
Environmental Status of the Hanford Site for CY 1982

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August 1983

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute



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PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5205 Port Royal Road
Springfield, Virginia 22161

NTIS Price Codes
Microfiche ADI

Printed Copy

Pages	Price Codes
001-025	A02
026-050	A03
051-075	A04
076-100	A05
101-125	A06
126-150	A07
151-175	A08
176-200	A09
201-225	A010
226-250	A011
251-275	A012
276-300	A013

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ACKNOWLEDGMENTS

Acknowledgment is given to those who helped produce this report. Mary Ann McKinney edited and arranged for its publication. Secretarial support for this report was provided by G. L. Dirkes, D. R. Reis and K. E. Shoop.

FOREWORD

Environmental surveillance at the Hanford Site involves measuring a variety of environmental media for potential radioactive contaminants. The results of these measurements are used for assessing the environmental impact of site operations, for demonstrating compliance with applicable regulations, and for verifying the adequacy of containment and effluent control systems applied to onsite facilities and operations.

The data generated by routine environmental surveillance measurements are reported annually in three separate reports. The first report, Environmental Surveillance at Hanford, summarizes offsite environmental sampling data and any onsite data that pertain to the assessment of offsite radiation doses. The report discusses the significance of observed results relative to background levels, previous measurements and regulatory limits. It also provides an assessment of the impact of site operations on the environment in terms of radiation dose. The 1982 report was issued in May 1983.

The second report, Ground-Water Surveillance at the Hanford Site, summarizes and evaluates the concentrations and distribution of radioactive and chemical constituents in the ground water beneath the Hanford Site and discusses their potential environmental impact. The 1982 report was issued in July 1983.

The third report, Environmental Status of the Hanford Site, is provided here. This report specifically addresses surface environmental measurements made onsite. The primary purpose of this report is to present data concerning the radiological conditions in the immediate environs of the site's operating areas. The report also includes a summary of both radioactive and nonradioactive environmental discharges and related unusual occurrences for 1982 as reported for the various operating areas.



SUMMARY

Samples of air, surface water, soil, vegetation, and wildlife were collected and external penetrating radiation dose measurements were made in the vicinity of the major operating areas on the Hanford Site. The samples were analyzed for radioactive constituents including tritium, strontium-90, plutonium, and gamma-emitting radionuclides. In addition, site roads, railroad tracks, and burial grounds were surveyed periodically to detect any abnormal levels of radioactivity. Radioactive and nonradioactive waste discharges and environmental related unusual occurrences reported for the major operating areas were reviewed and summarized.

Highlights of the results for 1982 are:

- General airborne particulate radioactivity levels in the Hanford environs were lower in 1982 than in 1981 as airborne radionuclides associated with the October 1980 atmospheric nuclear test conducted by the People's Republic of China continued to decline.
- Airborne strontium-90, cesium-137, and plutonium concentrations were not significantly different from background measurements. Iodine-131 was not identified in any air sample.
- Tritium concentrations in atmospheric water vapor were similar for all sample locations.
- Cesium-137 concentrations in B-Pond continued to decrease during 1982 from a peak observed during 1980. Strontium-90 concentrations in B-Pond during 1982 were similar to 1981 levels. Radionuclide concentrations in other onsite ponds in 1982 were similar to those observed in 1981.
- Analyses of tissue samples from several types of wildlife collected onsite continue to indicate that in some areas Hanford-produced radionuclides are accessible to onsite wildlife.
- Several onsite soil and vegetation samples contained radionuclide concentrations above background levels. However, levels measured during 1982 were similar to those reported in recent years.

- External penetrating dose measurements during 1982 showed that dose rates at several onsite locations were above background levels but, were similar to levels observed during 1981.
- No radioactive contamination was observed during routine road and railroad monitoring surveys during 1982.
- No significant changes were observed in the radiological status of radioactive waste burial grounds located outside of operating area perimeter fences.
- Reported discharges of radioactive and nonradioactive materials to the environment during 1982 were generally similar to those reported by site contractors for 1981.
- A total of eight environmental-related unusual occurrences were reported at Hanford during 1982.

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ENVIRONMENTAL STATUS OF THE HANFORD SITE FOR CY 1982

INTRODUCTION

The U. S. Department of Energy (DOE) operations on the Hanford Site began in 1943 and have involved a wide variety of nuclear and non-nuclear activities, the most notable of which has been the large-scale production and processing of radioactive materials for the national defense program. During the performance of these activities, materials have been discharged to the environment both in a routine controlled manner and, occasionally, as a result of a process upset or other unplanned occurrence. Effluent and environmental monitoring programs are conducted to aid onsite waste management activities and to assess the impact of radioactive and nonradioactive discharges to the environment.

The Hanford Environmental Surveillance Program is conducted by Pacific Northwest Laboratory (PNL), which is operated by the Battelle Memorial Institute for DOE. The program provides for the measurement, interpretation, and evaluation of environmental samples and other measurements for the purposes of assessing environmental impact, determining compliance with pertinent regulations, and evaluating the adequacy of onsite waste management practices. The program is designed to evaluate all significant pathways of potential environmental impact, with emphasis on those that are most significant. Summaries and evaluations of the data generated during the performance of environmental surveillance activities are published annually in three reports. These are:

- Environmental Surveillance at Hanford (offsite environmental surveillance report).
- Ground-Water Surveillance at the Hanford Site
- Environmental Status of the Hanford Site (onsite environmental surveillance report).

This report is the last of the three reports to be issued covering the year 1982. The Environmental Surveillance at Hanford for CY 1982 was issued as PNL-4656 (Sula et al. 1983) and the Ground-Water Surveillance at the Hanford Site for CY 1982 was issued as PNL-4659 (Eddy, Prater and Rieger 1983).

The data provided in this report concern the radiological status of the environment in the immediate vicinity of the major operating areas. In general, the data were compared both to background measurements made during 1982 and to previous years' data. Sample analysis procedures are described in Appendix A and data analysis methods are summarized in Appendix B.

THE HANFORD SITE

The Hanford Site is located in a rural region of southeastern Washington State and occupies an area of 1500 km² (560 square miles). The site, shown in Figure 1, lies about 320 km (200 miles) east of Portland, Oregon, 270 km (170 miles) southeast of Seattle, Washington, and 200 km (125 miles) southeast of Spokane, Washington. The Columbia River flows through the northern edge of the Hanford Site and forms part of its eastern boundary.

The desert plain on which Hanford is located has a sparse covering of vegetation primarily suited for grazing. The most broadly distributed type of vegetation on the site is the sagebrush/cheatgrass/bluegrass community. The mule deer is the most abundant big-game animal on the site, and the most

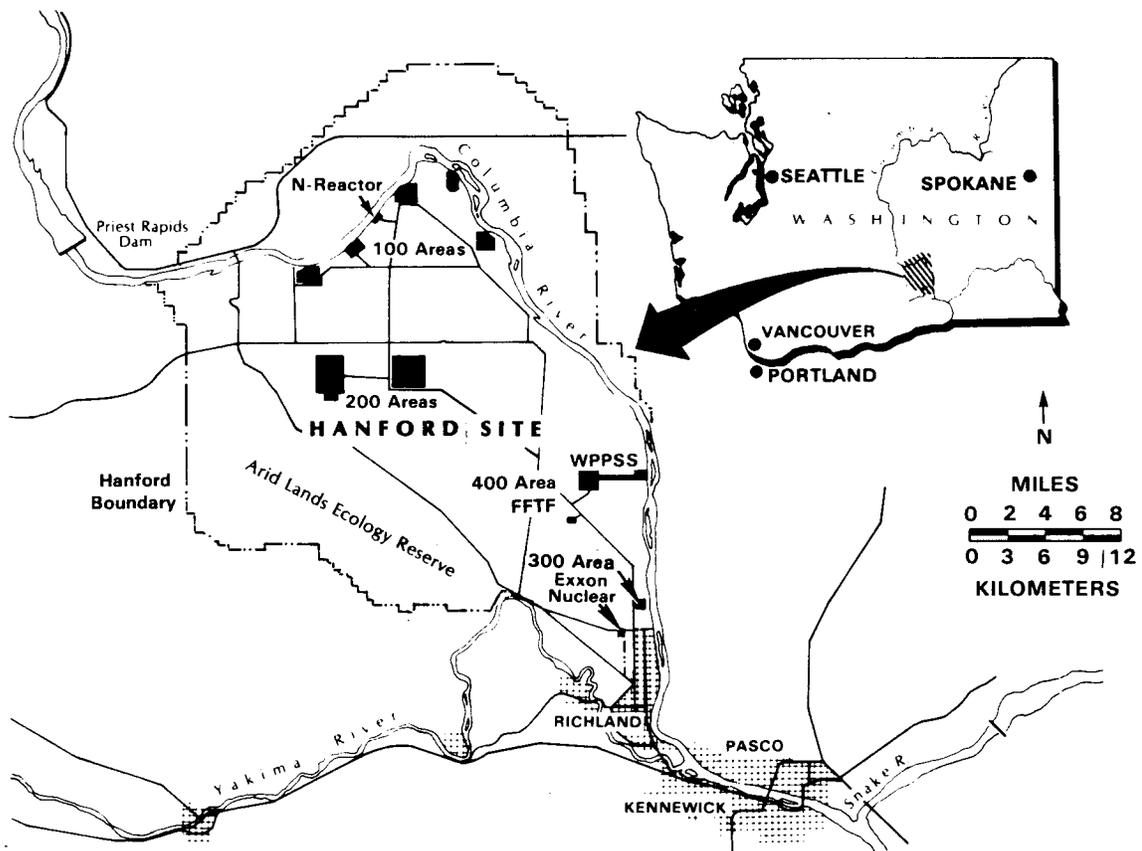


FIGURE 1. DOE's Hanford Site in Washington State

abundant small-game animal is the cottontail rabbit. The raccoon and coyote are the most abundant fur-bearing animals. The osprey, golden eagle, and bald eagle are occasional visitors to the relatively large areas of uninhabited land comprising the Hanford Site.

Hanford's climate is mild and dry; the area receives approximately 16 cm (6.3 in.) of precipitation annually. About 40% of the total precipitation occurs during November, December, and January, with only 10% falling in July, August, and September. The average maximum and minimum temperatures in July are 33°C (92°F) and 16°C (61°F). For January, the respective averages are 3°C (37°F) and -6°C (22°F). Approximately 45% of all precipitation from December through February is snow.

Mean monthly wind speeds range from about 14 km/h (9 mph) in the summer to 10 km/h (6 mph) in the winter. The prevailing regional winds are from the northwest with strong drainage and crosswinds causing complicated surface flow patterns. The region is a typical desert area with frequent strong atmospheric inversions that occur at night and break during the day, causing unstable and turbulent conditions.

With the exception of Hanford Site-related industries, the economy of the region is primarily agricultural. Major crops include alfalfa, wheat, corn, and potatoes. Several fruit orchards are located within a short distance of the Hanford Site. The Columbia River within and adjacent to the Hanford Site is used extensively for recreational purposes including fishing and waterfowl hunting.

The population center nearest to the Hanford Site is the Tri-Cities area (Richland, Pasco, and Kennewick), situated on the Columbia River downstream from the site with a combined population of approximately 90,000. Approximately 340,000 people live within an 80-km (50-mile) radius of the Hanford Site in the Yakima area, the Tri-Cities, several small communities, and the surrounding agricultural areas. Considerably more detail on site characteristics and activities is available in the Final Environmental Statement, Waste Management Operations at Hanford (USERDA 1975).

Established in 1943, the Hanford plant was originally designed, built, and operated to produce plutonium for nuclear weapons. At one time, nine production reactors were in operation, including eight with once-through cooling by treated river water. Between December 1964 and January 1971, all eight reactors with once-through cooling were deactivated. N Reactor, the remaining production reactor in operation, has a closed primary cooling loop.

Four major operating areas exist at the Hanford Site. The "100 Areas" include facilities for the N-Production Reactor and the eight deactivated production reactors along the Columbia River. The reactor fuel processing and waste management facilities are on a plateau about 11.3 km from the river in the "200 Areas." The "300 Area," just north of the city of Richland, contains the reactor fuel manufacturing facilities and research and development laboratories. The Fast Flux Test Facility (FFTF) is located in the "400 Area" approximately 8.8 km northwest of the 300 Area.

Privately owned facilities located within the Hanford Site boundaries include the Washington Public Power Supply System generating station adjacent to N Reactor, the Washington Public Power Supply System power reactor site and office building (under construction), a hazardous waste disposal site, and a radioactive waste burial site. The Exxon fuel fabrication facility is located immediately adjacent to the southern boundary of the Hanford Site.

Principal DOE contractors operating at Hanford are:

- Rockwell Hanford Operations (RHO)--responsible for fuel processing, waste management, and site support services such as plant security, fire protection, central stores, electrical power distribution, etc.
- Battelle Memorial Institute--responsible for operating the Pacific Northwest Laboratory (PNL). This includes research in the physical, life and environmental sciences, environmental surveillance, and advanced methods of nuclear waste management.
- UNC Nuclear Industries (UNC)--responsible for fabricating fuel and operating N Reactor.

- Westinghouse Hanford Company (WHC)--responsible for operating the Hanford Engineering Development Laboratory (HEDL), including advanced reactor developments, principally the Liquid Metal Fast Breeder Reactor Program and FFTF.

Highlights of operational activities at Hanford during 1982 were:

- N Reactor operated for 204 days during which time it supplied steam used by the Washington Public Power Supply System to generate 870 MW of electrical power. Since its startup, N Reactor has supplied steam for the production of over 50 billion kilowatt-hours of electric power, which has been supplied to the Bonneville Power Administration grid covering the Pacific Northwest.
- The FFTF completed its first 100-day full power operating campaign.
- New double-walled underground tanks for storage of high-level radioactive liquid wastes were put into service in the 200 Areas.
- N Reactor began operating in a 6% ^{240}Pu production mode in support of national defense program commitments.

Work at Hanford during 1982 also included Hanford National Environmental Research Park studies, Arid Land Ecology studies, and Basalt Waste Isolation Program activities, as well as continued operation of a variety of national research and laboratory facilities.

AIR SAMPLING

Airborne particulate and radioiodine sampling stations have been established at 23 onsite locations, primarily in the immediate vicinity of the four major operating areas as shown in Figure 2. Samples were collected and analyzed according to the schedule presented in Table 1. Samples are also collected at five locations distant from the site (Figure 2). These locations provide background concentrations for comparison.

Particulate airborne radionuclides were sampled by drawing air at a flow rate of 2.6 m³/h through a 5-cm diameter high-efficiency particulate filter.^(a) Radioiodines were collected on a 4.4-cm diameter by 5.5-cm deep bed of KI- and TEDA impregnated charcoal located downstream of the particulate filter.^(b) Samplers located at 100 D, 200 ESE and 400 E (see Table 1) also contain an atmospheric water vapor collection unit.

The particulate filters were collected biweekly and analyzed for gross beta and, in some cases, for gross alpha radioactivity after a seven-day holding period that allowed the short-lived naturally occurring radon and thoron daughters collected by the filter to decay. The filters were combined monthly according to geographical location and analyzed as a composite for gamma-emitting radionuclides, most importantly ¹³⁷Cs. On a quarterly basis, the filters for each geographical group were combined and analyzed as a composite for ⁹⁰Sr and plutonium. All analyses were performed by U.S. Testing Company, Inc.

Charcoal cartridges from several of the sampling locations were exchanged on a biweekly frequency and analyzed for ¹³¹I. The remaining cartridges were exchanged monthly to replenish the adsorption media, but were only to be analyzed if ¹³¹I was identified in one of the routinely analyzed samples. Tritium concentrations in atmospheric water vapor were measured biweekly in

(a) Model LB 5211, manufactured by Hollingsworth and Vose. Measured efficiencies exceed 99% for DOP (dioctyl-phthalate) particles.

(b) Manufactured by Nuclear Consulting Services, Inc. Retention efficiencies are 99% for both elemental and methyl iodine.

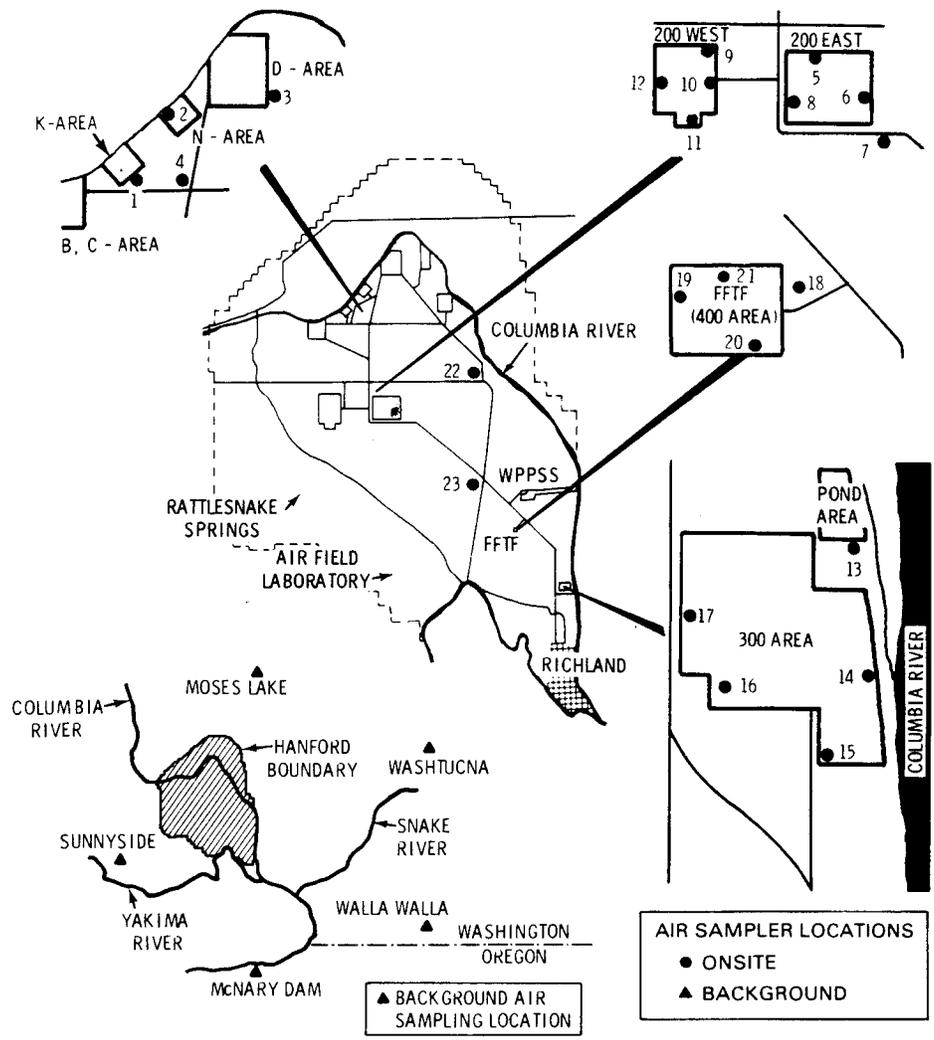


FIGURE 2. Onsite and Background Environmental Air Sampling Locations

the vicinity of the 100, 200 E, and 400 Areas. The water vapor collection unit consists of a 5-cm diameter by 20-cm deep cartridge containing silica gel through which a stream of air is passed at a flow rate of $0.03 \text{ m}^3/\text{h}$. Moisture removed from the air stream by the silica gel was recovered in the laboratory and analyzed for tritium. Tritium in atmospheric water vapor is thus reported in pCi/l of water vapor.

Results of the airborne particulate and radioiodine samples collected onsite during 1982 are summarized in Tables 2 through 7. General airborne particulate radioactivity levels in the Hanford environs were lower in 1982

TABLE 1. Onsite Air Sampling Schedule

Sample Location	Map Number	Airborne Particulates					Radiiodine		Water Vapor	
		Filter Exchange Period	Analysis Frequency			Pu	Cartridge Exchange Period	Analysis Frequency	Cartridge Exchange Period	Analysis Frequency
			Gross Beta	Gross Alpha	Gamma Scan					
<u>100 Areas</u>										
100 K	1	BW (a)								
100 N	2	BW								
100 D	3	BW								
Fire Station Composite	4	BW		M	Q (c)	Q	M (b)	NRA (d)	BW	BW
<u>200 East Area</u>										
200 ENC	5	BW	BW				M	NRA		
200 EEC	6	BW	BW				M	NRA		
200 ESE	7	BW	BW				BW	BW		
200 EMC Composite	8	BW	BW	M	Q	Q	M	NRA	BW	BW
<u>200 West Area</u>										
200 WNE	9	BW	BW				M	NRA		
200 WEC	10	BW	BW				M	NRA		
Redox	11	BW	BW				M	NRA		
200 WMC Composite	12	BW	BW	M	Q	Q	M	NRA		
<u>300 Area</u>										
300 Pond	13	BW	BW				M	NRA		
3614-A Bldg.	14	BW	BW				M	NRA		
300-S Gate	15	BW	BW				M	NRA		
300-SW Gate	16	BW	BW				BW	BW		
3705 Bldg. Composite	17	BW	BW	M	Q	Q	M	NRA		
<u>400 Area</u>										
400 E	18	BW	BW				BW	BW		BW
400 W	19	BW	BW				BW	BW		BW
400 S	20	BW	BW				BW	BW		BW
400 N Composite	21	BW	BW	M	Q	Q	M	BW		
<u>Inner East Sector</u>										
Hanford	22	BW	BW				M	NRA		
Wye Barricade Composite	23	BW	BW	M	Q	Q	M	NRA		

No entry indicates no analysis.
(a) Biweekly.
(b) Monthly.
(c) Quarterly.
(d) Not routinely analyzed.

than in 1981 as airborne radionuclides associated with the October 1980 atmospheric nuclear test conducted in the People's Republic of China continue to decline (Sula and Blumer 1981). The effect of atmospheric nuclear tests on ambient airborne radioactivity levels is demonstrated in Figure 3 which shows monthly averaged gross-beta particulate air concentrations near operating areas and at distant locations during the past five years. An increase in general background levels was observed almost immediately following the October 1980 atmospheric nuclear test, with maximum concentrations observed in samples collected during the spring and summer of 1981. By the beginning of 1982, airborne concentrations had returned to pretest levels. The figure also illustrates the similarity of airborne radioactivity levels at onsite and offsite locations during recent years.

In concert with gross radioactivity concentrations, individual radionuclides ($^{95}\text{ZrNb}$, ^{90}Sr , $^{144}\text{CePr}$, ^{137}Cs , ^{239}Pu) were detected less frequently and at lower concentrations during 1982 compared to 1981. Radionuclide concentrations in air samples were also observed to be similar between locations as shown in Tables 2 through 7. As in recent previous years, ^{131}I was not observed in any of the air samples collected. Tritium concentrations in atmospheric water vapor during 1982 are provided in Table 8.

In previous years atmospheric tritium as HTO has been reported in terms of atmospheric concentrations per unit volume of air (pCi/m^3). However, it has been determined that the tritium collection unit in operation at Hanford since 1977 has not reliably provided quantitative removal of water vapor from the sampled air stream, and hence, previously reported atmospheric HTO concentrations per volume of air are biased low. To enable comparison of the 1982 data with that obtained by the tritium samplers in previous years, historical data were converted from pCi of tritium per m^3 of air to pCi of tritium per % of atmospheric moisture and graphed in Figure 4. The figure shows that tritium levels in atmospheric moisture have been relatively constant for the last several years and that concentrations did not differ appreciably between sampling locations. Furthermore, the failure of the HTO sampler to completely remove all atmospheric water vapor from the sample stream resulted in contamination of the collecting media in the gaseous

tritium (HT) samplers located downstream of the HTO samplers at the 100-D and 200-ESE sampling locations. As a result tritium as HT data reported in the previous report in this annual report series (PNL-3729) as well as the data obtained from samples collected during 1982 is invalid.^(a)

(a) The HTO sampler has been redesigned and future data will be reportable in terms of pCi/m³ as well as pCi/l of moisture.

TABLE 2. Airborne Radioactivity Concentrations During 1982--100 Areas

Radionuclide	Sample Location	No. of Samples	No. of Results >DL (b)	Concentration, pCi/m ³ (a)		
				Maximum	Minimum	Average 1982 (c)
⁹⁰ Sr	Composite (d)	4	2	2.3X10 ⁻⁴ ± 5.5X10 ⁻⁵	<DL (e)	(1.3X10 ⁻⁴ ± 1.1X10 ⁻⁴) (1.0X10 ⁻⁴ ± 1.0X10 ⁻⁴)
⁹⁵ Zr/ ⁹⁵ Nb	Composite	13	4	0.008 ± 0.003	<DL	0.002 ± 0.002 (<0.01)
¹³¹ I	K Area	13				NRA (f)
	N Area	1	0	<DL	<DL	(<0.001)
	D Area	26	0	<DL	<DL	(<0.003)
	Fire Station	13				NRA
¹³⁷ Cs	Composite	13	3	0.004 ± 0.002	<DL	(<9.3X10 ⁻⁴) (<0.005)
¹⁴⁴ CePr	Composite	13	1	0.006 ± 0.005	<DL	(<0.0054)
	Composite	4	3	2.1X10 ⁻⁵ ± 1.3X10 ⁻⁵	<DL	1.2X10 ⁻⁵ ± 1.0X10 ⁻⁵ (3.0X10 ⁻⁵ ± 2.0X10 ⁻⁵)
Gross Beta	K Area	26	26	0.06 ± 0.005	0.02 ± 0.004	0.03 ± 0.005
	N Area	26	26	0.06 ± 0.005	0.01 ± 0.004	0.04 ± 0.005
	D Area	26	26	0.05 ± 0.005	0.02 ± 0.004	0.03 ± 0.004
	Fire Station	26	26	0.05 ± 0.005	0.02 ± 0.004	0.03 ± 0.004
						0.03 ± 0.002

(a) Maximum and minimum concentrations include the ±2σ counting error. Averages include the two-standard error term (95% confidence interval). If fewer than 75% of the results were >DL, the average was enclosed within parenthesis except that if fewer than 25% of the results were >DL, no average was calculated and the average minimum detectable concentration is shown. Averages were also included within parenthesis if less than their associated two-standard error term.

(b) >DL - Greater than the detection level, i.e., analysis of the sample yielded a positive identification.

(c) Except as noted, based on annual average of samples collected at "distant" stations during 1982. The distant stations were located at Moses Lake, Washucna, Walla Walla, McNary Dam, and Sunnyside as shown in Figure 1.

(d) Composites of biweekly samples from the individual sampling locations identified in Table 1.

(e) <DL - Less than the detection level; radionuclide not identified in sample.

(f) NRA - Not routinely analyzed.

TABLE 3. Airborne Radioactivity Concentrations During 1982--200-E Area

Radionuclide	Sample Location	No. of Samples	No. of Results >DL (b)	Concentration, pCi/m ³ (a)		
				Maximum	Minimum	Average 1982 Background (c)
90Sr	Composite (d)	4	4	3.2X10 ⁻⁴ ± 1.3X10 ⁻⁴	1.6X10 ⁻⁴ ± 1.0X10 ⁻⁴	2.2X10 ⁻⁴ ± 9.5X10 ⁻⁵
95ZrNb	Composite	13	3	0.04 ± 0.004	<DL (e)	(<0.007)
131I	200 ENC 200 EEC 200 ESE 200 EWC	26	0	<DL	<DL	NRA (f) NRA NRA
137Cs	Composite	13	9	0.003 ± 0.001	<DL	(1.2X10 ⁻³ ± 6.9X10 ⁻⁴)
144CePr	Composite	13	3	0.02 ± 0.01	<DL	(<0.005)
238Pu	Composite	4	0	<DL	<DL	(<3.6X10 ⁻⁶)
239,240Pu	Composite	4	2	2.0X10 ⁻⁵ ± 1.4X10 ⁻⁵	<DL	(1.2X10 ⁻⁵ ± 8.6X10 ⁻⁶)
Gross Beta	200 ENC 200 EEC 200 ESE 200 EWC	26 26 26 26	26 26 26 26	0.07 ± 0.005 0.07 ± 0.005 0.05 ± 0.005 0.05 ± 0.005	0.02 ± 0.004 0.02 ± 0.004 0.01 ± 0.005 0.01 ± 0.004	0.03 ± 0.005 0.04 ± 0.006 0.03 ± 0.004 0.03 ± 0.005 0.03 ± 0.003
Gross Alpha	200 ENC 200 EEC 200 ESE 200 EWC	26 26 26 26	26 26 26 26	1.7X10 ⁻³ ± 6.1X10 ⁻⁴ 1.8X10 ⁻³ ± 6.1X10 ⁻⁴ 2.0X10 ⁻³ ± 6.4X10 ⁻⁴	4.6X10 ⁻⁴ ± 3.7X10 ⁻⁴ 5.0X10 ⁻⁴ ± 3.5X10 ⁻⁴ 4.7X10 ⁻⁴ ± 3.3X10 ⁻⁴	1.0X10 ⁻³ ± 1.7X10 ⁻⁴ 9.8X10 ⁻⁴ ± 1.6X10 ⁻⁴ 9.8X10 ⁻⁴ ± 1.8X10 ⁻⁴ NRA
				1.0X10 ⁻³ ± 9.7X10 ⁻⁵		0.03 ± 0.002
						NS (g)

- (a) Maximum and minimum concentrations include the ±2σ counting error. Averages include the two-standard error term (95% confidence interval). If fewer than 75% of the results were >DL, the average was enclosed within parenthesis except that if fewer than 25% of the results were >DL, no average was calculated and the average minimum detectable concentration is shown. Averages were also included within parenthesis if less than their associated two-standard error term.
- (b) >DL - Greater than the detection level, i.e., analysis of the sample yielded a positive identification.
- (c) Except as noted, based on annual average of samples collected at "distant" stations during 1982. The distant stations were located at Moses Lake, Washtucna, Walla Walla, McNary Dam, and Sunnyside as shown in Figure 1.
- (d) Composites of biweekly samples from the individual sampling locations identified in Table 1.
- (e) <DL - Less than the detection level; radionuclide not identified in sample.
- (f) NRA - Not routinely analyzed.
- (g) NS - Not sampled.

TABLE 4. Airborne Radioactivity Concentrations During 1982--200-W Area

Radionuclide	Sample Location	No. of Samples	No. of Results >DL (b)	Concentration, pCi/m ³ (a)		
				Maximum	Minimum	Average 1982(c) Background
⁹⁰ Sr	Composite (d)	5	2	4.0X10 ⁻⁴ ± 6.3X10 ⁻⁵	<DL (e)	(1.6X10 ⁻⁴ ± 1.5X10 ⁻⁴) (1.0X10 ⁻⁴ ± 1.0X10 ⁻⁴)
⁹⁵ ZrNb	Composite	13	3	0.009 ± 0.005	<DL	(<0.0016) (<0.01)
¹³¹ I	200 WNE 200 WEC 200 WWC Redox					NRA (f) NRA NRA NRA
¹³⁷ Cs	Composite	13	6	0.003 ± 0.001	<DL	(9.2X10 ⁻⁴ ± 5.4X10 ⁻⁴) (<0.005)
¹⁴⁴ CePr	Composite	13	4	0.03 ± 0.01	<DL	(0.006 ± 0.006) (<0.05)
²³⁸ Pu	Composite	5	0	<DL	<DL	(<3.6X10 ⁻⁶)
^{239,240} Pu	Composite	5	3	2.6X10 ⁻⁵ ± 9.0X10 ⁻⁶	<DL	(2.5X10 ⁻⁵ ± 1.6X10 ⁻⁵) (3.0X10 ⁻⁵ ± 2.0X10 ⁻⁵)
Gross Beta	200 WNE 200 WEC 200 WWC Redox					0.03 ± 0.006 0.03 ± 0.005 0.03 ± 0.004 0.03 ± 0.006 0.03 ± 0.003
Gross Alpha	200 WNE 200 WEC 200 WWC Redox					1.2X10 ⁻³ ± 2.1X10 ⁻⁴ 1.1X10 ⁻³ ± 1.7X10 ⁻⁴ 1.1X10 ⁻³ ± 1.4X10 ⁻⁴ NS (g)

(a) Maximum and minimum concentrations include the ±2σ counting error. Averages include the two-standard error term (95% confidence interval). If fewer than 75% of the results were >DL, the average was enclosed within parenthesis except that if fewer than 25% of the results were >DL, no average was calculated and the average minimum detectable concentration is shown. Averages were also included within parenthesis if less than their associated two-standard error term.

(b) >DL - Greater than the detection level, i.e., analysis of the sample yielded a positive identification.

(c) Except as noted, based on annual average of samples collected at "distant" stations during 1982. The distant stations were located at Moses Lake, Washtucna, Walla Walla, McNary Dam, and Sunnyside as shown in Figure 1.

(d) Composites of biweekly samples from the individual sampling locations identified in Table 1.

(e) <DL - Less than the detection level; radionuclide not identified in sample.

(f) NRA - Not routinely analyzed.

(g) NS - Not sampled.

TABLE 5. Airborne Radioactivity Concentrations During 1982--300 Area

Radionuclide	Sample Location	No. of Samples	No. of Results >DL (b)	Concentration, pCi/m ³ (a)		Minimum	Average 1982 Background (c)
				Maximum	Annual Average		
⁹⁰ Sr	Composite (d)	4	3	1.6X10 ⁻⁴ ± 8.8X10 ⁻⁵	1.2X10 ⁻⁴ ± 6.3X10 ⁻⁵	<DL (e)	(1.0X10 ⁻⁴ ± 1.0X10 ⁻⁴)
⁹⁵ Zr/ ⁹⁵ Nb	Composite	13	4	0.008 ± 0.002	(0.002 ± 0.002)	<DL	(<0.01)
¹³¹ I	300 Pond 3614-A Bldg. 300-S Gate 300-SW Gate 3705 Bldg.	26	0	<DL	NRA (f) NRA NRA NRA	<DL	(<0.01)
¹³⁷ Cs	Composite	13	3	0.002 ± 0.001	(<4.1X10 ⁻⁴)	<DL	
¹⁴⁴ CePr	Composite	13	2	0.01 ± 0.01	(<0.004)	<DL	(<0.05)
²³⁸ Pu	Composite	4	0	<DL		<DL	
^{239,240} Pu	Composite	4	3	2.6X10 ⁻⁵ ± 9.0X10 ⁻⁶	1.4X10 ⁻⁵ ± 1.2X10 ⁻⁵	<DL	(3.0X10 ⁻⁵ ± 2.0X10 ⁻⁵)
Gross Beta	300 Pond 3614-A Bldg. 300-S Gate 300-SW Gate 3705 Bldg.	25 26 25 25 26	25 26 25 25 26	0.06 ± 0.006 0.07 ± 0.005 0.06 ± 0.005 0.05 ± 0.005 0.07 ± 0.005	0.03 ± 0.006 0.03 ± 0.006 0.03 ± 0.005 0.03 ± 0.004 0.03 ± 0.005	0.02 ± 0.005 0.02 ± 0.005 0.02 ± 0.004 0.02 ± 0.004 0.02 ± 0.004	0.03 ± 0.002
Gross Alpha	300 Pond 3614-A Bldg. 300-S Gate 300-SW Gate 3705 Bldg.	1 26	1 25	1.7X10 ⁻³ ± 5.9X10 ⁻⁴	4.0X10 ⁻³ ± 3.0X10 ⁻³ 9.8X10 ⁻⁴ ± 1.6X10 ⁻⁴	<DL	NS (g)

(a) Maximum and minimum concentrations include the ±2σ counting error. Averages include the two-standard error term (95% confidence interval). If fewer than 75% of the results were >DL, the average was enclosed within parenthesis except that if fewer than 25% of the results were >DL, no average was calculated and the average minimum detectable concentration is shown. Averages were also included within parenthesis if less than their associated two-standard error term.

(b) >DL - Greater than the detection level, i.e., analysis of the sample yielded a positive identification.

(c) Except as noted, based on annual average of samples collected at "distant" stations during 1982. The distant stations were located at Moses Lake, Washitucna, Walla Walla, McNary Dam, and Summyside as shown in Figure 1.

(d) Composites of biweekly samples from the individual sampling locations identified in Table 1.

(e) <DL - Less than the detection level; radionuclide not identified in sample.

(f) NRA - Not routinely analyzed.

(g) NS - Not sampled.

TABLE 6. Airborne Radioactivity Concentrations During 1982--400 Area (FFTF)

Radionuclide	Sample Location	No. of Samples	No. of Results >DL (b)	Concentration, pCi/m ³ (a)		
				Maximum	Minimum	Average 1982 (c) Background
90Sr	Composite (d)	4	3	1.9X10 ⁻⁴ ± 1.0X10 ⁻⁴	<DL (e)	1.4X10 ⁻⁴ ± 1.0X10 ⁻⁴ (1.0X10 ⁻⁴ ± 1.0X10 ⁻⁴)
95Zr/Nb	Composite	13	3	0.04 ± 0.004	<DL	(<0.006)
131I	400 E	26	0	<DL	<DL	(<0.002)
	400 W	24	0	<DL	<DL	(<0.002)
	400 S	26	0	<DL	<DL	(<0.002)
	400 N	25	0	<DL	<DL	(<0.003)
137Cs	Composite	13	4	0.003 ± 0.002	<DL	(5.4X10 ⁻⁴ ± 6.0X10 ⁻⁴) (<0.005)
144CePr	Composite	13	3	0.02 ± 0.01	<DL	(<0.005)
238Pu	Composite	4	2	1.3X10 ⁻⁴ ± 5.5X10 ⁻⁵	<DL	(5.0X10 ⁻⁵ ± 6.8X10 ⁻⁵)
239,240Pu	Composite	4	1	1.7X10 ⁻⁴ ± 6.0X10 ⁻⁵	<DL	(4.3X10 ⁻⁵ ± 8.3X10 ⁻⁵) (3.0X10 ⁻⁵ ± 2.0X10 ⁻⁵)
Gross Beta	400 E	26	26	0.05 ± 0.005	0.01 ± 0.004	0.03 ± 0.004
	400 W	24	24	0.05 ± 0.005	0.02 ± 0.004	0.03 ± 0.004
	400 S	26	26	0.06 ± 0.005	0.02 ± 0.004	0.03 ± 0.004
	400 N	25	25	0.06 ± 0.005	0.02 ± 0.004	0.03 ± 0.002
Gross Alpha	400 E	26	25	1.9X10 ⁻³ ± 6.3X10 ⁻⁴	<DL	9.6X10 ⁻⁴ ± 1.9X10 ⁻⁴
	400 W	24	23	1.8X10 ⁻³ ± 6.0X10 ⁻⁴	<DL	1.1X10 ⁻³ ± 2.0X10 ⁻⁴
	400 S	26	26	2.0X10 ⁻³ ± 6.3X10 ⁻⁴	3.8X10 ⁻⁴ ± 3.6X10 ⁻⁴	1.1X10 ⁻³ ± 1.8X10 ⁻⁴
	400 N	25	25	2.2X10 ⁻³ ± 6.7X10 ⁻⁴	6.0X10 ⁻⁴ ± 3.8X10 ⁻⁴	1.0X10 ⁻³ ± 1.7X10 ⁻⁴
						1.0X10 ⁻³ ± 9.1X10 ⁻⁵ NS (f)

(a) Maximum and minimum concentrations include the ±2σ counting error. Averages include the two-standard error term (95% confidence interval). If fewer than 75% of the results were >DL, the average was enclosed within parenthesis except that if fewer than 25% of the results were >DL, no average was calculated and the average minimum detectable concentration is shown. Averages were also included within parenthesis if less than their associated two-standard error term.

(b) >DL - Greater than the detection level, i.e., analysis of the sample yielded a positive identification.

(c) Except as noted, based on annual average of samples collected at "distant" stations during 1982. The distant stations were located at Moses Lake, Washitucna, Walla Walla, McNary Dam, and Summyside as shown in Figure 1.

(d) Composites of biweekly samples from the individual sampling locations identified in Table 1.

(e) <DL - Less than the detection level; radionuclide not identified in sample.

(f) NS - Not sampled.

TABLE 7. Airborne Radioactivity Concentrations During 1982--Inner East Sector

Radionuclide	Sample Location	No. of Samples	No. of Results >DL (b)	Concentration, pCi/m ³ (a)		Minimum	Average 1982 Background (c)
				Maximum	Annual Average		
⁹⁰ Sr	Composite (d)	5	1	3.5X10 ⁻⁴ ± 1.0X10 ⁻⁴	<DL (e)	<DL (e)	(1.0X10 ⁻⁴ ± 1.0X10 ⁻⁴)
⁹⁵ ZrNb	Composite	13	4	0.03 ± 0.02	<DL	<DL	(0.003 ± 0.006)
¹³¹ I	Hanford Wye Barricade						NRA (f) NRA
¹³⁷ Cs	Composite	13	3	0.003 ± 0.002	<DL	<DL	(<0.001)
¹⁴⁴ CePr	Composite	13	3	0.05 ± 0.04	<DL	<DL	(<0.01)
²³⁸ Pu	Composite	5	2	6.4X10 ⁻⁵ ± 4.2X10 ⁻⁵	<DL	<DL	(3.2X10 ⁻⁵ ± 5.2X10 ⁻⁵)
^{239,240} Pu	Composite	5	2	8.5X10 ⁻⁵ ± 4.5X10 ⁻⁵	<DL	<DL	(2.7X10 ⁻⁵ ± 3.7X10 ⁻⁵)
Gross Beta	Hanford Wye Barricade	25 26	25 26	0.06 ± 0.005 0.06 ± 0.005	0.02 ± 0.004 0.02 ± 0.004		0.03 ± 0.004 0.03 ± 0.004 0.03 ± 0.003
Gross Alpha	Hanford Wye Barricade	1 26	1 26	1.9X10 ⁻³ ± 6.5X10 ⁻⁴	5.0X10 ⁻⁴ ± 3.5X10 ⁻⁴		1.3X10 ⁻³ ± 5.3X10 ⁻⁴ 1.0X10 ⁻³ ± 1.8X10 ⁻⁴ 1.0X10 ⁻³ ± 1.7X10 ⁻⁴ NS(g)

(a) Maximum and minimum concentrations include the ±2σ counting error. Averages include the two-standard error term (95% confidence interval). If fewer than 75% of the results were >DL, the average was enclosed within parenthesis except that if fewer than 25% of the results were >DL, no average was calculated and the average minimum detectable concentration is shown. Averages were also included within parenthesis if less than their associated two-standard error term.

(b) >DL - Greater than the detection level, i.e., analysis of the sample yielded a positive identification.

(c) Except as noted, based on annual average of samples collected at "distant" stations during 1982. The distant stations were located at Moses Lake, Washitucna, Walla Walla, McNary Dam, and Sunnyside as shown in Figure 1.

(d) Composites of biweekly samples from the individual sampling locations identified in Table 1.

(e) <DL - Less than the detection level; radionuclide not identified in sample.

(f) NRA - Not routinely analyzed.

(g) NS - Not sampled.

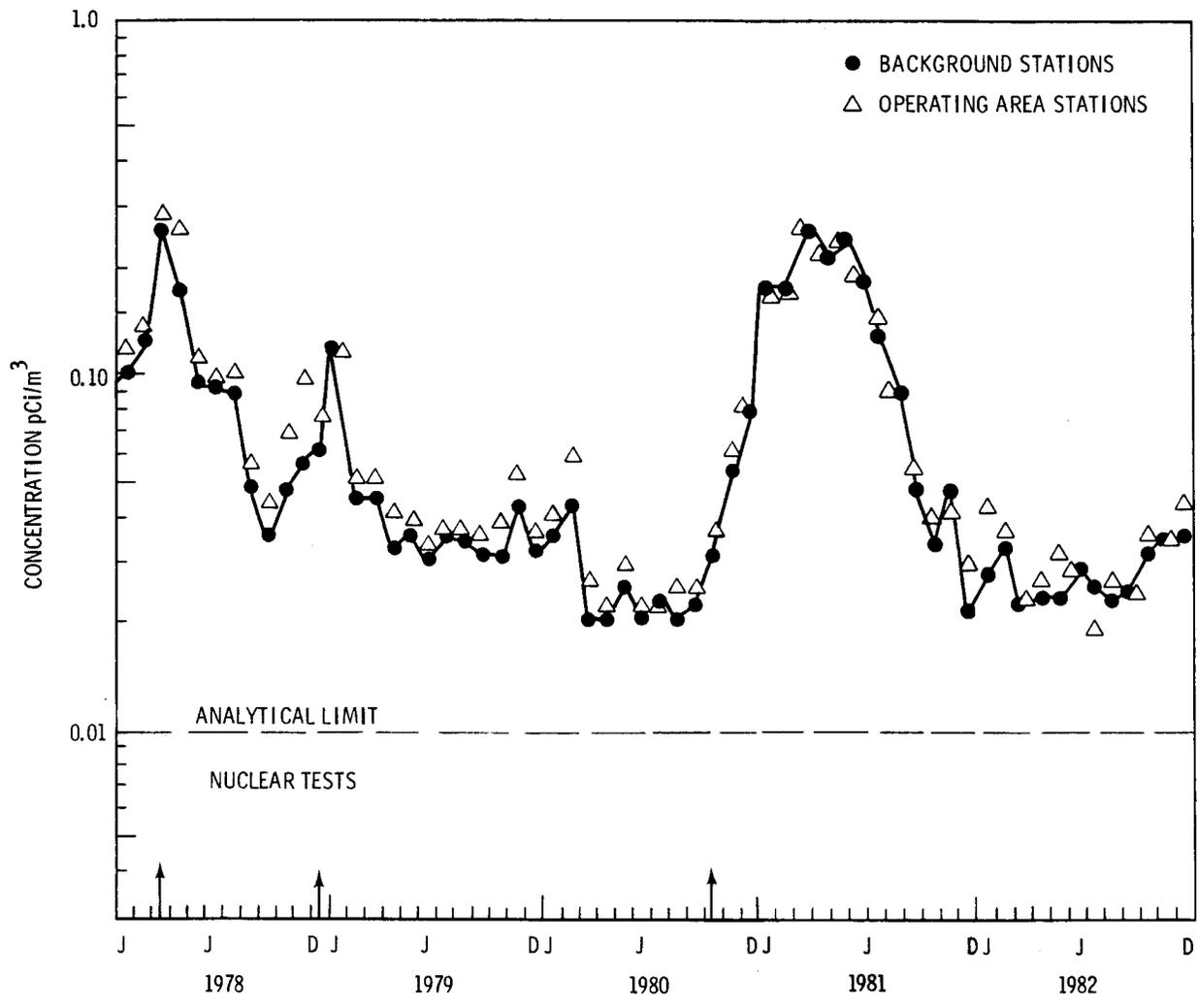


FIGURE 3. Monthly Average Gross Beta-Emitter Activity in the Atmosphere

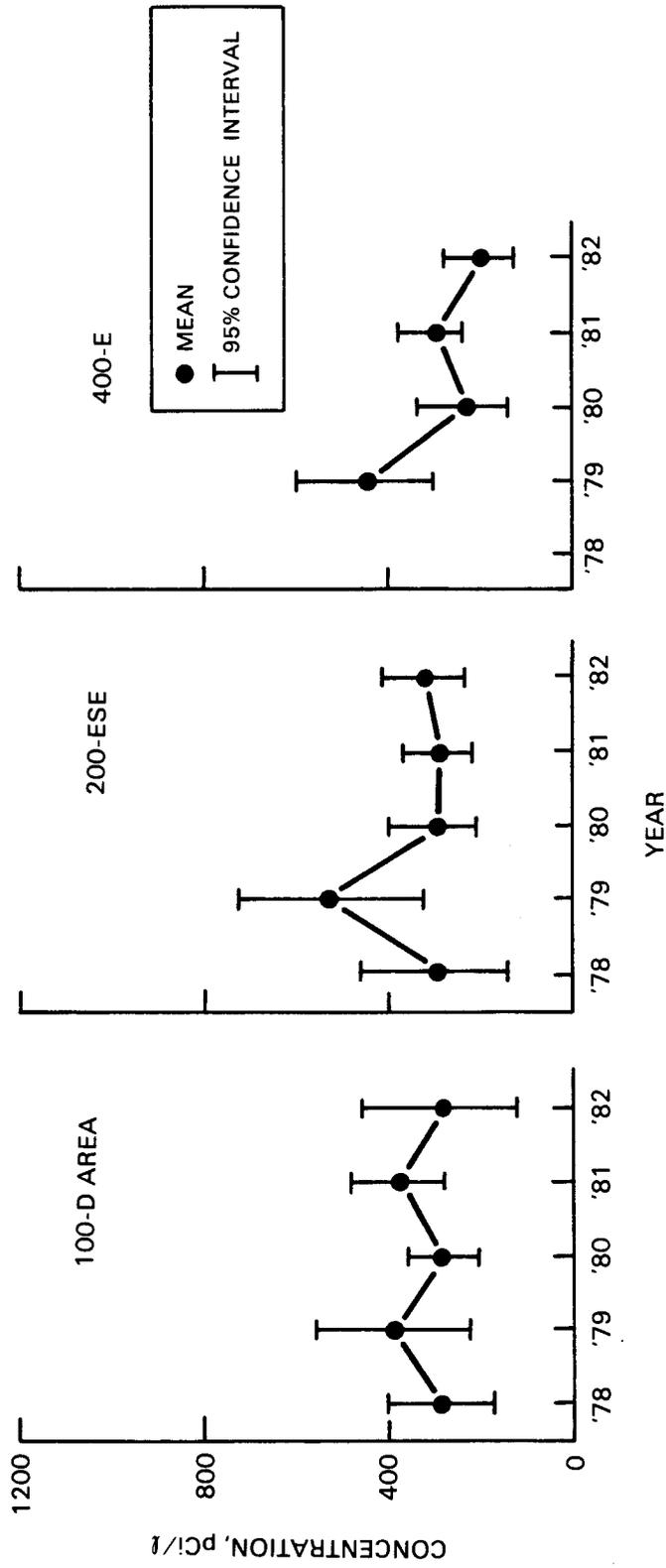


FIGURE 4. Average Annual Tritium Concentrations in Atmospheric Water Vapor at Onsite Sampling Locations

TABLE 8. Tritium Concentrations in Atmospheric Water Vapor Samples During 1982

Location	No. of Samples	No. of Results >DL ^(b)	Concentration, pCi/l ^(a)		
			Maximum	Minimum	Annual Average
<u>ONSITE</u>					
D Area	20	14	1500 ± 700	<DL ^(c)	290 ± 160
200 ESE	22	21	950 ± 430	<DL	320 ± 90
400 E	22	17	700 ± 250	<DL	200 ± 80
<u>OFFSITE</u>					
Fir Road	21	17	990 ± 270	<DL	240 ± 100
Richland	17	14	650 ± 250	<DL	250 ± 80
Benton City	20	15	870 ± 260	<DL	230 ± 110

- (a) Maximum and minimum concentrations include the $\pm 2\sigma$ counting error. Averages include the two-standard error term (95% confidence interval).
- (b) >DL - Greater than the detection level, i.e., analysis of the sample yielded a positive identification.
- (c) <DL - Less than the detection level; radionuclide not identified in sample.

PONDS

Four ponds located outside of operating area exclusion fences (Figure 5) were sampled periodically during 1982 for radioactivity. Two of the ponds, Gable Pond and B Pond near the 200 East Area, were built in the mid-1950s for disposal of chemical process cooling water and wastes occasionally containing low levels of radioactive contamination. The FFTF Pond, built in 1978, is a sewage disposal and treatment lagoon and does not receive any radioactive

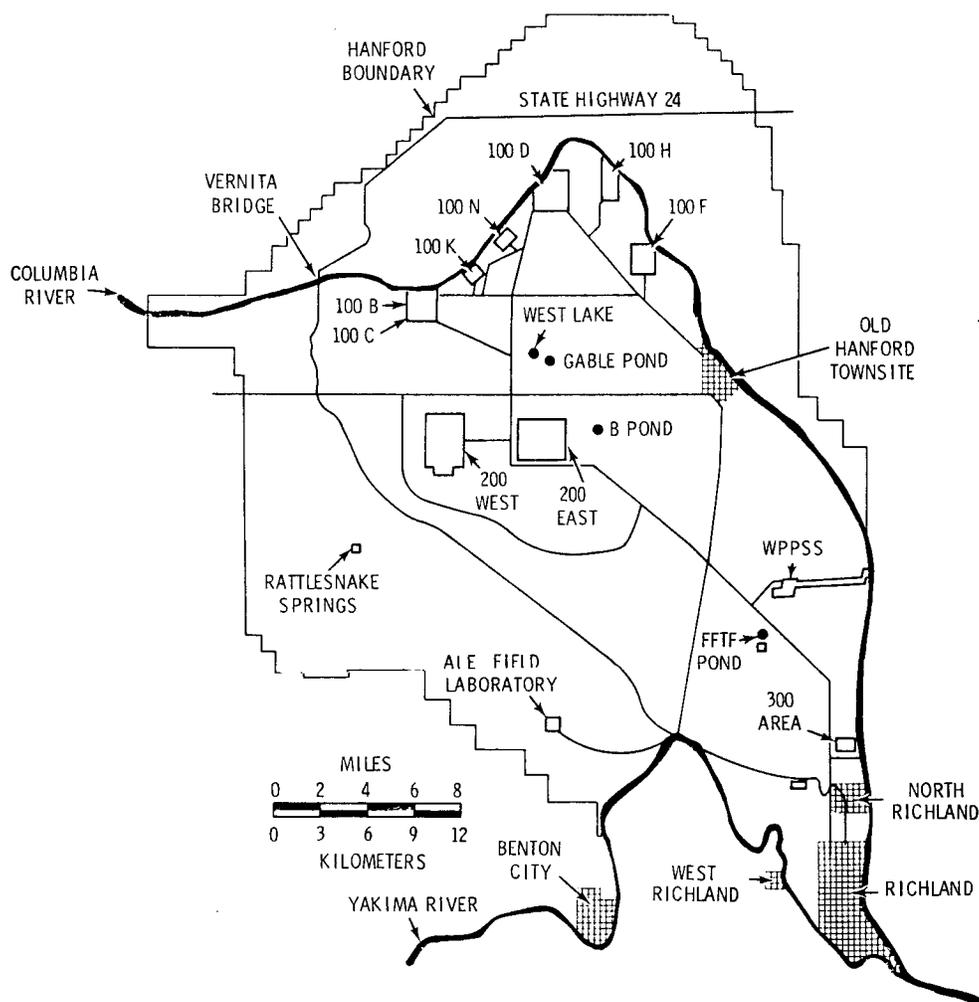


FIGURE 5. Onsite Ponds

wastes. The fourth pond, West Lake, is a natural lake and does not receive any discharges from site facilities. The ponds are accessible to migrating waterfowl as well as other animals. Thus, a potential pathway exists for removal and dispersal of contaminants that may be present in the pond water and sediments or in biota associated with the ponds.

Three-gallon grab samples of water from each pond were collected quarterly and analyzed for gross alpha, gross beta, gamma emitters, and ^{90}Sr , with the exception that FFTF Pond water was analyzed for ^{22}Na instead of ^{90}Sr . Results of 1982 samples are shown in Table 9.

Cesium-137 concentrations in B Pond were lower during 1982 compared to 1981 while ^{90}Sr concentrations remained about the same. Concentrations of these two radionuclides in B Pond increased during 1980 as shown in Figure 6. Monthly sampling was initiated during 1980 to enable trends to be observed more closely; however, with stabilization of radionuclide concentrations during 1981 the sampling was subsequently reduced to a quarterly frequency consistent with the other onsite ponds. The increased radionuclide concentrations observed during 1980 were well below applicable Concentration Guides and did not pose any special environmental problems.

A comparison of radionuclide concentrations in the other onsite ponds (West Lake, Gable Pond, and FFTF Pond) to data obtained from the previous year's samples (Sula, Blumer and Dirkes 1982) showed no significant changes.

The highest gross alpha and gross beta concentrations were observed in West Lake. Special water samples collected and analyzed in 1975 indicated the radioactivity in the pond to be primarily from naturally occurring uranium (Fix, Speer and Blumer 1976). West Lake is recharged from a deep aquifer with only minor exchange of water between the pond and the shallow aquifer (Gephart et al. 1976). Therefore, the observed radioactivity is the result of naturally occurring radionuclides in the pond recharge that have been concentrated by evaporation over the years.

TABLE 9. Radionuclide Concentrations in Onsite Ponds During 1982

Location	Date	Concentration, pCi/ℓ (a)				Total Alpha Activity	Total Beta Activity
		⁹⁰ Sr (b)	¹³⁷ Cs (c)	²² Na	(d)		
West Lake	2/9	3.8 ± 0.42	(-0.28 ± 4.8)	NA	192 ± 13	654 ± 69	
	5/4	2.7 ± 0.13	(-0.15 ± 1.5)		329 ± 35	482 ± 56	
	10/19	2.1 ± 0.41	0.66 ± 0.54		50 ± 3.0	159 ± 35	
Gable Pond	2/9	0.79 ± 0.05	25 ± 3.2		0.75 ± 0.45	18 ± 5.9	
	5/4	3.7 ± 0.06	45 ± 1.6		1.1 ± 0.54	26 ± 5.9	
	7/27	1.3 ± 0.06	18 ± 0.79		(0.38 ± 0.39)	18 ± 5.6	
	10/19	0.85 ± 0.08	19 ± 1.1		0.61 ± 0.44	22 ± 5.5	
B Pond	2/9	0.99 ± 0.42	6.5 ± 2.9		1.1 ± 0.51	12 ± 5.6	
	5/4	4.6 ± 0.13	3.0 ± 2.5		6.8 ± 1.2	23 ± 5.8	
	7/27	3.2 ± 0.13	11 ± 1.5		15 ± 3.9	47 ± 27	
	10/19	0.98 ± 0.27	4.1 ± 0.75		0.98 ± 0.52	7.7 ± 5.1	
FFTF Pond	2/9	NA	(-0.006 ± 1.4)	(0.15 ± 1.4)	(0.04 ± 0.32)	(19 ± 25)	
	5/4		(0.13 ± 1.9)	(0.28 ± 1.9)	(-0.04 ± 0.29)	--	
	7/27		0.33 ± 0.28	0.20 ± 0.18	(0.02 ± 0.30)	6.7 ± 5.8	
	10/19		(-0.18 ± 0.49)	(0.10 ± 0.24)	(0.22 ± 0.37)	14 ± 5.6	

- (a) Individual results show the 2σ counting error and are enclosed within parenthesis if less than the 2σ counting error.
- (b) Concentration Guide for uncontrolled areas is 300 pCi/ℓ (DOE 5480.1, Chapter XI).
- (c) Concentration Guide for uncontrolled areas is 20,000 pCi/ℓ (DOE 5480.1, Chapter XI).
- (d) NA - Not analyzed.

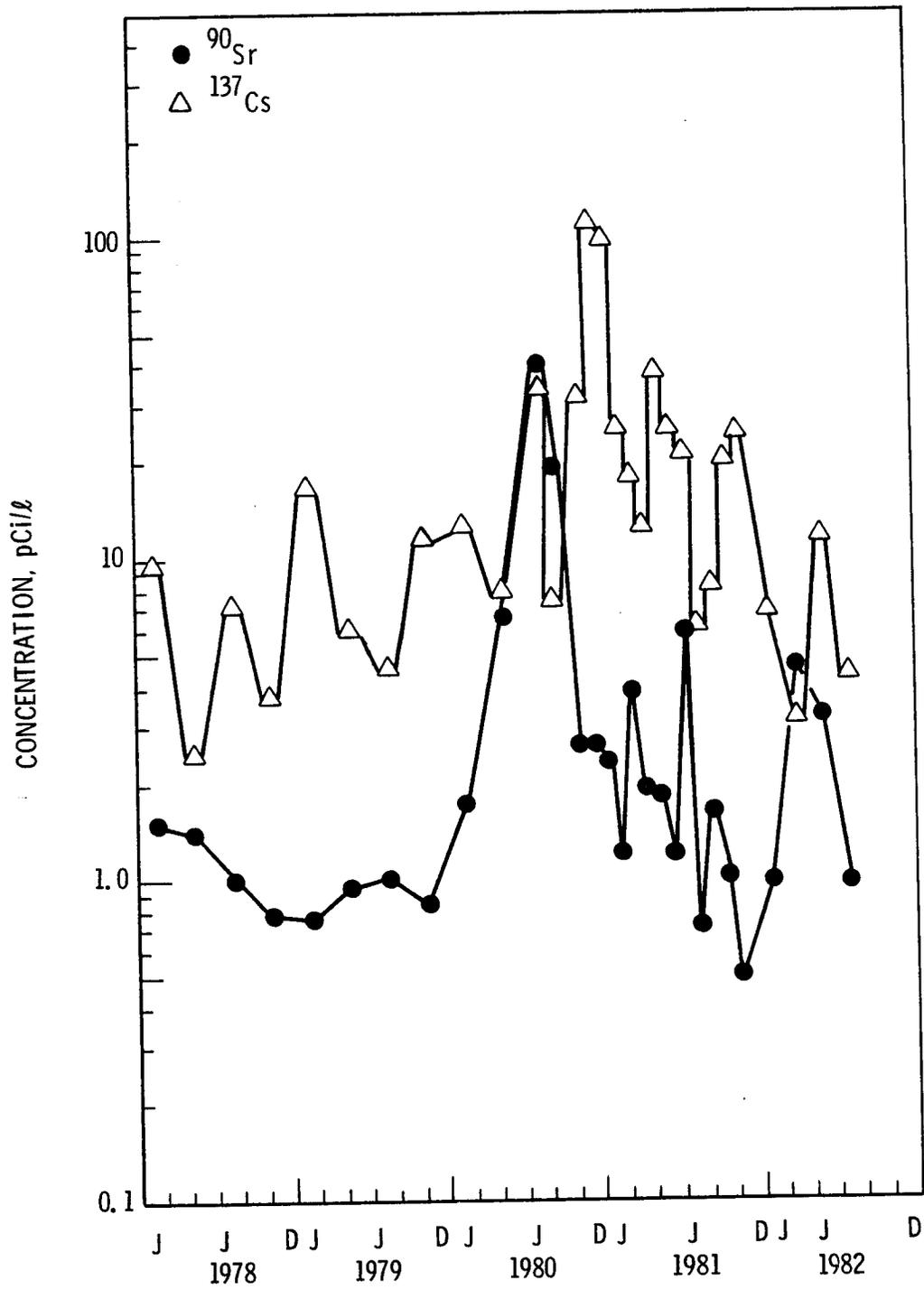


FIGURE 6. Strontium-90 and Cesium-137
 Concentrations in B Pond

WILDLIFE

The Hanford Site provides refuge for migratory and resident waterfowl, upland game birds, and a variety of other animals. These animals have access to contaminated onsite ponds (see previous section) and vegetation growing in and near the ponds. The ingestion of contaminated water or vegetation from the pond areas, or from any other contaminated area provides a mechanism for transfer of radionuclides away from the designated waste management areas. Additionally, for game animals, the ingestion of radioactive contamination represents a potential public exposure pathway.

Wildlife sampling provides an indication of the availability of contamination in the vicinity of the operating areas. Sampling was performed in and near operating areas to maximize the probability of collecting wildlife with detectable levels of Hanford-produced radionuclides.

Onsite wildlife sampling during 1982 included waterfowl (ducks, geese), upland game birds (quail, pheasant), deer, and rabbits. Results of 1982 wildlife samples and the associated potential for offsite radiological impact have been previously discussed in the Environmental Surveillance at Hanford for CY 1982 report (Sula et al. 1983).

DEER

Samples from deer that have accidentally been killed by vehicles on site roads are used to provide an indication of radionuclide levels for the herd residing on the site. During 1982 samples of muscle tissue were collected from three road-killed deer and analyzed for ^{137}Cs . The analyses indicated the presence of identifiable levels of ^{137}Cs in only one deer at 0.009 ± 0.008 pCi/g wet weight. This concentration was barely detectable (as indicated by the large analytical uncertainty), in the range generally associated with worldwide fallout, and consistent with levels observed in recent previous years. Although Hanford mule deer tend to have defineable home ranges, long-distance movements within or off the site are common; therefore, the specific foraging locations for the "randomly sampled" road-killed deer are unknown.

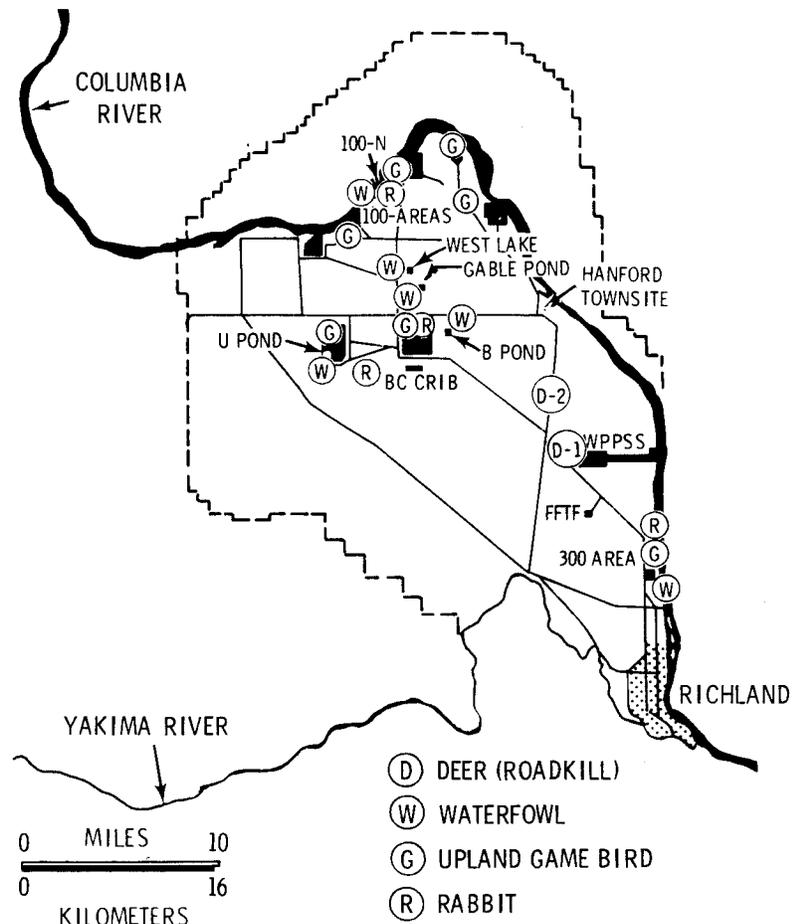


FIGURE 7. Onsite Wildlife Collection Sites

As a supplement to the routinely collected road-killed samples, a special sampling program was conducted during 1981 and 1982 to estimate maximum ^{137}Cs concentration in muscle tissue of deer residing on the Hanford Site (Eberhardt, Hanson and Cadwell 1982). Thirty-seven deer were captured in the vicinity of the 200-Area waste management sites and fitted with transmitting radiocollars. The movements of these deer were followed for a year, and during this period; deer that foraged consistently in the vicinity of the 200 Areas were collected and analyzed for ^{137}Cs . Several deer that had foraged away from the 200 Areas were also collected to provide an indication of background ^{137}Cs concentrations in local deer. In addition, samples of the collected deer were provided to U.S. Testing Co. for analysis of ^{90}Sr in bone and $^{239,240}\text{Pu}$ in liver. Table 10 provides the results of these

TABLE 10. Radionuclide Concentrations in Specially Sampled Hanford Deer, 1981 to 1982

Location, Forage Pattern	No. of Samples	Concentration, pCi/g wet weight (a)								
		¹³⁷ Cs - Muscle (b)		⁹⁰ Sr - Bone (c)		²³⁹ Pu - Liver (c)				
		Maximum	Minimum	Average	Maximum	Minimum	Average			
Residing near 200 Areas with >50% of time within 2 km of a waste management site	6	1.4 ± 0.2	<DL	(0.5 ± 0.5)	65 ± 1	5.3 ± 0.4	28 ± 17	0.01 ± 0.001	<DL	(0.003 ± 0.003)
Residing near 200 Areas with <50% of time within 2 km of a waste management site	6	0.02 ± 0.008	<DL	(0.004 ± 0.008)	8.2 ± 0.1	0.58 ± 0.03	3.3 ± 2.4	0.04 ± 0.01	<DL	(0.009 ± 0.013)
Residing away from 200 Areas	5	0.02 ± 0.008	<DL	(0.006 ± 0.010)	5.3 ± .6	0.52 ± 0.03	2.1 ± 1.9	0.003 ± 0.0008	<DL	(0.001 ± 0.001)

(a) Average includes an estimate of the two-standard error of the mean (95% confidence interval).

(b) From Eberhardt, Hansen, Cadwell 1982. Concentrations in pCi/g wet weight calculated from dry weight data using a wet to dry weight conversion factor of 0.264.

(c) Analyzed by U.S. Testing Company.

analyses and shows that deer residing near waste management areas contained greater concentrations of ^{137}Cs and ^{90}Sr than deer foraging elsewhere. No differences were observed; however, for plutonium concentrations. The data in Table 10 provide an indication of the magnitude of radionuclide concentrations in Hanford deer.

UPLAND GAME BIRDS

Upland game birds including pheasant and quail were obtained on the Hanford Site during 1982. Samples were collected near the 100, 200 and 300 Areas (Figure 7).

Samples of breast meat from each bird were analyzed for ^{137}Cs and ^{60}Co . Results are provided in Table 11. Cobalt-60 concentrations were fairly low, and near the minimum detectable concentration for all samples. Cesium-137 concentrations were similarly low except for a single bird collected in the vicinity of 200-W Area in which a concentration of 40 ± 0.2 pCi/g was observed.

WATERFOWL

Waterfowl samples (ducks and geese) were collected along the Columbia River in the vicinity of 100-N Area as well as from each of the five onsite ponds shown in Figure 7. An approximately 0.5 kg sample of breast meat from each bird was analyzed for ^{137}Cs . Results of the analyses are shown in Table 12.

Samples collected on the waste-water ponds near the 200 Areas showed an accumulation of ^{137}Cs in tissue at levels similar to those observed in recent years. The maximum concentration observed was 160 pCi/g in a duck collected from U Pond. Concentrations observed in samples collected from the Columbia River near 100-N Area and from the 300 Area pond showed lower concentrations, generally in the range attributable to worldwide fallout.

RABBITS

Cottontail rabbits and jack rabbit hares were collected in the vicinity of several onsite operating areas as indicated in Figure 7. The samples were

TABLE 11. Radionuclide Concentrations in Game Birds During 1982

Location	Concentration, pCi/g wet weight (a)					
	⁶⁰ Co		¹³⁷ Cs		Fraction of Results >DL	Average
	Fraction of Results >DL (b)	Maximum	Average (c)	Maximum		
100 Areas						
Quail	1/3	0.07 ± 0.06	(0.02 ± 0.06)	0.11 ± 0.08	2/3	0.08 ± 0.04
Pheasant	2/8	0.03 ± 0.02	(<0.02)	0.05 ± 0.02	3/8	0.01 ± 0.02
200 Areas						
Pheasant	0/2	<DL (d)	(<0.01)	40 ± 0.2	2/2	[21 ± 48] (e)
300 Area						
Quail	0/4	<DL	(<0.06)	0.17 ± 0.06	1/4	(<0.05)

(a) Maximum values shown with the ±2σ counting error term. Averages are shown with the ± two-standard error of the mean.

(b) >DL - Greater than the detection level; i.e., analysis of sample yielded a positive identification. Averages were enclosed within parenthesis if the ± two-standard error was greater than its associated mean.

(d) <DL - Less than detection level; radionuclide not identified in sample.

(e) [] - Average significantly biased by single high result.

TABLE 12. Cesium-137 in Muscle Tissue of Waterfowl During 1982

Location	Type	Fraction of Samples >DL (b)	Concentration, pCi/g wet weight (a)		
			Maximum	Minimum	Average (c)
100-N Area					
Columbia River	Geese	1/2	0.05 ± 0.01	<DL (d)	(0.03 ± 0.04)
Columbia River	Ducks	3/3	0.04 ± 0.02	0.01 ± 0.01	0.03 ± 0.01
200 Areas					
B Pond	Ducks	5/5	38 ± 1	12.0 ± 0.2	23 ± 10
U Pond	Ducks	7/7	160 ± 1	12.0 ± 0.2	58 ± 18
Gable Pond	Ducks	4/4	9.8 ± 0.2	0.09 ± 0.03	(3 ± 5)
West Lake	Ducks	6/6	62 ± 0.6	0.2 ± 0.06	23 ± 20
300 Area					
Pond	Ducks	5/7	0.26 ± 0.05	<DL	0.12 ± 0.04

- (a) Individual results shown with the $\pm 2\sigma$ counting error term. Average shown with the \pm two-standard error term (95% confidence interval).
- (b) >DL Greater than the detection level, i.e., analysis of sample yielded a positive indication.
- (c) Average enclosed within parenthesis if the \pm two-standard error term was equal to or greater than the indicated concentration.
- (d) <DL Less than the detection level; radionuclide not identified in sample.

analyzed for ^{60}Co and ^{137}Cs in muscle and ^{90}Sr in bone. Results are provided in Table 13.

Cesium-137 was identified consistently only in samples collected near the 200-E Area; however, concentrations in all three of the samples collected near 200-E Area were very low and near the minimum detectable concentration of about 0.03 pCi/g wet weight. Cobalt-60 was not identified consistently at any of the sampling locations. Cobalt-60 had been observed in seven of nine samples collected near 100-N Area in 1981. The reduced concentrations observed in the N-Area samples during 1982 may be attributed to the solid cover installed over the 100-N waste disposal trench in late 1981. Strontium-90 in bone was observed in all of the rabbits with the highest concentrations observed, as in previous years, in 100-N Area samples. Because the retention of ^{90}Sr in bone is relatively long, several years as compared to several days for ^{60}Co and ^{137}Cs in muscle, the observed ^{90}Sr concentrations may be the result of uptakes prior to the trench cover installation. The wide range of observed ^{90}Sr concentrations (nearly 3 orders of magnitude) is similar to that observed in 1982 with the difference in concentration most likely the result of the individual rabbit residence and foraging patterns.

TABLE 13. Radionuclide Concentrations in Rabbits and Hares During 1982

Location	Concentration, pCi/g, wet weight(a)											
	Muscle						Bone					
	60Co		137Cs		90Sr		60Co		137Cs		90Sr	
Fraction of Results >DL(b)	Maximum	Minimum <DL(c)	Average (c)	Fraction of Results >DL	Maximum	Minimum <DL	Average (<0.06)	Fraction of Results >DL	Maximum	Minimum	Average (370 ± 620)(e)	
100-N Area	2/5	0.11 ± 0.05	<DL	(0.02 ± 0.08)	1/5	0.15 ± 0.04	<DL	(<0.06)	5/5	1600 ± 70	0.6 ± 0.6	(370 ± 620)(e)
200-BC Crib	0/1	-	-	(<0.03)	0/1	-	-	(<0.03)	-	-	-	0.24 ± 0.08
200-E Area	1/3	0.02 ± 0.01	<DL	(0.01 ± 0.02)	3/3	0.06 ± 0.04	0.03 ± 0.01	(0.05 ± 0.02)	3/3	4.7 ± 0.5	2.5 ± 1.0	3.3 ± 1.4
300 Area	0/4	-	-	(<0.03)	0/4	-	-	(<0.02)	4/4	26 ± 1	0.27 ± 0.05	(7 ± 13)(e)

- (a) Individual results shown with the $\pm 2\sigma$ counting error term. Average shown with the \pm two-standard error term (95% confidence interval). Cottontails collected from the 100 and 300 Areas. Jack rabbits collected from other locations.
- (b) >DL Greater than the detection level, i.e., analysis of the sample yielded a positive identification.
- (c) Average enclosed within parenthesis if the \pm two-standard error term was equal to or greater than the indicated concentration.
- (d) <DL Less than the detection level; radionuclide not identified in sample.
- (e) Average significantly biased by a single high result.

SOIL AND VEGETATION

Soil and vegetation samples are collected annually to establish background concentrations of naturally occurring and fallout radionuclides and to assess any radionuclide build-up that might be attributable to site operations. Samples were collected from 16 onsite locations during 1982 as shown in Figure 8. Each sample consisted of a composite of five "plugs" of soil collected within a 100-m² area at the designated sampling location. Each plug of soil was 2.5 cm deep and 10 cm in diameter.

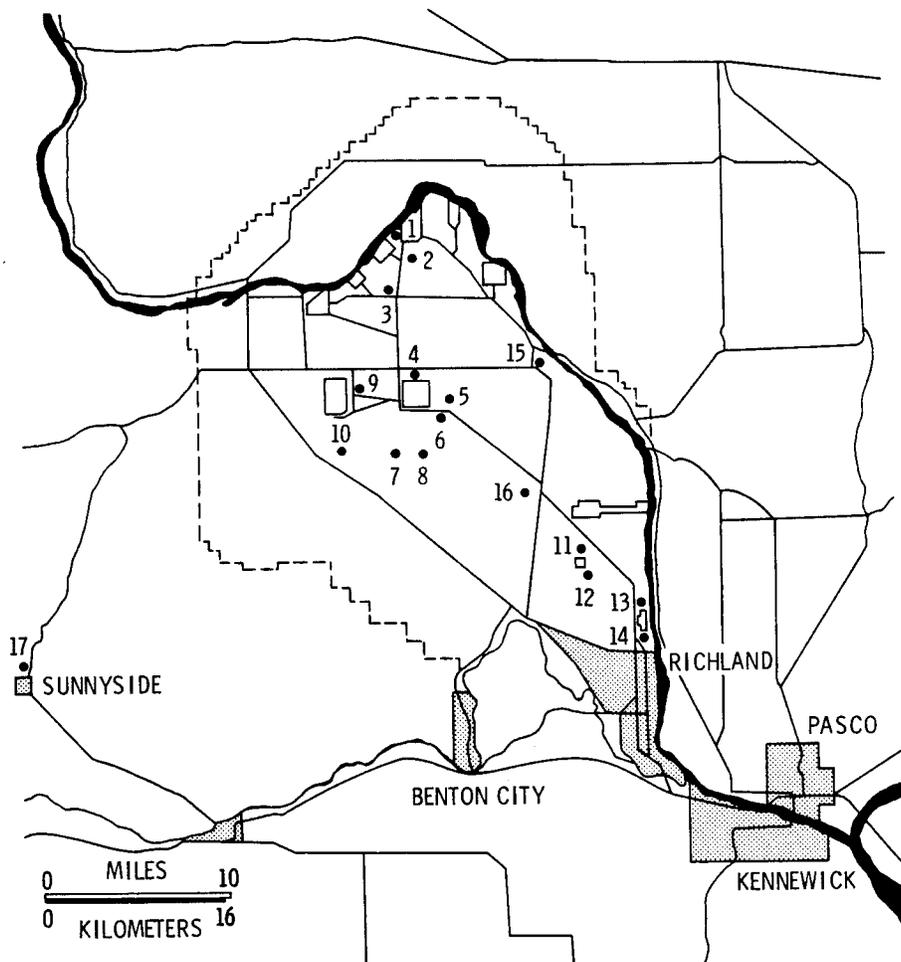


FIGURE 8. Onsite Soil and Vegetation Sampling Locations

Samples of perennial shrubs (rabbitbrush, sagebrush, and bitterbrush) were collected in the immediate vicinity of each soil sample location. Because no one type of perennial vegetation was available at every one of the sampling locations, each sample consisted of a mixture of the species present at the sampling location in proportion to its relative abundance. Both the soil and vegetation samples were analyzed for gamma-emitting radionuclides, ^{90}Sr , plutonium, and uranium.

Tables 14 and 15 show the radionuclide concentrations observed in onsite soil and vegetation samples collected during 1982. Included for comparison is the average concentration in samples collected at Sunnyside representative of general background levels of radionuclides. Additional soil and vegetation data at offsite locations during 1982 is provided in the report on environmental surveillance at Hanford for CY 1982 (Sula et al. 1983).

Soil radionuclide concentrations were, in general, similar to concentrations that have been reported in the previous several annual reports with ^{90}Sr , ^{137}Cs , and plutonium continuing to be observed at concentrations above background in several of the samples collected near the 200 Areas. Specifically, the "200-ENC" sample showed higher-than-background ^{90}Sr and ^{137}Cs concentrations consistent with previous samples collected at this location. The "East of 200-West Area" sample exhibited higher-than-background $^{239,240}\text{Pu}$ concentrations, as it has during previous years. There were no obvious trends in soil radionuclide concentrations as indicated by data collected during the last several years at these two locations.

Radionuclide concentrations in soil near the FFTF facility continue to appear to be somewhat below worldwide fallout levels. This may possibly be attributed to a range fire in 1970 that destroyed the cover vegetation in the FFTF Area and exposed the surface soil to wind erosion.

Short-lived radionuclides ($^{95}\text{ZrNB}$, ^{144}Ce) that had been observed in soil samples collected in 1981 were not observed in 1982 samples. The presence of the short-lived radionuclides in 1981 samples is attributed to worldwide fallout associated with a foreign atmospheric nuclear test in 1980.

TABLE 14. Radionuclide Concentrations in Onsite Soil Samples During 1982

Sample Location	Map Location	Concentration, pCi/g dry weight (a)							U-Total
		⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	^{239,240} Pu	²⁴¹ Am			
1 Mile NE of N Area	1	(<0.05)	0.20 ± 0.03	0.67 ± 0.08	0.02 ± 0.003				0.23 ± 0.08
1 Mile E of N Area	2	(<0.02)	0.15 ± 0.06	0.54 ± 0.04	0.03 ± 0.003				0.22 ± 0.08
100-Area Fire Station	3	(<0.03)	0.28 ± 0.04	0.99 ± 0.06	0.02 ± 0.003				0.32 ± 0.11
200 ENC	4	(<0.06)	0.93 ± 0.13	22 ± 0.37	0.06 ± 0.009		(<0.03)		0.45 ± 0.16
1.25 Mile E of Purex	5	(<0.06)	0.33 ± 0.09	1.5 ± 0.10	0.02 ± 0.002		(<0.03)		0.32 ± 0.11
200-East Hill	6	(<0.02)	0.29 ± 0.05	1.8 ± 0.08	0.02 ± 0.004		(<0.03)		0.37 ± 0.13
2 Miles S of Purex	7	(<0.06)	0.18 ± 0.05	0.54 ± 0.07	0.01 ± 0.001		(<0.03)		0.30 ± 0.11
3 Miles SSW of Purex	8	(<0.06)	0.13 ± 0.10	0.31 ± 0.06	0.01 ± 0.001		(<0.03)		0.27 ± 0.09
E of 200 W	9	(<0.02)	0.48 ± 0.11	3.2 ± 0.10	0.78 ± 0.02		(<0.03)		0.73 ± 0.26
2 Miles S of 200 W	10	(<0.08)	0.06 ± 0.005	0.21 ± 0.06	0.004 ± 0.002		(<0.03)		0.39 ± 0.14
NE of FFTF	11	(<0.03)	(<0.04)	0.13 ± 0.02	0.002 ± 0.001				0.30 ± 0.10
SE of FFTF	12	(<0.03)	(<0.05)	0.19 ± 0.03	0.005 ± 0.002				0.28 ± 0.10
N of 300 Area	13	(<0.03)	0.22 ± 0.03	0.85 ± 0.05	0.02 ± 0.003				0.99 ± 0.35
S of 300 Area	14	(<0.03)	0.24 ± 0.15	1.1 ± 0.06	0.02 ± 0.003				0.51 ± 0.18
Hanford Townsite	15	(<0.05)	0.24 ± 0.08	0.96 ± 0.08	0.02 ± 0.003		(<0.04)		0.32 ± 0.11
Wye Barricade	16	(<0.03)	0.21 ± 0.03	1.1 ± 0.06	0.02 ± 0.003		(<0.03)		0.38 ± 0.13
Offsite Location (b) (Sunnyside)	17	(<0.05)	(0.1 ± 0.3)	(0.4 ± 0.7)	(0.01 ± 0.03)		(<0.02)		(0.2 ± 0.4)

(a) Results include the ±2σ counting error. Counting error shown in parenthesis in cases where the radionuclide was not positively identified.
 (b) Represents general range of concentrations observed in samples collected during the past five years.

TABLE 15. Radionuclide Concentrations in Onsite Vegetation Samples During 1982

Sample Location	Map Location	Concentration, pCi/g dry weight (a)							U-Total
		⁶⁰ Co	⁹⁰ Sr	¹³⁷ Cs	¹⁵⁴ Eu	^{239,240} Pu	²⁴¹ Am		
1 Mile NE of N Area	1	(<0.09)	0.03 ± 0.002	(<0.06)	0.27 ± 0.13	(<0.0004)		0.01 ± 0.005	
1 Mile E of N Area	2	0.26 ± 0.09	0.05 ± 0.005	0.09 ± 0.07	(<0.19)	0.0012 ± 0.0010		0.02 ± 0.007	
100-Area Fire Station	3	(<0.08)	0.05 ± 0.007	(<0.07)	0.45 ± 0.18	(<0.0004)		0.008 ± 0.003	
200 ENC	4	(<0.06)	0.10 ± 0.02	0.23 ± 0.05	(<0.18)	(<0.0007)	(<0.03)	0.006 ± 0.002	
1.25 Mile E of Purex	5	(<0.12)	0.14 ± 0.009	0.37 ± 0.13	0.39 ± 0.34	0.0008 ± 0.0007	0.03 ± 0.02	0.01 ± 0.005	
200-East Hill	6	(<0.07)	0.03 ± 0.003	0.08 ± 0.05	(<0.15)	(<0.0006)	(<0.03)	0.006 ± 0.002	
2 Miles S of Purex	7	(<0.05)	0.17 ± 0.005	0.05 ± 0.04	0.12 ± 0.10	(<0.0006)	(<0.03)	0.01 ± 0.004	
3 Miles SSW of Purex	8	(<0.04)	0.05 ± 0.003	0.05 ± 0.02	(<0.09)	(<0.0006)	(<0.02)	0.01 ± 0.003	
E of 200 W	9	0.12 ± 0.08	0.07 ± 0.005	(<0.04)	(<0.22)	0.004 ± 0.0008	(<0.03)	0.01 ± 0.004	
2 Miles S of 200 W	10	(<0.07)	0.05 ± 0.003	(<0.06)	(<0.18)	(<0.0007)	(<0.02)	0.01 ± 0.003	
NE of FFTF	11	0.09 ± 0.06	0.009 ± 0.002	(<0.04)	0.17 ± 0.16	(<0.001)		0.002 ± 0.0008	
SE of FFTF	12	(<0.04)	0.02 ± 0.002	(<0.02)	(<0.07)	(<0.0004)		0.007 ± 0.002	
N of 300 Area	13	(<0.08)	0.008 ± 0.001	(<0.05)	(<0.16)	0.003 ± 0.0007		0.01 ± 0.005	
S of 300 Area	14	(<0.03)	0.03 ± 0.004	0.02 ± 0.01	(<0.09)	0.001 ± 0.0007		0.006 ± 0.002	
Hanford Townsite	15	(<0.04)	0.06 ± 0.003	0.07 ± 0.02	(<0.10)	0.0004 ± 0.0003	0.01 ± 0.002	0.01 ± 0.004	
Wye Barricade	16	(<0.07)	0.04 ± 0.008	0.07 ± 0.06	(<0.20)	(<0.0008)	(<0.03)	0.005 ± 0.002	
Offsite Location (b) (Sunnyside)	17	(<0.25)	(0.005 ± 0.2)	(0.03 ± 0.2)	(<0.1)	(0.001 ± 0.003)	(<0.02)	(.01 ± .02)	

(a) Results include the ±2σ counting error. Counting error is shown within parenthesis in cases where the radionuclide was not positively identified.

(b) Represents general range of concentrations observed in samples collected during the past five years.

Concentrations of long-lived radionuclides in vegetation samples (Table 15) were similar to those observed at the respective locations in previous years and were not significantly different from concentrations observed during 1982 at offsite locations (Sula et al. 1983).

EXTERNAL RADIATION MEASUREMENTS

Onsite external penetrating radiation measurements were made at the locations shown in Figure 9. The measurements were made using thermoluminescent dosimeters (TLDs) that consist of $\text{CaF}_2:\text{Mn}$ chips encased in an opaque plastic capsule with appropriate filtration to flatten their response to low-energy radiations (Fix and Miller 1978). The dosimeters integrate the dose received during their four-week field cycle.

The results of measurements taken onsite during 1982 are given in Table 16.

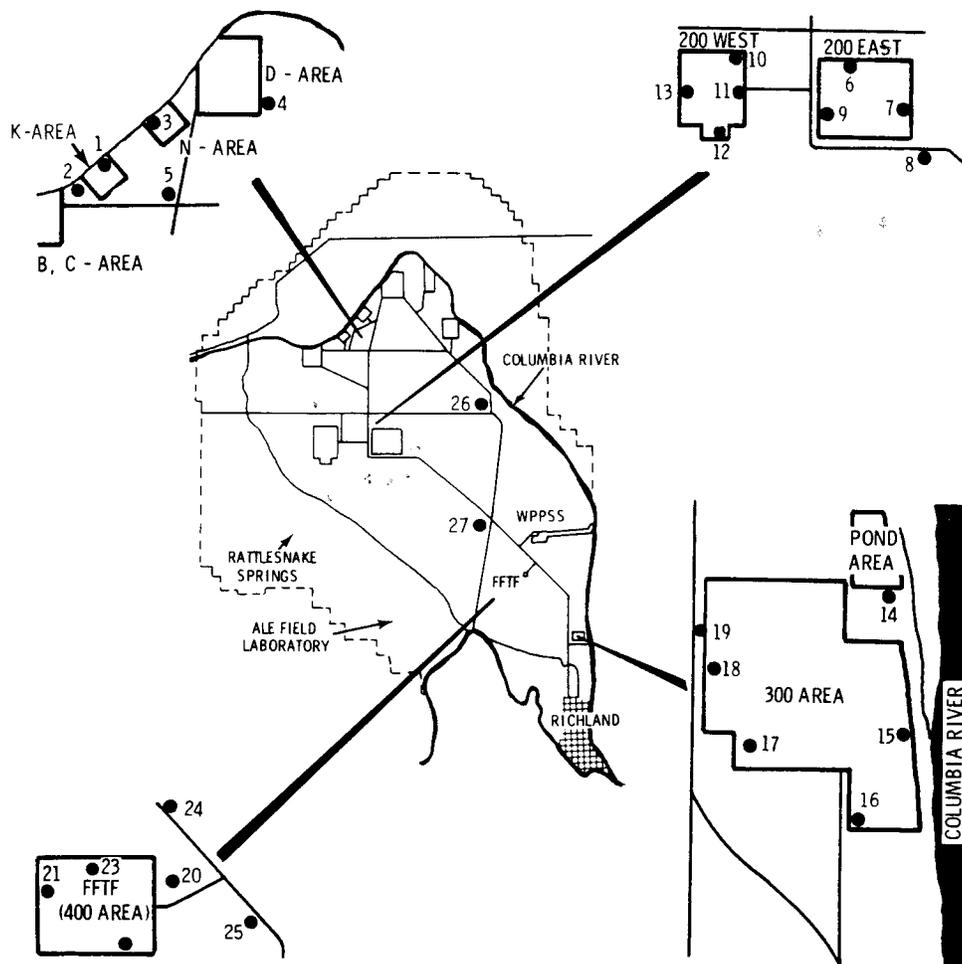


FIGURE 9. Onsite External Penetrating Dose Rate Measurement Locations

TABLE 16. Onsite External Penetrating Dose Measurements During 1982

Operating Areas	Location	Map Location	No. of Measurements	Dose Rate, mrem/hr (a)		Average (b)
				Maximum	Minimum	
100 Area	100 K	1	13	0.016	0.006	0.003 ± 0.001
	Below 100-K Retention Basin	2	10	0.061	0.021	0.040 ± 0.007
	100 N	3	13	0.014	0.005	0.010 ± 0.001
	100 D	4	13	0.010	0.007	0.008 ± 0.0005
	100-Area Fire Station	5	13	0.010	0.006	0.008 ± 0.0005
200-E Area	200 ENC	6	13	0.018	0.014	0.016 ± 0.0007
	200 EEC	7	13	0.011	0.009	0.010 ± 0.0005
	200 ESE	8	13	0.010	0.008	0.009 ± 0.0005
	200 EWC	9	13	0.010	0.007	0.008 ± 0.0005
	200 WNE	10	13	0.010	0.007	0.008 ± 0.0005
200-W Area	200 WEC	11	13	0.009	0.006	0.008 ± 0.0003
	Redox	12	13	0.011	0.008	0.009 ± 0.0007
	200 WWC	13	13	0.011	0.009	0.010 ± 0.0003
	300 Pond	14	13	0.046	0.008	0.011 ± 0.006
300 Area	3614-A Bldg.	15	13	0.009	0.008	0.008 ± 0.0002
	300-S Gate	16	12	0.010	0.008	0.008 ± 0.0003
	300-SW Gate	17	13	0.010	0.008	0.008 ± 0.0004
	3705 Bldg.	18	14	0.019	0.010	0.016 ± 0.011
	377 Bldg.	19	10	0.340	0.280	0.31 ± 0.02
	400 E	20	13	0.009	0.007	0.008 ± 0.0003
	400 W	21	12	0.010	0.006	0.008 ± 0.0006
400 Area	400 S	22	13	0.010	0.007	0.008 ± 0.0004
	400 N	23	13	0.010	0.007	0.008 ± 0.0004
	FFTF North	24	13	0.010	0.007	0.009 ± 0.0005
	FFTF Southeast	25	13	0.010	0.008	0.008 ± 0.0003
	Hanford	26	13	0.011	0.007	0.009 ± 0.0005
Inner East Sector	Wye Barricade	27	13	0.011	0.007	0.008 ± 0.0006

(a) Monthly integrated readings in mR were converted to hourly rates.
 (b) Average shown includes ± two-standard error term (95% confidence level).

External penetrating radiation above background levels was observed in several locations near onsite operating areas during 1982. The existence of a subsurface contamination deposit at the "Below 100-K Retention Basin" dosimeter location was responsible for the consistently elevated dose rates observed at this location during the year. Because of the stable but elevated background dose rate levels at this location, the site is not particularly suitable for monitoring dose rates associated with operations and effluents from the nearby facilities. Dose rate monitoring at this location thus was discontinued late in 1982.

Slightly elevated readings observed at the 100-N location were attributed to short-lived noble gases in airborne effluents or direct radiations during periods of N Reactor operation.

Several dosimeters located on the perimeter of the 200 Areas also showed dose rates above background. The highest dose rates were observed at the 200-ENC location. Stored radioactive wastes within the 200 Areas are considered to be the cause for the slightly elevated dose rates. Dose rates in the 200 Areas were similar to those observed in previous years. Dose rates in the 300 Area were within the range of normal background levels at three of the six locations monitored, but were elevated at the other three locations as a result of direct radiation from onsite research activities involving a radioactive nuclear power plant steam generator. The highest rates were observed at the 300 Area perimeter fence just west of the steam generator examination facility (Location 19 in Figure 9) where measured dose equivalent rates for 1982 averaged 0.3 mrem/hr.

Dose rates near the 400 Areas were at normal ambient levels during 1982.

RADIATION SURVEYS

Onsite roads, railroads and radioactive waste disposal sites outside of operating areas were routinely surveyed to detect abnormal levels of radioactivity. An annual aerial survey of the site perimeter was also conducted. Routes and frequencies for 1982 were defined in the surveillance program's Master Schedule (Blumer, Sula and Eddy 1981).

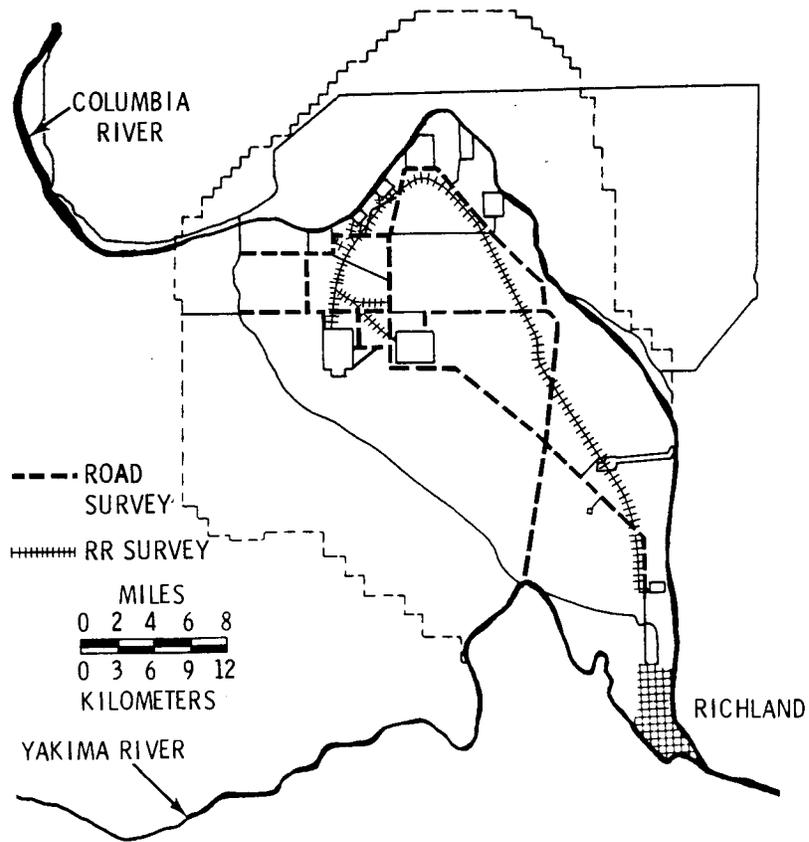


FIGURE 10. Road and Railroad Survey Routes

ROAD SURVEYS

Roads, shown in Figure 10, were surveyed routinely using four scintillation detectors mounted across the rear bumper of a vehicle positioned approximately 0.3 m above the surface of the road. During 1982, no abnormal conditions were observed on the site roadways.

RAILROAD SURVEYS

Railroad tracks, also shown in Figure 10, were surveyed using a single scintillation detector mounted approximately 0.3 m above the ground in the center of a small rail car. The use of the track and the potential for contamination dictated the survey frequencies that were defined in the master schedule. No abnormal contamination levels were detected during the 1982 surveys.

AERIAL SURVEY

The perimeter of the site was surveyed using a scintillation detector mounted in an aircraft. The plane was flown 500 ft above the ground at an air speed of 120 to 130 mph. During the 1982 survey, no indication of unusual contamination levels was observed.

WASTE DISPOSAL SITE SURVEYS

Waste disposal sites (active, inactive and retired) outside of operating area perimeter fences were surveyed for changes in levels of radioactivity and visually inspected for general physical conditions. During 1982, surveys of radioactive waste sites showed levels similar to those observed in recent past years.

ENVIRONMENTAL RELEASES

Each operating contractor at Hanford is responsible for controlling, monitoring and reporting effluents discharged from their facilities. This section summarizes the planned and unplanned release of effluents at Hanford during 1982 as reported by the appropriate operating contractor. The section is divided into two parts: "Environmental Discharges" and "Environmentally Related Unusual Occurrences."

Information included within the "Environmental Discharges" section was obtained from the following sources:

PNL--Radioactive discharges to the environment during 1982 are contained in the DOE Effluent Information System. Nonradioactive discharges are monitored through the National Pollutant Discharge Elimination System (NPDES).

WHC--Radioactive discharges to the environment during 1982 are contained in the DOE Effluent Information System.

UNC--Radioactive and nonradioactive discharges during 1982 are reported in an annual Effluent Release Report (Fogel 1983) and in the DOE Effluent Information System.

RHO--Radioactive and nonradioactive discharges during 1982 are reported in several reports which are issued annually (Aldrich 1983; Sliger 1983; Anderson, Poremba and McCann 1983; and McNair et al. 1983).

The "Environmentally Related Unusual Occurrences" portion of this section includes a compilation of those unusual occurrences during 1982 that involved the unplanned release of radioactive materials to the environment. Formal reporting of the occurrence by the contractor involved is required by DOE. The complete unusual occurrence reports, of which brief summaries are provided here, are maintained in the public reading room of the Hanford Science Center, located in the Federal Building, Richland, Washington.

ENVIRONMENTAL DISCHARGES

The planned release of radioactive and nonradioactive materials to the environment may occur as airborne or liquid effluents or as solid waste.

Airborne Effluents

Radioactive and nonradioactive pollutants discharged to the atmosphere during 1982 are summarized in Tables 17 and 18. The tables are subdivided according to the major operating areas and include all releases reported by contractors in each of the areas. Radioactive materials discharged to the atmosphere consisted of fission and activation products normally associated with the uranium fuel cycle. Nonradioactive airborne releases consisted primarily of emissions from fossil-fueled steam plants, oxides of nitrogen from fuel fabrication, waste handling facilities, PUREX process testing activities, and evaporated organic liquids from laboratory facilities.

Liquid Effluents

Liquid wastes generated at Hanford are placed in storage facilities, converted to solids, or discharged either to ground disposal facilities (cribs, trenches, ponds, etc.) or to the Columbia River.

Radioactive and nonradioactive liquid wastes, discharged to the ground during 1982, are shown in Tables 19 and 20, respectively. The quantities listed are totals for all ground disposal facilities within operating areas.

Radioactive liquids discharged to the Columbia River from operating facilities during 1982 are listed in Table 21. The reported discharges are for liquid effluent systems in the 100 Areas, including seepage from the 1301-N crib and trench system at 100-N Area. Not included in Table 21 are the quantities of ^3H (tritium) and ^{129}I that entered the Columbia River via the unconfined Hanford aquifer (Eddy, Prater and Rieger 1983). Comparison of radionuclide concentrations in the river upstream and downstream of the site did not show a statistically significant increase in tritium levels attributable to this source. The tritium contribution from the aquifer during 1982 was too small to be accurately measured in the presence of relatively high background concentrations in the Columbia River (Sula et al. 1983).

TABLE 17. Radioactive Airborne Discharges from DOE Facilities at Hanford During 1982

Radionuclide	Half-Life	Effluent, Ci ^(a)			
		Airborne Effluent			
		100 Area	200 Area	300 Area	400 Area
³ H (HTO)	12.3 y	22			
²⁴ Na	15.0 h	0.22			
⁴¹ Ar	1.8 h	114,000			
⁵⁴ Mn	303 d	0.008			
⁵⁶ Mn	2.6 h	0.099			
⁵⁹ Fe	46.0 d	0.007			
⁵⁸ Co	71.0 d	0.005			
⁶⁰ Co	5.3 y	0.015		3.0 x 10 ⁻⁶ (b)	
⁷⁶ As	26.4 h	1.3			
^{85m} Kr	4.4 h	130			
⁸⁵ Kr	10.7 y			5.0 x 10 ⁻¹	
⁸⁷ Kr	76.0 min	520			
⁸⁸ KrRb	2.8 h	550			140
⁸⁹ Sr	52.7 d	0.005			
⁹⁰ Sr	27.7 y	0.001	0.012	4.6 x 10 ⁻⁵ (c)	1.9 x 10 ⁻⁵
⁹¹ Sr	9.7 h	0.33			
⁹⁵ ZrNb	65.5 d	0.003			
⁹⁵ Nb	35.0 d	0.003			
^{99m} MoTc	66.7 h	0.29			
¹⁰³ Ru	39.5 d	0.01			
¹³¹ I	8.1 d	0.25		5.1 x 10 ⁻⁴	9.6 x 10 ⁻⁵
¹³² I	2.3 h	2.5			
¹³³ I	20.3 h	1.5			
¹³⁵ I	6.7 h	0.29			
¹³³ Xe	5.3 d	840			
¹³⁵ Xe	9.1 h	610			
¹³⁷ Cs	30.0 y	2.5 x 10 ⁻⁴	0.16		
¹³⁸ Cs	32.2 min	17,200			
¹⁴⁰ BaLa	12.8 d	0.15			
¹⁴⁴ CePr	284 d	0.05			
¹⁵⁵ Eu	1.8 y	2.7 x 10 ⁻⁴			
U-nat	4.4 x 10 ⁹ y			2.1 x 10 ⁻⁴	
²³⁸ Pu	86.4 y	1.0 x 10 ⁻⁴			
²³⁹ Pu	2.4 x 10 ⁴ y	6.2 x 10 ⁻⁴	4.9 x 10 ⁻⁴	1.9 x 10 ⁻⁵	7.3 x 10 ⁻⁶
²⁴⁴ Cm	18.1 y			5.5 x 10 ⁻⁸	

- (a) Except as specifically noted in this table, all Ci values are those reported by operating contractors via the DOE's Effluent Information System.
- (b) Reported as mixed activation products. Cobalt-60 was assumed for dose calculations.
- (c) 3.3 x 10⁻⁵ Ci reported as ⁹⁰Sr. 1.3 x 10⁻⁵ Ci reported as mixed-fission products and assumed to be ⁹⁰Sr for dose calculations.

TABLE 18. Nonradioactive Airborne Discharges from DOE Facilities at Hanford During 1982

Constituent	Effluent, kg			
	100 Area	200 Area	300 Area	1100 Area
Particulates	4.6×10^4	$5.9 \times 10^{5(a)}$	1.5×10^4	1.8×10^3
Nitrogen Oxides	1.6×10^5	4.6×10^5	$2.0 \times 10^{5(b)}$	9.5×10^3
Sulfur Oxides	5.4×10^5	8.2×10^5	3.4×10^5	5.8×10^3
Carbon Monoxide	8.1×10^3	6.1×10^4		0.02
Hydrocarbons	6.1×10^3	3.1×10^4		0.36
Aldehydes	2.2×10^3			
Fly Ash		589		
Perchloroethylene			$1.9 \times 10^{4(c)}$	
1,1,1,-Trichloroethane			699	

(a) Assume emission control is 95% efficient during time of operation based on compliance testing.

(b) Includes discharges by HEDL and UNC.

(c) Reported as quantity placed in an evaporation lugger.

NOTE: As reported by the operating contractor.

Nonradioactive liquid effluents discharged to the Columbia River are monitored in compliance with discharge permits issued under the National Pollution Discharge Elimination System (NPDES). Monitoring required by the permits includes flow, temperature, pH, suspended and settleable solids, chlorine, ammonia, chromium, heat discharge, and oil and grease as appropriate for each specific discharge point. Chemical pollutants reported discharged to the river during 1982 included aluminum sulfate, hydrazine, and morpholine (Fogel 1983).

Solid Wastes

Radioactive solid wastes are buried in trenches or special facilities within the 200 Areas. Radioactive materials in solid wastes include fission and activation products, uranium, and solid transuranics. Solid wastes containing ^{233}U or transuranics are packaged and buried separately from the nontransuranic wastes for possible retrieval at a future date. Table 22

TABLE 19. Radioactivity in Liquids Discharged to Ground Disposal Facilities at Hanford During 1982

Radionuclide	Quantity, Ci (except as noted)		
	100 Areas	200 Areas	300 Area
^3H	360	35	
^{32}P	28		
^{51}Cr	120		
^{54}Mn	460		
^{56}Mn	1.7		
^{59}Fe	290		
^{58}Co	32		
^{60}Co	500	0.565	
^{89}Sr	200		
^{90}Sr	140	2.21	
$^{95}\text{ZrNb}$	210		
$^{99\text{m}}\text{MoTc}$	660		
^{103}Ru	38		
^{106}Ru	120	0.006	
^{124}Sb	7.4		
^{125}Sb	ND (a)		
^{131}I	170		
^{133}Xe	220		
^{134}Cs	29	0.09	
^{137}Cs	270	19.4	
$^{140}\text{BaLa}$	2100		
^{141}Ce	90		
$^{144}\text{CePr}$	190		
^{147}Nd	22		
^{153}Sm	210		
^{154}Eu		0.002	
^{155}Eu	9.1	0.037	
^{187}W	280		
Unidentified Beta		59	0.34
Short-Lived Radionuclides (b)	8300		
^{234}U			0.061
^{235}U			0.003
^{238}U		<342 kg	0.060
^{241}Am		0.073 g	
^{238}Pu	0.36		
$^{239,240}\text{Pu}$	2.2		
Pu Total		0.59 g	

(a) ND - Not detected

(b) Short-lived radionuclides $T_{1/2} < 48\text{h}$.

NOTE: As reported by the operating contractor.

TABLE 20. Nonradioactive Liquid Discharges to the Ground at Hanford During 1982

Constituent	Quantity Discharged, kg (except as noted)		
	100 Area(a)	200 Area	300 Area
Aluminum Sulfate	2.2×10^5		
Chlorine	1.8×10^4		
Polyacrylamide	5.4×10^2		
Sulfuric Acid	5.2×10^5		
Ammonium Hydroxide	1.3×10^5		
Hydrazine	7.8×10^3		
Morpholine	9.2×10^2		
Sodium Hydroxide	5.8×10^5		
Nonradioactive Effluents		1.5×10^6	$m^3(b)$
Zn			227
Hg			1.59
NO ₃			8.7×10^4
Pb			18
Cd			9
Cu			904
F			2.3×10^3
Cr			23

(a) Reported as quantity consumed.

(b) Includes water treatment backwash, powerhouse cooling water, ash sluicing water, steam condensates, sewage, septic sludge.

NOTE: As reported by the operating contractor.

lists the quantities of radionuclides contained in solid waste burials during 1982 (Anderson, Poremba and McCann 1982).

Nonradioactive solid wastes include general refuse, asbestos and waste chemical that are buried in a sanitary landfill near the 200 Areas. The quantities buried during 1982 are listed in Table 22.

TABLE 21. Radioactive Liquid Discharges to the Columbia River from DOE Facilities at Hanford During 1982

<u>Radionuclide</u>	<u>Half-Life</u>	<u>Discharge, Ci</u>
³ H (HTO)	12.3 y	360
³² P	14.3 d	0.059
⁵⁴ Mn	303 d	0.017
⁵⁶ Mn	2.6 h	1.7
⁵⁹ Fe	46.0 d	0.12
⁶⁰ Co	5.3 y	0.58
⁸⁹ Sr	52.7 d	0.6
⁹⁰ Sr	27.7 y	2.7
^{99m} MoTc	66.7 h	2.4
¹⁰³ Ru	39.5 d	0.15
¹⁰⁶ Ru	368 d	0.31
¹²⁵ Sb	2.7 y	0.11
¹³¹ I	8.1 d	2.2
¹³³ Xe	5.3 d	2.2
¹³⁷ Cs	30.0 y	0.15
²³⁸ Pu	86.4 y	4.7 X 10 ⁻⁴
²³⁹ Pu	2.4 X 10 ⁴ y	3.0 X 10 ⁻⁴

NOTE: As reported by the operating contractor.

ENVIRONMENTAL RELATED UNUSUAL OCCURRENCES

Several unusual occurrences were documented by onsite operating contractors during 1982. Several of these involved the release of radioactive or nonradioactive pollutants to the environment. In all cases, the impact of the environmental related unusual occurrences during 1982 was reported as being negligible. The brief discussions of the occurrences provided here are based on information contained in the occurrence reports. Formal unusual occurrence reports were issued by the responsible contractor and are available for public review in the reading room of the Hanford Science Center.

TABLE 22. Solid Waste Buried at Hanford During 1982

<u>Waste</u>	<u>Quantity</u>
Radioactive	
Uranium	9.6 X 10 ⁶ g
Plutonium	6.8 X 10 ⁴ g
Other Transuranics	4.0 X 10 ³ g
Strontium-90	5.0 X 10 ⁴ Ci
Ruthenium-106	8.1 X 10 ³ Ci
Cesium-137	3.1 X 10 ⁵ Ci
Other Fission and Activation Products	6.2 X 10 ³ Ci
Nonradioactive	
General Wastes	19,700 m ³
Asbestos	263 m ³
Waste Chemicals	69 m ³

NOTE: As reported by the operating contractor.

Airborne Releases

Four occurrences involved an airborne release during 1982.

UNC Occurrence Report No. 82-18, 02/15/82 and 7/29/82

The smoke opacity standard was exceeded on the 184-N Boiler Stacks on February 15, 1982 and again on July 29, 1982. The durations of the violations were 60 and 45 minutes, respectively. Operating procedures were modified to include corrective actions to be taken when off-normal conditions are observed on the smoke density monitors. No adverse environmental impact was observed as a result of these occurrences.

Rockwell Occurrence Report No. 82-15, 04/12/82

Elevated radionuclide concentrations were detected in the 291-B (B-Plant) stack exhaust. The cause was found to be a combination of in-plant operations and a leaking plug in an old exhaust plenum.

Leaks around the plenum plug were sealed and several modifications were made in operating procedures to preclude a recurrence of this event. The release levels, while above normal operating levels, did not exceed any company control standards nor violate any DOE release limits. The environmental impact due to this event was negligible.

Rockwell Occurrence Report No. 82-33, 08/12/82)

Slightly elevated radionuclide concentrations were again observed in the 291-B stack exhaust. Leakage was identified in the exhaust plenum where the inlet and outlet ducts share a common barrier. The leak was pinpointed and repaired thereby eliminating the potential for future leakage at this point. No company release standards were exceeded or applicable release limits violated. The impact on the environment was again negligible.

UNC Occurrence Report No. 82-24, 10/18/82

A small fire occurred in the peel test saw exhaust duct, apparently started by sparks produced by the saw itself. Air surveys in the vicinity assured there was no spread of contamination outside the facility and no adverse impact on the environment. The exhaust system was redesigned and reinstalled.

Liquid Releases

Five unusual occurrences were reported involving liquid releases during 1982.

Rockwell Occurrence Report No. 82-07, 01/28/82

Approximately 30 gallons of contaminated liquid leached into the soil around the 219-S vault exhauster during a filter change operation. The filter change procedure was modified to handle the moisture properly, and the system design is under evaluation to determine a long-term solution to the moisture buildup and drainage problem. The contaminated soil was removed and disposed of using appropriate radwaste disposal procedures. There was no significant adverse environmental impact due to this incident.

Rockwell Occurrence Report No. 82-11, 03/19/82

A small amount of radioactive liquid leaked from testing equipment while the unit was being transported. The contaminated area was secured and subsequently decontaminated with little impact on the environment.

UNC Occurrence Report No. 82-13, 08/03/82

The daily maximum temperature limit for the 102-inch-diameter river return discharge (NPDES discharge number 009) was exceeded for approximately 4 hours. The daily limit was exceeded by only 3°F. Temperature monitoring instrumentation will be replaced and operating procedures modified to preclude a recurrence of this incident. No indication of any significant environmental impact was observed.

UNC Occurrence Report No. 82-14, 08/03/82, 08/13/82 and 08/18/82

The temperature limit for NPDES discharge 005 was exceeded nine times on August 3, twice on August 13 and twice more on August 18. The cause of the problem was found to be leakage of hot water from the afterheat removal storage tank into the 005 discharge line. Operating instructions were amended to reasonably assure the problem would not arise again. No adverse environmental impact was observed.

PNL Occurrence Report No. 82-10, 10/14/82

Radioactive wastewater was inadvertently dumped into a sanitary sewer system line. As a result approximately 300 gallons of liquid was diverted to a holding tank. Staff members have been instructed as to their responsibilities for preventing radioactive materials reaching the sanitary sewer. Building modifications were not considered feasible due to the excessive costs involved. There was no adverse impact on the environment.

Solid Wastes

No unusual occurrences relating to solid wastes were reported during 1982.

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APPENDIX A

ANALYTICAL PROCEDURES



APPENDIX A

ANALYTICAL PROCEDURES

RADIOLOGICAL SAMPLES

All routine environmental surveillance samples are analyzed according to detailed, written analytical procedures that are described in general terms below. Minimum detectable concentrations for the various medium/analysis combinations are shown in Table C.1.

Air Samples

Alpha-, Beta-, and Gamma-Emitting Radionuclides are measured by a direct count of the glass fiber filter; alpha on a low-background gas flow proportional counter, beta on a gas flow proportional counter, and gamma on a Ge(Li) detector with a multichannel pulse height analyzer.

Strontium-89, 90 are determined by leaching the glass fiber filters with nitric acid, scavenging with barium chromate, precipitating as a carbonate, transferring to a stainless steel planchet, and

counting with a low-background gas flow proportional counter.

Uranium is leached from the glass fiber filters with nitric acid and extracted as tetrapropyl ammonium uranyl trinitrate followed by back extraction into water. A portion of the water extract is fused with sodium and lithium fluoride and analyzed with a fluorometer.

Plutonium is leached from the glass fiber filters with fuming nitric acid and passed through an anion exchange resin. The plutonium on the resin column is eluted with nitric and hydrofluoric acids electrodeposited on a stainless steel disk, and then counted with an alpha spectrometer.

Tritium in air as HTO is determined by collecting the water vapor with silica gel. The water vapor is removed by heat and vacuum and collected in a freeze trap. The tritium content of the water vapor is determined with a liquid scintillation spectrometer.

TABLE A.1 Minimum Detectable Concentrations (MDC)^(a)

Radionuclide	Air		Water		Water (Resin Sampler)		Foodstuff & Wildlife		Soil & Vegetation	
	Minimum Sample Size, m ³	MDC, pCi/m ³	Minimum Sample Size, l	MDC, pCi/l	Minimum Sample Size, l	MDC, pCi/l	Minimum Sample Size, kg	MDC, pCi/kg	Minimum Sample Size, kg	MDC, pCi/kg
³ H (river)			1	50						
³ H (other)	5 m ^l	300 pCi/l	0.1	300			0.02 ^(b)	1500		
⁸⁹ Sr	1500	0.06	10	0.6			0.5	5		
⁹⁰ Sr	1500	0.006	10	0.06			0.5	2	0.5	5
¹²⁹ I					1000	0.00001	4	0.0001		
¹³¹ I	1500	0.01	1	4	1000	0.1	4l (milk)	0.5 (pCi/l)		
U-nat	1500	0.005	0.01	0.5					0.5	10
²³⁸ Pu					1000	0.01			0.5	0.6
^{239,240} Pu	1500	0.0001			1000	0.01			0.5	0.6
Gamma-Emitters	1500	0.1 ^(c)	5	8 ^(c)	1000	0.1 ^(c)	0.5	15 ^(c)	0.5	20 soil, 30 vege- tation
Gross Alpha	800	0.001	1	5						
Gross Beta	80	0.01	1	10						

(a) Contractually established MDC based on the minimum sample size shown. Lower MDCs are usually attained.

(b) 20 ml water from sample.

(c) Based on ¹³⁷Cs minimum detectable concentration. When present individually, other gamma emitting radionuclides will have a MDC commensurate with their photon yield and energy as related to ¹³⁷Cs.

Iodine-131 is collected on activated charcoal which is then counted on a Ge(Li) detector with a multichannel pulse height analyzer.

Water Samples

Beta-Emitting Radionuclides are measured by a direct count of dried residue with a gas flow proportional counter.

Alpha-Emitting Radionuclides (Uranium and Plutonium) are extracted into ether from strong nitric acid. The ether phase is evaporated. The residue is plated on a stainless steel planchet and counted with a low-background gas flow proportional counter.

Gamma-Emitting Radionuclides are determined by a direct count of 500 ml of sample concentrate using a Ge(Li) detector with a multichannel pulse height analyzer.

Strontium-90 in large-volume water samples is precipitated with fuming nitric acid, scavenged with barium chromate, precipitated as a carbonate, transferred to a stainless steel planchet, and counted with a low-background gas flow proportional counter. After a 15-day period the yttrium-90 daughter is separated and then counted with a proportional counter.

Tritium samples are either counted directly with a liquid scintillation spectrometer or the sample is enriched by alkaline electrolysis and then counted with a liquid scintillation spectrometer.

Filter-Resin Samples are analyzed for gamma-emitting radionuclides using a Ge(Li) detector with a multichannel gamma-ray spectrometer. Aliquots of the samples are analyzed by neutron activation analysis for ^{129}I and by chemical separation and alpha spectrometry for plutonium.

Milk

Gamma-Emitting Radionuclides are measured by a direct count of the sample on a Ge(Li) detector with a multichannel pulse height analyzer.

Tritium in water distilled from milk is counted directly with a liquid scintillation spectrometer.

Iodine-129 is separated from milk with an anion exchange resin, purified, and analyzed by the neutron activation method.

Iodine-131 is removed from milk with an anion exchange resin. The iodine is eluted with sodium hypochlorite, precipitated as palladium iodide and beta-counted with a low-background gas flow proportional counter.

Strontium-89,90 is removed from milk with a cation resin, eluted with sodium chloride, precipitated as a carbonate, and transferred to a stainless steel planchet for counting with a low-background gas flow proportional counter.

Farm Produce

Gamma-Emitting Radionuclides are determined by a direct count of the sample on a Ge(Li) detector with a multichannel pulse height analyzer.

Tritium in water distilled from farm produce is counted directly with a liquid scintillation spectrometer.

Plutonium analyses are made like those for air filter samples after drying, ashing in a furnace, and treating with nitric acid prior to the anion exchange step.

Uranium analyses are made like those for water samples after drying, ashing in a furnace, and treating with nitric acid prior to the ether extraction step.

Strontium-89,90 analyses are made like those for air samples after drying, ashing in a furnace, and treating with nitric acid prior to the fuming nitric acid step.

Vegetation

Uranium, Plutonium, Strontium, and Gamma-Emitting Radionuclides are determined using the procedures described for farm produce.

Soil

Gamma-Emitting Radionuclides are analyzed by placing the sample into a marinelli beaker and counting on a Ge(Li) detector with a multichannel pulse height analyzer.

Plutonium and Strontium-89,90 are determined after the soil is dried, mixed thoroughly, leached with a mixture of nitric and hydrochloric acids, and then passed through an ion exchange resin in nitric acid.

The nitric acid retains strontium and other metal ions. Strontium is separated and counted in a manner similar to the fuming nitric acid procedure described for air filter samples.

The plutonium is eluted from the resin column with nitric and hydrofluoric acids and analyzed by a method similar to the procedure described for air filter samples.

Uranium analysis is conducted after the sample is dried, ashed in a furnace, and leached with hot nitric acid. Uranium is extracted from the acid leachate as tetrapropyl ammonium uranyl trinitrate and then extracted back into water. A

portion of the water extract is fused with sodium and lithium fluoride and analyzed with a fluorometer.

NONRADIOLOGICAL SAMPLES

Water samples collected to monitor water quality of the Columbia River are analyzed according to standard methods. The most applicable methods recommended by the American Public Health Association in their publication *Standard Methods for the Examination of Water and Wastewater* are used for most onsite analyses. Supplemental USGS samples are analyzed according to approved USGS standard methods.



APPENDIX B

DATA ANALYSIS



APPENDIX B

DATA ANALYSIS

The measurement of any physical quantity, be it temperature, distance, time, or radioactivity has some degree of inherent uncertainty associated with the final result. The uncertainty results from the combination of all possible inaccuracies in the measurement process including, for example, the reading of the result, the calibration of the measurement device, numerical rounding errors, etc. In this report, individual radioactivity measurements are accompanied by a plus or minus (\pm) analytical uncertainty term. This term represents the statistical counting error (two-standard deviations) associated with the measurement of the radioactivity in the sample. Reported means also include an uncertainty term. The term used to express the uncertainty associated with the mean is the two-standard error of the mean (95% confidence interval) and includes consideration of the uncertainty of the individual results as well as their variability with respect to each other.

Maximum and minimum values are also included in most data tables. These are shown numerically only if the result was greater than the associated uncertainty level. To report maximum or minimum results in which the radionuclide was not identified in the sample would not be appropriate.

Radionuclide concentrations in many environmental type samples are very low, near zero, such that the uncertainty associated with the measurement is large relative to the result of the measurement. Concentrations may, in fact, be so low that the associated analytical uncertainty is equal to or greater than the reported result. In such cases, the radionuclide concentration was

too low to be measured given the analytical technique used, and individual results are reported as being "less than detectable" (<DL). Although results which are less than their associated analytical uncertainty do not represent a physically real quantity in themselves, it is nevertheless appropriate to use the values when calculating the mean of a set of similarly analyzed samples. Mean concentrations reported in this document therefore are calculated using all reported analytical results including those less than their associated analytical uncertainty.

As an aid to the reader in understanding the quality of such calculated means, the mean value and its two-standard error term are enclosed within parenthesis if a) fewer than three-fourths of the individual results used in the calculation were greater than their analytical uncertainty term (i.e., positively identified) or b) the calculated mean was less than its calculated two-standard error term. Furthermore, if fewer than one-fourth of the individual results indicated a positive identification, no average was calculated and instead, the average analytical uncertainty term was shown preceded by a less than sign (<) and enclosed within parenthesis. Generally, the use of parenthesis indicates that the concentrations measured in the sample were essentially indistinguishable from zero considering the analytical technique used. The term following the \pm or < sign provides an indication of the minimum concentration the analytical technique used is capable of achieving under the given circumstances.

Footnotes to the tables further explain the data presented.

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