PNL-3284
UC-41

Environmental Status of the Hanford Site for CY 1979

J. R. Houston
P. J. Blumer

August 1980

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

Battelle

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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
5285 Port Royal Road
Springfield, Virginia 22151

Price: Printed Copy $_______*; Microfiche $3.00

*Pages	NTIS Selling Price
001-025	$4.00
026-050	$4.50
051-075	$5.25
076-100	$6.00
101-125	$6.50
126-150	$7.25
151-175	$8.00
176-200	$9.00
201-225	$9.25
226-250	$9.50
251-275	$10.75
276-300	$11.00

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Pacific Northwest Laboratory
Richland, Washington 99352

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INTRODUCTION

Department of Energy (DOE) operations at the Hanford Site over the past 35 years have encompassed a wide variety of nuclear and nonnuclear activities involving the production and use of radioactive and nonradioactive materials. During the course of these activities, materials have been released to the environment either during routine day-to-day operation or, from time to time, as a result of a process upset or other unplanned event. Effluent and environmental monitoring programs are conducted routinely to help assure that adequate controls of processes and effluent streams are maintained.

THE HANFORD SITE

The Hanford Site is located in a rural region of southeastern Washington State and occupies an area of 1500 km^2 (570 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) southwest of Spokane, Washington. The Columbia River flows through the northern edge of the Hanford Site and forms part of its eastern boundary.

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. 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. Steam from N Reactor operation is used to drive turbine generators that produce up to 860 million watts of electrical power in the Washington Public Power Supply System's (WPPSS) Hanford Generating Plant. By the end of 1979, N Reactor had supplied enough steam to produce nearly 50 billion kilowatt-hours of electrical energy, which was fed to the Bonneville Power Administration grid covering the Pacific Northwest.

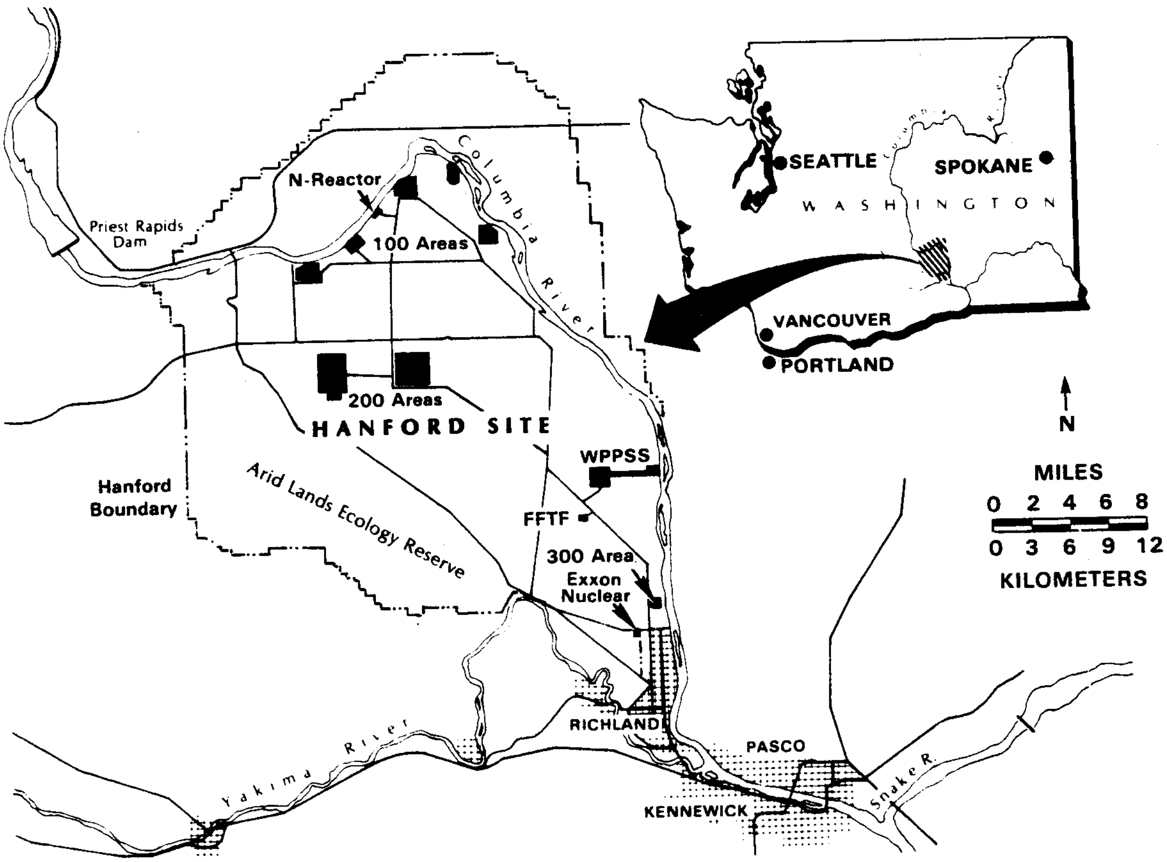


FIGURE 1. DOE's Hanford Site in Washington State

Facilities on the Hanford Site include the historic reactor facilities for plutonium production along the Columbia River, in what are known as the 100 Areas. The reactor fuel processing and waste management facilities are on a plateau about 11.3 km (7 miles) 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 (5.5 miles) northwest of the 300 Area.

Privately owned facilities within the Hanford Site boundaries include the WPPSS generating station adjacent to N Reactor, the WPPSS power reactor site and office buildings, 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 all site support services such as plant security, fire protection, central stores, electrical power distribution, etc.
- Battelle Memorial Institute's Pacific Northwest Laboratories--responsible for operating the Department of Energy's Pacific Northwest Laboratory (PNL), including research in the physical, life, and environmental sciences, environmental surveillance, and advanced methods of nuclear waste management.
- UNC Nuclear Industries (UNI)--responsible for operating and fabricating fuel for 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 the Fast Flux Test Facility.

During 1979, work at Hanford included N Reactor operation, nuclear fuel fabrication, liquid waste solidification, continued construction of the Fast Flux Test Facility, Hanford National Environmental Research Park (NERP) studies, and Arid Lands Ecology (ALE) studies, as well as continued use of a variety of research and laboratory facilities.

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 mammal on the site while the most abundant small game animal is the cottontail rabbit. The raccoon is the most abundant furbearing animal. The osprey, golden eagle, and bald eagle are all 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/hr (9 mph) in the summer to 10 km/hr (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 inversions that occur at night and break during the day, causing unstable and turbulent conditions.

ENVIRONMENTAL SURVEILLANCE AT HANFORD

The Hanford environmental surveillance program, conducted by Pacific Northwest Laboratory (PNL) under contract to DOE, provides for the measurement, interpretation, and evaluation of the radiological impact of Hanford operations on its onsite and offsite environs. The program is designed to evaluate all significant potential pathways for the release of radioactivity, especially those that may result in direct exposure of the public and those in which environmental reconcentration of radionuclides is likely to occur. Summaries and interpretations of the environmental measurements are published in several series of annual reports.

Presented in this report are the results of effluent and environmental monitoring and sampling conducted to determine the onsite impact of ongoing operations. (The previous report in this series, for 1978, is PNL-2933 (Houston and Blumer 1979). Environmental data and analyses for offsite locations are presented in a separate report series, "Environmental Surveillance at Hanford" (Houston and Blumer 1980). Groundwater monitoring and evaluation are presented in a third report, "Radiological Status of the Groundwater Beneath the Hanford Project" (Eddy and Wilbur 1980).

Specific locations of sample sites in or near the operating areas, and an explanation of the data analysis techniques used in preparing this report, are included in the appendices.

SUMMARY

Continued compliance of Hanford operations with all applicable state and federal environmental regulations, with the exception of suspended particulates from several steam power plants, was demonstrated by the environmental and effluent data collected during 1979. Included in the environmental data collected were measurements of external radiation, and radionuclide analyses of air samples, Columbia River water, other surface waters, wildlife, soil, and vegetation. Periodically all roadways, railways, and active as well as retired waste disposal sites were surveyed to detect any abnormal levels of radioactivity. Highlights of the environmental status of the Hanford Site for 1979 follow:

- Average onsite radionuclide air concentrations were essentially the same as those measured at distant offsite locations attributable to worldwide fallout. Small local increases in the ^{137}Cs air concentrations were observed from time to time around the 200 Areas. However, these increases were insignificant when compared to the applicable regulatory guidelines (Concentration Guides of Manual Chapter 0524 Appendix, U.S. Energy Research and Development Administration.)

- The impact of Hanford Operations on radionuclide concentrations in Columbia River water during 1979 was insignificant. While a few radionuclides of Hanford origin were observed in downstream samples, the concentrations of these radionucldes were far less than 1% of the most restrictive Concentration Guides of Manual Chapter 0524 Appendix.

- Radionuclide concentrations in onsite open surface waters were within the expected range during 1979 and were essentially the same as in recent years.

- Analyses of tissue samples taken from onsite wildlife continue to indicate that small quantities of radionuclides related to Hanford Operations are accessible to wildlife in some areas. Concentrations

of certain radionuclides were slightly lower than in recent years. Consumption of meat from the most contaminated waterfowl sample obtained in 1979 could potentially result in total body dose of about 5 mrem, a small fraction of the annual natural background dose of 100 mrem.

- In general, radionuclide concentrations in soil and vegetation were similar for on-and-offsite samples indicating no significant impact from Hanford Operation. Slightly higher concentrations were observed in the vicinity of 200 Areas as in previous years. No increase in soil or vegetation radionuclide concentrations over previous years was indicated.

- With a few exceptions, external radiation dose rates measured onsite were indistinguishable from natural background. The exceptions include locally higher dose rates around the 100-N and 200 Areas and at several locations along the Columbia River shoreline and islands. Residual radionuclides from past operation of the production reactors is responsible for the dose rates above natural background levels along the river.

- Surveys of Hanford Site roadways, railways and waste disposal sites revealed several situations requiring minor corrective action. None of these situations resulted in any measurable environmental impact.

- Routine releases of radionuclides to the environment from day to day operations during 1979 were at about the same low level as those measured in recent years.

- During 1979, 19 unusual occurrences on the Hanford Site led to minor accidental releases of effluents to the environment. These occurrences resulted in negligible impact on the environment.

ATMOSPHERIC MONITORING

During 1979, air samples were taken at 44 locations either on or offsite as shown in Figures 2 and 3. (Detailed maps showing specific locations of the sampling stations around the operating areas are contained in Appendix A.) Each air sampler draws air at a flow rate of 2.5 m^3/hr (1.5 ft^3/min) through a high-efficiency particulate filter, and a 5.5-cm-long by 4.4-cm-diameter (2-in. by 1.5-in.) charcoal cartridge used to collect gaseous radioiodine. The particulate filters were collected biweekly and analyzed for total alpha and total beta activity after a delay of 7 days to allow the short-lived radon and thoron daughters to decay. Once a month, the particulate filters were grouped into

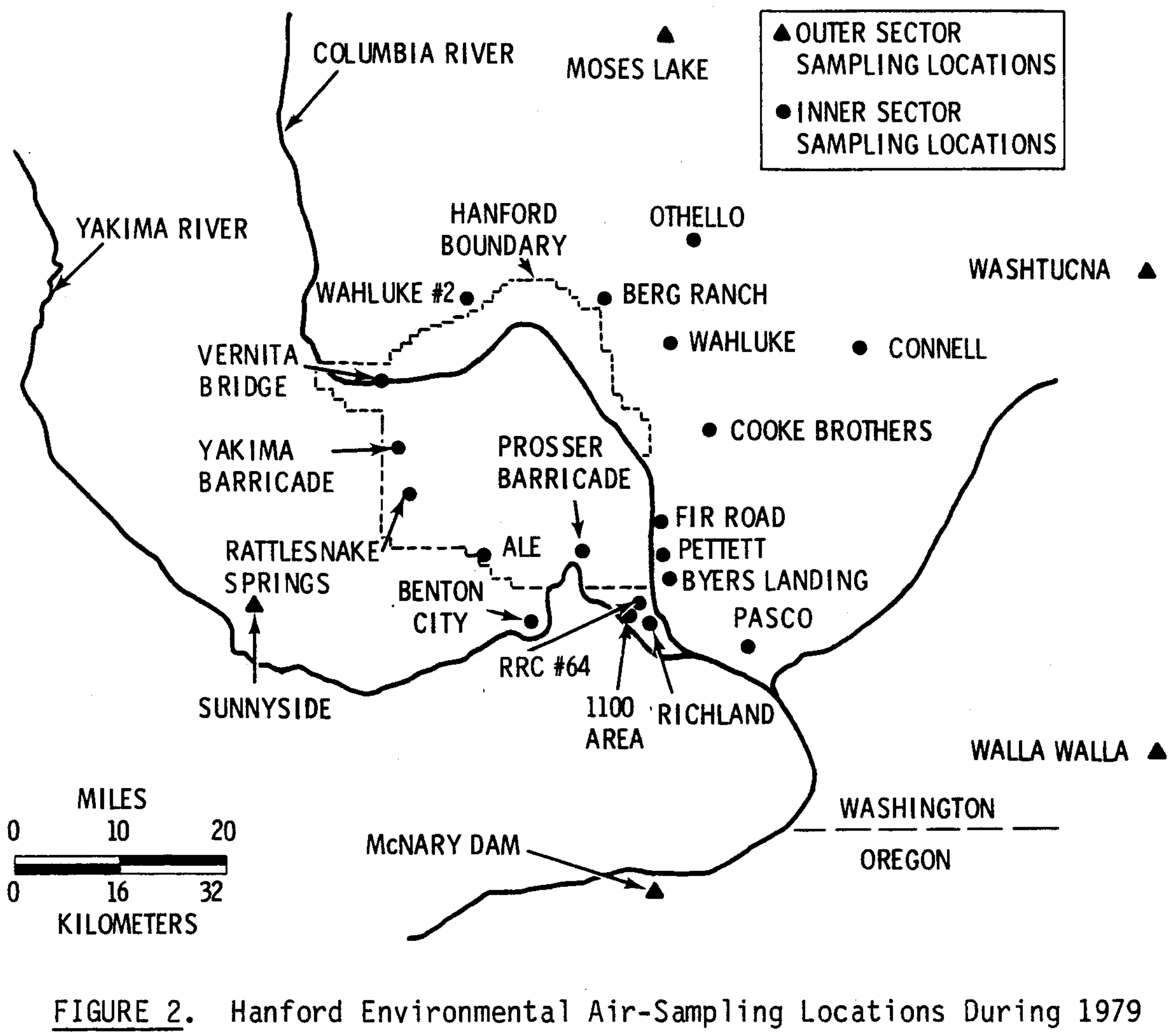


FIGURE 2. Hanford Environmental Air-Sampling Locations During 1979

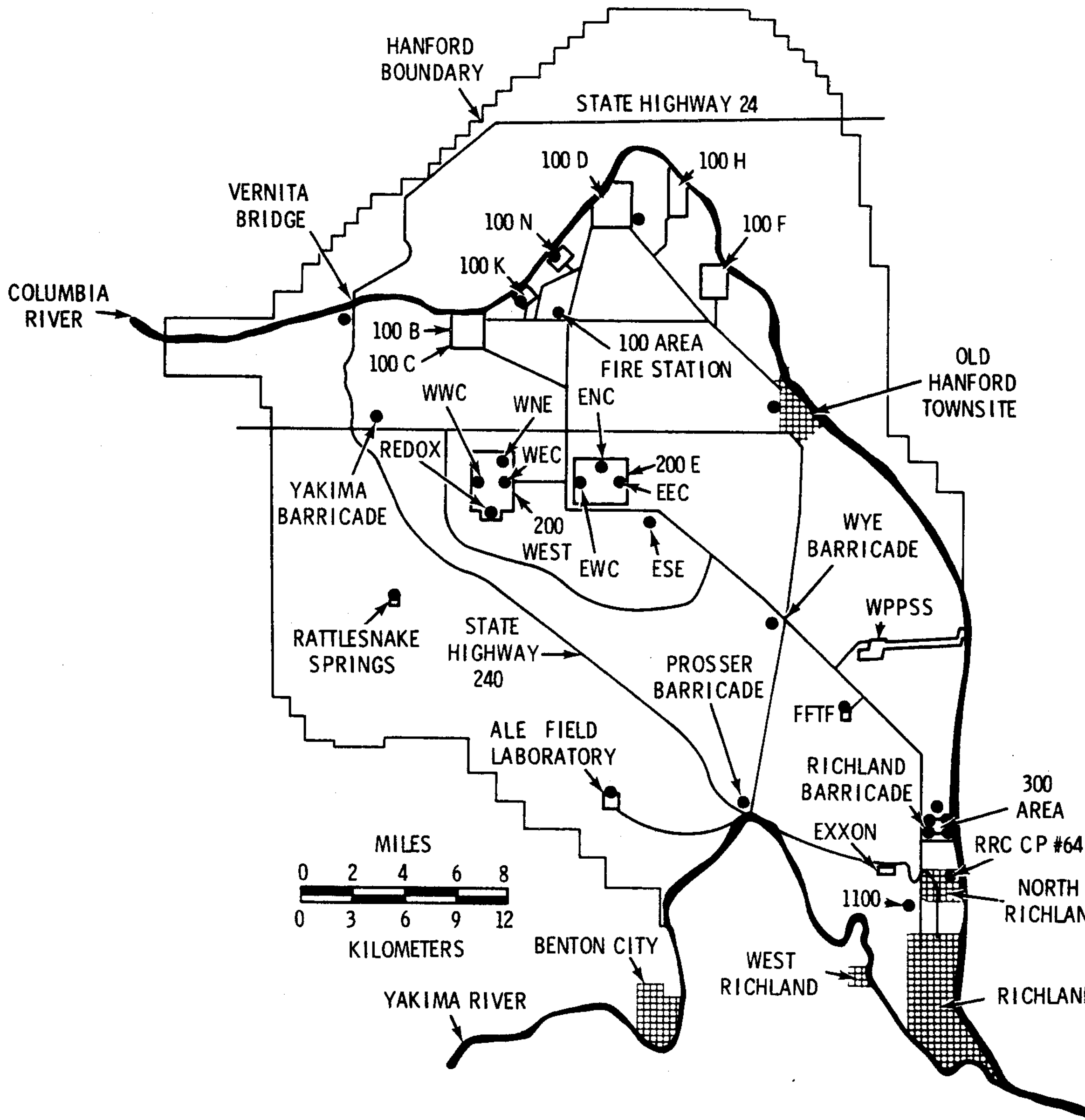


FIGURE 3. Onsite and North Richland Air-Sampling Locations During 1979

geographical composites[(a)] and analyzed by gamma spectrometry. On a quarterly frequency, the accumulated particulate filters from each geographical location were dissolved and analyzed for ^{90}Sr and plutonium. Charcoal

(a) The composites are made up of samples grouped by operating areas, sectors of an inner circle that approximates the Hanford Site boundary, and sectors of an outer circle that is considerably removed from the site boundary.

cartridges from 10 of the sampling stations were collected and analyzed biweekly for ^{131}I. The charcoal cartridges at the remaining 34 stations were collected monthly but not analyzed; these samples are analyzed only if one or more of the results from the biweekly analyses exceed the detection limit.

At five sampling locations, a small portion of the air is bled off after passage through the particulate filter. This air is then drawn through a transparent cartridge of indicating silica gel at a rate of 470 cm^3/min (1 ft^3/hr). These cartridges, 25 cm in length by 5 cm in diameter (10 in. by 2 in.), are used to collect airborne water. Water collected by the silica gel is driven off and analyzed for tritium (HTO).

The frequency of sample collection at each air sampling station and the location of and composite group for each station are shown in Table 1.

GROSS INDICATOR RADIOACTIVITY

Total alpha and total beta analyses of particulate air filters provide a relatively rapid and sensitive indication of the gross airborne radionuclide concentrations in the Hanford environs. Figure 4 shows the temporal patterns of total beta-emitter activity in air for the years 1975 through 1979. In this figure, concentrations of beta-emitting radionuclides at the inner northeast and inner southeast sector stations (usually downwind from Hanford) are compared with all operating area stations and the distant or outer stations. The outer stations are sufficiently remote from Hanford operations that the observed concentrations can be assumed to be due to natural radioactivity or to worldwide fallout. During 1979, a small peak in concentration was evident during January. This phenomenon was evident at all sampling locations (inner, outer, and operating), indicating it was due to an increase in natural and/or worldwide fallout levels. These concentrations were insignificant when compared with the concentration guide of Manual Chapter 0524.

Table 2 shows the results of total beta and total alpha analyses taken at all sampling locations during 1979. The average beta-emitter concentration for both the outer and inner stations was 0.04 x 10^{-12} μCi/ml. The average

TABLE 1. Hanford Environmental Air Sampling Network for 1979

Composite Group	Location[b]	Sampling Frequency[a] Particulate Filter	Charcoal Cartridge	Silica Gel Cartridge
100 Areas				
	100-K	BW	M (NRA)	
	100-N	BW	M (NRA)	
	100-D	BW	BW	BW
	100 Area Fire Station	BW	M (NRA)	
200 East Area				
	200 ENC	BW	M (NRA)	
	200 EEC	BW	M (NRA)	
	200 ESE	BW	BW	BW
	200 EWC	BW	M (NRA)	
200 West Area				
	200 WNE	BW	M (NRA)	
	200 WEC	BW	M (NRA)	
	Redox	BW	M (NRA)	
	200 WWC	BW	M (NRA)	
300 Area				
	300 Pond	BW	M (NRA)	
	3614-A Bldg.	BW	M (NRA)	
	300 South Gate	BW	M (NRA)	
	300 SW Gate	BW	BW	
	3705 Bldg.	BW	M (NRA)	
Inner Northeast Sector				
	Berg Ranch	BW	M (NRA)	
	Wahluke Watermaster	BW	M (NRA)	
	Cooke Brothers	BW	M (NRA)	
	Othello	BW	M (NRA)	
	Connell	BW	M (NRA)	
Inner East Sector				
	Hanford	BW	M (NRA)	
	Wye Barricade	BW	M (NRA)	
	FFTF	BW	BW	BW
Inner Southeast Sector				
	Fir Road	BW	BW	BW
	Pettett	BW	BW	
	Byers Landing	BW	BW	
	Pasco	BW	M (NRA)	
	CP #64	BW	M (NRA)	
	1100 Area	BW	M (NRA)	
	Richland	BW	BW	BW
Inner Southwest Sector				
	Prosser Barricade	BW	M (NRA)	
	Benton City	BW	BW	BW
	ALE Field Lab	BW	M (NRA)	
	Rattlesnake Springs	BW	M (NRA)	
Inner Northwest Sector				
	Vernita	BW	M (NRA)	
	Yakima Barricade	BW	M (NRA)	
	Wahluke #2	BW	M (NRA)	
Outer Northeast Sector				
	Moses Lake	BW	M (NRA)	
	Washtucna	BW	M (NRA)	
Outer Southeast Sector				
	Walla Walla	BW	M (NRA)	
	McNary	BW	M (NRA)	
Outer West Sector				
	Sunnyside	BW	BW	

(a) BW - biweekly. M - monthly. NRA - not routinely analyzed.
(b) Location: FFTF - Fast Flux Test Facility. ALE - Arid Lands Ecology.

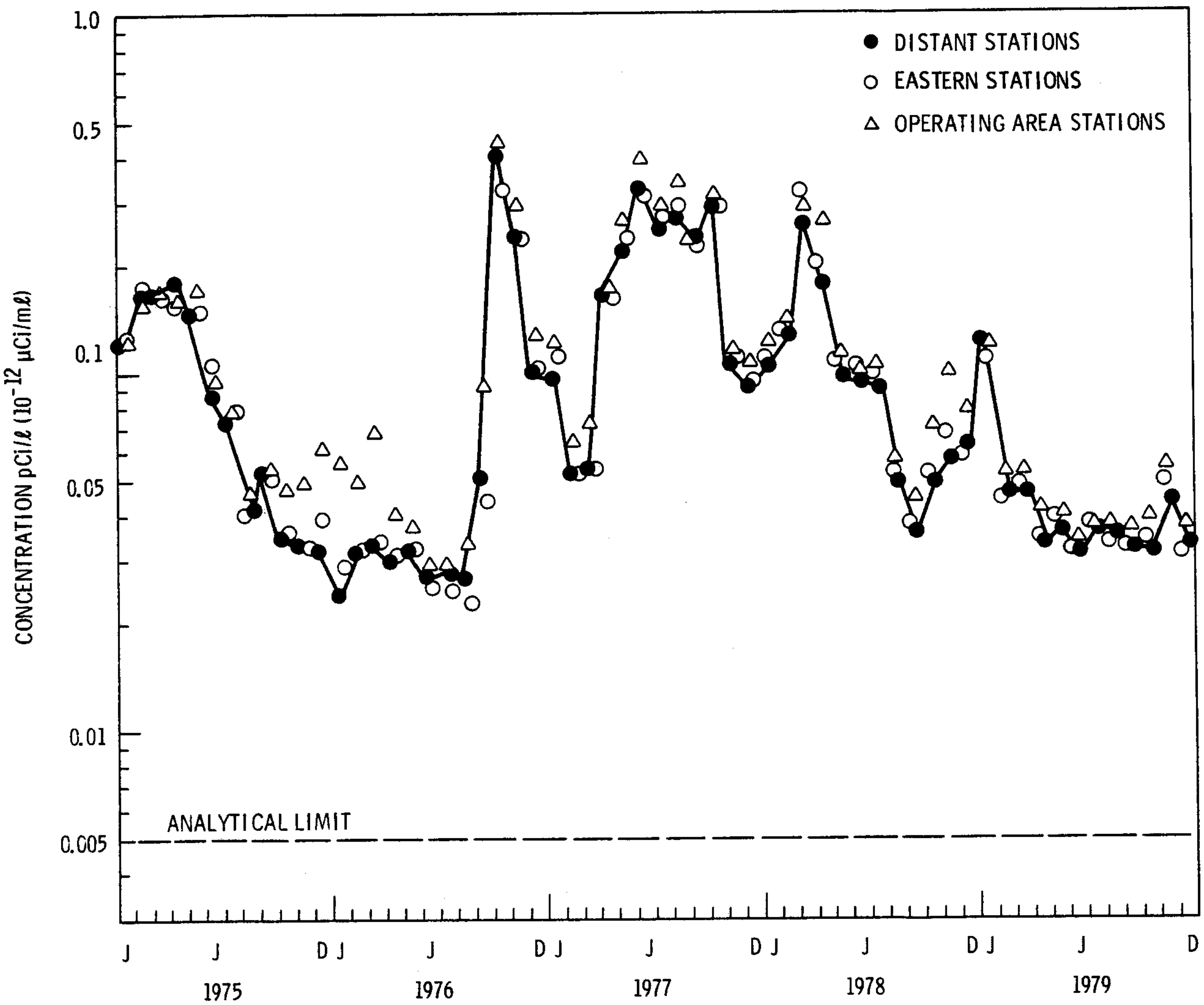


FIGURE 4. Monthly Average Gross Beta-Emitter Activity in the Atmosphere

beta-emitter concentration for the operating area stations was essentially the same (0.05×10^{-12} µCi/ml). No sampling locations in the operating areas had air concentrations significantly higher than the normal worldwide fallout levels, and all air concentrations were insignificant when compared with the Concentration Guides.

Analysis for alpha-emitting radionuclides was performed on filters obtained from 14 of the 44 sampling stations. The results were similar at all locations and are attributed to worldwide fallout and naturally occurring radionuclides in the air.

TABLE 2. Airborne Particulate Radioactivity During 1979

Composite Group	Location[c]	Total Beta: No. of Samples	Total Beta: Maximum	Total Beta: Minimum	Total Beta: Annual Average	Total Alpha[b]: No. of Samples	Total Alpha[b]: Maximum	Total Alpha[b]: Minimum	Total Alpha[b]: Annual Average[d]
		Concentration, 10^{-12} μCi/ml[a]							
100 Areas									
	100-K	25	0.15	0.01	0.04 ± 0.06				
	100-N	26	0.20	0.02	0.06 ± 0.09				
	100-D	26	0.15	0.02	0.05 ± 0.06				
	100 Area Fire Station	26	0.17	0.02	0.05 ± 0.06				
					0.05 ± 0.06				
200 East Area									
	200 ENC	24	0.15	0.01	0.06 ± 0.06	24	0.005	0.0005	0.001 ± 0.002
	200 EEC	25	0.12	0.03	0.04 ± 0.04	25	0.004	0.0008	0.001 ± 0.001
	200 ESE	25	0.13	0.01	0.04 ± 0.05	25	0.005	0.0002	0.001 ± 0.002
	200 EWC	25	0.16	0.02	0.04 ± 0.06				
					0.05 ± 0.06				0.001 ± 0.002
200 West Area									
	200 WNE	25	0.16	0.02	0.05 ± 0.06				
	200 WEC	26	0.13	0.01	0.04 ± 0.05	26	0.004	0.0004	0.001 ± 0.002
	Redox	26	0.12	0.02	0.05 ± 0.05	26	0.005	0.0005	0.002 ± 0.002
	200 WWC	26	0.15	0.02	0.04 ± 0.06				
					0.04 ± 0.06				0.002 ± 0.002
300 Area									
	300 Pond	28	0.15	0.02	0.04 ± 0.05				
	3614-A Bldg.	28	0.15	0.02	0.05 ± 0.05				
	300 South Gate	28	0.17	0.02	0.05 ± 0.06	27	0.006	0.0006	0.002 ± 0.002
	300 SW Gate	26	0.08	0.02	0.04 ± 0.03				
	3705 Bldg.	27	0.15	0.02	0.05 ± 0.06				
					0.04 ± 0.06				
Inner Northeast Sector									
	Berg Ranch	26	0.10	0.02	0.04 ± 0.04	26	0.003	0.0006	0.001 ± 0.002
	Wahluke Watermaster	26	0.08	0.01	0.04 ± 0.03				
	Cooke Brothers	26	0.16	0.007	0.05 ± 0.06				
	Othello	26	0.10	0.02	0.04 ± 0.04				
	Connell	26	0.12	0.01	0.04 ± 0.05				
					0.04 ± 0.04				
Inner East Sector									
	Hanford	25	0.17	0.01	0.04 ± 0.06				
	Wye Barricade	26	0.15	0.02	0.05 ± 0.05	26	0.005	0.0006	0.001 ± 0.002
	FFTF	26	0.12	0.02	0.04 ± 0.04	26	0.003	0.0003	0.001 ± 0.001
					0.04 ± 0.06				0.001 ± 0.002
Inner Southeast Sector									
	Fir Road	27	0.19	0.02	0.05 ± 0.07				
	Pettett	27	0.15	0.02	0.04 ± 0.06				
	Byers Landing	26	0.11	0.02	0.04 ± 0.04	25	0.004	0.0004	0.001 ± 0.002
	Pasco	24	0.15	0.02	0.04 ± 0.06				
	RRC CP 64	26	0.17	0.03	0.05 ± 0.06	26	0.005	0.0005	0.002 ± 0.002
	1100 Area	25	0.18	0.01	0.04 ± 0.06				
	Richland	24	0.16	0.02	0.05 ± 0.06	24	0.004	0.0005	0.001 ± 0.002
					0.04 ± 0.06				0.001 ± 0.002
Inner Southwest Sector									
	Prosser Barricade	24	0.16	0.02	0.05 ± 0.06	24	0.004	0.0004	0.001 ± 0.002
	Benton City	26	0.09	0.005	0.04 ± 0.03	26	0.004	0.0006	0.001 ± 0.002
	Ale Field Lab	26	0.19	0.02	0.04 ± 0.07				
	Rattlesnake Springs	26	0.15	0.02	0.05 ± 0.05				
					0.05 ± 0.06				0.001 ± 0.002
Inner Northwest Sector									
	Vernita	27	0.13	0.01	0.04 ± 0.05				
	Yakima Barricade	25	0.18	0.02	0.05 ± 0.06				
	Wahluke 2	27	0.10	0.02	0.04 ± 0.04				
					0.04 ± 0.06				
Outer Northeast Sector									
	Moses Lake	26	0.12	0.02	0.04 ± 0.04				
	Washtucna	25	0.15	0.02	0.05 ± 0.06				
					0.05 ± 0.06				
Outer Southeast Sector									
	Walla	26	0.16	0.02	0.04 ± 0.05				
	McNary	26	0.17	0.02	0.04 ± 0.06				
					0.04 ± 0.06				
Outer West Sector									
	Sunnyside	26	0.13	0.01	0.04 ± 0.05				
Detection Limit					0.005				0.0003
Concentration Guide					100				0.02

(a) 10^{-12} μCi/ml = 1 pCi/m^3
(b) Total alpha activity does not include any significant contribution from naturally occurring radon daughters in the air. The filters are held 7 days before analysis to allow decay of these radionuclides.
(c) Location: FFTF - Fast Flux Test Facility. ALE - Arid Lands Ecology.
(d) Manual Chapter 0524 Appendix standards apply to concentrations of radioactivity in excess of those due to naturally occurring or worldwide fallout radioactivity.

IODINE-131 CONCENTRATIONS

During 1979, biweekly analysis for ^{131}I in the atmosphere was performed on samples obtained from 10 sampling stations; samples at the other stations were changed monthly but not analyzed. All samples collected but not analyzed were temporarily stored and available for analysis in case there was any indication that iodine was present in the atmosphere. Concentrations of ^{131}I in the air were all below the detection limit during 1979.

TRITIUM CONCENTRATIONS

Airborne water vapor was sampled at two operating area stations and at four inner sector stations during 1979. Analytical results for the biweekly samples are shown in Figure 5. The small randomly varying concentrations observed at all stations are attributed to worldwide fallout. During 1979, the average concentration of tritiated water vapor in the air was 0.7×10^{-12} μCi/ml, less than 0.001% of the most restrictive Concentration Guide.

SPECIFIC RADIONUCLIDE CONCENTRATIONS

Figure 6 shows the results of specific radionuclide analyses of the 12 composite groups shown in Table 1. Beryllium-7 and ^{137}Cs were the only radionuclides routinely detected in the samples by gamma spectrometry. With the exception of ^{7}Be, the presence of the radionuclides can be attributed to worldwide fallout and, potentially, to Hanford operations (^{7}Be is produced naturally by cosmic ray interaction with the atmosphere).

During 1979 the concentration pattern in each composite group was similar for all radionuclides. The slightly higher concentrations of ^{137}Cs observed in the 200 areas several times during the year are attributed to Hanford operations. In addition to the routinely observed radionuclides, other gamma emitters were occasionally observed in the vicinity of the operating areas at levels slightly above the detection limit. These included observations of ^{60}Co in the 100 areas and $^{95}ZrNb$ in the 200 areas at concentrations up to 0.006×10^{-12} μCi/ml.

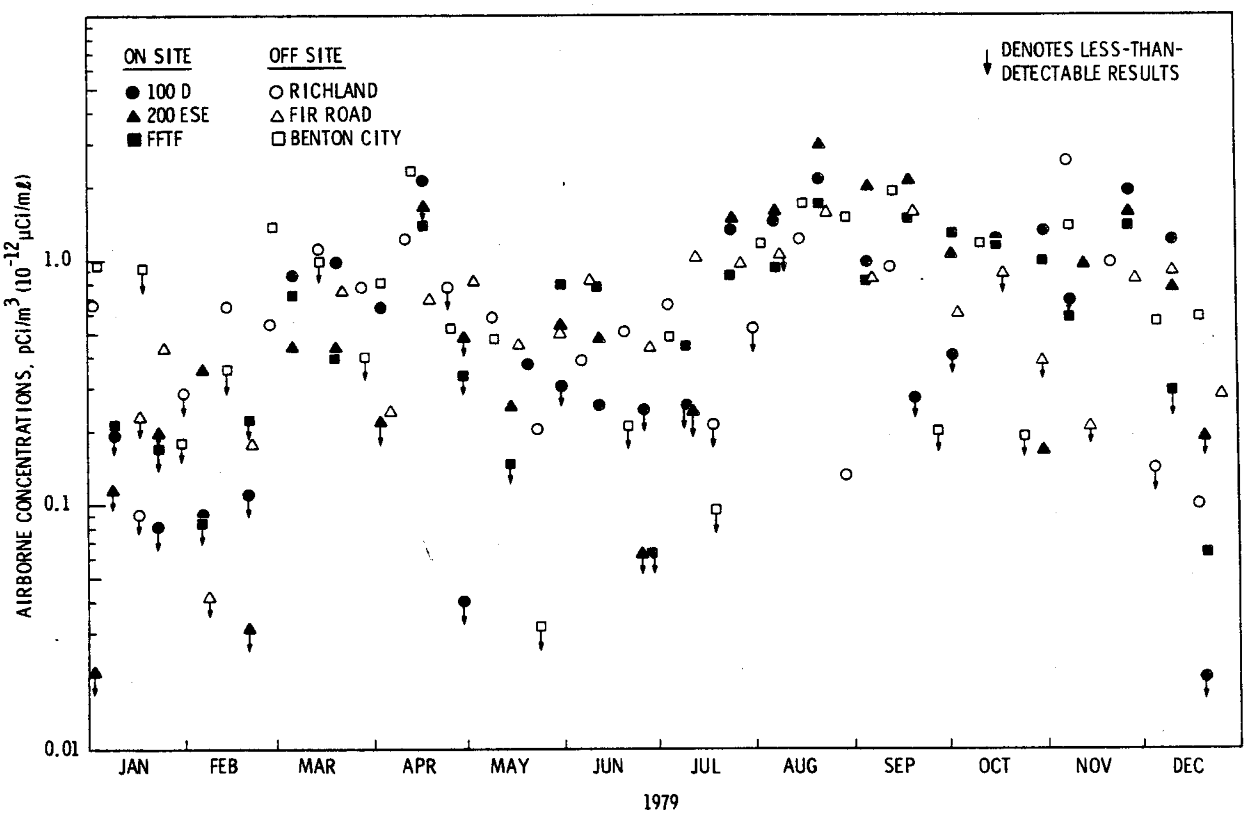
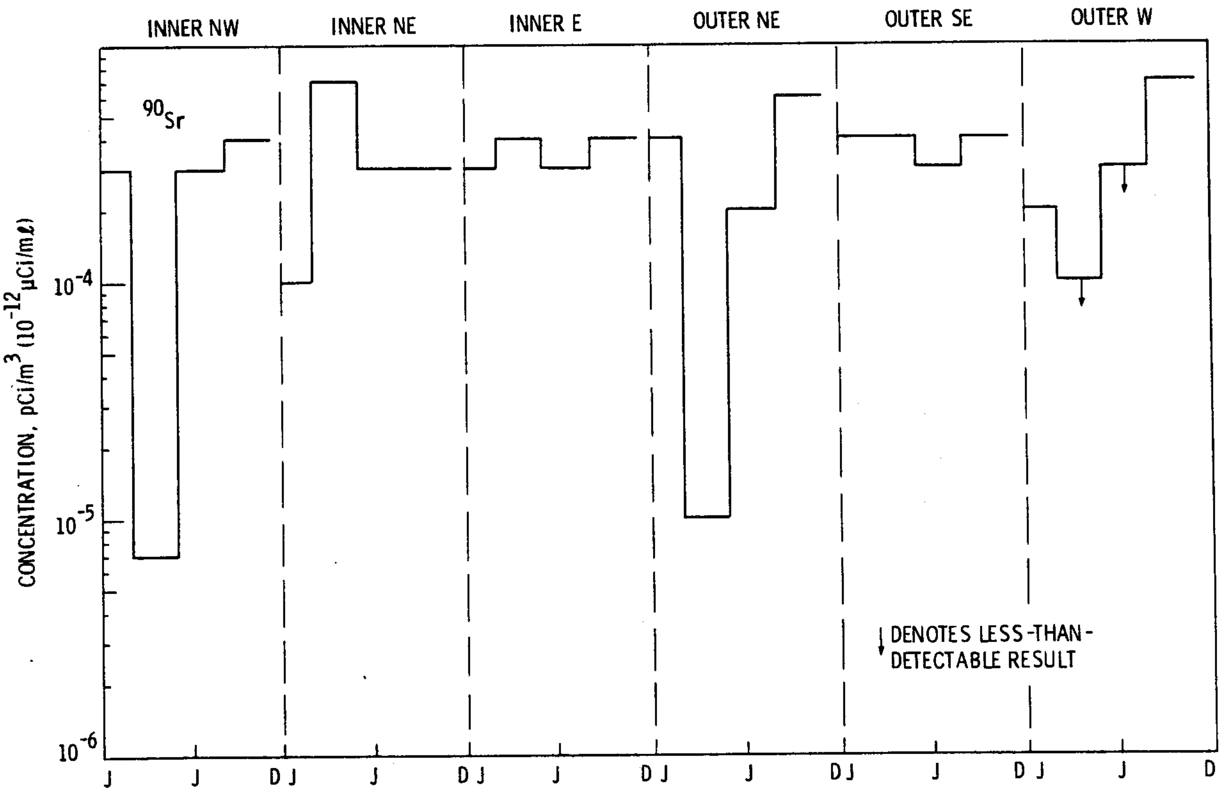


FIGURE 5. Tritiated Water Vapor Concentrations During 1979

Except for the higher concentrations of ^{137}Cs and the occasional detection of ^{60}Co and $^{95}ZrNb$ in the operating areas, radionuclide concentrations were similar for all composite groups, implying no distinguishable offsite impact concentrations. Onsite impact was limited to the immediate vicinity of the 100 and 200 areas.

The annual average airborne concentrations of specific radionuclides are shown in Table 3 and can be compared with the Concentration Guides of Manual Chapter 0524 Appendix. In all cases, the observed values are a small fraction of the Concentration Guides.



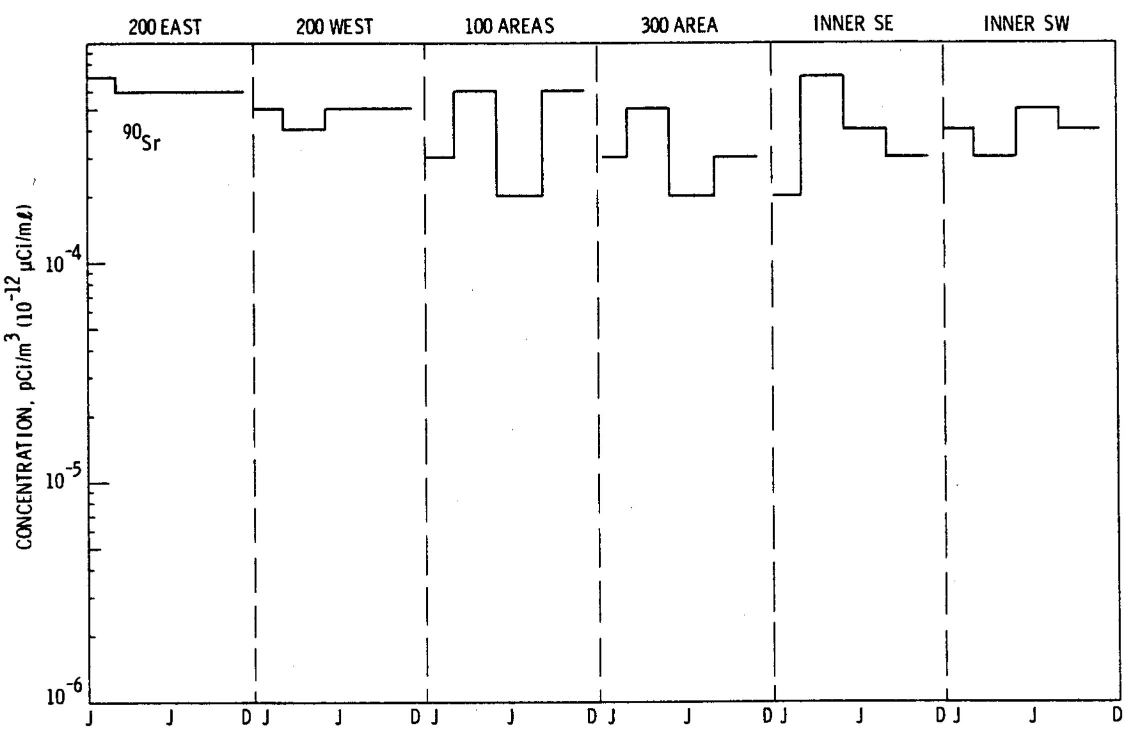
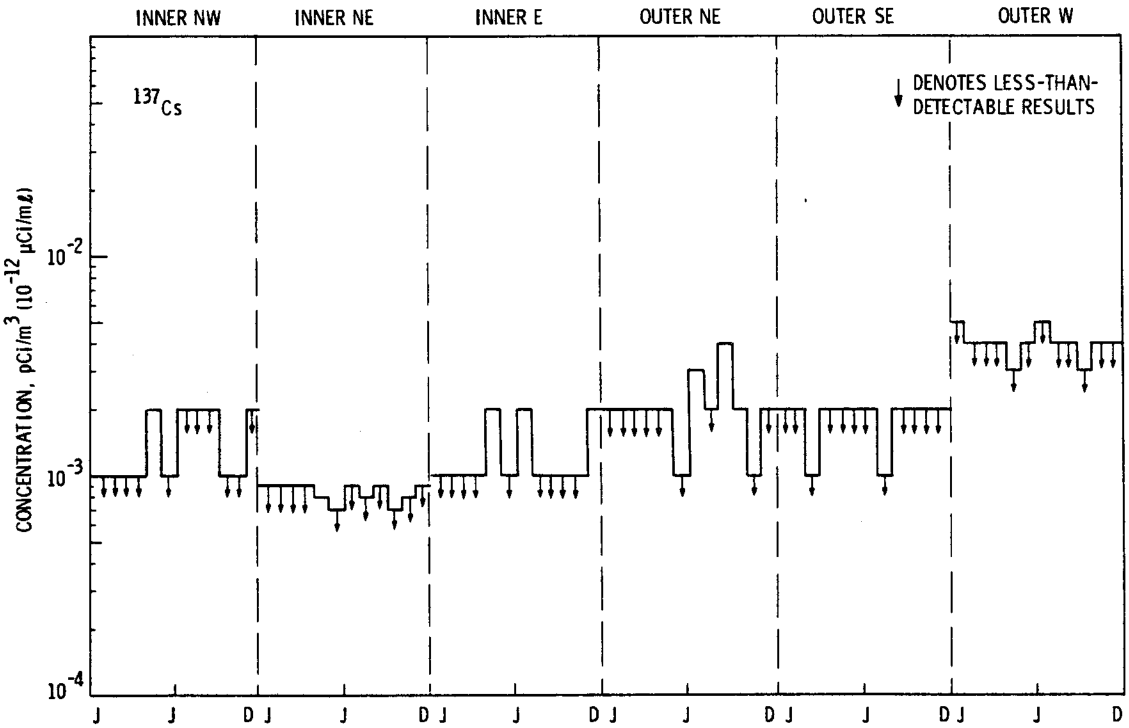


FIGURE 6. Radionuclide Concentrations in Air by Composite Group During 1979



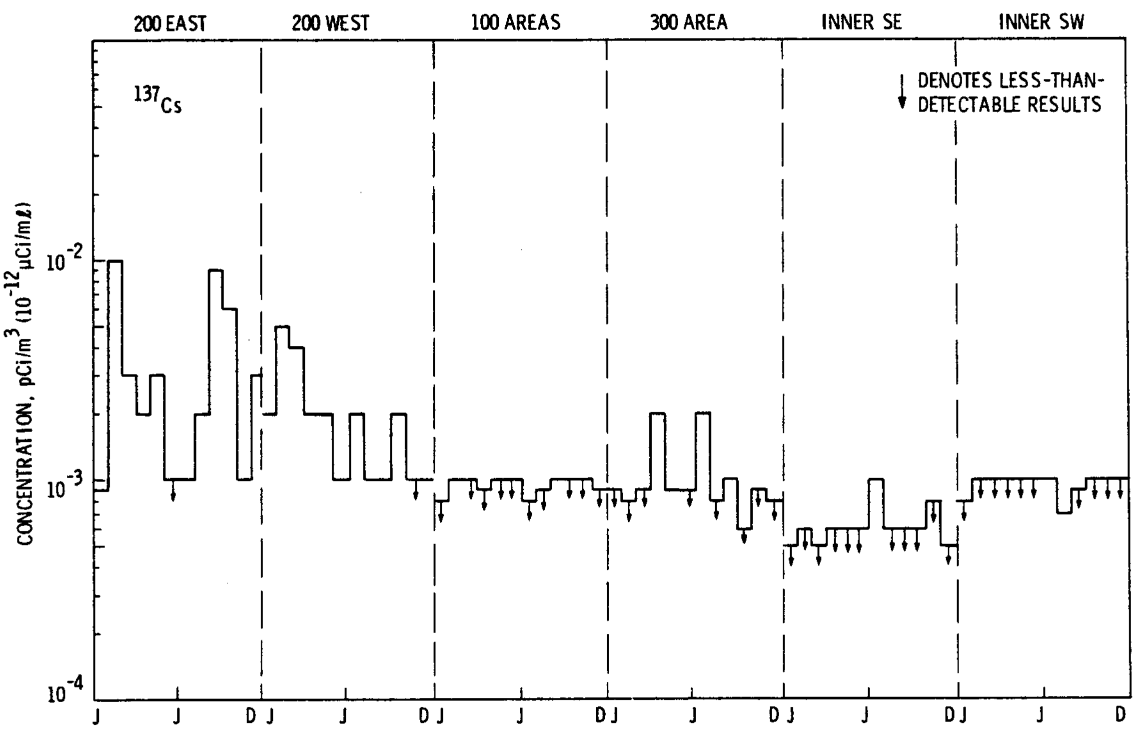
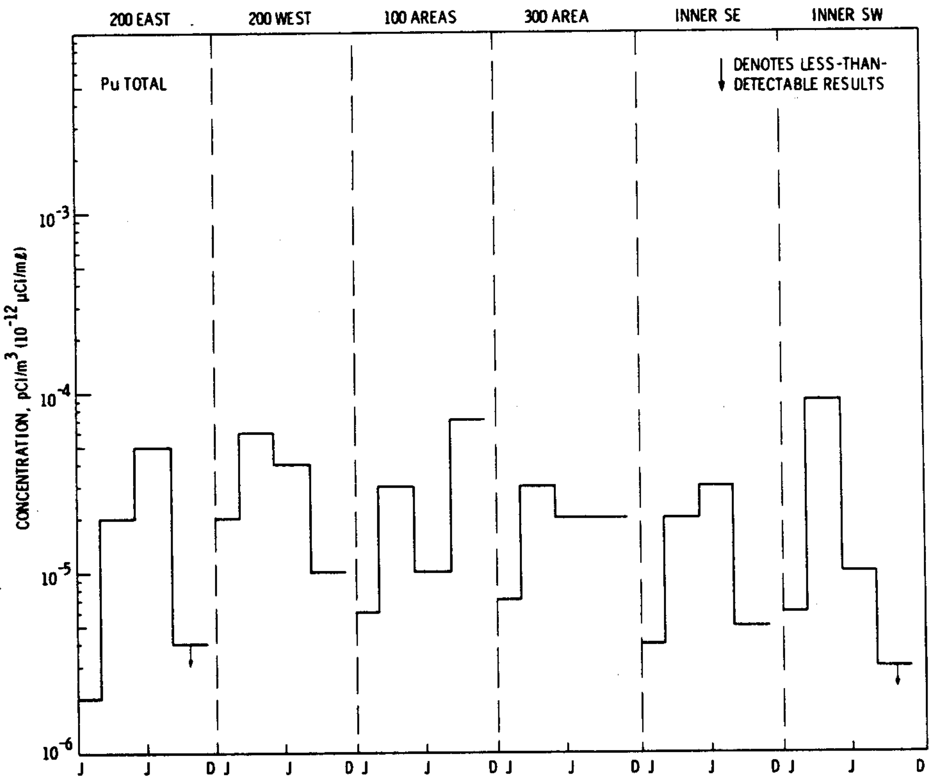


FIGURE 6. (contd)



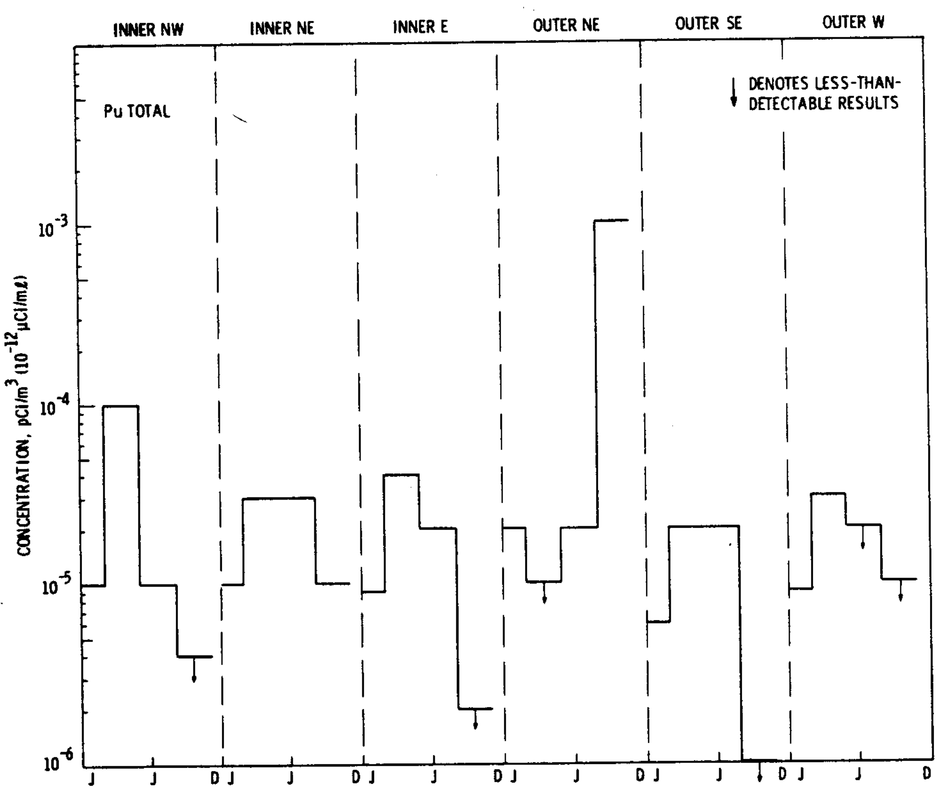


FIGURE 6. (contd)

TABLE 3. Airborne Concentrations of Specific Radionuclides During 1979

	Annual Average Concentration, pCi/m^3 (10^{-12} μCi/ml)			
Composite Group	^{7}Be	^{90}Sr	^{137}Cs	Total Pu
Operational Areas				
100 Areas	0.02 ± 0.05	0.0004 ± 0.0004	0.00004 ± 0.001	0.00003 ± 0.00006
200 East Area	0.02 ± 0.05	0.0006 ± 0.0002	0.004 ± 0.006	0.00002 ± 0.00004
200 West Area	0.03 ± 0.06	0.0005 ± 0.0001	0.002 ± 0.003	0.0003 ± 0.00004
300 Area	0.04 ± 0.07	0.0003 ± 0.0003	0.0004 ± 0.002	0.00002 ± 0.00002
Inner Sectors				
Northeast	0.03 ± 0.06	0.0004 ± 0.0005	0.0002 ± 0.001	0.00002 ± 0.00002
East	0.02 ± 0.06	0.0004 ± 0.00006	0.0007 ± 0.002	0.00002 ± 0.00003
Southeast	0.03 ± 0.05	0.0004 ± 0.0004	0.0001 ± 0.001	0.00001 ± 0.00003
Southwest	0.02 ± 0.04	0.0004 ± 0.0002	0.0002 ± 0.001	0.00003 ± 0.00008
Northwest	0.03 ± 0.09	0.0003 ± 0.0003	0.0002 ± 0.002	0.00003 ± 0.00009
Outer Sectors				
Northeast	0.03 ± 0.09	0.0003 ± 0.0005	0.0005 ± 0.003	0.0003 ± 0.001
Southeast	0.02 ± 0.09	0.0004 ± 0.0001	-0.0004 ± 0.002	0.00001 ± 0.00002
West	0.02 ± 0.20	0.0002 ± 0.0007	0.0002 ± 0.004	0.00002 ± 0.00002
Approximate Detection Limit	0.02	0.00007	0.002	0.00001
Concentration Guide	-	30	500	0.06(a)

(a) Concentration guide for ^{239}Pu.

COLUMBIA RIVER MONITORING

Columbia River water was sampled upstream from the 100-N Area (at Priest Rapids Dam, Vernita Bridge, and the 100-B Area) and downstream at the 300 Area forebay and the Richland pumping dock for radiological, chemical, physical and/or biological analyses. Information on Columbia River sampling has been presented and evaluated in the 1979 environmental surveillance report (Houston and Blumer 1980). Only a brief summary of that information is included here.

Analyses for ^{3}H, U, and ^{90}Sr in Columbia River water were performed on integrated water samples obtained at the 100-B Area and at Richland. Samples were collected weekly and monthly composites of these samples were analyzed. Samples to be analyzed for gamma-emitting radionuclides, ^{129}I, and plutonium in the river water were obtained from filter-resin samplers at Priest Rapids Dam and the 300 Area forebay (Fix and Robertson 1976). These samples were collected biweekly and both the filter and resin portions of the sample were analyzed for gamma-emitting radionuclides. The resin was composited quarterly and an aliquot analyzed for ^{129}I using neutron activation analysis (Brauer and Kaye 1973). Also on a quarterly basis, specific analysis for plutonium was performed on a composite of the biweekly filter-resin samples.

In Figure 7, concentrations of soluble radionuclides collected from the filter-resin samples at Priest Rapids Dam (upstream) are compared with those from the 300 Area forebay (downstream). Gaps in the histograms occur where no concentration was reported by the analytical laboratory. The radionuclides shown are the result of fallout from past atmospheric nuclear tests and from Hanford operations (downstream). Throughout 1979, ^{60}Co and ^{129}I were the only radionuclides observed at concentrations attributable to Hanford operations. Small quantities of these radionuclides routinely reach the river as a result of current and past Hanford operations. In all cases, the concentrations of radionuclides observed in Columbia River water were far less than 1% of the Concentration Guides.

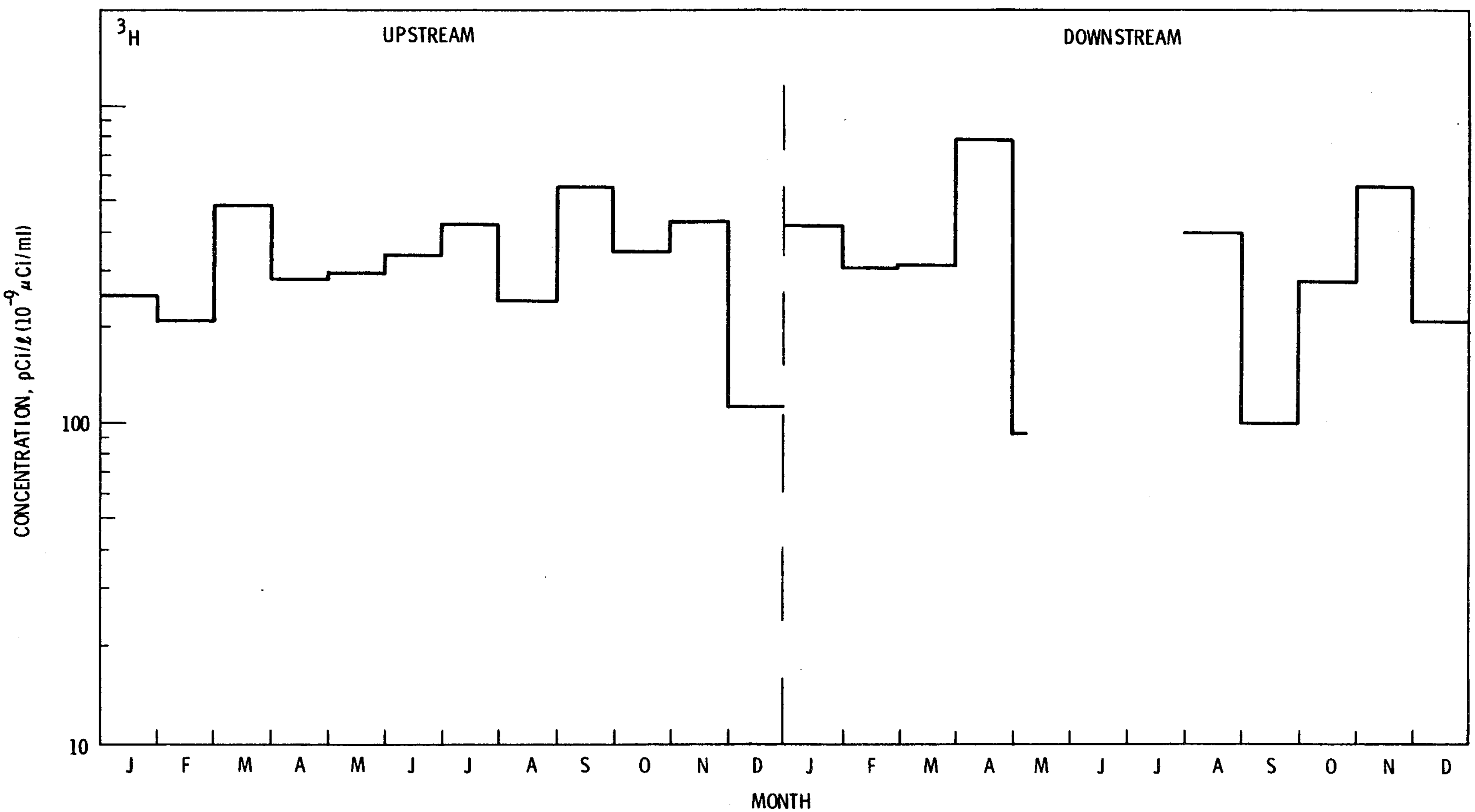


FIGURE 7. Radionuclide Concentrations in Columbia River Water During 1979

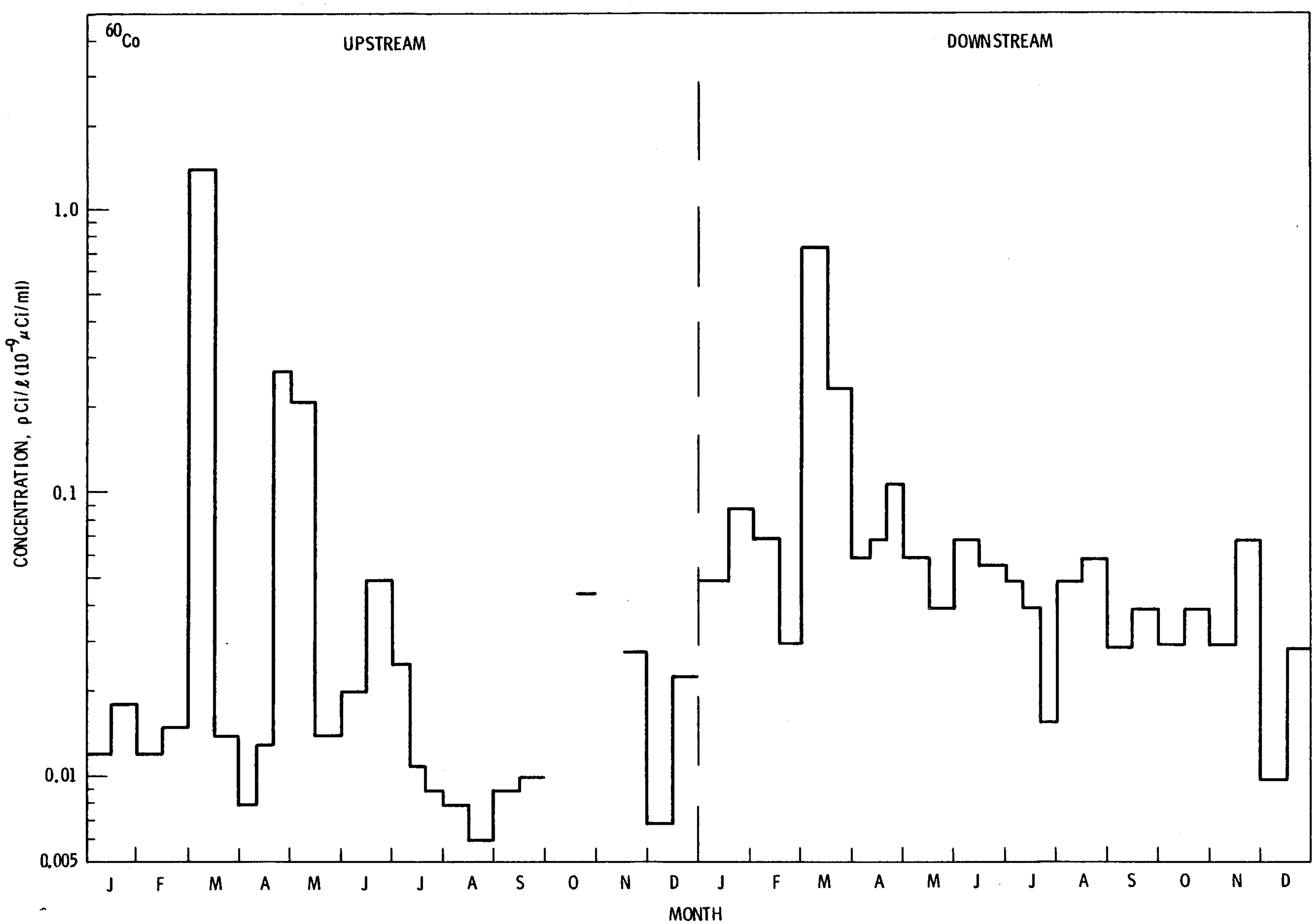


FIGURE 7. (contd)

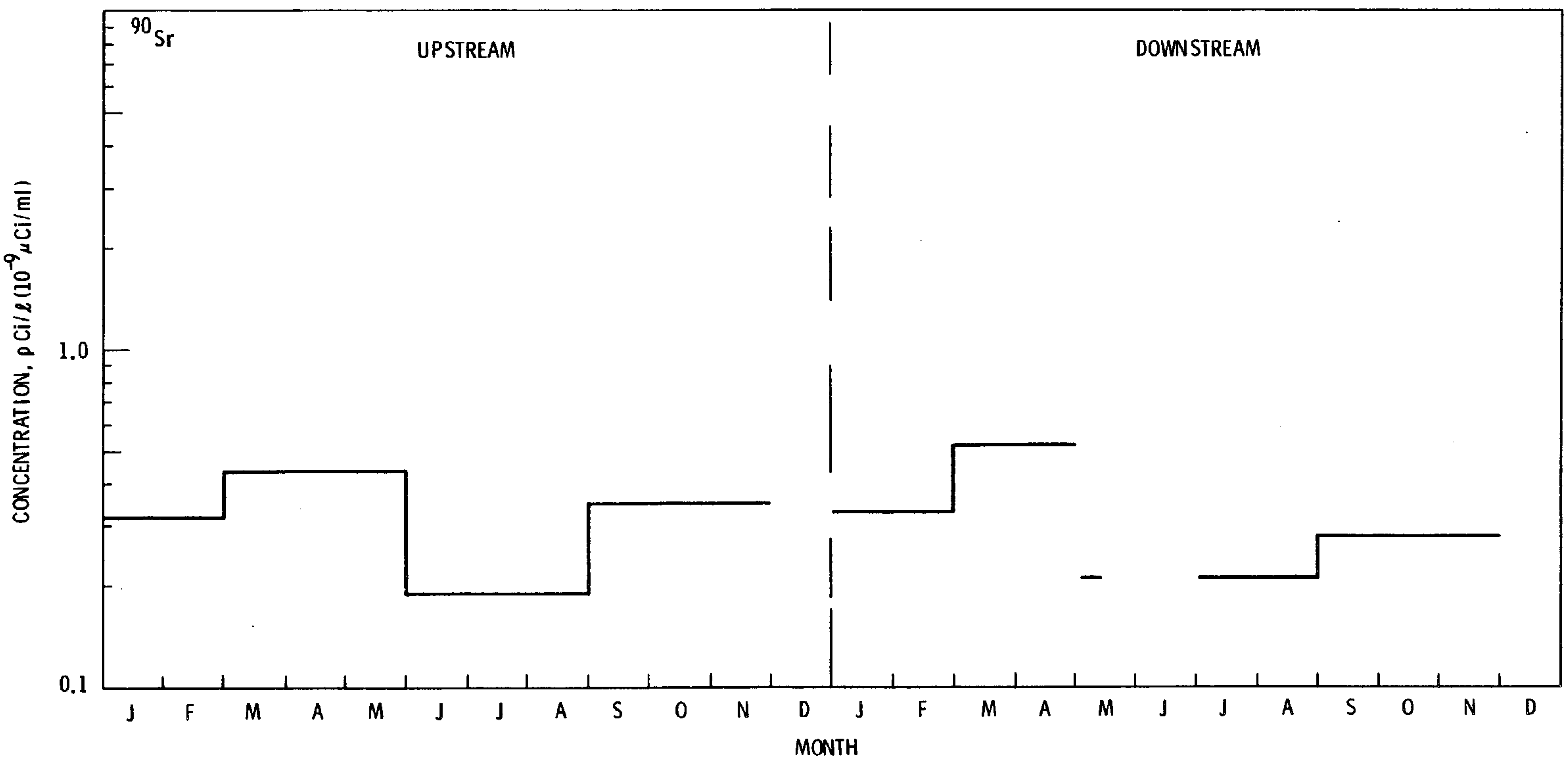


FIGURE 7. (contd)

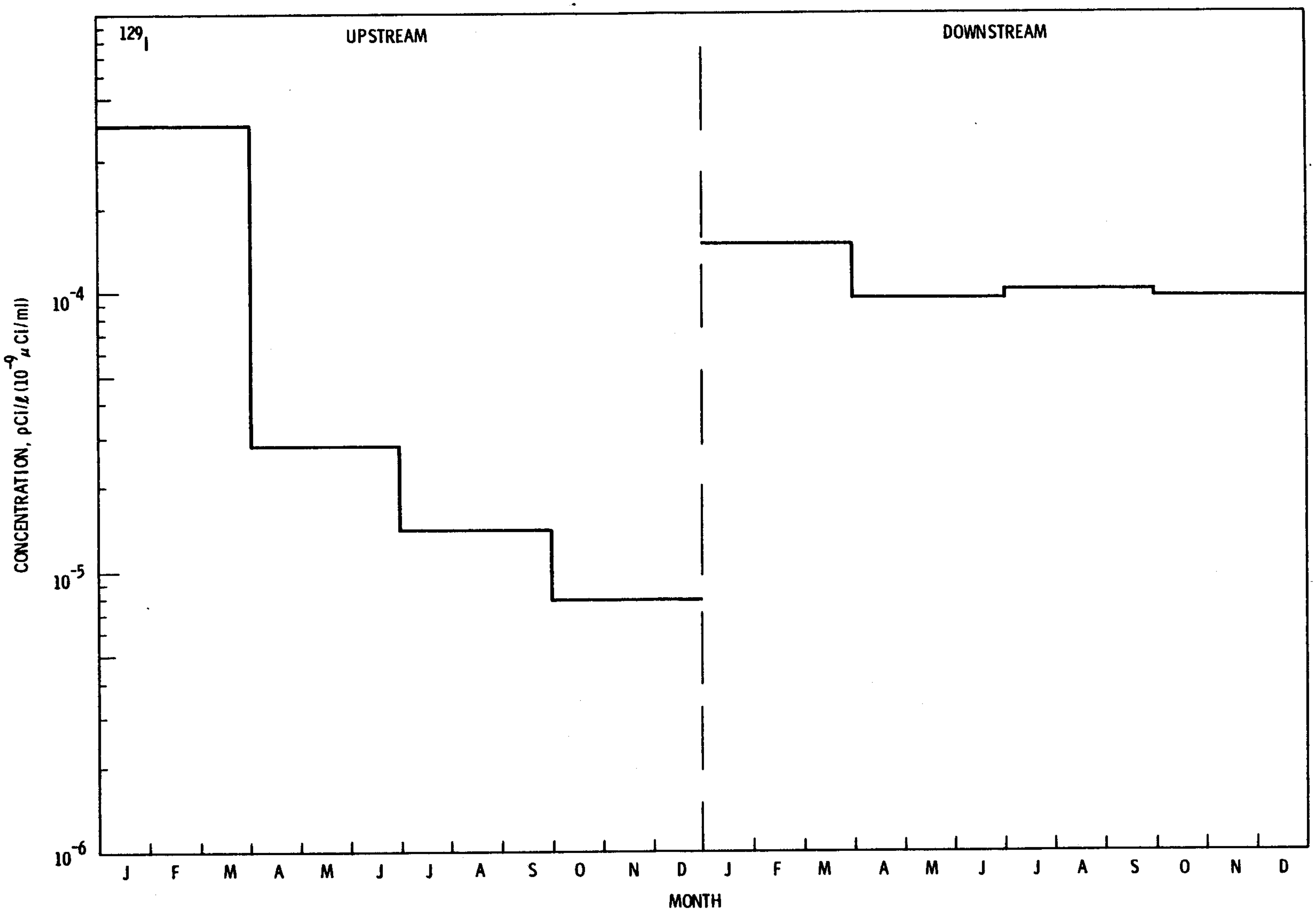


FIGURE 7. (contd)

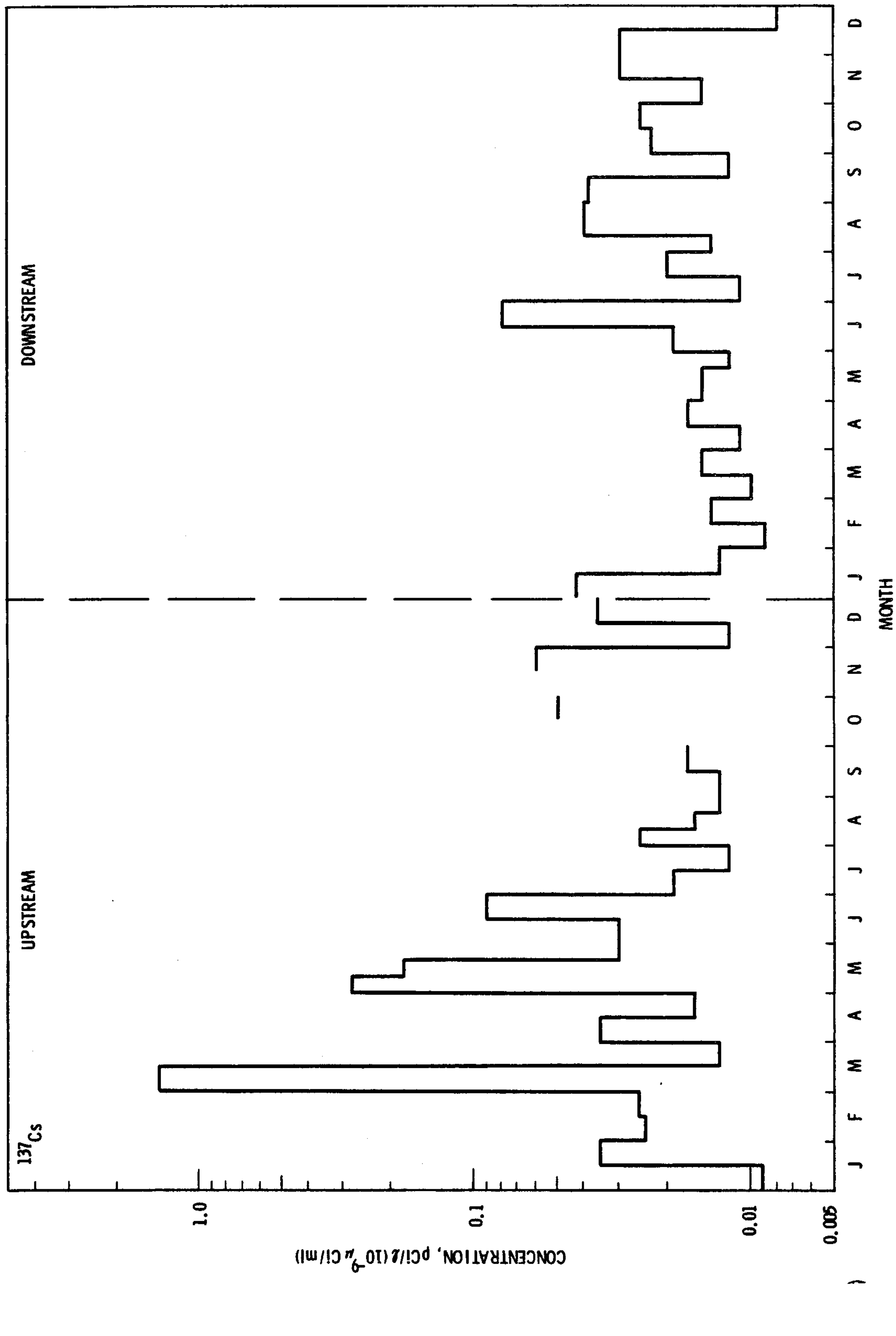


FIGURE 7. (contd)

PONDS

Surface water that has accumulated on the Hanford site outside of contractor operating areas was routinely sampled in 1979. Disposal of process cooling water is responsible for two of the ponds (B Pond and Gable Pond). The third pond (West Lake) is a naturally occurring water table intersection pond that also serves as a natural basin for a relatively large water shed area. Grab samples were collected on a quarterly frequency and analyzed for total alpha, and total beta-emitter radioactivity, for specific gamma emitting radionuclides, and for ^{90}Sr. Figure 8 shows the locations of the ponds sampled during 1979.

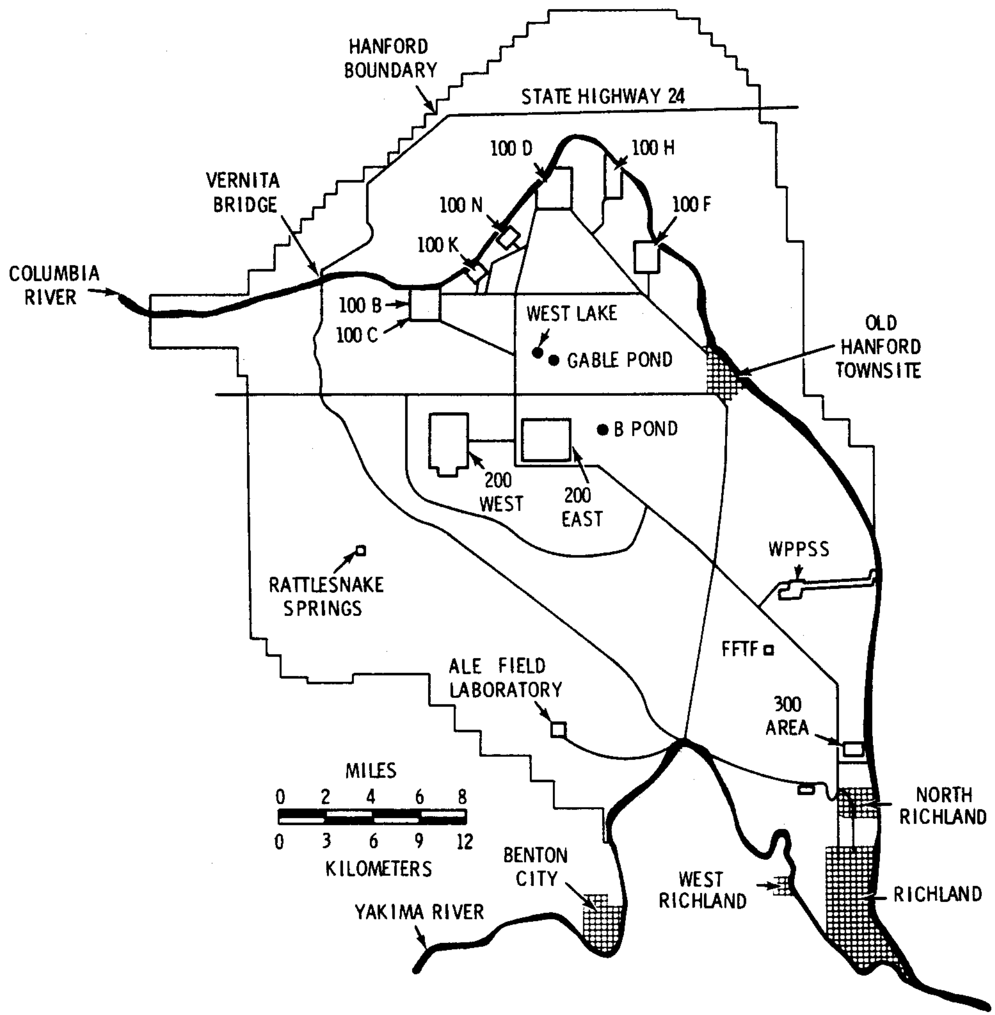


FIGURE 8. Surface Water Areas Sampled During 1979

Analytical results for surface water samples are shown in Figures 9 through 12. In general, the concentrations observed in 1979 are similar to concentrations observed in past years (Houston and Blumer 1979). To provide some perspective, the analytical results shown in Figures 9 through 12 may be compared with the average concentrations observed in the Columbia River. These average concentrations are 0.4 x 10^{-9} μCi/ml for total alpha, 3 x 10^{-9} μCi/ml for total beta, 0.7 x 10^{-9} μCi for ^{90}Sr, and 0.1 x 10^{-9} μCi/ml for ^{137}Cs.

Of the three ponds, West Lake had the highest levels of total alpha-emitter activity. No waste water is discharged directly into West Lake.

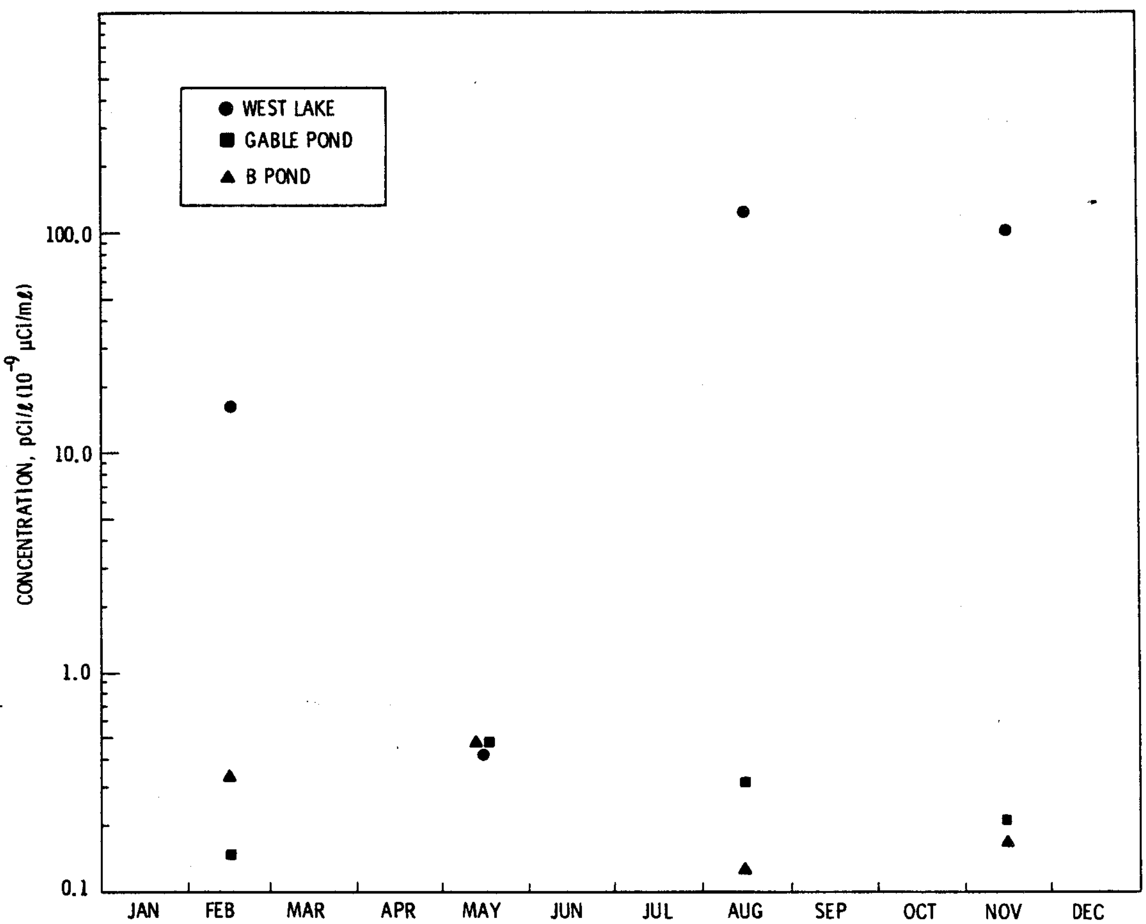


FIGURE 9. Total Alpha-Emitter Activities Observed in 200 Area Ponds During 1979

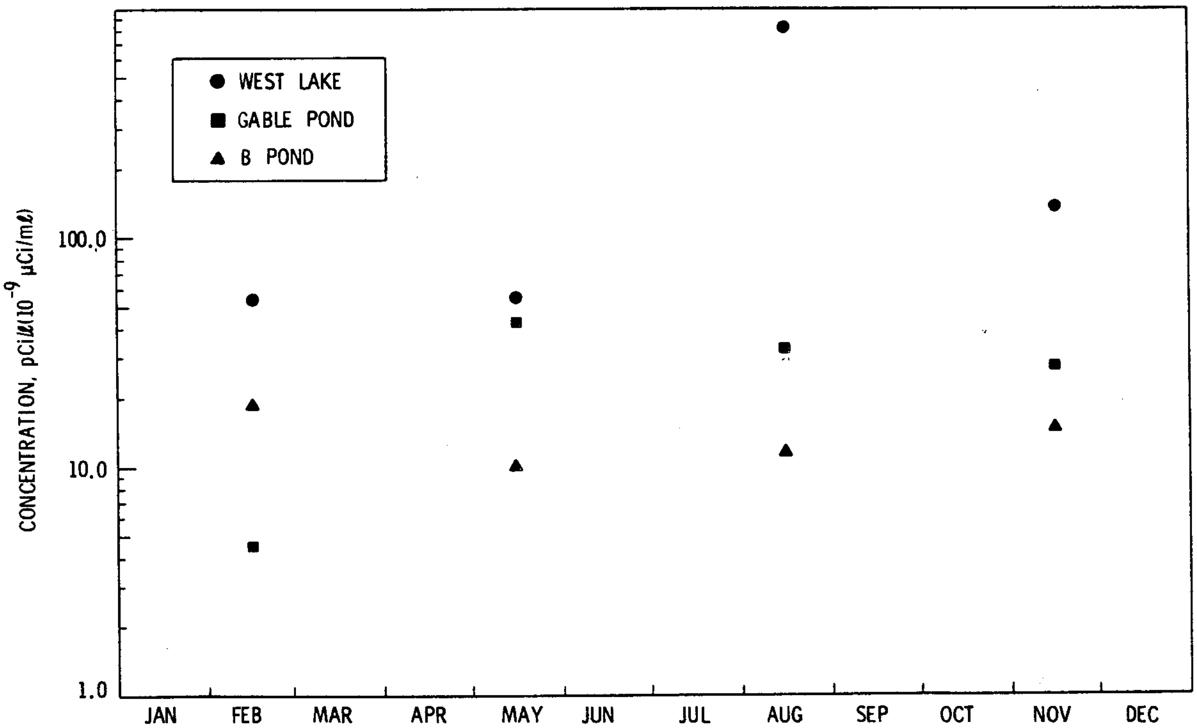


FIGURE 10. Total Beta-Emitter Activities Observed in 200 Area Ponds During 1979

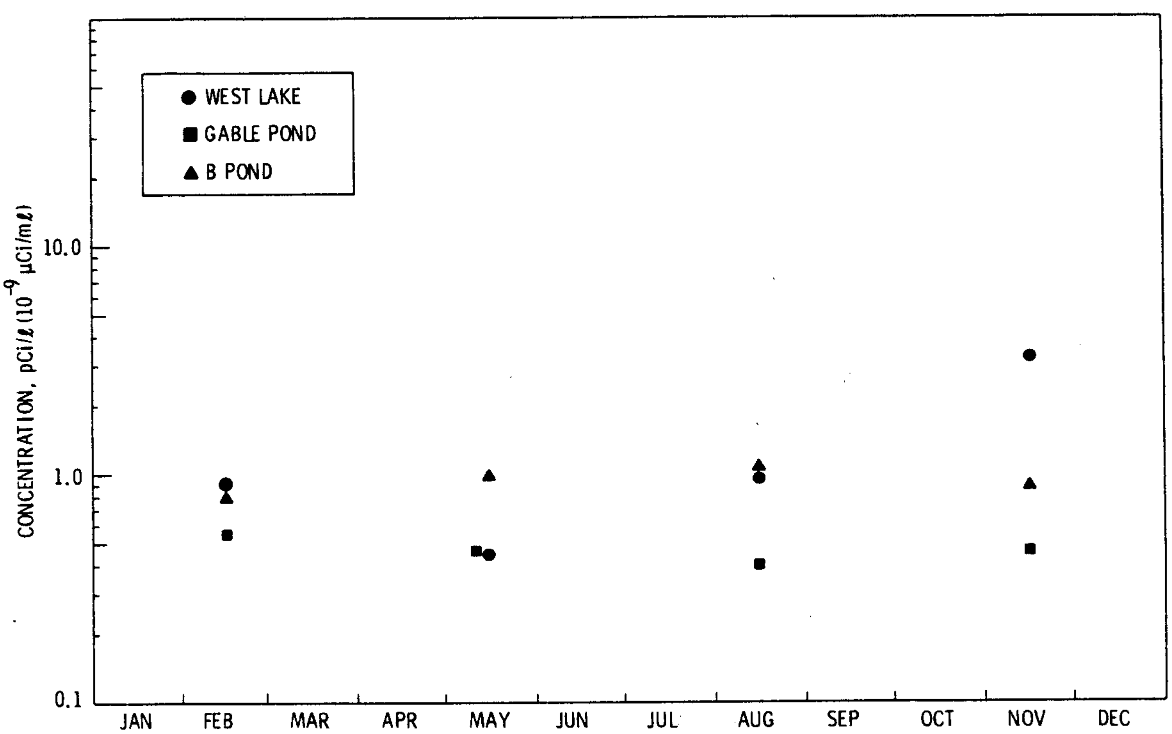


FIGURE 11. Strontium-90 Concentrations Observed in 200 Area Ponds During 1979

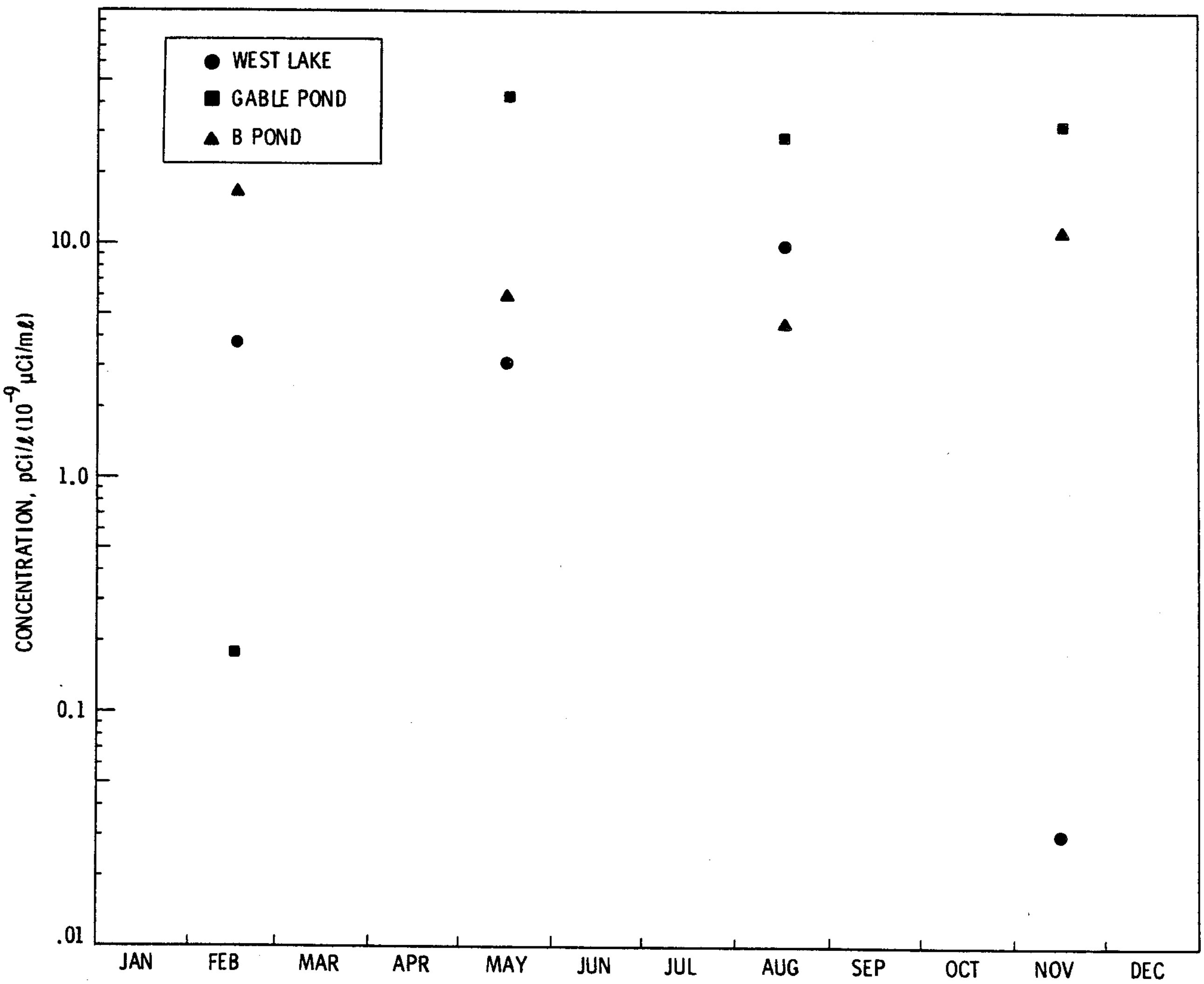


FIGURE 12. Cesium-137 concentrations Observed in 200 Area Ponds During 1979

The relatively high concentration of total alpha-emitter activity in West Lake is due to uranium, which is thought to have been leaching from the soil during the entire history of West Lake's existence. Another possible cause is the concentrating effect of the continual evaporation of water from the pond. By way of contrast, waste water discharged into the other ponds has been diluted with Columbia River water, which has relatively low concentrations of uranium and other radionuclides. All three ponds had similar levels of ^{90}Sr, typical of Columbia River concentrations. Concentrations of ^{137}Cs in the ponds were about a factor of 100 higher than the concentrations observed in the Columbia River.

Numerical values of the gamma spectroscopy and ^{90}Sr analyses are shown in Table 4. This data, along with data from previous years, shows no recent trends either up or down.

TABLE 4. Radionuclide Concentrations in Surface Water Samples During 1979

		Concentration, pCi/ℓ (10^{-9} μCi/ml)[(a)]	
Location	Date	^{90}Sr	^{137}Cs
West Lake	2/13	0.90 ± 0.34	3.8 ± 3.7
	5/8	0.44 ± 0.23	31 ± 2.7
	8/14	0.95 ± 1.4	9.8 ± 2.5
	11/6	3.2 ± 1.4	0.03 ± 7.2
Gable Pond	2/13	0.52 ± 0.09	0.17 ± 0.1
	5/8	0.44 ± 0.10	41 ± 1.4
	8/14	0.38 ± 0.18	27 ± 1.2
	11/6	0.44 ± 0.18	31 ± 1.2
B Pond	2/13	0.76 ± 0.09	16 ± 1.1
	5/8	0.95 ± 0.10	5.8 ± 1.1
	8/14	1.0 ± 0.18	4.4 ± 1.8
	11/6	0.84 ± 0.18	11 ± 1.1
Approximate Detection Limit[(b)]		0.4	2.1

(a) Value ± 2 standard deviations.
(b) The detection limit shown is the average of the individual detection limits.

WILDLIFE

The Hanford Site is a refuge for migratory and resident waterfowl, dry-land game birds, and a variety of mammals. All have access to swamps, ponds, and trenches on the site that receive low-level radioactive wastes. Ingestion of contaminated waste water or vegetation may result in measurable quantities of radionuclides being incorporated in the animals' tissues.

Selected wildlife were collected throughout the Hanford environs as an indicator of radionuclide accessibility and potential transfer through the food chain leading to man. Although the Hanford Site south of the Columbia River is not open to public hunting, several of its wildlife species are game animals that could be taken by hunters during the time they spend offsite.

GAME BIRDS

Gamma spectroscopy was performed on 454g (1 lb) samples of muscle tissue from game birds collected during 1979. The results of these analyses are shown in Table 5.

Ducks (subfamilies Anatinae and Aythyinae) were collected from each of the ponds on the Hanford Site and along the Columbia River. Only those radionuclides observed at levels higher than the detection limit are shown in Table 5. Cesium-137 was the only artificially produced radionuclide detected in the muscle samples. This radioactivity in the waterfowl is probably the result of uptake during residence on the surface-water ponds in the 200 Areas. The maximum concentration found was similar to that measured in previous years.

If an individual consumed 454 g (1 lb) of meat from the duck containing the highest levels of ^{137}Cs observed during 1979 (175×10^{-6} μCi/g), that individual would incur a 50-year internal dose commitment of about 5 mrem to the total body, a small fraction of the annual natural background dose of 100 mrem. The major portion of this dose would be received during the first year following ingestion.

TABLE 5. Radionuclide Concentrations in Game Bird Muscle Samples During 1979

			Concentration, pCi/g (10^{-6} μCi/g wet weight)					
			^{40}K			^{137}Cs		
Location	Species	No. of Samples	Maximum	Minimum	Average(a)	Maximum	Minimum	Average(a)
300 Pond	Ducks	4	2.9	2.5	2.7 ± 0.33	0.07	0.03	0.04 ± 0.04
U Pond	Ducks	1			2.1			0.26
Gable Pond	Ducks	4	6.6	1.8	3.8 ± 4.3	175	0.45	67 ± 150
West Lake	Ducks	2	5.8	2.6	4.2 ± 4.5	86	66	76 ± 14
B Pond	Ducks	4	5.3	2.0	3.1 ± 3.0	40	6.6	21 ± 29
Columbia River	Ducks	2	3.3	2.7	3.0 ± 0.85	0.03	-0.02	0.005 ± 0.07
Columbia River	Geese	3	2.6	2.4	2.5 ± 0.2	0.05	0.004	0.03 ± 0.05
100 Areas	Quail	2	3.2	2.1	2.7 ± 1.6	0.13	0.03	0.08 ± 0.07
100 Areas	Pheasants	4	4.2	2.5	3.1 ± 1.5	0.06	-0.007	0.02 ± 0.07
Detection Limit(b)					1.2			0.46

(a) Average ± 2 standard deviations is shown for each location.
(b) The detection limit shown is the average of the individual detection limits.

DEER

Muscle, liver, and bone tissue samples were obtained from three "road-killed" deer on the Hanford Site in the vicinity of the operating areas. The muscle tissue was analyzed for gamma-emitting radionuclides and the bone and liver samples were analyzed for ^{90}Sr and plutonium, respectively.

In general, the radionuclide concentrations shown in Table 6 are about the same as those observed in deer tissue samples analyzed in 1978. Naturally occurring ^{40}K was observed, as expected in all muscle samples. The only other gamma-emitting radionuclide detected (^{137}Cs) was observed at slightly lower concentrations in 1979 than in recent years. These ^{137}Cs concentrations are lower than levels measured in deer muscle obtained far from the Hanford Site, indicating that worldwide fallout, not Hanford operations, is responsible for the ^{137}Cs in the deer sampled.

Plutonium concentrations in all deer liver samples were below the detection limit. This is somewhat lower than concentrations observed in recent

TABLE 6. Radionuclide Concentrations in Deer Tissues During 1979

			Concentration, pCi/g (10^{-6} μCi/g wet weight)			
Location	Date	Tissue	^{40}K	^{90}Sr	^{137}Cs	^{239}Pu
100N	3/13	Muscle	2.0		0.03	
		Bone		22		
		Liver				0.0002
Route 3 Mile 4	6/15	Muscle	2.1		0.09	
		Bone		3.3		
		Liver				0.006
Route 4S Mile 9	9/12	Muscle	2.3		0.02	
		Bone		1.4		
		Liver				-0.003
Detection Limit(a)			0.28	0.86	0.03	0.003

NOTE: A blank indicates no analysis was made.
(a) The detection limit shown is the average of the individual detection limits.

years. Concentrations of ^{90}Sr in bone tissue from deer were similar to those measured in recent years and about the same as that expected from worldwide fallout.

RABBITS

Rabbits collected around surface waters and radioactive waste sites on the Hanford reservation were analyzed for selected radionuclides to determine the accessibility of radioactive material to small mammals. The results of these analyses are shown in Table 7.

TABLE 7. Radionuclide Concentrations in Rabbit Tissues During 1979

			Concentration, pCi/g (10^{-6} μCi/g Wet Weight)		
Location	Date	Tissue	^{40}K	^{90}Sr	^{137}Cs
200 B-C Crib	1/31	Muscle	2.0		3.0
		Bone		7.8	
200 East Area	1/31	Muscle	2.3		0.79
		Bone		3.4	
100 B Area	4/5	Muscle	2.4		-0.02
		Bone		0.51	
100 F Area	6/30	Muscle	2.6		0.07
		Bone		0.65	
200 B-C Crib	8/16	Muscle	2.9		0.04
		Bone		5.4	
100 F area	9/7	Muscle	3.4		0.06
		Bone		0.27	
300 Area	9/14	Muscle	4.1		0.12
		Bone		0.54	
300 Area	11/8	Muscle	2.0		0.08
		Bone		0.39	
100 N Area	11/9	Muscle	3.1		0.09
		Bone		72	
Detection Limit[(a)]			1.0	0.11	0.08

(a) The detection limit shown is the average of the individual detection limits.

Bone samples taken from rabbits that inhabit the 200 areas had lower concentrations of ^{90}Sr in 1979 than in previous years. Cesium-137 concentrations in muscle tissue samples were similar to those observed in past years.

SOIL AND VEGETATION

Surface soil and vegetation samples were collected during September 1979 from 21 locations both on and off the Hanford reservation at the sites shown in Figure 13. Details on the sample locations around operating areas are given in the Appendix. Each soil sample was a composite of five "plugs" of soil from an area approximately 100 m^2 (1075 ft^2). Each plug was approximately 2.5 cm (1 in.) in depth by 10 cm (4 in.) in diameter. The vegetation samples, collected in the vicinity of each soil sampling area, consisted of a representative collection of new growth from perennial vegetation, including

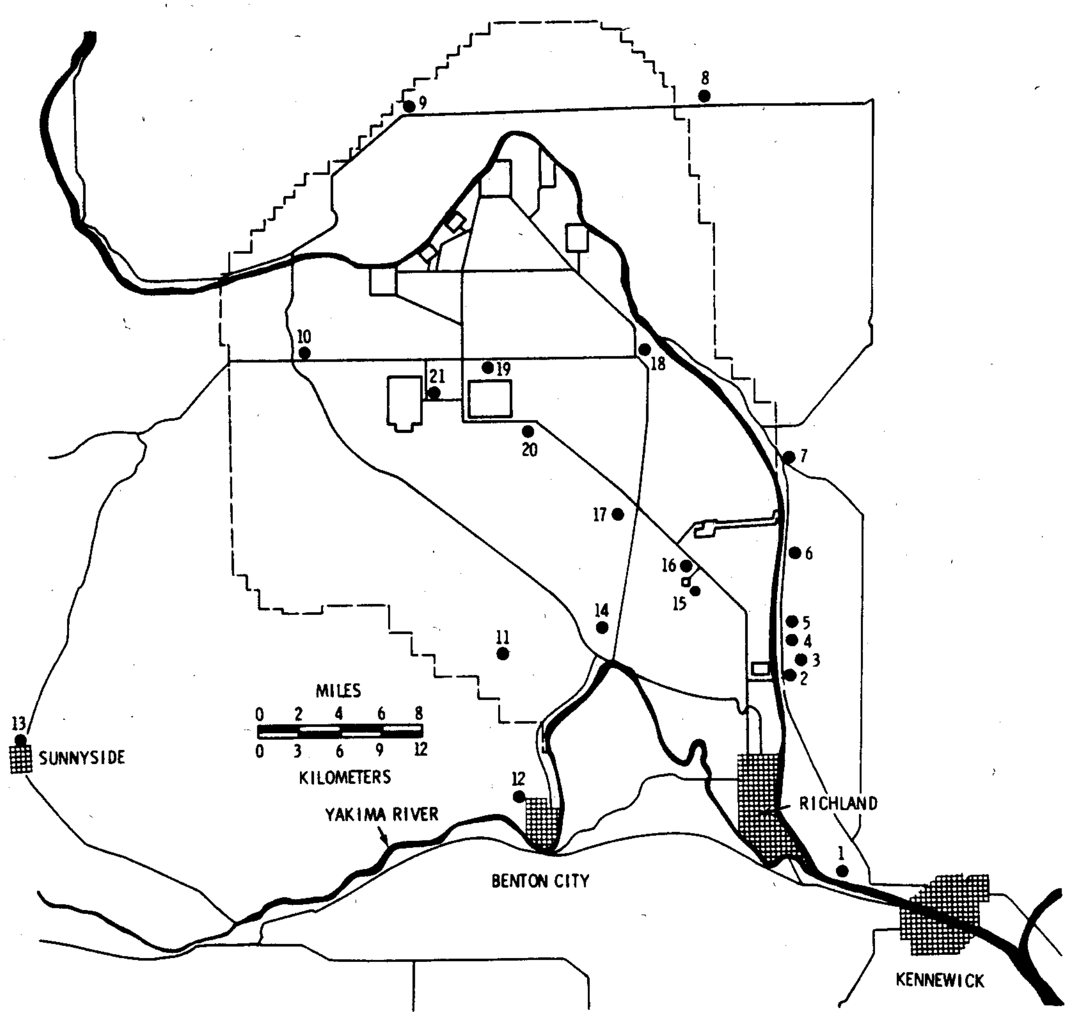


FIGURE 13. Soil and Vegetation Sampling Locations During 1979

rabbitbrush (Chrysothamnus spp.), bitterbrush (Purshia tridentata) and sagebrush (Artemisia tridentata). Both sets of samples were analyzed for gamma-emitting radionuclides using a lithium-drifted germanium detector; for plutonium isotopes using radiochemical separation and alpha spectroscopy; and for ^{90}Sr using radiochemical techniques.

Surface soil and vegetation samples are collected to provide an indication of the cumulative buildup and distribution of radionuclides in the Hanford environment. Assessing the Hanford impact is difficult, since some of the same radionuclides that are potentially released by Hanford activities are also present as a result of worldwide fallout from weapons testing. One analytical tool that can be helpful in detecting the presence of a Hanford contribution to the environmental levels of radionuclides is probability plotting. This technique produces a straight line on a log plot if the concentrations are log-normally distributed and are produced by a single source such as worldwide fallout. Analysis of many background samples has shown that radionuclide concentrations in soil and vegetation are approximately log-normally distributed (Speer and Waite 1975; Miller, Fix and Bramson 1977). If the plotted concentrations describe two straight lines or if a few points at high cumulative probability fall significantly above a single straight line drawn through the rest of the data, then Hanford activities may be contributing to the observed concentrations.

Analytical results for onsite and offsite soil samples are shown in Table 8. Several of the onsite samples contained ^{137}Cs and $^{239-240}Pu$ at unusual concentrations. Log-normal probability plots of the onsite soil sample data for ^{90}Sr, ^{137}Cs and $^{239-240}Pu$ (Figures 14, 15, and 16) show graphically which values exceeded the concentrations generally attributed to worldwide fallout. All results considered to be in excess of the worldwide fallout levels were obtained from samples taken in the vicinity of the 200 Areas. The ^{137}Cs concentration observed at the 200 ENC location is similar to the concentration found in recent years, indicating that the deposition in this area is not new.

The results of vegetation sample analyses from onsite and offsite locations are shown in Table 9. Strontium-90, ^{137}Cs, and $^{239-240}Pu$ were found

TABLE 8. Concentrations of Artificially Produced Radionuclides in Soil Samples During 1979

Sample Location	Map Location	Concentration, pCi/g (10^{-6} μCi/g Dry Weight)							
		^{60}Co	^{90}Sr	$^{95}ZrNb$	^{134}Cs	^{137}Cs	^{144}Ce	^{238}Pu	$^{239-240}Pu$
Onsite									
Wahluke 2	9	-0.009	0.10	0.07	0.06	0.46	0.46	0.0001	0.006
Yakima Barricade	10	0.01	0.23	-0.07	0.04	0.82	0.41	-0.0009	0.005
ALE Field Lab	11	-0.006	0.37	0.08	0.01	1.1	0.34	0.002	0.03
Prosser Barricade	14	-0.02	0.11	0.03	-0.02	0.92	0.40	-0.0004	0.02
NE of FFTF	15	-0.01	0.09	-0.009	0.01	0.19	0.24	-0.0004	0.002
SE of FFTF	16	-0.002	0.08	0.02	0.006	0.19	0.29	0.0002	0.02
Wye Barricade	17	0.02	0.26	0.02	0.02	0.79	0.28	0.0002	0.02
Hanford Townsite	18	0.03	0.20	0.001	0.06	1.1	0.42	0.003	0.02
200 ENC	19	-0.03	0.95	0.04	0.04	35	0.46	0.001	0.06
200 East Hill	20	0.001	0.26	0.13	0.04	2.3	0.47	0.0002	0.03
East of 200 West Area	21	0.06	1.1	-0.04	0.04	3.8	0.54	0.007	0.83
Average		0.004 ± 0.05	0.34 ± 0.70	0.03 ± 0.11	0.03 ± 0.05	4.2 ± 21	0.39 ± 0.19	0.001 ± 0.005	0.10 ± 0.49
Offsite									
Harris Farm	1	-0.04	0.37	0.03	0.04	0.35	0.29	0.00006	0.02
Byers Landing	2	0.006	0.18	-0.06	0.05	0.94	0.56	0.0003	0.02
Sagemoor Farm	3	-0.001	0.03	0.08	-0.0003	0.09	0.37	0.0006	0.001
Taylor Flats 1	4	-0.04	0.06	0.08	0.06	0.13	0.45	0.0004	0.002
Taylor Flats 2	5	0.02	0.34	0.03	0.04	1.6	0.35	0.001	0.03
West End of Fir Road	6	-0.01	0.12	0.09	0.04	0.57	0.44	-0.0002	0.01
Ringold	7	-0.04	0.18	0.24	0.02	0.69	0.47	0.002	0.02
Berg Ranch	8	-0.01	0.30	0.07	0.06	0.86	0.20	0.0001	0.01
Benton City	12	-0.01	0.34	0.03	0.02	0.75	0.25	0.003	0.02
Sunnyside	13	0.02	0.25	-0.01	0.04	0.74	0.43	0.00009	0.03
Average		-0.01 ± 0.05	0.22 ± 0.24	0.06 ± 0.16	0.04 ± 0.04	0.67 ± 0.88	0.38 ± 0.22	0.0005 ± 0.001	0.02 ± 0.02
Detection Limit		0.02	0.009	0.06	0.03	0.07	0.14	0.001	0.004

in vegetation samples from all sites at concentrations similar to those of previous years. The log-normal probability analysis of the onsite data (see Figures 14, 15, and 16) indicate that 200 ENC is the only sample site where Hanford operations have probably contributed to the radionuclide levels in vegetation.

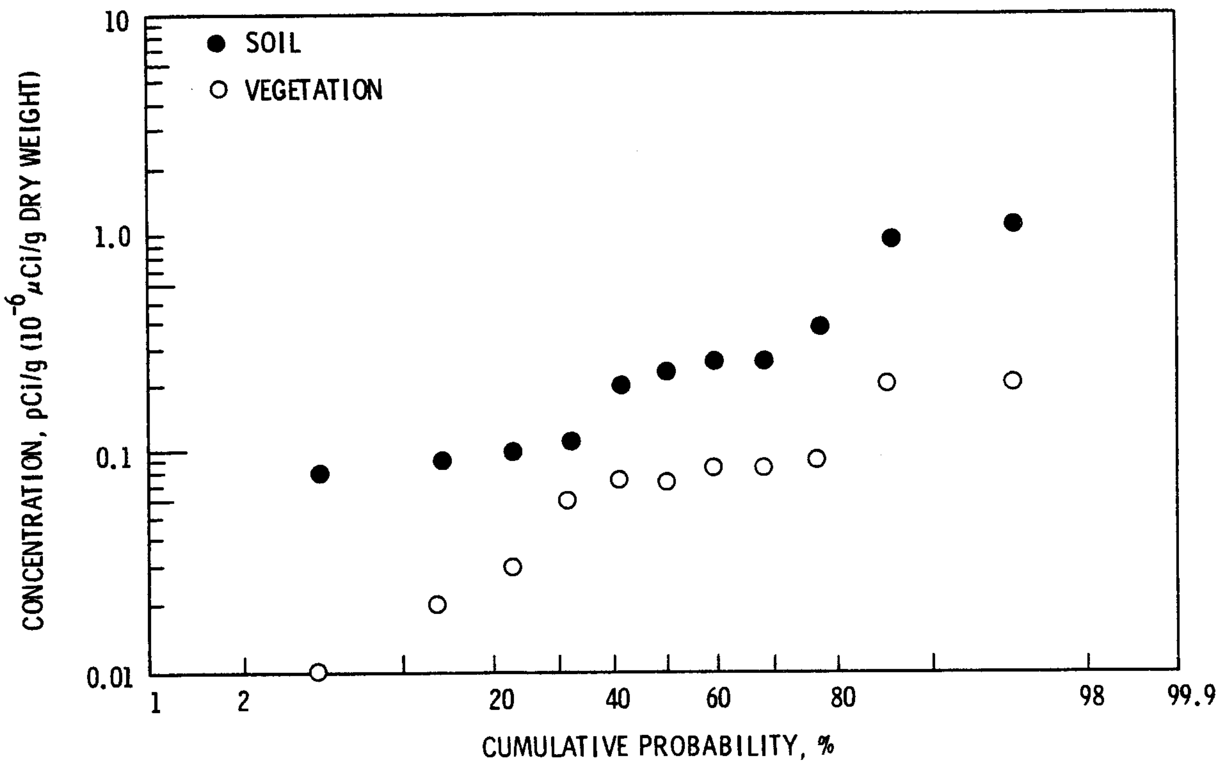


FIGURE 14. Log-Normal Probability Plot of ^{90}Sr in Soil and Vegetation

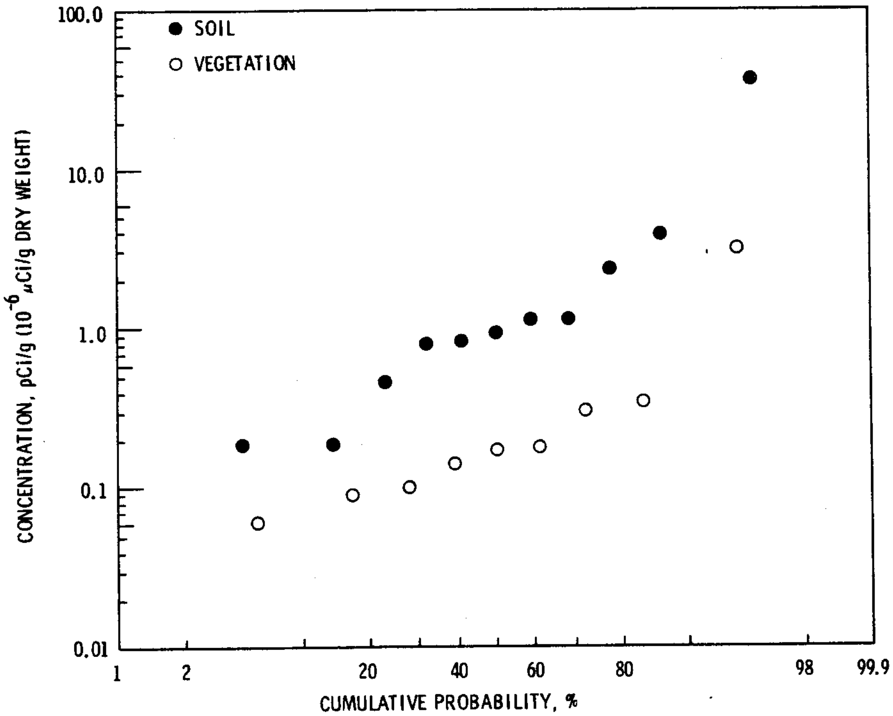


FIGURE 15. Log-Normal Probability Plot of ^{137}Cs in Soil and Vegetation

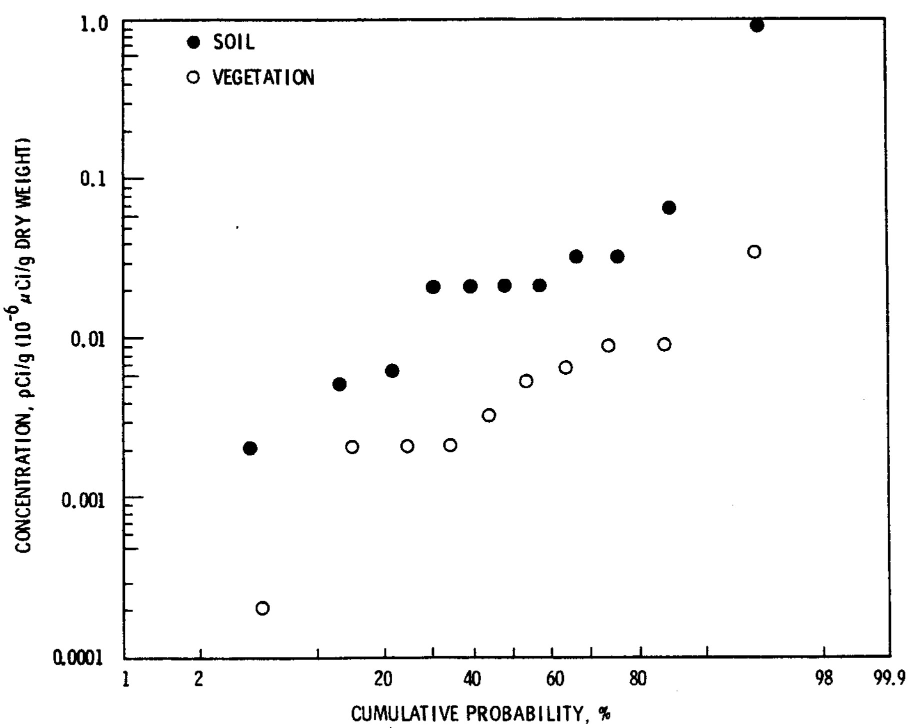


FIGURE 16. Log-Normal Probability Plot of $^{239-240}Pu$ in Soil and Vegetation

TABLE 9. Concentrations of Artificially Produced Radionuclides in Vegetation Samples During 1979

Sample Location	Map Location	Concentration, pCi/g (10^{-6} µCi/g Dry Weight)						
		^{60}Co	^{90}Sr	$^{95}ZrNb$	^{137}Cs	^{144}Ce	^{238}Pu	$^{239-240}Pu$
Onsite								
Wahluke 2	9	-0.006	0.03	0.03	0.09	0.98	0.0002	0.0002
Yakima Barricade	10	0.09	0.09	0.23	0.18	0.72	-0.001	0.002
ALE Field Lab	11	-0.03	0.20	0.23	0.35	0.51	0.004	0.008
Prosser Barricade	14	0.06	0.08	0.20	0.14	0.36	0.04	0.03
NE of FFTF	15	0.02	0.07	0.32	0.06	0.70	-0.002	0.002
SE of FFTF	16	-0.01	0.06	0.13	0.10	0.72	-0.001	0.003
Wye Barricade	17	0.05	0.07	0.03	-0.01	0.40	-0.002	-0.0006
Hanford Townsite	18	0.06	0.01	0.02	-0.03	-0.19	0.0006	0.005
200 ENC	19	0.09	0.20	0.75	3.1	1.2	0.005	0.002
200 East Hill	20	0.03	0.02	0.17	0.30	1.2	0.02	0.006
East of 200 West Area	21	-0.04	0.08	0.08	0.17	0.56	0.001	0.008
Average		0.03 ± 0.09	0.08 ± 0.13	0.20 ± 0.41	0.41 ± 1.8	0.65 ± 0.80	0.006 ± 0.03	0.006 ± 0.02
Offsite								
Harris Farm	1	-0.02	0.06	0.21	0.22	0.46	-0.002	0.004
Byers Landing	2	-0.03	0	-0.23	-0.006	1.0	0.02	0.01
Sagemoor Farm	3	0.08	0.03	-0.03	0.20	0.34	0.0003	0.003
Taylor Flats 1	4	-0.03	0.07	0.14	0.14	0.33	-0.0002	0.001
Taylor Flats 2	5	0.21	0.03	0.23	0.09	0.59	0.02	0.001
West End of Fir Road	6	-0.03	0.32	-0.10	0.09	0.30	0.001	0.002
Ringold	7	-0.07	0.06	0.18	0.19	0.70	-0.001	0.002
Berg Ranch	8	0.07	0.03	0.16	0.01	0.26	0.002	0.002
Benton City	12	0.25	0.46	0.20	0.42	0.81	0.02	0.002
Sunnyside	13	-0.01	0.11	0.06	0.16	1.2	0.008	0.002
Average		0.004 ± 0.22	0.12 ± 0.30	0.08 ± 0.31	0.15 ± 0.24	0.60 ± 0.65	0.007 ± 0.02	0.003 ± 0.005
Detection Limit		0.14	0.03	0.34	0.16	0.76	0.006	0.006

EXTERNAL RADIATION

Thermoluminescent dosimeters (TLDs) were used to measure the external dose at several onsite, perimeter, and distant locations, as shown in Figure 17. Detailed maps showing the locations of TLDs around each operating area are included in Appendix A. In general, the onsite dosimeters were

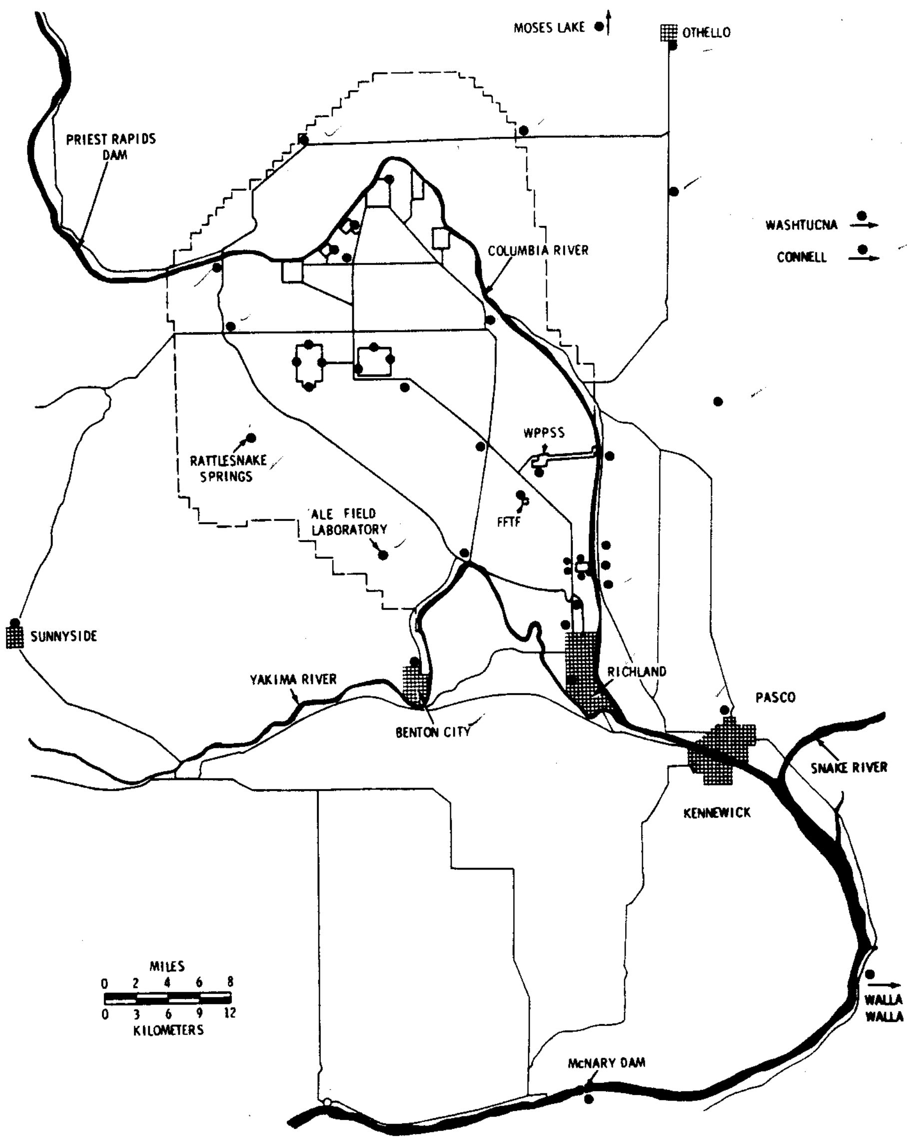


FIGURE 17. TLD External Dose Measurement Locations During 1979

located on the perimeter of each operating area. The dosimeters consisted of CaF_2:Mn chips (Harshaw TLD-400) encased in an opaque plastic capsule lined with 0.025 cm (0.01 in.) of tantalum and 0.005 cm (0.002 in.) of lead to flatten the low-energy response (Fix and Miller 1978). The dosimeters were mounted approximately 1 m above ground level and changed monthly.

Table 10 shows the results of the dose measurements made during 1979. Variability in the measured doses from different locations was expected, primarily because of spatial differences in the amount of natural radioactivity in the soil. The external dose measured at any location is affected by several parameters, including the height of the dosimeter above ground level, its elevation above sea level, the amounts of natural and worldwide radionuclide fallout in the area, and the presence of any radionuclides of Hanford origin.

A log-normal probability plot of the annual average dose rate for two groups of dosimeters is shown in Figure 18. The two groups represent onsite and offsite stations. Dose rates from both groups produced straight-line plots, although several higher dose rates were measured onsite, as expected, primarily around the 100-N and 200 Areas. The straight-line plot for the offsite dose rates indicates that contributions from Hanford operations were indiscernible offsite.

The external background dose rate received by the population in the Hanford environs can be estimated from data in Table 10. The average annual dose measured at the nonoperating area stations on the Hanford Site during 1979 was about 73 mrem (1 mrem equals 1 mrad in this case). An additional 6 mrem must be added to account for the neutron component of cosmic radiation (Oakley 1972), and an additional 25 mrem must be added for the dose received from internal radionuclides in the human body, primarily ^{40}K (U.S. Environmental Protection Agency 1972). The annual average background dose from all sources in the Hanford environs is thus about 100 mrem.

Environmental dosimeters were also submerged in the Columbia River at Coyote Rapids and the Richland Pumphouse (shown in Figure 19) to measure the dose potentially received by swimmers immersed in the Columbia River. Only

TABLE 10. Results of TLD Measurements During 1979

Composite Group	Location	No. of Measurements	Dose Rate, mrad/yr Maximum	Minimum	Average
100 Area					
	100 K	13	84	58	69 ± 15
	100 N	13	128	68	96 ± 28
	100 D	13	90	71	80 ± 12
	100 Area Fire Station	13	90	56	73 ± 18
200 East Area					
	200 ENC	13	173	131	159 ± 25
	200 EEC	13	105	71	87 ± 18
	200 ESE	13	90	64	78 ± 17
	200 EWC	13	83	64	75 ± 12
200 West Area					
	200 WNE	13	79	60	71 ± 14
	200 WEC	13	86	53	72 ± 17
	Redox	13	94	62	80 ± 19
	200 WWC	13	168	117	142 ± 24
300 Area					
	300 Pond	13	84	66	75 ± 13
	3614-A Bldg	13	88	58	72 ± 18
	300 South Gate	13	80	58	70 ± 13
	300 SW Gate	13	99	58	72 ± 20
	3705 Bldg.	13	84	47	66 ± 22
Inner Northeast Sector					
	Berg Ranch	13	88	69	80 ± 11
	Wahluke Watermaster	13	80	55	72 ± 14
	Cooke Bros.	13	73	58	66 ± 10
	Othello	13	84	55	64 ± 15
	Connell	12	77	62	68 ± 9
Inner East Sector					
	Hanford	13	88	58	69 ± 17
	Wye Barricade	13	88	58	72 ± 14
	FFTF Site	13	88	66	72 ± 13
	FFTF North	13	84	66	74 ± 11
	FFTF Southeast	13	77	62	70 ± 12
Inner Southeast Sector					
	Fir Road	12	91	58	72 ± 16
	Pettett	13	84	47	64 ± 21
	Sagemoor	13	88	69	74 ± 10
	Byers Landing	13	84	66	72 ± 11
	Pasco	13	66	55	62 ± 7
	Richland	13	77	58	66 ± 9
	1100 Area	13	77	51	63 ± 14
	CP #64	13	80	58	68 ± 12
Inner Southwest Sector					
	Prosser Barricade	13	91	69	76 ± 13
	Benton City	13	73	51	58 ± 12
	ALE Field Lab	12	91	73	78 ± 11
	Rattlesnake Springs	13	88	62	75 ± 14
Inner Northwest sector					
	Vernita	13	80	69	74 ± 8
	Yakima Barricade	13	95	69	77 ± 15
	Wahluke #2	13	120	69	82 ± 25
Outer Northeast Sector					
	Moses Lake	13	88	58	68 ± 14
	Washtucna	13	84	62	70 ± 12
Outer Southeast Sector					
	Walla Walla	13	73	47	61 ± 14
	McNary	13	88	58	72 ± 17
Outer West Sector					
	Sunnyside	13	66	51	61 ± 9

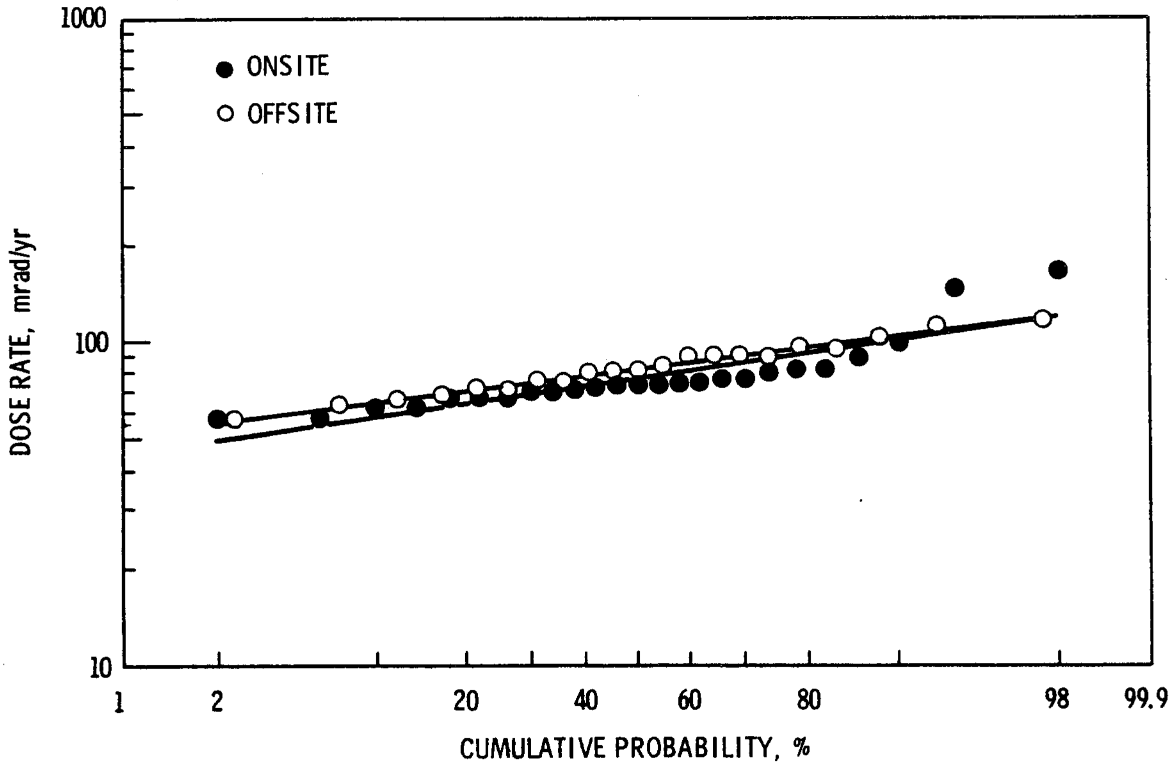


FIGURE 18. Log-Normal Probability Plot of TLD External Dose Measurements 1979

two stations are currently monitored because dose rates measured in the river (~0.004 mrad/hr) are currently about half of those on land. Data for these stations are shown in Table 11.

In the past, analyses of sediment samples collected along the Columbia River and surveys made with portable radiation detection instruments have revealed the presence of a few long-lived radionuclides, primarily ^{60}Co, ^{137}Cs, and ^{152}Eu. This activity, released to the river during past operation of the once-through-cooled production reactors, was deposited on many of the river's islands and on the shoreline and slough areas along the Hanford reach, and remains there, slowly decaying (Fix 1976). Table 12 summarizes TLD measurements of external radiation taken at 12 locations along the Columbia River shoreline, and at 3 of the larger islands during 1979. These locations are shown in Figure 20. The variation in dose rates among the locations is due to differences in radionuclide concentrations.

TABLE 11. Columbia River Immersion Dose Rates During 1979

Location	No. of Measurements	Dose rate, μrad/hr[a] Maximum	Minimum	Average[b]
Coyote Rapids	9	6	3	5 ± 2
Richland Pumphouse	13	5	3	4 ± 1

(a) Monthly measurements in mrad were converted to average dose rate in microrad per hour
(b) Average ±2 standard deviation is shown for each location

TABLE 12. Dose Rate Measurements Along the Columbia River Islands and Shoreline During 1979

Location	No. of Samples	Dose Rate (μrad/hr)[a] Maximum	Minimum	Average[b]
Above 100-K Area	9	9	7	8 ± 1
100-N Trench Springs	9	85	32	56 ± 39
Opposite 100-D Area	9	8	7	8 ± 1
Locke Island	9	10	8	9 ± 1
White Bluffs	9	10	7	9 ± 1
Below 100-F Area	9	8	7	8 ± 1
Hanford Powerline Crossing	9	10	8	9 ± 2
Hanford Ferry Landing	9	10	8	9 ± 1
Hanford RR Track	9	16	13	14 ± 5
Ringold Island	9	10	8	9 ± 1
Powerline Crossing	9	11	9	10 ± 1
Wooded Island	9	11	8	10 ± 2

(a) Monthly measurements in mrad were converted to average dose rate in microrad per hour.
(b) Average ±2 standard deviation is shown for each location.

During the summer of 1979 an extensive radiological survey of the shore and islands along the Hanford reach of the Columbia River was performed to evaluate the magnitude and distribution of the radioactive contamination present (Sula, 1980). The contamination in these areas was found to be present in three different distributions.

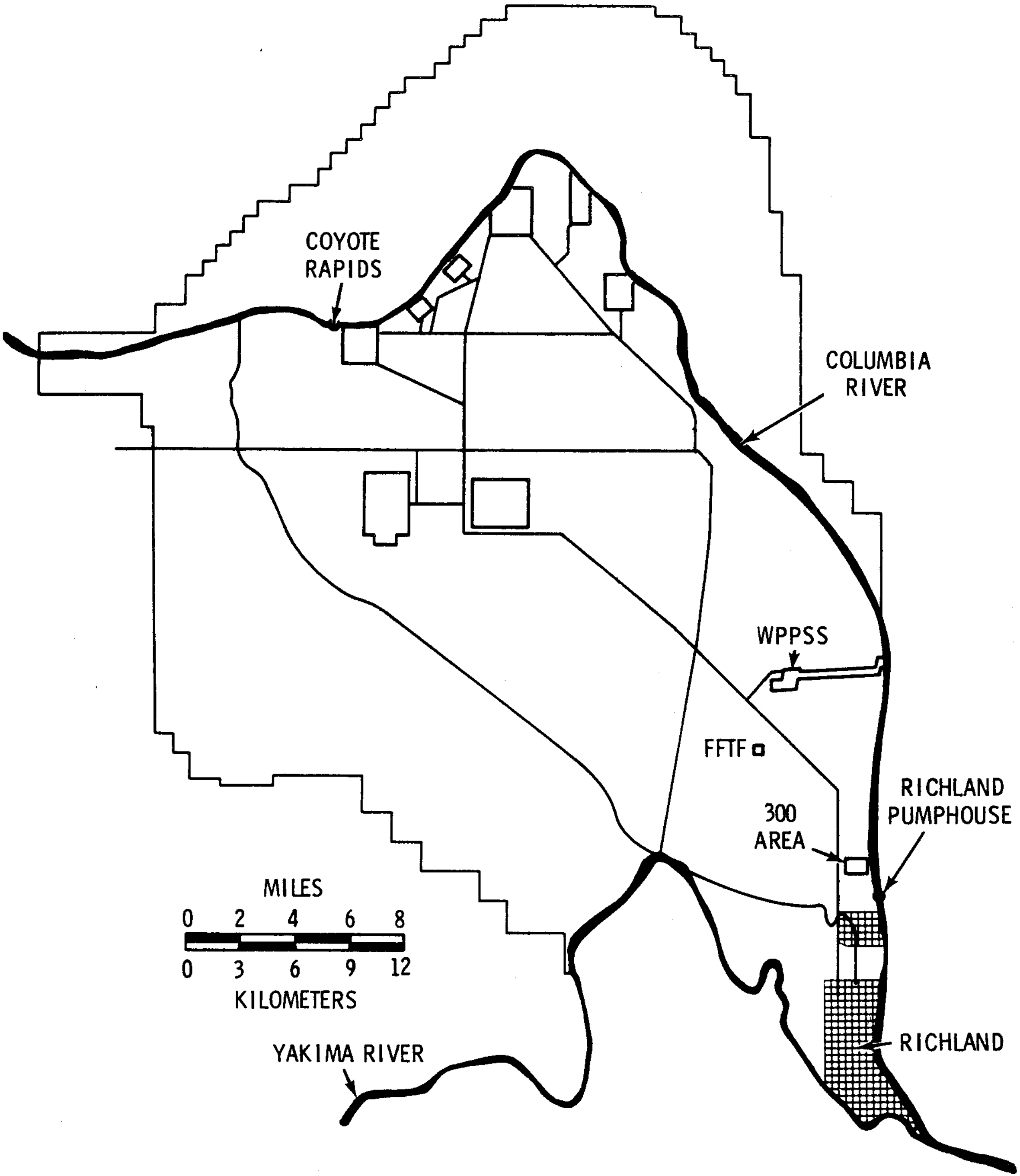


FIGURE 19. Locations of Immersion Dose Measurements in the Columbia River During 1979

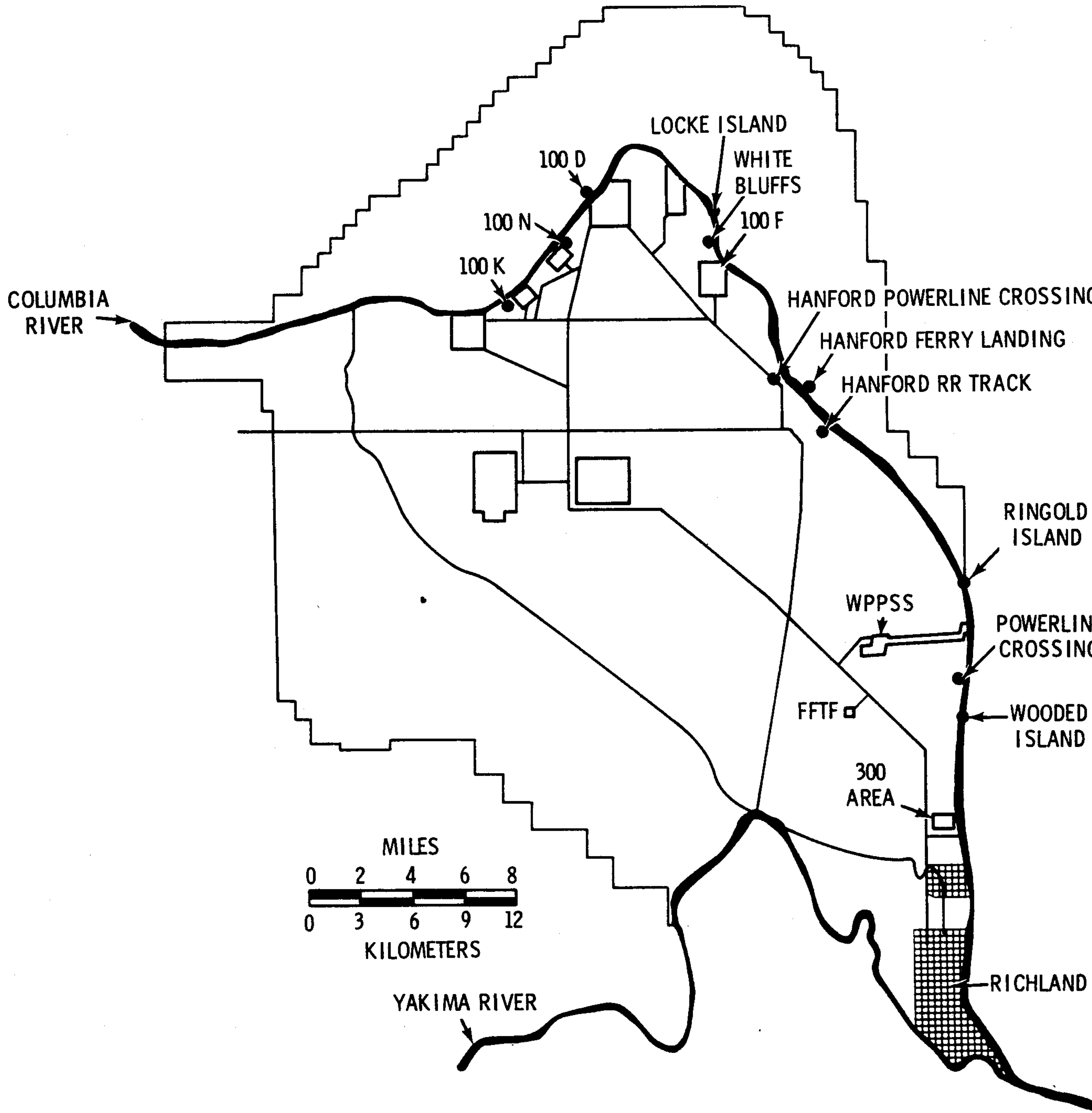


FIGURE 20. Locations of External Dose Measurements Along the Columbia River During 1979

Low level contamination was observed over much of the study area, producing an average exposure rate of 0.011 mR/hr; about 0.004 mR/hr above the background exposure rate observed upstream of the Hanford Site.

Exposure rates in the range of 0.025 to 0.045 mR/hr were observed in ninety-two areas. These areas ranged in size from a few square meters to several thousand square meters, and were usually coincident with areas of dense vegetation. Analyses of the soil in these areas showed a mixture of ^{60}Co, ^{137}Cs, and ^{152}Eu in approximately equal proportions.

Discrete particles of contamination containing ^{60}Co were also observed along the river, usually in flat, rocky areas with little or no vegetation. The particles were found to be minute metallic flakes, possibly fragments of stellite valve and pump components used in the production reactors. These particles were found at depths of 0 to 13 cm (5 in.) below the surface and contained from 2 to 25 μCi of ^{60}Co activity. The existence of particles has been reported previously (Nees and Corley, 1974).

During the course of this survey, several areas in the vicinity of the production reactor site were found where radiation levels in excess of natural background were observed. These radiation levels were attributed primarily to onsite sources and, to a much smaller degree, to contaminated sediments on the shoreline. The maximum exposure rate (0.8 mR/hr) was measured with a portable instrument along the 100-N area shore in the vicinity of the 1314 N building, 30 meters (100 ft.) from the water line.

RADIATION SURVEYS

The Hanford environmental surveillance program includes the surveillance of roads, railways, and waste disposal sites to detect any abnormal levels of radioactivity.

HANFORD ROADS SURVEY

Roads on the Hanford Site were routinely surveyed during 1979 with a scintillation detector attached to the right front end of a truck and positioned about 0.3 m (1 ft) above the road surface. The road monitor has been described in BNWL-62 (Philipp and Sheen 1965). Survey frequency ranged from monthly to quarterly, depending on road usage and contamination potential, with most roads surveyed monthly.

During 1979, one situation on the roadways requiring corrective action was detected. A spot of contamination that read 100,000 counts per minute at contact with a GM type instrument was discovered on route 4-S at milepost 18 during the February road survey. The speck of contamination was found to be under material used to resurface the roadway and therefore not of recent origin. Apparently, on previous surveys of this road section, the detector did not pass close enough to the spot to detect the contamination. No other roadway situations requiring corrective action were detected.

RAILROAD SURVEY

All Hanford railroad tracks outside of the operating area fences were surveyed either quarterly or annually. The survey was conducted using a road monitor attached to a railroad maintenance car. No conditions requiring corrective action were detected.

WASTE DISPOSAL SITES

Active, inactive, and retired sites for waste disposal were surveyed and inspected for general physical condition during 1979. A list of these sites and the survey frequency may be found in the Master Schedule for CY-1979 (Blumer, Houston and Eddy 1979). Most sites were surveyed semiannually.

A routine survey of the 300 Area Burial Ground #4 in September resulted in the discovery of a uranium fuel element lying on the ground outside the burial ground fence. Additional fuel elements were found in the same area just below ground in subsequent surveys. Except for a few instances of animal burrowings, minor subsidences and housekeeping problems, all other sites were found to be in good condition. Problems identified during these surveys were recorded and reported to the responsible contractor.

ENVIRONMENTAL RELEASES

For the purposes of this report, anything disposed of to the environment is considered an environmental release. These releases can result either from the planned day-to-day operation of facilities or from accidents or unusual occurrences. Temporary storage of materials or wastes in an engineered facility is not considered an environmental release.

Both routine and accidental releases to the environment can be further subdivided into groups with similar dispersion characteristics, such as gaseous, liquid, and solid wastes. Within these groups, contaminants can be classified by their nature, e.g., radioactivity, chemicals, particulates, heat, and sewage.

Monitoring and sampling programs are conducted routinely by each Hanford contractor to help assure that adequate controls of processes and effluent streams are maintained.

ROUTINE RELEASES

Routine releases are those expected as a matter of course during the operation of a facility, such as ventilation exhausts and cooling water discharges. They arise out of the basic design of the facility and are regulated by effluent control systems and other factors providing containment of waste materials. Routine releases of waste materials from Hanford facilities are generally consistent with those expected based on the facilities' design.

Gaseous Effluents

Gaseous effluents are primarily filtered air from building ventilation systems, process gas streams treated by various means such as scrubbers, chemical reactors, and filters, and the exhaust gases from steam power plants. Contaminants in gaseous effluents at the Hanford Site include radioactive materials, various chemical compounds, and particulates.

Radionuclide concentrations in routine gaseous effluents at Hanford have been rather low, particularly in recent years. Operations at N Reactor currently produce the bulk of the activity released to the atmosphere. Most of this activity, however, is made up of short-lived radionuclides. The total quantities of radionuclides released to the air from each operating area during 1979 are shown in Table 13.

The nonradioactive pollutants in Hanford's routine gaseous effluents consist primarily of oxides of sulfur from the steam power plants, oxides of nitrogen from chemical processes and steam power plants, and particulates. Smaller quantities of other pollutants such as carbon monoxide, hydrocarbons, aldehydes, and a number of other materials are also released.

The nonradioactive pollutant content of gaseous effluents for 1979 is shown in Table 14. The data in this table are not complete because effluent streams are generally not sampled for nonradioactive pollutants. In most cases the values are calculated from the quantities of the material used (in the case of volatile materials) or burned (in the case of fuel oil and coal).

Liquid Effluents

Liquid effluents consist of the large volumes of water used for processing and cooling during routine operations. Contaminants in liquid effluents may include low concentrations of radioactive and chemical constituents, suspended particulates, heat, and oil or grease.

Discharges to the Columbia River

Hanford Site waste waters are discharged at nine points along the Hanford reach of the Columbia River. These discharges, within certain limits, are allowed under the National Pollutant Discharge Elimination System (NPDES) permit. Sources of these discharges are backwash water from intake screens, cooling water, overflow from water storage tanks, and fish hatchery waste water.

Summarized in Table 13 are the quantities of radionuclides discharged to the river during 1979. The majority of this activity reaches the river via the 1301-N Crib (Greager 1980).

Chemical pollutants in liquid discharges to the river consist primarily of sulfate ion and small quantities of hydrazine and morpholine. Suspended solids are also discharged back into the river during intake screen and filter

TABLE 13. Routine Radionuclide Releases to the River and Atmosphere During 1979

Radionuclide	Half Life	Effluent (Ci) Liquid To River	Gaseous 100 Area	Gaseous 200 Areas	Gaseous 300 Area
^{3}H (HTO)	12.3 yr	200	15	--	8.4
^{14}C	5730 yr	--	9.7	--	--
^{24}Na	15.0 hr	--	0.20	--	--
^{32}P	14.3 d	0.012	--	--	--
^{41}Ar	1.8 hr	--	86,000	--	--
^{51}Cr	27.8 d	--	0.080	--	--
^{54}Mn	303.0 d	0.82	0.037	--	--
^{56}Mn	2.6 hr	5.2	5.1	--	--
^{59}Fe	46.0 d	2.1	0.045	--	--
^{58}Co	71.0 d	0.13	0.012	--	--
^{60}Co	5.3 yr	0.93	0.053	--	2.0×10^{-5}(a)
^{65}Zn	245.0 d	--	0.009	--	--
^{76}As	26.4 hr	--	0.45	--	--
^{85m}Kr	4.4 hr	--	420	--	--
^{85}Kr	10.8 hr	--	--	--	1,500
^{87}Kr	76.0 min	--	1,300	--	--
$^{88}KrRb$	2.8 hr	--	970	--	--
^{89}Sr	52.7 d	0.58	0.012	--	--
^{90}Sr	27.7 yr	1.6	0.0004	0.19(b)	7.0×10^{-5}(b)
^{91}Sr	9.7 hr	--	2.4	--	--
^{95}Zr	65.5 d	0.13	0.010	--	--
^{95}Nb	35.0 d	0.17	0.009	--	--
$^{97}ZrNb$	17.0 hr	--	0.055	--	--
$^{99m}MoTc$	66.7 hr	1.0	0.39	--	--
^{103}Ru	39.5 hr	0.52	0.020	--	--
^{106}Ru	368.0 d	0.45	0.083	--	--
^{122}Sb	2.8 d	--	0.016	--	--
^{124}Sb	60.4 d	0.087	0.0043	--	--
^{125}Sb	2.7 yr	0.19	0.0012	--	--
^{132}Te	77.7 yr	--	0.069	--	--
^{129}I	1.7×10^{7} yr	2.7×10^{-10}	2.3×10^{-8}	--	--
^{131}I	8.1 d	5.1	0.54	--	4.1×10^{-4}
^{132}I	2.3 hr	--	11	--	--
^{133}I	20.3 hr	1.1	3.0	--	--
^{135}I	6.7 hr	--	6.7	--	--
^{133}Xe	5.3 d	6.9	4.1	--	--
^{135}Xe	9.1 hr	--	1,400	--	--
^{138}Xe	17.5 min	--	5,300	--	--
^{134}Cs	2.1 yr	--	0.011	--	--
^{137}Cs	30.0 yr	0.078	0.039	--	--
^{140}Ba	12.8 d	0.45	0.16	--	--
^{140}La	40.2 hr	2.7	0.36	--	--
^{141}Ce	32.5 d	0.053	0.030	--	--
$^{144}CePr$	284.0 d	--	0.060	--	--
^{147}Nd	11.1 d	--	0.073	--	--
^{153}Sm	46.8 hr	0.28	0.12	--	--
^{154}Eu	16.0 yr	--	0.0074	--	--
^{155}Eu	1.8 yr	--	0.014	--	--
^{187}W	23.9 hr	--	0.094	--	--
Th-Nat.	1.4×10^{10} yr	--	--	--	1.9×10^{-7}
U-Nat.	4.4×10^{9} yr	--	--	--	2.7×10^{-5}
^{239}Np	2.3 d	--	0.78	--	--
^{238}Pu	86.4 yr	6.8×10^{-5}	3.4×10^{-7}	--	--
^{239}Pu	2.44×10^{4} yr	5.0×10^{-5}	2.0×10^{-6}	0.0019	4.0×10^{-5}(c)
^{244}Cm	18.1 yr	--	--	--	5.1×10^{-8}

(a) Actually reported as mixed activation products. Cobalt-60 was assumed for simplicity and was used in dose calculations.
(b) Actually reported as mixed fission products. Strontium-90 was assumed for simplicity and was used in dose calculations.
(c) Actually reported as gross alpha. Plutonium-239 was assumed for simplicity and was used in dose calculations.
— Radionuclide not reported in effluent.

TABLE 14. Nonradioactive Pollutants in Hanford Gaseous Effluents During 1979

Pollutant	Quantity Released, metric tons 100 Areas	200 Areas	300 Areas
Sulfur Oxides	480.	870.	280.
Carbon Monoxide	7.7	65.	12.
Hydrocarbons	6.0	33.	8.4
Nitrogen oxides	160	490.	190
Aldehydes	2.1	--	--
Trichloroethylene	--	--	-0.8
Perchloroethylene	--	--	15
1,1,1-Trichloroethylene	--	--	3
Particulates	44.	4,700.	16.

--No release reported.

backwash operations. The large volumes of water used in the cooling of N Reactor result in about 5.7 x 10^{11} liters (1.5 x 10^{11} gallons) of heated water being discharged to the river each year (Greager 1980).

Discharges to the Soil

Large quantities of water are used in operations at Hanford and disposed of to the soil on site. The bulk of this water is used for cooling purposes and never comes in contact with radioactive or hazardous chemicals. Waste water from these uses is discharged to surface ponds for evaporation and/or percolation.

Other water either is contaminated during routine operations or has a reasonable likelihood of being contaminated in the event of equipment malfunction or process upset. These waste waters are disposed of in controlled ditches, trenches, and cribs in such a manner as to take advantage of the favorable ion exchange characteristics of the soil in removing contaminants from the water.

Nonradioactive effluents to soil during 1979 consisted of liquid process waste, power house wastes (coal ash slurry), laboratory chemical waste, filter backwash from water treatment plants, demineralizer wastes, and sanitary sewage. Routine discharges of waste water to the soil during 1979 were as follows:

100-N Area. About 5.0 billion liters (1.3 billion gallons) of primary coolant bleed water and coolant water from N Reactor's fuel storage basin contaminated with about 70,000 curies (Ci) of fission and activation product radionuclides were disposed of to the 1301-N crib (Greager 1980). The majority of this activity is made up of short-lived radionuclides. Less than 1% of the activity discharged to this crib reaches the Columbia River. Most of it either decays or sorbs on to soil particles as it passes through the soil.

100-K Area. During 1979, about 1.5 million liters (0.4 million gallons) of water from the KE Reactor's fuel storage basin seeped to the soil through an expansion joint. This basin was converted from its original purpose several years ago and now serves as a temporary storage basin for spent fuel from N Reactor. In June 1979, corrective action was taken and the seepage that had been occurring through the expansion joint was stopped. A total of about 220 curies of fission and activation product radionuclide reached the soil beneath the basin in 1979 (Greager 1980). Most of this radioactivity is retained on the soil particles in the immediate vicinity of the basin and will not reach the river. Studies have shown that the Pu, Cs and Sr activity is retained in the soil column (Dorian and Richards 1978).

200-E Area. Cooling water and steam condensate containing less than 50 Ci of radionuclides in 15 billion liters (3.9 billion gallons) of water were discharged to various ponds, ditches, and trenches in 1979. Another 130 Ci in 270 million liters (71 million gallons) of process and steam condensate water were disposed of to various cribs in the 200 East Area (Sliger 1980).

200-W Area. Less than 5 Ci of radionuclides in 4.8 billion liters (1.3 billion gallons) of cooling water, steam condensate, and other low-level contaminated waste water were disposed of to a number of ditches, trenches, and surface ponds. Another 50 curies in 23 million liters (6.1 million gallons) of process and steam condensate waste water were disposed of to various cribs in the 200 West Area (Sliger 1980).

300 Area. Process trenches in the 300 Area received 3.2 billion liters (850 million gallons) of process waste water containing 360 kg (793 lb) of uranium, 291 kg (640 lb) of copper, 1441 kg (3170 lb) of fluoride, 500 kg (1100 lb) of zinc, 1.8 kg (4 lb) of mercury, 6,273 kg (13,800 lb) of nitrate, and a total of about 1 Ci of radioactivity. Sanitary trenches received 380 million liters (100 million gallons) of laboratory, animal, and other wastes containing 1.4 kg (3 lb) of uranium, 16 kg (35 lb) of copper, 82 kg (180 lb) of fluoride, 40 kg (88 lb) of zinc, 0.05 kg (0.1 lb) of mercury, and 1591 kg (3500 lb) of nitrate.

Solid Wastes

Solid wastes include a wide variety of materials, from ordinary trash to large pieces of contaminated equipment. Contaminants in Hanford's solid wastes include radioactivity, and hazardous chemicals and substances. All solid wastes are buried in trenches or landfills in or near the 200 Areas.

Some solid wastes are contaminated to varying degrees with the many forms of radioactive materials generated at Hanford. These materials consist of fission products, induced radionuclides, uranium, and transuranic elements, principally plutonium. Solid waste containing ^{233}U or transuranic elements is packaged and buried separately from nontransuranic radionuclide waste for future retrieval. Other radioactively contaminated solids are packaged in boxes, drums, or other containers and buried underground in trenches. The quantities of these radioactively contaminated solid wastes buried during 1979 are shown in Table 15 (Anderson and Poremba 1980).

Other solid wastes produced during 1979 included general wastes or sanitary landfill, hazardous chemicals, and asbestos. The quantities of these waste materials that are buried are shown in Table 15 (Boothe, et. al 1980).

TABLE 15. Hanford Solid Waste Effluents During 1979

Waste Type	Quantity
Radioactive Waste	
Uranium	3.7×10^6 g
Plutonium	6.3×10^4 g
Other transuranics	4.8×10^3 g
Strontium-90	5.3×10^3 Ci
Rhuthenium-106	4.0×10^3 Ci
Cesium-137	1.9×10^5 Ci
Other fission and activation radionuclides	1.4×10^5 Ci
General Waste (sanitary landfill)	11,200 m^3
Hazardous chemicals	43 m^3
Asbestos	825 m^3

ACCIDENTAL RELEASES

Several unplanned releases of contaminants occurred in 1979 as a result of accidents or other unusual occurrences (equipment or instrumentation malfunctions, operator errors, and design errors or inadequacies). The releases included discharges into several environmental media and one instance of wildlife contamination. The instance of wildlife contamination represents an isolated case associated with identifiable sources of radioactivity and does not reflect the general condition of the Hanford Site as shown in previous sections of this report. All of the releases had negligible impact on the environment and, for the most part, the impact was confined to the immediate vicinity of the release.

Further details and the corrective actions taken to prevent a recurrence of these releases are contained in the occurrence reports summarized below. These reports may be found in the public reading room of the Hanford Science Center in Richland, Washington.

Airborne Effluents

Six accidental releases to the atmosphere of radioactive airborne contaminents occurred during 1979. There was also one nonradioactive pollutant emission occurrence. A brief description of each release and its environmental impact is presented below.

RHO Occurrence Report No. 79-1- 1/2/79

Loose surface contamination in the 241 S and SX Tank Farms in the 200 West area was resuspended and deposited in an adjacent area. An undeterminable quantity of radioactivity was released to the environment. Results of air samples taken in the vicinity showed that environmental air concentrations were well within applicable guidelines for uncontrolled areas.

RHO Occurrence Report No. 79-29 - 1/3/79

Radioactively contaminated vapor was observed escaping from a liquid measurement riser on Tank 118 at the 241-TX Tank Farm in the 200 West Area. Samples of the vapor contained radionuclide concentrations at about the Concentration Guide for controlled areas. Environmental air samples taken in the vicinity showed concentrations well below the Concentration Guides for controlled areas. Average air concentrations of ^{137}Cs along the perimeter of the 200 West area during this period were several times higher than normal but far below the Concentration Guide for uncontrolled areas.

PNL Occurrence Report No. 79-PNL 4 - 3/13/79

A plutonium oxide storage can ruptured during an unpacking operation in the 303-C storage facility in the 300 area. An estimated 1.2 to 1.3 millicuries of alpha-emitting, transuranic radionuclides escaped through the gaseous exhaust system. Potential lung radiation exposures as high as 0.64 rem to employees and 0.0084 rem to transient members of the public could have resulted if they had been on the center line of the plume for the duration of the release.

RHO Occurrence Report No. 79-34 - 3/22/79

Radioactively contaminated vapor was observed escaping from a liquid measurement riser on Tank 106 at the 241-U Tank Farm in the 200 West Area.

Samples of the vapor contained radionuclide concentrations that were below the Concentration Guide for contolled areas. Average air concentrations of ^{137}Cs along the perimeter of the 200 West Area during this period were several times higher than normal but far below the Concentration Guides for controlled areas.

RHO Occurrence Report No. 79-52 - 4/27/79

During cleanup operations following a filter change at the Waste Encapsulation and Storage Facility in the 200 East Area, wind gusts caused a spread of radioactive contamination to the immediate vicinity. Plastic sheeting used for contamination control during the filter change was the source of the contamination. Environmental air samples collected during the period showed no unusual air concentrations and the area has been decontaminated.

UNC Occurrence Report No. 79-21 - 6/21/79

During a test of the Foster-Wheeler boiler at the 184-N powerhouse in the 100 N Area, the opacity limit for the stacks of 20% for greater than 15 minutes was exceeded. The smoke opacity exceeded 20% for approximately 45 minutes.

RHO Occurrence Report No. 79-101 - 10/9/79

During the replacement of high efficiency particulate air filters at 232-Z Building in the 200 West Area approximately 200 μCi of alpha-emitting radioactive material was released from the main Z Plant stack. No unusual environmental air concentrations were detected for the period.

Liquid Effluents

Three accidental releases of liquid to the Columbia River occurred in 1979, all involving violations of the temperature limit on the NPDES permit. In addition, there were six unplanned releases of radioactive liquid to the soil. All of these releases are described below.

HEDL Occurrence Report No. 79-2 - 1/8/79

An attempt to transfer some liquid radioactive waste through underground lines from the 325-A Building to the 340 Building in the 300 Area resulted in about 3000 gallons containing 70 curies of activity being discharged to the soil beneath the 325-A Building. A valve in the wrong position caused the waste water to backup into other tanks in the 325-A Building, overflow the tanks, and seep through cracks in the floor. Samples obtained from nearby ground water monitoring wells indicated that the ground water was not contaminated as a result of this event.

RHO Occurrence Report No. 79-11 - 1/18/79

A small amount of soil was contaminated when less than one-half gallon of radioactively contaminated liquid was spilled from a railroad tank car during unloading operations in the 200 West area. The contaminated soil was removed, resulting in no significant environmental impact.

RHO Occurrence Report No. 79-25 - 2/12/79

A 100 square foot area of ground in the 241-S Tank Farm in the 200 West area was radioactively contaminated during an attempt to flush a waste transfer line. An improper valving sequence during the flushing operation caused the contaminated liquid to be discharged on the ground near the flush pit. The environmental impact from this occurrence is judged to be negligible.

RHO Occurrence Report No. 79-40 - 3/28/79

Low level radioactive liquid waste was released from the 222-S Building into the 207-SL Retention Basin in the 200 West area and subsequently to the 216-S-19 pond. The concentration in the effluent from the 222-S Building exceeded operational limits for discharge as low level waste. Concentrations in the 207-SL Retention Basin were below operational release limits because of dilution. The liquid was released to the pond. The environmental impact of this release is considered to be negligible.

UNC Occurrence Report No. 79-11 - 5/579

Spillage of water from the After Heat Removal and/or Emergency Raw water tanks at the 100 N area resulted in releases to the Columbia River from discharge point 005 exceeding the maximum daily temperature limit of 100°F. For short periods spanning several days, water temperatures as high as 130°F were recorded.

UNC Occurrence Report No. 79-12 - 5/19/79

During a required pumping test on the emergency low-lift diesel pumps at N-Reactor, the maximum daily flow limit of 20.87 million gallons specified by the Hanford NPDES permit was exceeded for discharge point 005. Flows of 50.4 million gallons and 31.5 million gallons were recorded on two days beginning May 19.

UNC Occurrence Report No. 79-31 - 8/15/79

The maximum daily temperature limit of 83.4°F specified by the Hanford NPDES permit for discharge point 009 was exceeded for a total of 15 minutes when temperatures reached a maximum of 106°F. The cause was a mismatch between N-Reactor power output and electrical power generation resulting in excess heat being dumped to the cooling water.

RHO Occurrence Report No. 79-106 - 10/25/79

Contaminated liquid waste in excess of operating limits was discharged to the 216-S-25 Crib in the 200 West area. The apparent cause was the failure of an ion exchange column used to decontaminate process condensate at the 242-S Evaporator-Crystallizer.

RHO Occurrence Report No. 79-113 - 11/14/79

Liquid radioactive waste was found to be flowing into a deactivated crib (216-A-24) in the 200 East area. The cause was found to be a valve in the wrong position, allowing the waste destined for the 216-A-08 Crib to be disposed of in the 216-A-24 Crib.

Solid Wastes

Three unplanned releases of solid waste, all involving radioactive material, occurred in 1979. Brief descriptions of these releases are presented below.

RHO Occurrence Report No. 79-24 - 2/12/79

A railroad track from B Plant to the burial ground in the 200 East area was contaminated with radioactive material during a routine equipment burial operation. A spill of liquid from the equipment in the B Plant railroad tunnel was determined to be the source of the contamination. The track was decontaminated and the environmental impact was negligible.

RHO Occurrence Report No. 79-60 - 5/23/79

Swallow's nests made of contaminated mud were discovered at the 244-AR Vault in the 200 East area. The source of the contaminated mud was found to be the 216-A-40 retention basin, also in the 200 East area. Leaks in the bladder-type containment bags in the retention basin resulted in radioactively contaminated liquid becoming available to the swallows in the basin. The source of the contamination has been cleaned up and the contaminated nests removed.

RHO Occurrence Report No. 79-96 - 9/20/79

While performing a routine radiological survey around a retired burial ground north of the 300 area, a depleted uranium fuel element was found protruding above the surface. Nineteen additional fuel elements were found in the same area during followup surveys. The area where the fuel elements were located was inadvertently left outside a new fence installed around the burial ground in 1974. The 20 recovered fuel elements were subsequently buried in a 200 area burial ground. The environmental impact from this occurrence was negligible.

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APPENDIX A

SPECIFIC SAMPLING LOCATIONS AROUND HANFORD FACILITIES

100-D Area

100-K Area

100-N Area

200 East Area

200 West Area

300 Area

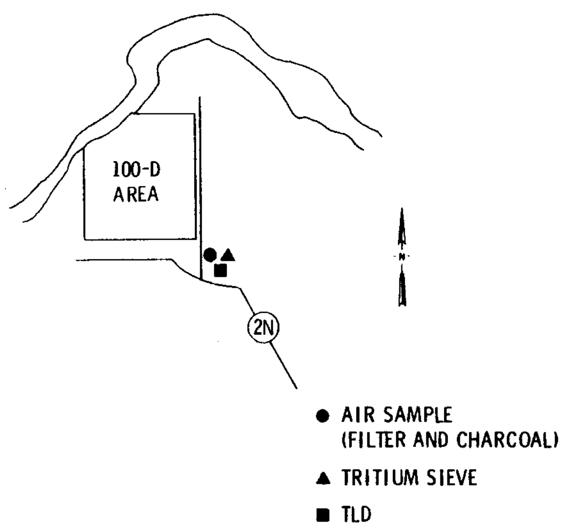

FIGURE A.1. Sampling Locations in the 100-D Area

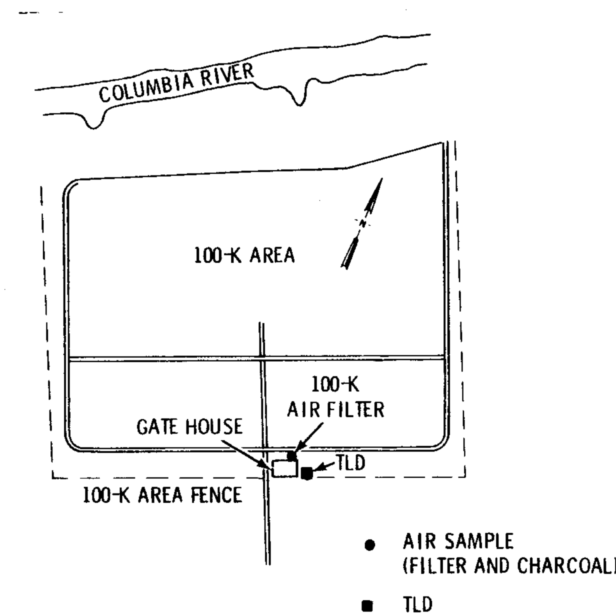

FIGURE A.2. Sampling Locations in the 100-K Area

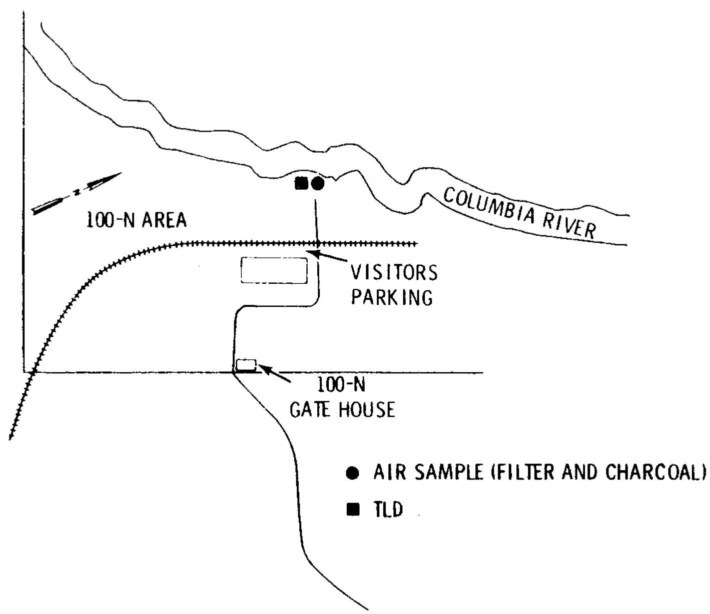

FIGURE A.3. Sampling Locations in the 100-N Area

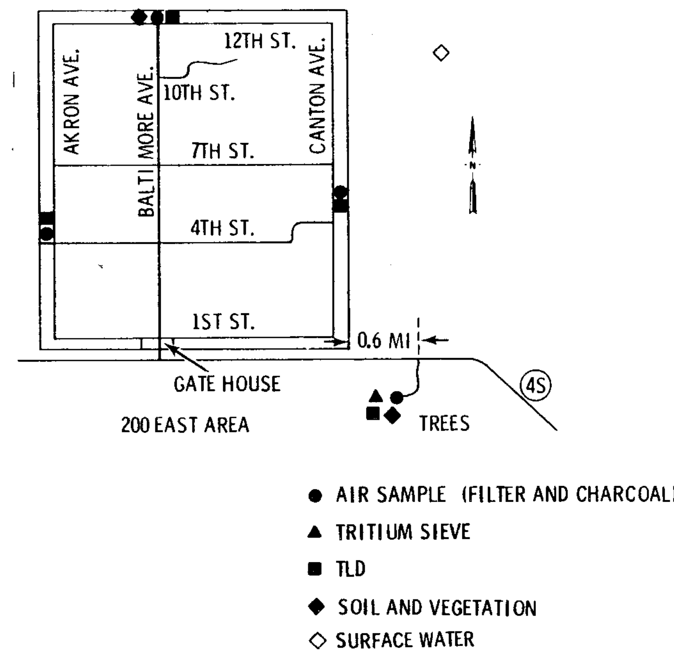

FIGURE A.4. Sampling Locations in the 200 East Area

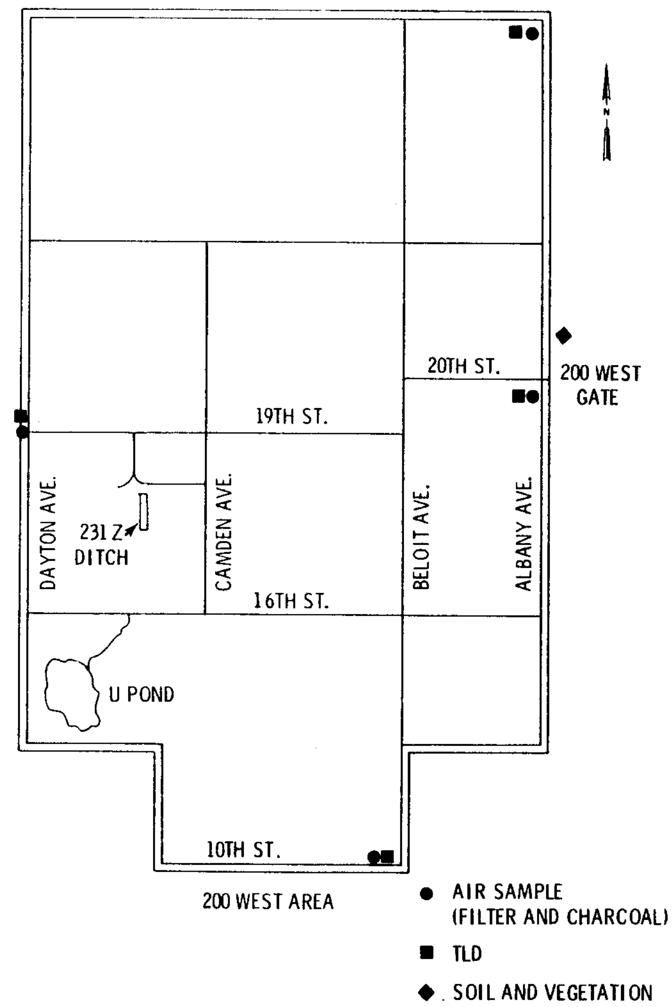

FIGURE A.5. Sampling Locations in the 200 West Area

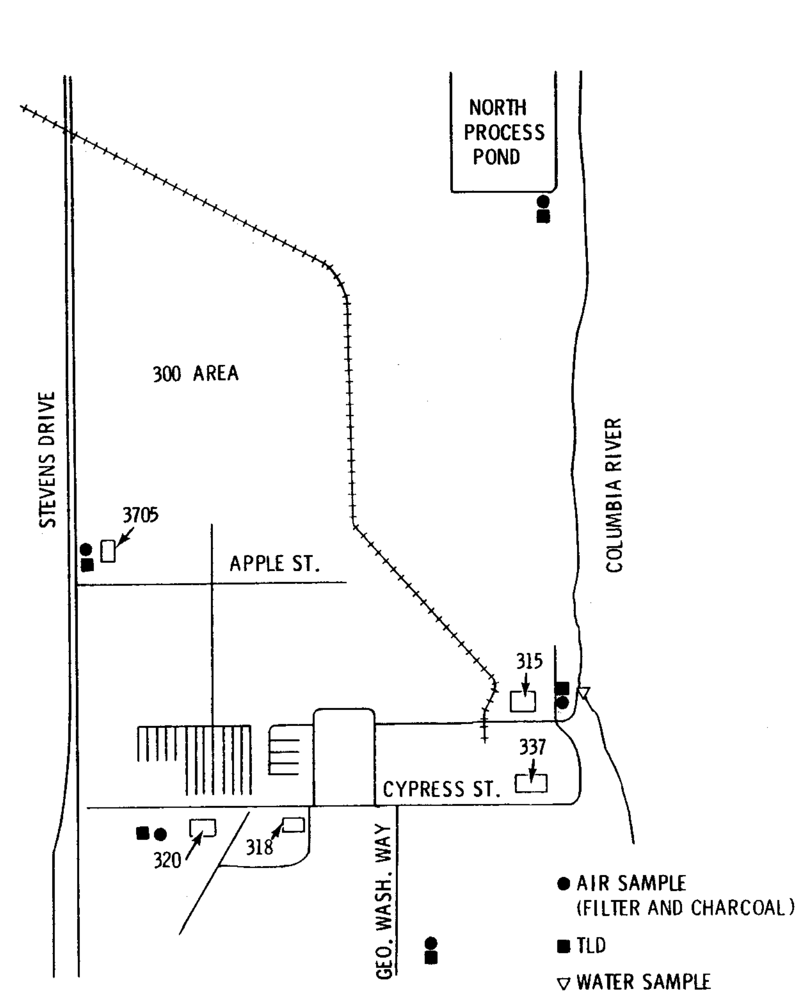

FIGURE A.6. Sampling Locations in the 300 Area

APPENDIX B

DATA ANALYSIS

APPENDIX B

DATA ANALYSIS

Most data summary tables in this report show maximum, minimum and average concentration values for various radionuclide-media-location combinations. Maximum and minimum refer to the largest and smallest concentrations found in a single sample during the year. Average values are usually accompanied by a plus or minus (±) value. This value is equivalent to twice the standard deviation of the distribution of the observed individual sample results and is a measure of the range in concentration or level encountered for those samples. When an average is shown for groups of locations, this value has been computed from the individual results and the plus or minus value accompanying the average is twice the standard deviation of the distribution of all the individual results.

The arithmetic averages and standard deviations shown in this report were calculated using the following equations:

$$\overline{X} = \frac{1}{n} \sum_{i=1}^{n} X_i$$

where: $\overline{X}$ = arithmetic average
n = numbers of samples analyzed
X_i = individual sample results

$$s = \sqrt{\frac{\sum_{i=1}^{n} \left(X_i - \overline{X}\right)^2}{n - 1}}$$

where: s = standard deviation
n = number of samples analyzed
$\overline{X}$ = arithmetic average
X_i = individual sample results

For many sample analyses, it is possible to obtain net values that are lower than the detection limit of the system. This is particularly true when an instrument or chemical background must be subtracted. It is not uncommon for individual measurements to result in negative numbers due to statistical fluctuations. In fact with many measurements of a true zero sample an approximately equal number of net positive and negative results would be expected. Although negative values do not represent a physical reality, they must be included along with the other values in order to compute the correct average for the population. For this reason the primary values given in this report are the actual values obtained from individual measurements.

A detection limit was computed for each sample analyzed during 1979 as an aid in determining the significance of each result. A sample result at the detection limit, as currently defined, means that there is a 95% chance that the material being measured is actually present. At the same time it means that there is a 5% chance that the result is due to a high statistical fluctuation in the background and the material being measured is not present. Since the detection limits vary considerably over the course of a year, an average detection limit is computed and presented in most tables to provide some perspective for the reader in evaluating the sample results.

Environmental data have been found to be better described by a Gaussian distribution function of the logarithms of the data than by the data itself (Speer and Waite 1975). This being the case, log-normal probability plots have been freely used throughout the report as analytical tools and to more graphically present the data. Log-normal probability plotting produces a straight line plot if the data are log-normally distributed and result from a single source such as worldwide fallout. If the data describe two connecting straight lines or if data points at high cumulative probability fall significantly above a single straight line, more than one source may be contributing to the observed values.

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