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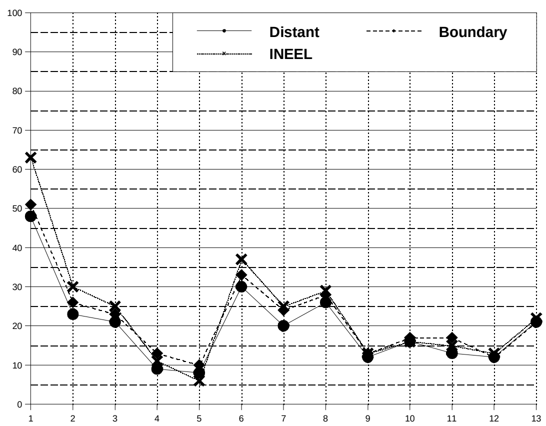

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Program Description

The Environmental Science and Research Foundation conducts the Idaho National Engineering and Environmental Laboratory (INEEL) Offsite Environmental Surveillance Program. The Foundation's environmental surveillance program monitors the effects, if any, of Department of Energy (DOE) activities on the offsite environment, collects data to confirm compliance with applicable environmental laws and regulations, and observes any trends in environmental levels of radioactivity.

The Foundation collected filters weekly from low-volume air samplers at 12 offsite locations. Five were at distant locations and seven at INEEL boundary locations. An additional three samplers were operated on the INEEL. Weekly measurements were made of gross alpha and gross beta concentrations in airborne particulates. Charcoal cartridges were screened weekly for the presence of Iodine-131. At the end of the quarter, weekly filters from each location were combined to form a composite sample for each location. These composites were then analyzed for gamma-emitting radionuclides. Selected composites were also submitted for Strontium-90 and transuranic analyses (Plutonium-238, Plutonium-239/240, and Americium-241).

Atmospheric moisture and precipitation samples were collected to monitor for tritium. Atmospheric moisture samples were collected for a period of approximately eight weeks. The Foundation collected two precipitation samples monthly, one onsite and one offsite, as well as a weekly onsite sample.

Drinking water samples were collected from 13 offsite locations and surface water samples were obtained from five sites. All water samples were analyzed for gross alpha, gross beta, and tritium concentrations.

The Foundation collected a weekly milk sample from a dairy in Idaho Falls and collected monthly milk samples from eight additional dairies around the INEEL. All milk samples were analyzed for Iodine-131. Selected samples were also analyzed for either tritium or Strontium-90.

Annual sheep samples from flocks grazing on the INEEL and in an area distant from the INEEL were collected and analyzed for gamma-emitting radionuclides. Two road-killed game animals were also sampled and analyzed for gamma-emitting radionuclides.

The Foundation collected 14 offsite TLDs (environmental radiation dosimeters) to determine environmental radiation levels around the INEEL.

Executive Summary of Second Quarter 1997 Results

During the second quarter of 1997, the Foundation's offsite monitoring program conducted analyses on 494 air samples, 20 water samples, 38 milk samples, 6 game samples, 12 sheep samples, and 14 environmental radiation samples. All concentrations of radioactivity found in these samples were consistent with historical levels. No evidence of radionuclides from the INEEL was found in offsite samples. Concentrations of radionuclides found in all samples were below the guidelines set by both the Department of Energy and the Environmental Protection Agency (EPA) for radiation protection of the public.

Technical Summary

During the second quarter of 1997, gross alpha and gross beta concentrations in low-volume air samples were within the expected range of values for background radioactivity. Mean concentrations of gross alpha were similar at onsite, boundary, and distant locations. Mean concentrations of gross beta were greater for onsite locations than boundary and distant locations. Boundary concentrations were similar to those at distant locations. Iodine-131 was not found in any air sample. Cesium-137 was detected in the composite sample from Monteview. However, Cesium-137 was not detected in the composite from the replicate sampler located in Monteview. One composite sample had a detectable concentration of ^{241}Am, well within the ranges observed in recent years. Strontium-90 was detected in all six of the composite samples analyzed for that radionuclide. All soil is known to have Strontium-90 in the top few centimeters due to world-wide fallout. Although the concentrations were not higher than has been observed in a few samples from recent years, the fact that all six of them had detectable concentrations was cause for concern. These detections were attributed to major dust storms occurring during the second quarter, suspending soil made vulnerable to wind erosion by several range fires during 1995 and 1996.

Tritium was detected in two of eight atmospheric moisture samples; one from a boundary station and one from a distant station. The tritium detected at the boundary station may be from INEEL operations, although it was within the range consistent with concentrations attributed to natural atmospheric processes and historic nuclear weapons tests.

Tritium was not found in any of the six precipitation samples.

Tritium was detected in one of 18 offsite water samples. None of the samples contained detectable levels of gross alpha. Almost all of the samples contained concentrations of gross beta, consistent with levels previously measured. Gross beta radioactivity in these water samples was, and historically has been, attributed to naturally-occurring radionuclides in the earth's crust.

None of the 38 milk samples collected during the second quarter contained detectable concentrations of Iodine-131. None of four samples had detectable concentrations of tritium. Three samples analyzed for Strontium-90 had detectable concentrations. The presence of Strontium-90 was attributed to fallout from historic nuclear weapons tests.

Two sheep grazing onsite and two sheep from offsite were collected and analyzed for man-made gamma-emitting radionuclides. All of the sheep had detectable concentrations of Cesium-137 in muscle tissue. One offsite sheep had detectable concentrations of Cesium-137 in the liver. None of the thyroids from the four sheep contained detectable concentrations of Iodine-131. Samples were also taken from two road-killed game animals: a pronghorn antelope along Highway 20 within the INEEL boundary and a mule deer near Craters of the Moon National Monument. The pronghorn contained detectable concentrations of Cesium-137 in its muscle tissue. Iodine-131 was not detected in the thyroid glands of either animal.

The environmental radiation results were consistent with previously reported data and indicated no increase in detectable levels of environmental radiation due to INEEL activities.

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1. Introduction

Consistent with requirements of applicable Department of Energy (DOE) Orders, the Foundation's environmental surveillance program monitors the effects, if any, of DOE activities on the offsite environment, collects data which verifies compliance with applicable environmental laws and regulations, and observes trends in environmental levels of radioactivity. This work is performed under DOE Contract DE-AC07-ID13268.

This quarterly report summarizes the data collected by the Foundation's INEEL Offsite Environmental Surveillance Program during the period April 1 through June 30, 1997. The scope of the Foundation's sampling program is outlined in Table 1. Analyses for Foundation surveillance samples were performed by the Environmental Monitoring Laboratory at Idaho State University and Quanterra Environmental Services in Richland, WA.

Nearly all of the reported environmental results represent background levels of radioactivity; many results are near the detection limits of the laboratory procedures. Table 2 summarizes the approximate minimum detectable concentrations (MDC) of radioactivity the laboratories can detect and quantify for a given sample type and analysis. All results are reported with an associated 2s ("two sigma") uncertainty term. Results less than or equal to the 2s uncertainty, which includes some results that are negative, are considered as "not detected." For results greater than 2s (the 95% confidence level), but not exceeding 3s (the 99% confidence interval), detection of the radioactivity is questionable. Results may exceed the 2s level simply due to the inherent random nature of radioactive decay events. This is expected to occur approximately 2.5% of the time. Results exceeding 3s are interpreted as indicating that radioactivity was detected.

Where appropriate, the results in this report are compared to the following:

- For air, concentrations are compared to the DOE Derived Concentration Guides. This is the concentration of a radionuclide that, under conditions of continuous exposure, would result in an effective dose equivalent of 100 mrem (the DOE standard for members of the public);

- For drinking water, concentrations are compared to the Environmental Protection Agency's Maximum Contaminant Level. This is the maximum permissible level of a contaminant in water that is delivered to any user of a community water system.

Table 1.
Summary of the Foundation's Environmental Surveillance Program

Sample Type Analysis	Collection Frequency	Locations: Distant	Locations: Boundary	Locations: INEEL
Air				
Gross Alpha	weekly	Blackfoot, Craters of the Moon, Idaho Falls, Rexburg	Arco, Atomic City, FAA Tower, Howe, Monteview, Mud Lake, Reno Ranch	Main Gate, EFS, Van Buren
Gross Beta ^{131}I	weekly	Blackfoot, Craters of the Moon, Idaho Falls, Rexburg	Arco, Atomic City, FAA Tower, Howe, Monteview, Mud Lake, Reno Ranch	Main Gate, EFS, Van Buren
Gamma Spec Particulate Mass	quarterly	Blackfoot, Craters of the Moon, Idaho Falls, Rexburg	Arco, Atomic City, FAA Tower, Howe, Monteview, Mud Lake, Reno Ranch	Main Gate, EFS, Van Buren
^{90}Sr Transuranics	quarterly	Rotating schedule	Rotating schedule	Rotating schedule
PM_{10}	every sixth day	Mountain View, Rexburg	Atomic City	None
Air Moisture				
Tritium	4 to 13 weeks	Blackfoot, Idaho Falls, Rexburg	Atomic City	None
Precipitation				
Tritium	monthly	Idaho Falls	None	CFA
Tritium	weekly	None	None	EFS
Surface H_2O				
Gross Alpha, Gross Beta, ^{3}H	quarterly→ semiannually→	Twin Falls, Buhl, Hagerman Idaho Falls, Bliss	None	None
Drinking H_2O				
Gross Alpha Gross Beta, ^{3}H	semiannually	Aberdeen, Blackfoot, Carey, Idaho Falls, Fort Hall, Minidoka, Roberts, Shoshone	Arco, Atomic City, Howe, Monteview, Mud Lake, Reno Ranch	None
Milk				
^{131}I	weekly	Idaho Falls	None	None
^{131}I	monthly	Blackfoot, Carey, Dietrich, Minidoka, Roberts	Howe, Terreton, Arco	None
Tritium ^{90}Sr	annually	Blackfoot, Carey, Dietrich, Idaho Falls, Minidoka, Roberts	Howe, Terreton, Arco	None
Potatoes				
Gamma Spec ^{90}Sr	annually	Blackfoot, Idaho Falls, Rupert	Arco, Mud Lake	None
Wheat				
Gamma Spec ^{90}Sr	annually	American Falls, Blackfoot, Dietrich, Idaho Falls, Minidoka, Carey	Arco, Monteview, Mud Lake, Tabor, Terreton	None
Lettuce				
Gamma Spec ^{90}Sr	annually	Blackfoot, Carey, Idaho Falls, Pocatello	Arco, Atomic City, Howe, Mud Lake	None
Fish				
Gamma Spec	annually	None	None	Big Lost River
Sheep				
Gamma Spec	annually	Blackfoot	None	INEEL grazing areas
Waterfowl				
Gamma Spec ^{90}Sr Transuranics	annually	Fort Hall	None	Waste disposal ponds
Game				
Gamma Spec	varies	None	None	INEEL roads
Soil				
Gamma Spec ^{90}Sr Transuranics	biennially	Carey, Crystal Ice Caves, Blackfoot, St. Anthony	Butte City, Monteview, Atomic City, FAA Tower, Howe, Mud Lake (2), Reno Ranch	None
TLDs				
Gamma Radiation	semiannual	Aberdeen, Blackfoot, Craters of the Moon, Idaho Falls, Minidoka, Mtn. View, Rexburg, Roberts	Arco, Atomic City, Howe, Monteview, Mud Lake, Reno Ranch	None

Table 2.
Summary of Approximate Minimum Detectable Concentrations for Radiological Analyses (Second Quarter 1997)

Sample Type	Analysis	Approximate Minimum Detectable Concentration[a] (MDC)	Derived Concentration Guide[b] (DCG)	Drinking Water Detection Limits[c]
Air (particulate filter)[d]	Gross alpha	1×10^{-15} µCi/ml	2×10^{-14} µCi/ml	--
	Gross beta	4×10^{-15} µCi/ml	3×10^{-12} µCi/ml	--
	Specific gamma (^{137}Cs)	2×10^{-15} µCi/ml	4×10^{-10} µCi/ml	--
	^{238}Pu	2×10^{-18} µCi/ml	3×10^{-14} µCi/ml	--
	$^{239/240}Pu$	3×10^{-18} µCi/ml	2×10^{-14} µCi/ml	--
	^{241}Am	2×10^{-18} µCi/ml	2×10^{-14} µCi/ml	--
	^{90}Sr	3×10^{-17} µCi/ml	9×10^{-12} µCi/ml	--
Air (charcoal cartridge)[d]	^{131}I	4×10^{-15} µCi/ml	4×10^{-10} µCi/ml	--
Air (atmospheric moisture)[e]	^{3}H	4×10^{-12} µCi/ml	1×10^{-7} µCi/ml	--
Air (precipitation)	^{3}H	1×10^{-7} µCi/ml	2×10^{-3} µCi/ml	--
Water (drinking & surface)	Gross alpha	4 pCi/l	30 pCi/l	3 pCi/l
	Gross beta	2 pCi/l	100 pCi/l	4 pCi/l
	^{3}H	100 pCi/l	2×10^{6} pCi/l	1000 pCi/l
Milk	^{131}I	2×10^{-9} µCi/ml	--	--
	^{3}H	1×10^{-7} µCi/ml	--	--
	^{90}Sr	3×10^{-10} µCi/ml	--	--
Thyroid tissue	^{131}I	3×10^{-7} µCi/g	--	--
Liver tissue	^{137}Cs	5×10^{-9} µCi/g	--	--
Muscle tissue	^{137}Cs	4×10^{-9} µCi/g	--	--

a. The MDC is an estimate of the concentration of radioactivity in a given sample type that can be identified with a 95% level of confidence and a precision of plus or minus 100% under a specified set of typical laboratory measurement conditions.
b. DCGs, set by the DOE, represent reference values for radiation exposure. They are based on a radiation dose of 100 mrem/yr for exposure through a particular exposure mode such as direct exposure, inhalation, or ingestion of water.
c. These limits are required by the National Primary Drinking Water Regulations (40 CFR 141). The "detection limit" is the terminology used by the EPA and means the same as the MDC defined above.
d. The approximate MDC is based on an average filtered air volume (pressure corrected) of 570 m^3/week.
e. The approximate MDC is expressed for tritium (as tritiated water) in air, and is based on an average filtered air volume of 25 m^3, assuming an average sampling period of eight weeks.

2. Air Sampling

2.1.1 Low-Volume Air Samplers

Airborne particulate radioactivity was continuously monitored by 14 air samplers (Figure 1), designed to provide an effective network to detect INEEL releases of radioactivity. Five offsite air samplers are designated as distant, or background, stations and seven are designated as boundary stations. Three air samplers are situated on the INEEL. Distant locations were used to make comparisons of airborne concentrations of radioactivity with boundary and onsite locations. As part of the quality assurance program, two replicate samplers, located in Monteview and the FAA tower, were operated adjacent to regular air samplers to provide a means of quality control.

Each air sampler averaged a flow of approximately 50 l/min (2 ft^3/min) through a filter head consisting of two types of filters—a 1.2-micrometer pore size particulate filter and a charcoal cartridge for the monitoring of radioactive iodine. Filters on each sampler were changed weekly. In order to be considered a valid sample, each filter must sample a pressure-corrected air volume of at least 200 m^3 (7000 ft^3). Filters generally sample an average air volume of about 510 m^3 (18,000 ft^3) per week.

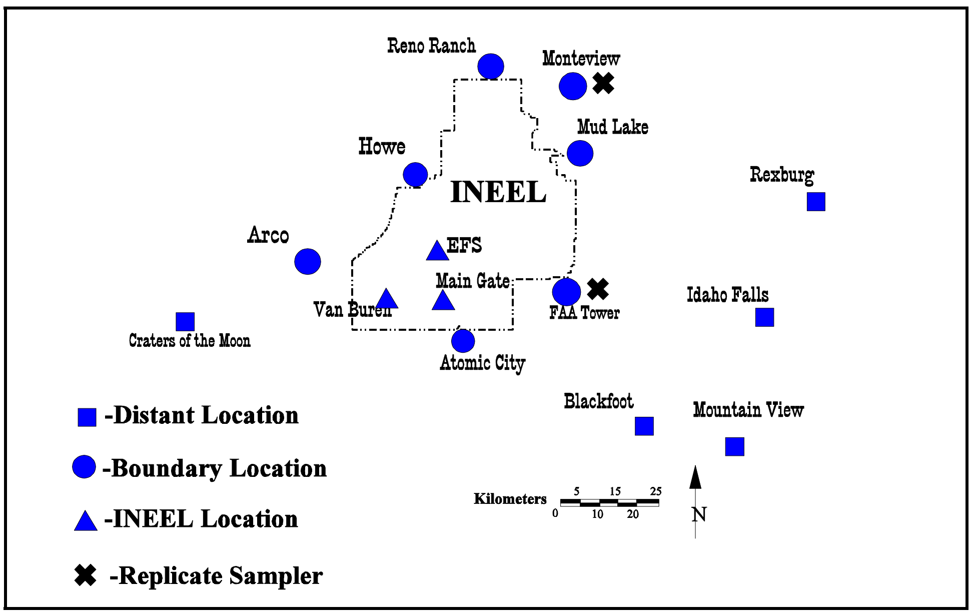

Figure 1. Air Sampling Location Map

Various screening analyses were performed weekly. Charcoal cartridges were screened weekly in batches for ^{131}I activity. If activity was detected in any batch greater than a preset action level, cartridges were then analyzed individually. Particulate filters were counted each week for gross (nonspecific) beta activity in a low-background beta counter after waiting a minimum of four days for the naturally occurring decay products of radon and thoron to decay. The particulate filters were also counted for gross alpha activity.

At the end of the quarter, weekly filters from each location were combined to form a composite. All composites were then analyzed by gamma spectrometry for specific radionuclides. Selected composites were also analyzed for ^{90}Sr or transuranic radionuclides (^{238}Pu, $^{239/240}$Pu, and ^{241}Am).

No ^{131}I was detected in any of the weekly charcoal cartridge batches.

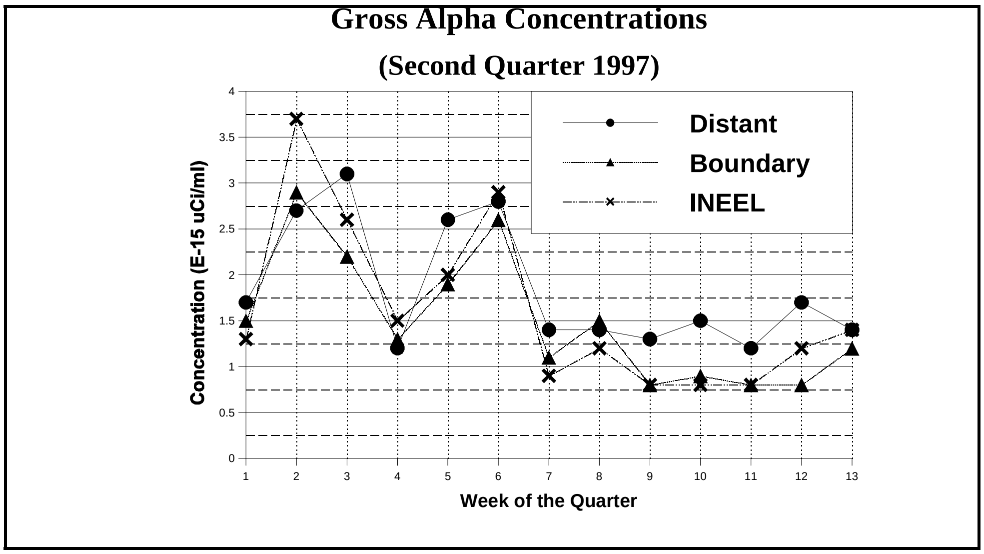

Figure 2. Weekly Gross Alpha Concentrations

All gross alpha concentrations were within the expected range of background levels (Figure 2, Table 3, and Appendix A). Figure 2 indicates the levels of airborne radioactivity measured for distant, boundary, and INEEL stations are similar, within uncertainty limits, and track each other quite closely over the 13 weeks. The quarterly mean gross alpha concentrations for the onsite and boundary locations were not statistically higher than the mean for the distant locations (Table 3).

All gross beta concentrations were also within the expected range of background levels (Figure 3, Table 4, and Appendix A). Figure 3 indicates the levels of airborne radioactivity for distant, boundary, and INEEL stations were similar, within uncertainty limits, and closely track each other over the 13 weeks.

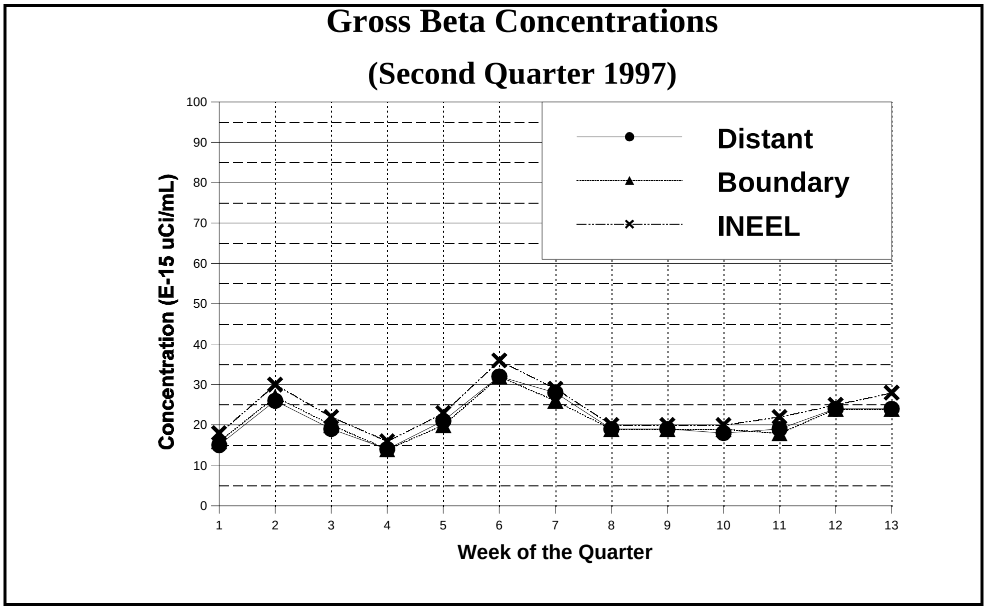

Figure 3. Weekly Gross Beta Concentrations

Statistical analysis indicated the mean gross beta concentration for INEEL locations was statistically greater than the mean gross beta concentrations for the distant locations. This was primarily due to higher gross beta concentrations at EFS.

The gross alpha and gross beta data for the Monteview and FAA tower quality assurance replicates assisted in data validation. The Monteview and FAA tower mean values were not statistically different from their respective replicate mean values (Tables 3 and 4).

Quarterly composite samples from all stations were analyzed for gamma-emitting radionuclides. Beryllium-7, a naturally-occurring gamma-emitting radionuclide produced by cosmic rays in the atmosphere, was detected in nearly all of the composites. Cesium-137 was detected in the Monteview composite sample at a concentration of (0.4 ± 0.2) x 10^{-15} µCi/ml. However, ^{137}Cs was not detected in Monteview's replicate composite. No detectable concentrations of manmade radionuclides were detected for any of the onsite locations.

Several composite samples were also selected for analysis of ^{90}Sr and transuranics of interest (^{241}Am, ^{238}Pu, and $^{239/240}$Pu). Americium-241 was detected in the Mountain View (Blackfoot) sample at (0.003 ± 0.002) x 10^{-15} µCi/ml. This

Table 3.
Gross Alpha Concentrations in Air
(Second Quarter 1997)

Group	Location	Number of Samples	Gross Alpha Concentration ($\times 10^{-15}$ µCi/ml) Range of Samples	Mean with 95% Confidence Interval
Distant	Blackfoot	13	1.1 - 4.3	1.9 ± 0.6
	Mountain View	13	1.3 - 4.1	2.3 ± 0.5
	Craters of the Moon	12	0.4 - 2.2	1.0 ± 0.3
	Idaho Falls	13	0.8 - 3.5	1.9 ± 0.5
	Rexburg	13	1.2 - 3.5	2.0 ± 0.5
			Group Mean	**1.8 ± 0.2**
Boundary	Arco	13	0.4 - 2.7	1.4 ± 0.4
	Atomic City	13	0.4 - 2.6	1.3 ± 0.4
	FAA Tower (Replicate)	13 (13)	0.6 - 3.7 (0.0 - 3.6)	1.6 ± 0.6 (1.6 ± 0.6)
	Howe	13	0.5 - 3.2	1.4 ± 0.4
	Monteview (Replicate)	13 (13)	0.7 - 3.3 (0.3 - 3.8)	1.7 ± 0.6 (1.5 ± 0.6)
	Mud Lake	13	0.4 - 3.2	1.7 ± 0.5
	Reno Ranch	13	0.1 - 3.3	1.4 ± 0.6
			Group Mean	**1.5 ± 0.2**
INEEL	EFS	13	0.6 - 4.0	1.8 ± 0.6
	Main Gate	13	0.4 - 3.2	1.4 ± 0.5
	Van Buren	13	0.6 - 3.8	1.7 ± 0.6
			Group Mean	**1.6 ± 0.3**
			DOE Derived Concentration Guide	20

concentration is consistent with past results found throughout the sampling network. No other composites contained detectable amounts of ^{241}Am, ^{238}Pu, or $^{239/240}$Pu. Six composite samples were analyzed for ^{90}Sr. All of them had detectable concentrations consistent with some of the higher levels measured in recent years (Table 5). Although an INEEL source is a possible cause for these detections, the consistency of results between distant, boundary, and onsite samples contests this possibility. Strontium-90 is a radionuclide known to be present primarily in the top few centimeters of most all soils due to world-wide fallout. During the summers of 1995 and 1996, range fires on and to the southwest of the INEEL burned approximately 300,000 acres. During the second quarter of 1997, several major dust storms occurred on and around the INEEL, suspending soil made vulnerable to wind erosion by these fires. It is likely these prolonged suspensions of airborne soil particles contributed to the concentrations of ^{90}Sr measured on the composite air filters.

2.1.2 PM_{10} Air Samplers

PM_{10} air sampling continued at Madison Middle School (Rexburg), Mountain View Middle School (Blackfoot), and Atomic City. Sampling was conducted to determine the concentration of airborne particulates smaller than 10 microns. Particles this size can penetrate the body's natural air filtering system and enter the lungs. These filters are not analyzed for radionuclides.

Thirteen samples were obtained from Madison Middle School, 14 samples from Mountain View, and 11 from Atomic City. In April, high winds damaged the Atomic City sampler causing the loss of three samples. The mean concentration of airborne particulates smaller than 10 microns was 19 $\mu g/m^3$ in Rexburg, 17 $\mu g/m^3$ in Blackfoot, and 14 $\mu g/m^3$ in Atomic City. The ranges of concentrations were 4 - 44 $\mu g/m^3$, 4 - 47 $\mu g/m^3$, and 0 - 31 $\mu g/m^3$, respectively. All concentrations were well within the 24-hour EPA standard of 150 $\mu g/m^3$.

Table 4.
Gross Beta Concentrations in Air
(Second Quarter 1997)

			Gross Beta Concentration ($x\ 10^{-15}$ µCi/ml)	
Group	**Location**	**Number of Samples**	**Range of Samples**	**Mean with 95% Confidence Interval**
Distant	Blackfoot	13	14 - 32	22 ± 3
	Mountain View	13	15 - 33	22 ± 3
	Craters of the Moon	12	13 - 30	19 ± 3
	Idaho Falls	13	14 - 31	21 ± 3
	Rexburg	13	13 - 35	23 ± 4
			Group Mean	**21 ± 1**
Boundary	Arco	13	14 - 30	20 ± 3
	Atomic City	13	14 - 31	20 ± 3
	FAA Tower (Replicate)	13 (13)	13 - 30 (12 - 31)	20 ± 3 (20 ± 3)
	Howe	13	13 - 33	22 ± 3
	Monteview (Replicate)	13 (13)	14 - 35 (13 - 32)	23 ± 3 (21 ± 3)
	Mud Lake	13	14 - 32	21 ± 3
	Reno Ranch	13	16 - 32	23 ± 3
			Group Mean	**21 ± 1**
INEEL	EFS	13	17 - 39	26 ± 4
	Main Gate	13	14 - 34	22 ± 3
	Van Buren	13	16 - 34	23 ± 3
			Group Mean	**24 ± 2**
			DOE Derived Concentration Guide	3000

Table 5.
Manmade Radionuclides in Particulate Filter Quarterly Composites
(Second Quarter 1997)

Strontium-90	
Location	Strontium-90 (10^{-15} µCi/ml ± 2s)
Distant Locations	
Mountain View Middle School	0.2 ± 0.06
Rexburg	0.2 ± 0.06
Boundary Locations	
Arco	0.2 ± 0.06
Monteview	0.3 ± 0.08
Replicate	0.1 ± 0.06
INEEL Location	
INEEL Main Gate	0.1 ± 0.06
DOE Derived Concentration Guide	9000

Transuranic Radionuclides			
Location	Americium-241 (10^{-15} µCi/ml ± 2s)	Plutonium-238 (10^{-15} µCi/ml ± 2s)	Plutonium-239/240 (10^{-15} µCi/ml ± 2s)
Distant Locations			
Craters of the Moon	Not Detected	Not Detected	Not Detected
Idaho Falls	Not Detected	Not Detected	Not Detected
Mountain View Middle School	0.003 ± 0.002	Not Detected	Not Detected
Boundary Locations			
Atomic City	Not Detected	Not Detected	Not Detected
FAA Tower	Not Detected	Not Detected	Not Detected
Replicate	Not Detected	Not Detected	Not Detected
Mud Lake	Not Detected	Not Detected	Not Detected
INEEL Location			
EFS	Not Detected	Not Detected	Not Detected
DOE Derived Concentration Guide	20	30	20

2.1.3 Atmospheric Moisture Samplers

Four air samplers, located in Atomic City, Idaho Falls, Rexburg, and Blackfoot, collected atmospheric moisture for tritium analysis. Air was passed through a column of silica gel that absorbs water vapor in the air. Tritium concentrations were determined by extracting water from the silica gel and counting the water sample by liquid scintillation.

Eight atmospheric moisture samples were analyzed for ^{3}H: two each from Atomic City, Idaho Falls, Rexburg, and Blackfoot. Two samples had positive results: Atomic City at $(7.8 \pm 3.9) \times 10^{-14}$ µCi/ml and Idaho Falls at $(9.7 \pm 3.2) \times 10^{-14}$ µCi/ml. While there may be a contribution from INEEL operations, no source was identified. Atmospheric tritium is generally due to natural sources (cosmic ray interactions in the atmosphere) and man-made sources (historic nuclear weapons tests, nuclear reactor operations, and spent nuclear fuel handling).

2.1.4 Precipitation Samplers

When available, weekly precipitation samples were collected at the Experimental Field Station (EFS) on the INEEL. In addition, two samples were collected monthly: one at the Central Facilities Area on the INEEL and one in Idaho Falls. All precipitation samples were analyzed for tritium.

Six precipitation samples, four from onsite locations and two from a distant location, were collected in the second quarter and analyzed for tritium. Tritium was not detected in any of the samples.

3. Water Sampling

Thirteen drinking water samples were collected in May from local businesses throughout the sampling network (Figure 5). Five surface water samples were also collected, four from the Magic Valley area and one from Idaho Falls. Surface water locations included three springs in the Thousand Springs area (Figure 5). These springs are some of the outlets for the Snake River Plain Aquifer, which flows beneath the INEEL. Each sample was analyzed for gross alpha, gross beta, and tritium.

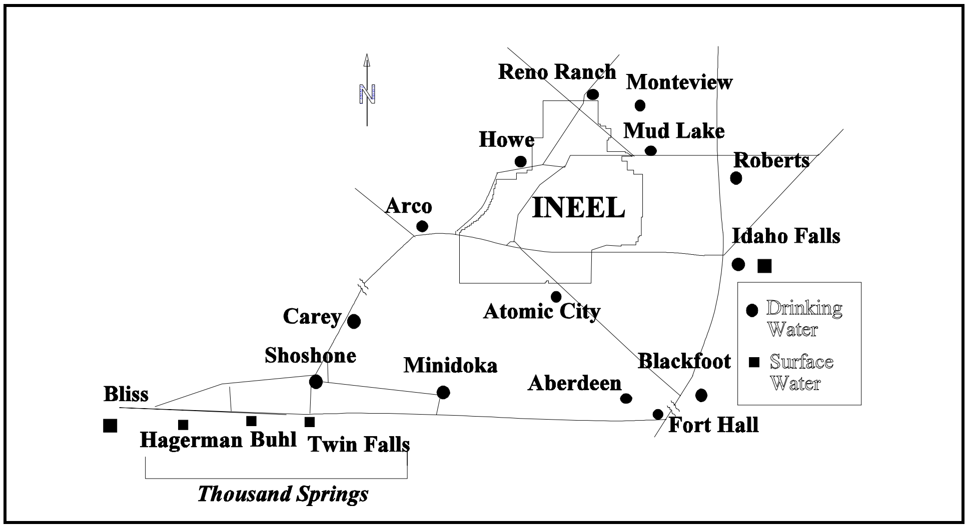

Figure 5. Water Sampling Locations

One of the drinking water samples (Shoshone) showed measurable concentrations of ^{3}H (Table 6). Environmental ^{3}H is due primarily to contributions from natural processes and historic nuclear weapons tests.

None of the water samples contained a detectable concentration of gross alpha; almost all of the samples contained detectable gross beta concentrations. At these levels, radioactivity in water samples is generally attributed to naturally occurring decay products, primarily from primordial deposits of uranium and thorium, entrained in the water as it travels through the earth's crust.

Table 6.
Radionuclide Concentrations in Offsite Water Samples
(Second Quarter 1997)

Location	^{3}H (pCi/l ± 2s)	Gross Alpha (pCi/l ± 2s)	Gross Beta (pCi/l ± 2s)
Drinking Water			
Aberdeen	-30 ± 90	-1 ± 1	7 ± 3
Arco	50 ± 80	2 ± 2	5 ± 2
Atomic City	40 ± 80	0 ± 1	3 ± 2
Atomic City Replicate	-40 ± 80	1 ± 1	4 ± 2
Blackfoot	60 ± 80	1 ± 2	3 ± 2
Carey	10 ± 80	0 ± 1	3 ± 2
Fort Hall	50 ± 80	0 ± 1	5 ± 2
Howe	10 ± 80	0 ± 1	1 ± 2
Idaho Falls	80 ± 80	1 ± 1	3 ± 2
Minidoka	80 ± 80	1 ± 2	6 ± 3
Monteview	-10 ± 80	2 ± 3	9 ± 3
Mud Lake	80 ± 80	0 ± 1	10 ± 3
Reno Ranch	no sample collected	no sample collected	no sample collected
Roberts	-50 ± 80	-1 ± 1	6 ± 2
Shoshone	90 ± 80	0 ± 1	5 ± 2
Surface Water			
Alpheus Spring (Twin Falls)	70 ± 80	0 ± 2	8 ± 3
Bill Jones Hatchery (Hagerman)	70 ± 80	0 ± 1	4 ± 2
Clear Spring (Buhl)	-10 ± 80	0 ± 1	4 ± 2
Bliss	40 ± 80	1 ± 1	5 ± 2
Idaho Falls	10 ± 80	0 ± 1	3 ± 2
Idaho Falls Replicate	30 ± 80	0 ± 1	1 ± 2
EPA Maximum Contaminant Level (MCL)	20,000	15	50

4. Milk Sampling

Milk samples were collected weekly in Idaho Falls and monthly at eight other locations around the INEEL (Figure 6). Both single family dairies and large commercial dairies were sampled. Each milk sample was analyzed for ^{131}I. Selected milk samples were also analyzed for ^{3}H and ^{90}Sr.

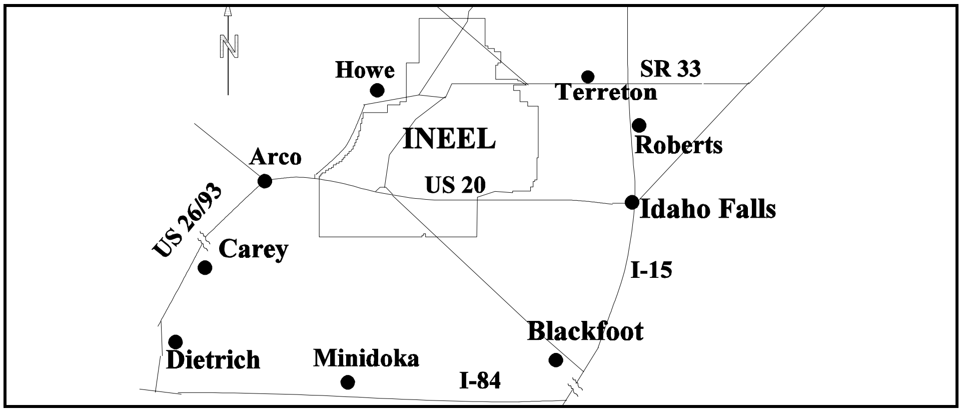

Figure 6. Milk Sampling Locations

Thirty-eight milk samples were collected during the second quarter. Iodine-131 was not detected in any of the samples.

Tritium was not detected in samples from Howe, Roberts, Arco/Moore, and Dietrich. Five milk samples were analyzed for ^{90}Sr. Due to analytical delays, samples from Minidoka and Terreton soured and could not be analyzed. The other three samples contained detectable levels of ^{90}Sr (Table 7). All concentrations were consistent with previous measurements and those reported by the EPA, and are due to worldwide fallout from historic nuclear weapons tests.

Table 7.
^{90}Sr Concentrations in Milk
(Second Quarter 1997)

Location	Result (µCi/ml ± 2s) x 10^{-9}
Blackfoot	1.4 ± 0.3
Carey	1.1 ± 0.2
Idaho Falls	0.6 ± 0.3
Minidoka	nd[a]
Terreton	nd

[a] No data

5. Animal Sampling

Samples of thyroid, muscle, and liver were taken from two sheep grazing on authorized allotments from the north end of the INEEL. Control samples were taken from the St. Anthony area. In addition, the same organ and tissue samples were taken from road-killed game at locations on or in the region of the INEEL. The samples were analyzed for man-made gamma-emitting radionuclides.

Muscle samples from all of the sheep, showed detectable concentrations of ^{137}Cs (Table 8). A liver sample from one of the two control sheep contained a detectable concentration of ^{137}Cs. None of the thyroids from the four sheep indicated detectable concentrations of ^{131}I.

Two road-killed game animals were sampled during this report period, one located on Highway 20 on the INEEL, and one near Craters of the Moon National Monument (Table 8). The thyroids were analyzed for ^{131}I. No concentrations were detected. Cesium-137 was detected in the muscle of the pronghorn antelope killed on the INEEL (Table 8).

For sheep and game animals, ^{137}Cs concentrations at these levels are consistent with past results, and are attributed to world-wide fallout from historic nuclear weapons testing. In some cases, animals which have grazed onsite may ingest radioactivity (primarily ^{137}Cs) from areas of contaminated soil.

Table 8.
Radionuclide Concentrations in Sheep and Game
(Second Quarter 1997)

Location	Tissue/Organ	^{137}Cs Result (μCi/g ± 2s) x 10^{-9}
	Sheep	
Tractor Flats	Muscle #1	6.7 ± 2.8
	Liver #1	nd[a]
	Muscle #2	3.8 ± 2.8
	Liver #2	nd
St. Anthony (control)	Muscle #1	3.2 ± 3.1
	Liver #1	2.7 ± 1.8
	Muscle #2	5.9 ± 2.4
	Liver #2	nd
	Road-killed Game	
Highway 20, MP 272	Muscle (pronghorn)	3.8 ± 2.8
	Liver (pronghorn)	nd
Craters of the Moon	Muscle (mule deer)	nd
	Liver (mule deer)	nd

[a] not detected.

6. Environmental Radiation

Thermoluminescent dosimeters (TLDs), changed semiannually, were collected from six boundary and eight distant locations (Figure 8).

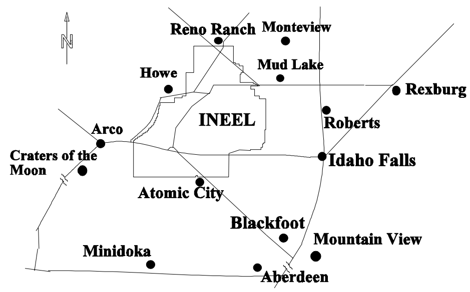

Figure 8. TLD Locations

The results for the first half of 1997 (November 1996 through April 1997) show similar exposure levels to the previous six-month intervals (Table 9). There were no statistical difference between the distant and boundary groups.

Table 9.
Environmental Radiation Exposure (mR) for Nov. 1996-May 1997

Location	11/95-5/96 Exposure (mR ± 2s)	5/96-11/96 Exposure (mR ± 2s)	11/96-5/97 Exposure (mR ± 2s)
Distant Locations			
Aberdeen	56 ± 4	missing TLD	69 ± 6
Blackfoot	57 ± 3	63 ± 7	62 ± 2
Mountain View[a]	–	–	59 ± 7
Craters of the Moon	55 ± 2	62 ± 4	59 ± 4
Idaho Falls	61 ± 3	59 ± 4	63 ± 4
Minidoka	56 ± 4	62 ± 3	57 ± 5
Rexburg	60 ± 3	62 ± 3	70 ± 6
Roberts	71 ± 5	69 ± 7	71 ± 10
Group Mean[b]	**59 ± 5**	**63 ± 5**	**64 ± 5**
Boundary Locations			
Arco	58 ± 3	73 ± 5	62 ± 7
Atomic City	70 ± 5	66 ± 3	64 ± 5
Howe	57 ± 5	60 ± 6	64 ± 5
Monteview	60 ± 2	62 ± 4	63 ± 5
Mud Lake	62 ± 2	67 ± 6	64 ± 7
Reno Ranch	57 ± 3	53 ± 3	58 ± 7
Group Mean[b]	**61 ± 5**	**63 ± 5**	**62 ± 2**

a. Mountain View Middle School in Blackfoot, established in November, 1996.
b. Mean ± 95% confidence interval.

Appendix A

Weekly Gross Alpha and Gross Beta Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} µCi/ml) Gross Alpha	Gross Beta
-------------------------------Distant Locations---------------------------------			
Blackfoot	04/09/97	2.1 ± 1.0	15 ± 2
	04/16/97	1.6 ± 1.2	26 ± 3
	04/23/97	3.6 ± 1.2	20 ± 2
	04/30/97	1.2 ± 0.9	14 ± 2
	05/07/97	1.9 ± 1.0	22 ± 2
	05/14/97	4.3 ± 1.2	32 ± 3
	05/21/97	1.1 ± 0.8	28 ± 2
	05/28/97	1.4 ± 0.7	20 ± 2
	06/04/97	1.4 ± 0.7	18 ± 2
	06/11/97	1.2 ± 0.7	18 ± 2
	06/18/97	1.5 ± 0.7	19 ± 2
	06/25/97	1.7 ± 0.8	24 ± 2
	07/02/97	1.4 ± 0.7	23 ± 2
Craters of the Moon	04/09/97	0.7 ± 0.8	14 ± 2
	04/16/97	------------invalid sample------------	
	04/23/97	1.6 ± 1.0	17 ± 2
	04/30/97	0.4 ± 0.7	13 ± 2
	05/07/97	2.2 ± 1.0	19 ± 2
	05/14/97	1.2 ± 0.7	30 ± 3
	05/21/97	1.3 ± 0.8	25 ± 2
	05/28/97	0.8 ± 0.6	17 ± 2
	06/04/97	0.6 ± 0.6	17 ± 2
	06/11/97	0.8 ± 0.6	18 ± 2
	06/18/97	0.8 ± 0.6	14 ± 2
	06/25/97	0.5 ± 0.6	20 ± 2
	07/02/97	0.7 ± 0.6	20 ± 2
Idaho Falls	04/09/97	2.2 ± 1.1	17 ± 2
	04/16/97	2.2 ± 1.2	24 ± 2
	04/23/97	3.5 ± 1.4	21 ± 2
	04/30/97	0.9 ± 0.9	14 ± 2
	05/14/97	3.3 ± 1.3	20 ± 2
	05/14/97	2.8 ± 1.0	31 ± 3
	05/21/97	1.6 ± 1.0	28 ± 3
	05/28/97	1.5 ± 0.8	19 ± 2
	06/04/97	0.9 ± 0.7	20 ± 2
	06/11/97	1.3 ± 0.7	16 ± 2
	06/18/97	0.8 ± 0.6	19 ± 2
	06/25/97	2.1 ± 0.8	25 ± 2
	07/02/97	1.9 ± 0.8	26 ± 2

Appendix A (cont.)

Weekly Gross Alpha and Gross Beta Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} µCi/ml) Gross Alpha	Gross Beta
Mountain View	04/09/97	2.2 ± 0.9	16 ± 2
	04/16/97	4.1 ± 1.2	27 ± 2
	04/23/97	3.3 ± 1.1	20 ± 2
	04/30/97	1.3 ± 0.8	15 ± 2
	05/07/97	2.1 ± 1.0	21 ± 2
	05/14/97	3.0 ± 0.8	33 ± 2
	05/21/97	1.7 ± 0.8	27 ± 2
	05/28/97	1.7 ± 0.7	19 ± 2
	06/04/97	2.2 ± 0.8	19 ± 2
	06/11/97	2.4 ± 0.7	17 ± 2
	06/18/97	1.8 ± 0.7	22 ± 2
	06/25/97	2.0 ± 0.7	22 ± 2
	07/02/97	1.6 ± 0.7	26 ± 2
Rexburg	04/09/97	1.3 ± 0.7	13 ± 1
	04/16/97	2.8 ± 1.2	28 ± 2
	04/23/97	3.3 ± 1.1	19 ± 2
	04/30/97	2.3 ± 0.9	15 ± 2
	05/07/97	3.5 ± 1.2	24 ± 2
	05/14/97	2.4 ± 0.8	35 ± 2
	05/21/97	1.2 ± 0.7	30 ± 2
	05/28/97	1.4 ± 0.7	21 ± 2
	06/04/97	1.3 ± 0.7	20 ± 2
	06/11/97	2.0 ± 0.7	21 ± 2
	06/18/97	1.2 ± 0.6	21 ± 2
	06/25/97	2.2 ± 0.8	29 ± 2
	07/02/97	1.7 ± 0.7	27 ± 2
------------------------------Boundary Locations--------------------------------			
Arco	04/09/97	0.9 ± 1.0	14 ± 2
	04/16/97	2.7 ± 1.2	30 ± 3
	04/23/97	1.4 ± 1.0	17 ± 2
	04/30/97	2.0 ± 1.0	14 ± 2
	05/07/97	2.1 ± 1.0	16 ± 2
	05/14/97	2.6 ± 0.9	29 ± 2
	05/21/97	0.8 ± 0.7	24 ± 2
	05/28/97	1.9 ± 0.8	19 ± 2
	06/04/97	0.9 ± 0.6	15 ± 2
	06/11/97	0.9 ± 0.6	19 ± 2
	06/18/97	0.4 ± 0.5	19 ± 2
	06/25/97	1.2 ± 0.7	26 ± 2
	07/02/97	0.9 ± 0.6	21 ± 2

Appendix A (cont.)

Weekly Gross Alpha and Gross Beta Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} µCi/ml) Gross Alpha	Gross Beta
Atomic City	04/09/97	1.0 ± 0.8	14 ± 2
	04/16/97	2.6 ± 1.2	23 ± 2
	04/23/97	1.7 ± 1.0	20 ± 2
	04/30/97	0.4 ± 0.8	14 ± 2
	05/07/97	2.2 ± 1.1	21 ± 2
	05/14/97	2.4 ± 0.9	31 ± 3
	05/21/97	0.9 ± 0.7	26 ± 2
	05/28/97	1.3 ± 0.7	16 ± 2
	06/04/97	0.8 ± 0.6	18 ± 2
	06/11/97	0.7 ± 0.6	17 ± 2
	06/18/97	1.0 ± 0.6	17 ± 2
	06/25/97	0.6 ± 0.6	24 ± 2
	07/02/97	1.5 ± 0.7	24 ± 2
FAA Tower (Replicate)	04/09/97	1.5 ± 0.9 (1.6 ± 0.9)	13 ± 2 (12 ± 2)
	04/16/97	3.7 ± 1.4 (3.6 ± 1.3)	28 ± 3 (24 ± 2)
	04/23/97	2.2 ± 1.1 (2.7 ± 1.1)	18 ± 2 (19 ± 2)
	04/30/97	0.6 ± 0.8 (1.5 ± 0.9)	14 ± 2 (12 ± 2)
	05/07/97	2.2 ± 1.1 (2.4 ± 1.1)	19 ± 2 (20 ± 2)
	05/14/97	2.8 ± 1.0 (2.6 ± 0.9)	30 ± 3 (31 ± 3)
	05/21/97	1.0 ± 0.8 (1.1 ± 0.9)	27 ± 2 (23 ± 2)
	05/28/97	1.7 ± 0.8 (1.3 ± 0.7)	21 ± 2 (18 ± 2)
	06/04/97	1.0 ± 0.7 (0.9 ± 0.6)	17 ± 2 (17 ± 2)
	06/11/97	1.1 ± 0.6 (0.5 ± 0.5)	17 ± 2 (17 ± 2)
	06/18/97	1.2 ± 0.7 (0.8 ± 0.6)	20 ± 2 (18 ± 2)
	06/25/97	0.7 ± 0.6 (0.0 ± 0.8)	20 ± 2 (23 ± 3)
	07/02/97	0.9 ± 0.7 (1.5 ± 0.8)	21 ± 2 (25 ± 2)
Howe	04/09/97	1.3 ± 1.0	18 ± 2
	04/16/97	2.2 ± 1.2	27 ± 3
	04/23/97	1.1 ± 1.0	20 ± 2
	04/30/97	1.4 ± 0.9	13 ± 2
	05/07/97	2.0 ± 1.1	22 ± 2
	05/14/97	3.2 ± 1.0	33 ± 3
	05/21/97	1.5 ± 0.9	27 ± 3
	05/28/97	0.9 ± 0.6	20 ± 2
	06/04/97	0.5 ± 0.6	20 ± 2
	06/11/97	1.2 ± 0.7	20 ± 2
	06/18/97	0.8 ± 0.6	19 ± 2
	06/25/97	0.9 ± 0.6	22 ± 2
	07/02/97	1.4 ± 0.7	24 ± 2

Appendix A (cont.)

Weekly Gross Alpha and Gross Beta Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} µCi/ml) Gross Alpha	Gross Beta
Monteview (Replicate)	04/09/97	1.7 ± 1.0 (0.7 ± 0.8)	18 ± 2 (16 ± 2)
	04/16/97	3.3 ± 1.4 (2.6 ± 1.2)	25 ± 3 (26 ± 2)
	04/23/97	3.3 ± 1.2 (3.8 ± 1.2)	22 ± 2 (17 ± 2)
	04/30/97	2.9 ± 1.1 (1.1 ± 0.8)	14 ± 2 (13 ± 2)
	05/07/97	1.1 ± 1.0 (1.8 ± 1.0)	21 ± 2 (20 ± 2)
	05/14/97	2.3 ± 0.9 (2.2 ± 0.8)	35 ± 3 (32 ± 2)
	05/21/97	1.2 ± 0.8 (1.0 ± 0.8)	27 ± 2 (24 ± 2)
	05/28/97	1.4 ± 0.7 (1.8 ± 0.8)	19 ± 2 (20 ± 2)
	06/04/97	0.7 ± 0.6 (0.8 ± 0.6)	21 ± 2 (19 ± 2)
	06/11/97	0.8 ± 0.6 (1.5 ± 1.0)	22 ± 2 (17 ± 3)
	06/18/97	0.8 ± 0.6 (0.3 ± 0.5)	19 ± 2 (19 ± 2)
	06/25/97	0.9 ± 0.7 (0.8 ± 0.7)	25 ± 2 (25 ± 2)
	07/02/97	1.2 ± 0.7 (1.1 ± 0.7)	27 ± 2 (24 ± 2)
Mud Lake	04/09/97	2.0 ± 1.0	15 ± 2
	04/16/97	3.2 ± 1.3	24 ± 2
	04/23/97	3.1 ± 1.2	24 ± 2
	04/30/97	1.8 ± 1.0	14 ± 2
	05/07/97	2.6 ± 1.1	20 ± 2
	05/14/97	1.7 ± 0.8	32 ± 3
	05/21/97	1.0 ± 0.8	27 ± 2
	05/28/97	1.4 ± 0.7	20 ± 2
	06/04/97	1.3 ± 0.7	19 ± 2
	06/11/97	0.5 ± 0.9	18 ± 3
	06/18/97	0.4 ± 0.5	16 ± 2
	06/25/97	1.3 ± 0.8	22 ± 2
	07/02/97	1.6 ± 0.8	25 ± 2
Reno Ranch	04/09/97	1.9 ± 1.2	17 ± 2
	04/16/97	2.4 ± 1.4	32 ± 3
	04/23/97	2.8 ± 1.3	22 ± 3
	04/30/97	0.1 ± 0.9	16 ± 2
	05/07/97	1.2 ± 1.1	21 ± 3
	05/14/97	3.3 ± 1.1	32 ± 3
	05/21/97	1.0 ± 0.9	27 ± 3
	05/28/97	1.7 ± 0.8	21 ± 2
	06/04/97	0.5 ± 0.7	21 ± 2
	06/11/97	1.4 ± 0.8	22 ± 2
	06/18/97	1.0 ± 0.7	19 ± 2
	06/25/97	0.3 ± 0.6	27 ± 3
	07/02/97	1.2 ± 0.7	23 ± 2

Appendix A (cont.)

Weekly Gross Alpha and Gross Beta Concentrations in Air

Location	Weekly Collection Date	Concentration ± 2s Uncertainty (10^{-15} µCi/ml) Gross Alpha	Gross Beta
-----INEEL Locations-----			
EFS	04/09/97	1.3 ± 1.2	21 ± 3
	04/16/97	4.0 ± 1.5	33 ± 3
	04/23/97	2.4 ± 1.2	25 ± 2
	04/30/97	2.5 ± 1.1	17 ± 2
	05/07/97	2.0 ± 1.2	26 ± 3
	05/14/97	3.6 ± 1.1	39 ± 3
	05/21/97	0.6 ± 0.8	32 ± 3
	05/28/97	1.6 ± 0.8	25 ± 2
	06/04/97	0.6 ± 0.7	22 ± 2
	06/11/97	0.9 ± 0.7	23 ± 2
	06/18/97	1.2 ± 0.7	24 ± 2
	06/25/97	1.5 ± 0.8	27 ± 3
	07/02/97	1.6 ± 0.8	29 ± 3
Main Gate	04/09/97	1.3 ± 0.8	17 ± 2
	04/16/97	3.2 ± 1.2	26 ± 2
	04/23/97	2.3 ± 1.0	20 ± 2
	04/30/97	1.1 ± 0.8	16 ± 2
	05/07/97	1.8 ± 1.0	21 ± 2
	05/14/97	2.0 ± 0.8	34 ± 3
	05/21/97	1.2 ± 0.7	27 ± 2
	05/28/97	0.7 ± 0.5	14 ± 2
	06/04/97	1.0 ± 0.6	20 ± 2
	06/11/97	0.4 ± 0.4	18 ± 2
	06/18/97	0.8 ± 0.5	22 ± 2
	06/25/97	1.1 ± 0.6	24 ± 2
	07/02/97	0.8 ± 0.5	29 ± 2
Van Buren	04/09/97	1.2 ± 0.9	17 ± 2
	04/16/97	3.8 ± 1.4	32 ± 3
	04/23/97	3.0 ± 1.2	21 ± 2
	04/30/97	0.8 ± 0.9	16 ± 2
	05/07/97	2.2 ± 1.2	22 ± 2
	05/14/97	3.2 ± 1.0	34 ± 3
	05/21/97	0.9 ± 0.7	27 ± 2
	05/28/97	1.1 ± 0.7	20 ± 2
	06/04/97	0.8 ± 0.7	20 ± 2
	06/11/97	1.2 ± 0.7	19 ± 2
	06/18/97	0.6 ± 0.6	21 ± 2
	06/25/97	1.1 ± 0.7	24 ± 2
	07/02/97	1.8 ± 0.8	26 ± 2

Helpful Information for Readers

Radionuclide Nomenclature

Radionuclides are sometimes expressed with the one- or two-letter chemical symbol for the element. A radionuclide is an unstable, or radioactive, form of an element. A given element may have many different radionuclides. Each is designated by a superscript number to the left of the chemical symbol. This number is the atomic weight of the radionuclide, equal to the number of protons and neutrons in its nucleus. Radionuclides which may be used in this report are shown in the following table:

Symbol	Radionuclide	Symbol	Radionuclide
^{3}H	Tritium	^{131}I	Iodine-131
^{7}Be	Beryllium-7	^{134}Cs	Cesium-134
^{51}Cr	Chromium-51	^{137}Cs	Cesium-137
^{54}Mn	Manganese-54	^{144}Ce	Cerium-144
^{58}Co	Cobalt-58	^{181}Hf	Hafnium-181
^{60}Co	Cobalt-60	^{238}Pu	Plutonium-238
^{65}Zn	Zinc-65	$^{239/240}Pu$	Plutonium-239/240
^{90}Sr	Strontium-90	^{241}Am	Americium-241
^{95}Nb	Niobium-95		

Scientific Notation

Scientific notation is used to express numbers which are very small and very large. A very small number will be expressed with a negative exponent, e.g., 1.3×10^{-6}. To convert this number to the more commonly used form, the decimal point must be moved left by a number of places equal to the exponent (in this case, six). 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 (or one million) 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. Prefixes that may be used in this report are:

Prefix	Abbreviation	Meaning
milli	m	1/1,000 (=1 x 10^{-3})
micro	µ	1/1,000,000 (=1 x 10^{-6})
pico	p	1/1,000,000,000,000 (=1 x 10^{-12})

Units of Radioactivity and Radiation Exposure and Dose

The basic unit of radioactivity used in this report is the curie, abbreviated Ci. The curie is defined as the amount of radioactivity equivalent to 37 billion nuclear transformations per second. Historically, this was based upon the radioactivity from one gram of the radionuclide Radium-226. For any other radionuclide, one curie is the amount of that 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.

Units of Environmental Concentrations

Concentration of radioactivity in air and milk samples is expressed in units of microcuries per milliliter (µCi/mL). Concentrations in water samples are expressed as picocuries per liter (pCi/l); federal standards are expressed in these units. Radioactivity in foodstuffs are given in microcuries per gram (µCi/g), dry weight. Radioactivity in soil samples is expressed as picocuries per gram (pCi/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).

Uncertainty of Measurements

Due to many variables, there is always an uncertainty associated with the measurement of environmental contaminants. For radioactivity, the predominant source of uncertainty is due to 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 result with a "±" (uncertainty) term. This report follows convention in reporting the uncertainty as a 95% confidence limit (or interval), designated in the tables as “±2s." That means there is approximately a 95% level of confidence that the real concentration in the sample lies somewhere between the measured (reported) concentration minus the uncertainty term and the measured (reported) concentration plus the uncertainty term.

Negative Numbers as Results

Negative values occur when the measured result is less than a pre-established average background level for the particular system and procedure used. These values, rather than "not detectable" or "zero," are reported to better enable statistical analyses and to observe trends in the data.

Gross versus Specific Analyses

Many of the radiological analyses of environmental samples yield information only about the overall, or gross, amount of a particular type of radiation (e.g., gross beta), rather than identifying and quantifying specific radionuclides. For example, rather than performing an analysis for particular gamma-emitting radionuclides, called gamma spectroscopy, one can do a gross gamma or, more commonly, a gross beta analysis, since gamma-emitting radionuclides also emit beta particles. This type of analysis is an effective screening tool and is much quicker and more cost effective than specific radionuclide analyses.