3	4.8 ± 0.7
10/15	0.4 ± 0.9	-1.1 ± 1.1	2.5 ± 0.5	1.1 ± 1.2	0.9 ± 0.9	2.7 ± 0.5	1.7 ± 1.6	0.0 ± 1.5	2.9 ± 0.6
10/22	1.7 ± 0.7	0.3 ± 1.2	1.3 ± 0.4	1.7 ± 0.9	1.6 ± 1.1	1.7 ± 0.4	2.6 ± 1.0	2.0 ± 1.3	1.8 ± 0.5
10/29	1.5 ± 0.6	0.6 ± 1.2	3.0 ± 0.6	3.3 ± 1.0	-0.7 ± 6.0	3.4 ± 0.6	3.4 ± 1.0	1.3 ± 1.5	2.6 ± 0.6
11/5	1.2 ± 0.7	-0.6 ± 1.0	0.8 ± 0.4	1.4 ± 0.7	-0.1 ± 0.8	0.7 ± 0.4	1.5 ± 0.9	-0.2 ± 1.1	NS
11/12	1.7 ± 0.6	1.4 ± 1.3	0.7 ± 0.5	1.6 ± 0.7	0.6 ± 0.9	0.6 ± 0.5	2.2 ± 0.9	-0.2 ± 1.3	0.9 ± 0.5
11/19	2.0 ± 0.7	1.2 ± 1.2	1.4 ± 0.4	3.0 ± 0.9	1.4 ± 0.9	1.4 ± 0.4	1.9 ± 1.0	3.0 ± 1.2	1.5 ± 0.4
11/26	0.2 ± 0.4	NS	0.4 ± 0.3	0.2 ± 0.6	NS	0.6 ± 0.4	0.8 ± 0.8	NS	0.7 ± 0.4
12/3	0.9 ± 0.5	3.6 ± 1.4	0.3 ± 0.4	0.8 ± 0.7	2.2 ± 1.5	0.4 ± 0.4	0.8 ± 0.8	1.4 ± 1.3	0.5 ± 0.4
12/10	0.7 ± 0.4	-0.3 ± 1.1	NS	1.0 ± 0.6	0.4 ± 0.8	1.1 ± 0.4	0.7 ± 0.7	2.3 ± 1.4	1.0 ± 0.4
12/17	0.1 ± 0.3	1.6 ± 1.2	0.6 ± 0.3	0.2 ± 0.5	0.3 ± 0.7	0.6 ± 0.3	0.5 ± 0.6	1.1 ± 1.1	0.9 ± 0.4
12/24	1.1 ± 0.6	0.4 ± 1.2	-0.2 ± 0.4	0.8 ± 0.7	0.0 ± 0.8	0.2 ± 0.4	1.1 ± 0.9	3.3 ± 1.4	1.5 ± 0.4
12/31	1.1 ± 0.5	NS	1.1 ± 0.4	1.4 ± 0.6	NS	1.9 ± 0.4	1.5 ± 0.7	NS	0.4 ± 0.3

[a] Analytical results ± 2s, where s represents the total uncertainty.

[b] NS means no sample collected or sample was invalid due to low volume.

Table 9-8. Comparison of ESER, INEEL M&O, and State of Idaho Air Monitoring Results – Gross Beta (1999).

Gross Beta (10^{-15} µCi/mL)									
Week Ending	Craters of the Moon			EFS			Van Buren		
	ESER	M&O	State	ESER	M&O	State	ESER	M&O	State
1/08	22 ± 2[a]	15 ± 1	39 ± 2	27 ± 2	27 ± 2	66 ± 2	22 ± 2	28 ± 2	52 ± 2
1/15	25 ± 2	25 ± 2	23 ± 1	23 ± 2	35 ± 2	60 ± 2	39 ± 2	34 ± 3	40 ± 2
1/22	8 ± 1	35 ± 2	4 ± 1	12 ± 2	10 ± 2	13 ± 1	9 ± 1	5 ± 2	8 ± 1
1/29	9 ± 1	9 ± 2	18 ± 1	16 ± 2	11 ± 2	24 ± 1	11 ± 1	9 ± 2	21 ± 1
2/05	19 ± 1	20 ± 2	29 ± 2	34 ± 3	25 ± 2	47 ± 2	28 ± 2	27 ± 3	29 ± 2
2/12	8 ± 1	10 ± 2	13 ± 1	15 ± 2	15 ± 2	13 ± 1	10 ± 1	11 ± 2	13 ± 1
2/19	13 ± 1	12 ± 2	22 ± 1	19 ± 2	19 ± 2	26 ± 1	18 ± 2	14 ± 2	25 ± 1
2/26	7 ± 1	3 ± 2	11 ± 1	8 ± 1	9 ± 2	13 ± 1	8 ± 1	<1 ± 2	12 ± 1
3/05	15 ± 1	9 ± 2	10 ± 1	15 ± 1	13 ± 2	12 ± 1	14 ± 1	11 ± 3	11 ± 1
3/12	13 ± 1	12 ± 2	14 ± 1	14 ± 1	11 ± 2	20 ± 1	14 ± 1	8 ± 2	17 ± 1
3/19	28 ± 2	20 ± 2	36 ± 2	28 ± 2	24 ± 2	46 ± 2	28 ± 2	31 ± 3	34 ± 2
3/26	21 ± 2	16 ± 2	30 ± 2	26 ± 2	21 ± 2	36 ± 2	25 ± 2	16 ± 2	33 ± 2
4/02	20 ± 1	16 ± 2	18 ± 1	23 ± 2	18 ± 2	16 ± 1	21 ± 2	18 ± 3	18 ± 1
4/09	18 ± 1	18 ± 2	21 ± 1	10 ± 1	16 ± 2	24 ± 1	15 ± 1	13 ± 3	22 ± 1
4/16	18 ± 1	16 ± 2	22 ± 1	20 ± 2	16 ± 3	21 ± 1	18 ± 2	14 ± 2	22 ± 1
4/23	21 ± 2	21 ± 2	30 ± 2	25 ± 2	16 ± 2	34 ± 2	25 ± 2	23 ± 3	32 ± 2
4/30	20 ± 1	18 ± 2	20 ± 1	19 ± 2	NS[b]	22 ± 1	19 ± 2	22 ± 3	20 ± 1
5/07	7 ± 1	7 ± 2	9 ± 1	8 ± 1	7 ± 1	13 ± 1	9 ± 1	5 ± 2	11 ± 1
5/14	19 ± 2	19 ± 2	22 ± 1	22 ± 2	16 ± 2	26 ± 2	19 ± 2	22 ± 3	22 ± 1
5/21	14 ± 1	19 ± 2	23 ± 1	14 ± 2	14 ± 1	28 ± 2	16 ± 2	16 ± 2	24 ± 2
5/28	24 ± 2	26 ± 2	38 ± 2	26 ± 2	26 ± 2	42 ± 2	26 ± 2	32 ± 3	38 ± 2
6/04	22 ± 2	23 ± 2	14 ± 1	22 ± 2	19 ± 2	13 ± 1	23 ± 2	18 ± 2	11 ± 1
6/11	16 ± 2	11± 2	21 ± 1	17 ± 2	17 ± 2	28 ± 2	16 ± 2	18 ± 2	22 ± 1
6/18	21 ± 2	20 ± 2	34 ± 2	20 ± 2	22 ± 2	40 ± 2	23 ± 2	20 ± 3	35 ± 2
6/25	25 ± 2	24 ± 2	32 ± 2	24 ± 2	26 ± 2	35 ± 2	28 ± 2	29 ± 3	31 ± 2
7/02	20 ± 2	18 ± 2	21 ± 1	22 ± 2	19 ± 2	25 ± 2	22 ± 2	18 ± 2	23 ± 2
7/09	18 ± 2	22 ± 2	25 ± 2	22 ± 2	20 ± 2	31 ± 2	19 ± 2	26 ± 3	28 ± 2
7/16	30 ± 2	28 ± 2	42 ± 2	33 ± 3	37 ± 3	48 ± 2	31 ± 3	22 ± 2	46 ± 2
7/23	24 ± 3	24 ± 2	26 ± 2	27 ± 2	24 ± 2	36 ± 2	29 ± 3	28 ± 3	26 ± 2
7/30	24 ± 2	23 ± 2	23 ± 2	29 ± 3	27 ± 2	29 ± 2	27 ± 3	31 ± 3	28 ± 2
8/06	33 ± 3	26 ± 2	32 ± 2	25 ± 3	28 ± 2	49 ± 2	33 ± 3	33 ± 3	38 ± 2
8/13	26 ± 2	27 ± 2	28 ± 2	26 ± 2	27 ± 2	35 ± 2	27 ± 3	27 ± 3	35 ± 2
8/20	24 ± 2	25 ± 2	NS	28 ± 2	24 ± 2	39 ± 2	26 ± 3	27 ± 3	34 ± 2
8/27	25 ± 2	29 ± 3	NS	29 ± 3	28 ± 2	39 ± 2	31 ± 3	37 ± 3	NS
9/03	25 ± 2	27 ± 2	34 ± 2	28 ± 2	29 ± 2	43 ± 2	28 ± 2	29 ± 3	NS
9/10	26 ± 2	27 ± 3	40 ± 2	30 ± 2	25 ± 2	42 ± 2	30 ± 3	32 ± 3	NS
9/17	23 ± 2	30 ± 2	36 ± 2	29 ± 2	26 ± 2	40 ± 2	28 ± 2	33 ± 3	NS
9/24	34 ± 2	35 ± 3	57 ± 2	35 ± 3	38 ± 2	59 ± 2	32 ± 3	35 ± 3	NS
10/1	25 ± 2	27 ± 3	38 ± 2	28 ± 2	32 ± 2	40 ± 2	29 ± 3	38 ± 4	22 ± 2
10/8	28 ± 2	25 ± 3	NS	31 ± 3	31 ± 2	50 ± 2	31 ± 3	25 ± 3	43 ± 2
10/15	20 ± 2	27 ± 3	34 ± 2	27 ± 2	26 ± 2	37 ± 2	30 ± 3	31 ± 3	36 ± 2
10/22	27 ± 2	23 ± 3	45 ± 2	30 ± 2	26 ± 2	47 ± 2	25 ± 2	15 ± 2	43 ± 2
10/29	37 ± 2	40 ± 3	65 ± 2	56 ± 3	73 ± 12	81 ± 3	52 ± 3	55 ± 4	66 ± 2
11/5	18 ± 2	18 ± 2	31 ± 2	23 ± 2	16 ± 2	35 ± 2	22 ± 2	17 ± 2	NS
11/12	22 ± 2	27 ± 3	37 ± 2	30 ± 2	32 ± 2	45 ± 2	32 ± 2	35 ± 3	38 ± 2
11/19	34 ± 2	38 ± 3	53 ± 2	46 ± 3	48 ± 2	54 ± 2	47 ± 3	39 ± 3	55 ± 2
11/26	9 ± 1	NS	14 ± 1	14 ± 2	NS	18 ± 1	14 ± 2	NS	19 ± 1
12/3	20 ± 1	14 ± 2	25 ± 1	24 ± 2	40 ± 3	24 ± 1	21 ± 2	26 ± 3	27 ± 1
12/10	14 ± 1	16 ± 2	NS	25 ± 2	24 ± 2	31 ± 2	16 ± 2	20 ± 3	33 ± 2
12/17	14 ± 1	16 ± 2	20 ± 1	24 ± 2	17 ± 2	28 ± 2	20 ± 2	24 ± 3	33 ± 2
12/24	11 ± 1	13 ± 2	11 ± 1	18 ± 2	16 ± 2	20 ± 1	19 ± 2	15 ± 2	21± 1
12/31	33 ± 2	NS	45 ± 2	63 ± 3	NS	80 ± 3	48 ± 3	NS	60 ± 2

[a] Analytical results ± 2s, where s represents the total uncertainty.

[b] NS means no sample collected or sample was invalid due to low volume.

Table 9-9. Comparison of ESER and State of Idaho Water Monitoring Results (1999).

		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	05/99	0 ± 1	1 ± 1	4 ± 2	3 ± 1	-27 ± 92	20 ± 100
(Drinking Water)	11/99	0 ± 1	1 ± 2	2 ± 2	2 ± 1	34 ± 81	-60 ± 50
Shoshone	05/99	1 ± 1	3 ± 1	9 ± 2	2 ± 1	57 ± 94	185 ± 100
(Drinking Water)	11/99	0 ± 1	0 ± 2	2 ± 2	1 ± 1	81 ± 82	10 ± 80
Bill Jones	05/99	0 ± 1	2 ± 1	1 ± 2	3 ± 1	68 ± 94	50 ± 90
Hatchery	11/99	0 ± 1	1 ± 3	3 ± 2	3 ± 1	-36 ± 80	-15 ± 80
(Surface Water)							
Clear	05/99	0 ± 1	0 ± 1	4 ± 2	2 ± 1	69 ± 94	-20 ± 100
Springs	11/99	0 ± 1	1 ± 2	3 ± 2	3 ± 1	49 ± 81	-30 ± 80
(Surface Water)							
Alpheus	05/99	0 ± 1	0 ± 2	5 ± 2	7 ± 1	342 ± 98	170 ± 100
Spring	11/99	0 ± 1	1 ± 3	8 ± 2	4 ± 1	-22 ± 80	-30 ± 80
(Surface Water)							

Result ± 2s, where s is the total uncertainty.

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APPENDIX A
ENVIRONMENTAL STANDARDS AND REGULATIONS

The following environmental standards and regulations are applicable, in whole or in part, on the INEEL or at the INEEL boundary.

U.S. Environmental Protection Agency, "National Primary and Secondary Ambient Air Quality Standards," 40 CFR 50, 1999.

U.S. Environmental Protection Agency, "National Emission Standards for Hazardous Air Pollutants," 40 CFR 61, 1999.

U.S. Environmental Protection Agency, "National Pollutant Discharge Elimination System," 40 CFR 122, 1999.

U.S. Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," 40 CFR 141, 1999.

U.S. Environmental Protection Agency, "Hazardous Waste Management System: General," 40 CFR 260, 1999.

U.S. Environmental Protection Agency, "Identifying and Listing of Hazardous Wastes," 40 CFR 261, 1999.

U.S. Environmental Protection Agency, "Standards Applicable to Generators of Hazardous Waste," 40 CFR 262, 1999.

U.S. Environmental Protection Agency, "Standards Applicable to Transporters of Hazardous Waste," 40 CFR 263, 1999.

U.S. Environmental Protection Agency, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," 40 CFR 264, 1999.

U.S. Environmental Protection Agency, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," 40 CFR 265, 1999.

U.S. Environmental Protection Agency, "Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities," 40 CFR 267, 1999.

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 (DCG's) are based on the 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 DCG's 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, entitled "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 (DCG's) 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	S	3-hour average	1300
	P	24-hour average	365
	P	Annual average	80
NO_2	S&P	Annual average	100
	S	24-hour average	150
Total Particulates[c]	S&P	Annual average	50

[a] National primary (P) ambient air quality standards define levels of air quality to protect the public health. Secondary (S) 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 Non-transient Non-community Drinking Water Systems.

Gross alpha	1.5×10^{-8} µCi/mL
Gross beta	5.0×10^{-8} µCi/mL
Manmade radionuclides	Concentrations resulting in 4 mrem total body or organ dose equivalent
Nitrate (as N)	10 mg/L
Fluoride	4 mg/L
Trihalomethanes (Chloroform)	0.1 mg/L
Carbon Tetrachloride	0.005 mg/L
Tetrachloroethylene	0.005 mg/L
Toluene	1.0 mg/L
1,1,1-trichloroethane	0.2 mg/L
Trichloroethylene	0.005 mg/L
Arsenic	0.05 mg/L
Barium	2 mg/L
Cadmium	0.005 mg/L
Chromium	0.1 mg/L
Lead	0.05 mg/L
Mercury	0.002 mg/L
Selenium	0.05 mg/L
Silver	0.05 mg/L

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 INEEL operations, meteorological data, and worldwide events that might conceivably have an effect 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% 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, and 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%

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% 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% 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% 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% 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% ($\alpha = 0.05$).

APPENDIX C
USGS 1999 INEEL PUBLICATION ABSTRACTS

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-1]

The USGS and the Idaho Department of Water Resources, in cooperation with the DOE, sampled 18 sites as part of the fourth round of a long-term project to monitor water quality of the SRPA Aquifer 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 two domestic wells, twelve irrigation wells, two stock wells, one spring, and one public supply well. Two quality-assurance samples were also 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.

Geologic Controls of Hydraulic Conductivity in the Snake River Plain Aquifer at and near the Idaho National Engineering and Environmental Laboratory, Idaho [Reference C-2]

The effective hydraulic conductivity of basalt and interbedded sediment that compose the SRPA at and near the INEEL ranges from about 1.0×10^{-2} to 3.2×10^{4} feet per day (ft/d). This six-order-of-magnitude range of hydraulic conductivity was estimated from single-well Aquifer tests in 114 wells, and is attributed mainly to the physical characteristics and distribution of basalt flows and dikes. Hydraulic conductivity is least in flows and deposits cut by dikes. Estimates of hydraulic conductivity at and near the INEEL are similar to those measured in similar volcanic settings in Hawaii.

The largest variety of rock types and the greatest range of hydraulic conductivity are in volcanic rift zones, which are characterized by numerous aligned volcanic vents and fissures related to underlying dikes. Volcanic features related to individual dike systems within these rift zones are approximated in the subsurface by narrow zones referred to as vent corridors. Vent corridors at and near the INEEL are generally perpendicular to groundwater flow and average about 1 to 2 miles in width and 5 to 15 miles in length. Forty-five vent corridors are inferred to be beneath the INEEL and adjacent areas. Vent corridors are characterized locally by anoxic water and altered basalt. In many of the vent corridors, water from the uppermost 200 feet of the Aquifer is 1 to 7 degrees Celsius warmer than the median temperature of water (13 degrees Celsius) throughout the Aquifer.

Three broad categories of hydraulic conductivity corresponding to six general types of geologic controls can be inferred from the distribution of wells and vent corridors. Hydraulic conductivity of category 1 includes 73 estimates, ranges from 1.0×10^{2} to 3.2×10^{4} ft/d, and corresponds to (1) the contacts, rubble zones, and cooling fractures of thin, tube-fed pahoehoe flows; and (2) the numerous voids present in shelly pahoehoe and slab pahoehoe flows; and bedded scoria, spatter, and ash near volcanic vents. Hydraulic conductivity of category 2 includes 28 estimates, ranges from 1.0×10^{0} to 1.0×10^{2} ft/d, and corresponds to (1) relatively thick, tube-fed pahoehoe flows that may be ponded in topographic depressions; and (2) thin, tube-fed pahoehoe flows cut by discontinuous

dikes. Hydraulic conductivity of category 3 includes 13 estimates, ranges from 1.0×10^{-2} to 1.0×10^{0} ft/d, and corresponds to (1) localized dike swarms; and (2) thick, tube-fed pahoehoe flows cut by discontinuous dikes. Some overlap between these categories and controls is likely because of the small number of hydraulic conductivity estimates and the complex geologic environment.

Hydraulic conductivity of basalt flows probably is increased by localized fissures and coarse mixtures of interbedded sediment, scoria, and basalt rubble. Hydraulic conductivity of basalt flows is decreased locally by abundant alteration minerals of probable hydrothermal origin. Hydraulic conductivity varies as much as six orders of magnitude in a single vent corridor and varies from three to five orders of magnitude within distances of 500 to 1000 feet. Abrupt changes in hydraulic conductivity over short distances suggest the presence of preferential pathways and local barriers that may greatly affect the movement of groundwater and the dispersion of radioactive and chemical wastes downgradient from points of waste disposal.

The Use of Chemical and Physical Properties for Characterization of Strontium Distribution Coefficients at the Idaho National Engineering and Environmental Laboratory, Idaho [Reference C-3]

The USGS and Idaho State University, in cooperation with the DOE, conducted a study to determine strontium distribution coefficients (K_ds) of surficial sediments at the INEEL. Batch experimental techniques were used to determine experimental K_ds of 20 surficial sediment samples from the INEEL. The K_ds describe the distribution of a solute between a solution and solid phase. K_ds of the 20 surficial-sediment samples ranged from 36 to 275 milliliters per gram. Many chemical and physical properties of both the synthesized aqueous solution and sediments used in the experiments were also determined. The following solution properties were determined: initial and equilibrium concentrations of calcium, magnesium, and strontium; pH and specific conductance; and initial concentrations of potassium and sodium. Sediment properties determined were grain-size distribution, mineralogy, whole-rock major oxide, strontium and barium concentrations, and Brunauer-Emmett-Teller surface area. Multivariate regression techniques were used to identify which of these variables or set of variables could best predict the strontium K_d values. Partial least squares regression was used to fit these data to an empirical model that could be used to predict strontium K_ds of surficial sediments at the INEEL. The best-fit model was obtained using a four-variable data set consisting of surface area, manganese oxide concentration, specific conductance, and pH. Application of the model to an independent split of the data resulted in an average relative error of prediction of 20 percent and a correlation coefficient of 0.921 between predicted and observed strontium K_ds. Chemical and physical characteristics of the solution and sediment that could successfully predict the K_d values were identified. Predication variable selection was limited to variables which are either easily determined or have available tabulated characteristics. The selection criterion could circumvent the need for time- and labor-intensive laboratory experiments and provide a faster alternate method for estimating strontium K_ds.

Strontium Distribution Coefficients of Basalt and Sediment Infill Samples from the Idaho National Engineering and Environmental Laboratory, Idaho [Reference C-4]

The USGS and Idaho State University, in cooperation with the DOE, are conducting a study to determine and evaluate strontium distribution coefficients (K_ds) of subsurface materials at the INEEL. The purpose of this study is to aid in assessing the variability of strontium K_ds at the INEEL as part of an ongoing investigation of chemical transport of strontium-90 in the SRPA. Batch experimental techniques were used to determine K_ds of six basalt core samples, five

samples of sediment infill of vesicles and fractures, and six standard material samples. The basalt and sediment infill samples were collected from a selected site at the INEEL. Batch experimental techniques used to determine strontium K_ds of the sediment infill samples ranged from 201.6 ± 10.8 to 356.2 ± 8.4 milliliters per gram (mL/g). Calculated strontium K_ds of the basalt samples ranged from 1.3 ± 8.4 to 9.3 ± 9.8 mL/g. The differences in strontium K_ds arise from the variations in chemical composition and preparation of samples. The sorption process that occurs, physisorption or ion exchange, depends largely on the type of the sample material. Analyses of data from these experiments indicate that the K_ds of the sediment infill samples are significantly larger than those of the basalt samples. Quantification of such information is essential for furthering the understanding of transport processes of strontium-90 in the SRPA and in similar environments.

Chemical Constituents in Groundwater from 39 Selected Sites with an Evaluation of Associated Quality Assurance Data, Idaho National Engineering And Environmental Laboratory and Vicinity, Idaho [Reference C-5]

Groundwater quality data, collected during 1990-1994 from 39 locations in the eastern Snake River Plain, are presented as part of the USGS continuing hydrogeologic investigation at the INEEL. The minimum and maximum concentrations for dissolved cations, anions, and silica were: calcium, 5.4 and 88 mg/L (milligrams per liter); magnesium, 0.82 and 23 mg/L; sodium, 5.4 and 47 mg/L; potassium, 1.0 and 15 mg/L; silica, 2.0 and 200 mg/L; bicarbonate, 41 and 337 mg/L; and fluoride, <0.1 and 4.8 mg/L.

Purgeable organic compounds and extractable acid and base/neutral organic compounds were detected in water from 10 and 15 sites, respectively. Concentrations of dissolved organic carbon ranged from 0.1 to 1.2 mg/L.

Concentrations of gross alpha-particle radioactivity as thorium-230 ranged from less than the reporting level to 14.4 ± 1.2 pCi/L, and concentrations of gross beta-particle radioactivity as cesium-137 ranged from 1.5 ± 0.38 to 106 ± 6.2 pCi/L. Concentrations of selected transuranics were less than the reporting level. Concentrations of radon-222 ranged from 48 ± 14 to 694 ± 14 pCi/L. Tritium concentrations in 38 samples analyzed by the DOE's Radiological and Environmental Sciences Laboratory ranged from less than the reporting level to 40,900 ± 900 pCi/L.

Relative isotopic ratios ranged from -141 to -120 per mil for δ^2H, -18.55 to -14.95 per mil for δ^{18}O, -13.5 to -7.5 per mil for δ^{13}C, 3.36 to 16.0 per mil for δ^{34}S, and 3.7 to 9.5 per mil for δ^{15}N.

Of 600 quality assurance sample pairs, 592, or 99 percent, were statistically equivalent. Equivalence of two sample pairs was statistically indeterminate.

Chlorine-36 in Water, Snow, and Mid-Latitude Glacial Ice of North America: Meteoric and Weapons-Tests Production in the Vicinity of the Idaho National Engineering and Environmental Laboratory, Idaho [Reference C-6]

Measurements of chlorine-36 (^{36}Cl) were made for 64 water, snow, and glacial-ice and -runoff samples to determine the meteoric and weapons-tests-produced concentrations and fluxes of this radionuclide at mid-latitudes in North America. The results will facilitate the use of ^{36}Cl as a hydrogeologic tracer at the INEEL. This information was used to estimate meteoric and weapons-tests contributions of these nuclides to environmental inventories at and near the INEEL. Eighteen surface-water samples from six sites were selected from the USGS archive-sample library at the INEEL for ^{36}Cl analyses. These 18 samples had been collected during 1969-1994. ^{36}Cl concentrations ranged from 0.2 ± 0.02 x 10^8 to 2.2 ± 0.05 x 10^8 atoms/liter (atoms/L). In 1994-1995, an additional 14 surface-water and 2 spring samples from the eastern Snake River Plain were collected and analyzed for ^{36}Cl. ^{36}Cl concentrations ranged

from 0.014 ± 0.001 x 10^8 to 6.2 ± 0.7 x 10^8 atoms/L, a range similar to the range of concentrations in the 18 archived samples. For comparison, ^{36}Cl concentrations in water from two monitoring wells at the INEEL were as large as 0.06 ± 0.003 x 10^8 atoms/L for a well (Site 14) not affected by site waste disposal and 19,000 ± 914 x 10^8 atoms/L for a well (USGS well 77) about 500 meters (m) hydraulically downgradient from the INTEC.

Four snow samples were collected in 1991 at and near the INEEL to aid in establishing meteoric concentrations. The detectable ^{36}Cl concentrations in the snow samples ranged nearly four orders of magnitude, from 6.3 ± 0.9 x 10^6 atoms/L at Harriman State Park, 150 kilometers (km) north-east of the INEEL, to 1.7 ± 0.3 x 10^{10} atoms/L near the INTEC. The estimated ^{36}Cl flux for a sample collected in Harriman State Park was 1.2 ± 0.2 x 10^{-2} atoms/square centimeter/second (atoms/cm^2 sec). The estimated ^{36}Cl flux for a sample collected in Copper Basin, 75 km west of the INEEL, was 3 ± 2 x 10^{-3} atoms/cm^2 sec. For comparison, 2 snow samples were collected at the INEEL downwind from the INTEC during nuclear-waste calcining operations. The estimated ^{36}Cl flux for the sample collected 11 km southwest of the effluent stack at INTEC was 1.0 ± 0.03 atoms/cm^2 sec and for the sample 1.5 km downwind, the flux was 12.0 ± 2.4 atoms/cm^2 sec.

A 160-m ice core was collected in 1991 from the Upper Fremont Glacier in the Wind River Range of Wyoming in the western United States. In 1994-1995, ice from this core was processed at the National Ice Core Laboratory in Denver, Colorado, and analyzed for ^{36}Cl. A tritium weapons-test peak identified in the ice core was used as a marker to estimate the depth of weapons-tests produced ^{36}Cl. Tritium concentrations ranged from 0 tritium units for older ice to more than 360 tritium units at 29 m below the surface of the glacier, a depth that includes ice that was deposited as snow during nuclear-weapons tests through the early 1960s. Maximum ^{36}Cl production during nuclear-weapons tests was in the late 1950s, therefore, analyses were performed on ice samples from depths of 29.8 to 35.3 m. The peak ^{36}Cl concentration in these samples was 7.7 ± 0.2 x 10^7 atoms/L at a depth of about 32 m. Estimated flux for ^{36}Cl in ice deposited as snow in the 1950s ranged from 9.0 ± 0.2 x 10^{-2} atoms/cm^2 sec for an ice sample from 34.2 to 34.8 m to 2.9 ± 0.1 x 10^{-1} atoms/cm^2 sec for an ice sample from 31.5 to 32.0 m. A mean global natural-production flux for ^{36}Cl of 1.1 x 10^{-3} atoms/cm^2 sec has been reported. The peak ^{36}Cl flux calculated in the present study was two orders of magnitude larger than the mean global natural-production flux and was similar to the weapons-tests flux of 5 x 10^{-1} atoms/cm^2 sec reported for the Dye 3 ice core from Greenland which was deposited during the same period of time as the Upper Fremont Glacier ice.

Ice samples from depths of 19.6 to 25.0 m, 39.6 to 46.4 m, and 104.7 to 106.3 m were selected to represent pre- and post-weapons sections of glacial ice and runoff were less than 2 x 10^7 atoms/L. The estimated fluxes from these cores ranged from 4.5 ± 0.7 x 10^{-3} atoms/cm^2 sec to 6.3 ± 0.3 x 10^{-2} atoms/cm^2 sec. For comparison, a glacial-runoff sample collected in 1995 at Galena Creek Rock Glacier, 180 km north of the Upper Fremont Glacier, had an estimated concentration of 3.2 ± 0.5 x 10^6 atoms/L and an estimated flux of 1.6 ± 0.2 x 10^{-2} atoms/cm^2 sec.

The data presented in this report suggest a meteoric source of ^{36}Cl for environmental samples collected in southeastern Idaho and western Wyoming if the concentration is less than 1 x 10^7 atoms/L. Additionally, concentrations in water, snow, or glacial ice between 1 x 10^7 and 1 x 10^8 atoms/L may be indicative of a weapons-tests component from peak ^{36}Cl production in the late 1950s. Chlorine-36 concentrations between 1 x 10^8 and 1 x 10^9 atoms/L may be representative of re-suspension of weapons-tests fallout, airborne disposal of ^{36}Cl from the INTEC, or evapotranspiration.

It was concluded from the water, snow, and glacial data presented here that concentrations of ^{36}Cl measured in

environmental samples at the INEEL larger than 1 x 10^9 atoms/L can be attributed to waste-disposal practices.

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-7]

The USGS, in response to a request from the 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 SRPA in the vicinity of the NRF. Water samples were analyzed for naturally occurring constituents and man-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 samples 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.

A Transient Numerical Simulation of Perched Groundwater Flow at the Test Reactor Area, Idaho National Engineering and Environmental Laboratory, Idaho, 1952-94 [Reference C-8]

Perched groundwater zones have formed in the upper 200 feet of surficial alluvium, basalt, and sedimentary interbeds beneath wastewater infiltration ponds at the 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 primarily as 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 intergranular 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 mile by 0.5 mile for an area of about 14 million square feet. 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 feet of the unsaturated zone beneath the Test Reactor Area (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, 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 feet per day were uniformly assigned to cells in layers 2 and 3, respectively. Calibrated values of hydraulic conductivity of 0.0028 feet per day 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 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 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 stream flow exceeding 20,000 acre-ft per month. Because short-term stream flow infiltration fluctuations were not well approximated, simulated recharge peaks did not occur in cells representing wells known to be affected by stream flow 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 stream flow.