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**OAK RIDGE
NATIONAL
LABORATORY**

MARTIN MARIETTA

**Environmental Surveillance
Data Report for the
Fourth Quarter of 1988**

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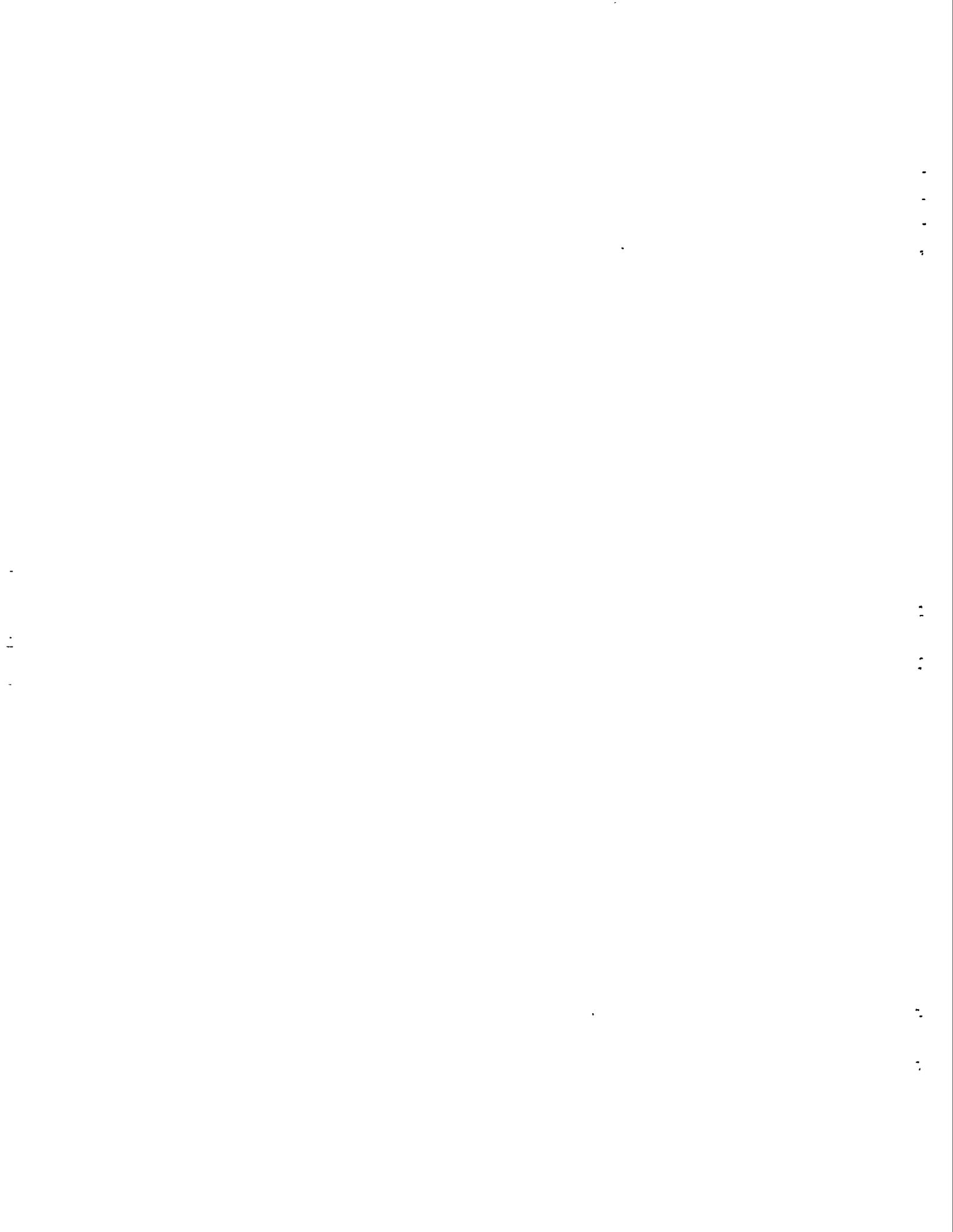
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ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR
THE FOURTH QUARTER OF 1988

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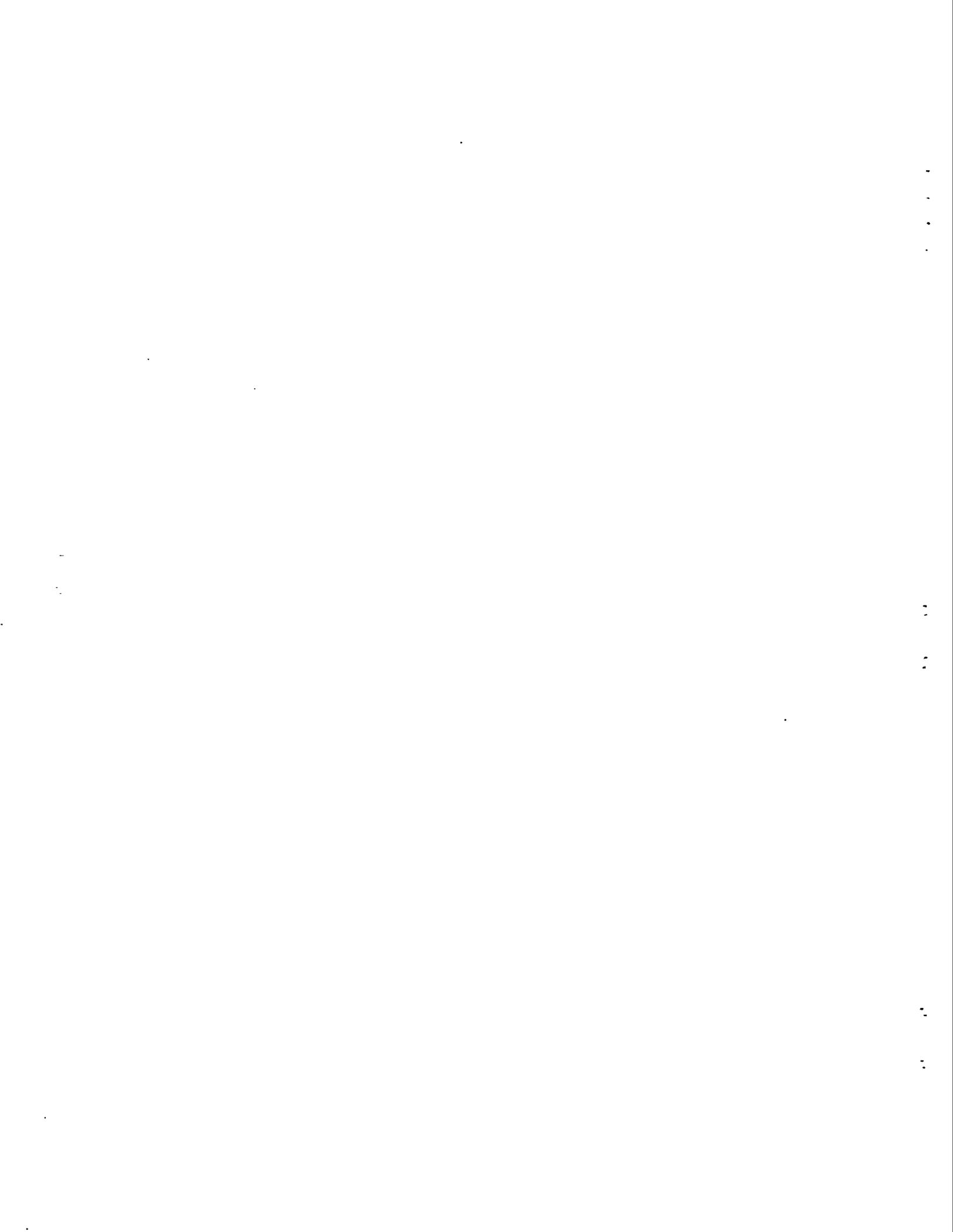
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LIST OF ACRONYMS

ATDD	Atmospheric Turbulence and Diffusion Division (NOAA)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CR	Clinch River
CRK	Clinch River kilometer
CWA	Clean Water Act
DCG	Derived concentration guide
DOE	Department of Energy
EHP	Environmental and Health Protection Division (ORNL)
EMC	Environmental Monitoring and Compliance Section (ORNL)
EPA	Environmental Protection Agency
ESD	Environmental Sciences Division (ORNL)
FDA	Food and Drug Administration
FRC	Federal Radiation Council
HFIR	High Flux Isotope Reactor
ICRP	International Commission on Radiological Protection
MB	Melton Branch
MSRE	Molten Salt Reactor Experiment Facility
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWT	Northwest Tributary
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PAM	Perimeter air monitor

PCB Polychlorinated biphenyl
PWTP Process Waste Treatment Plant

RAM Remote air monitor

RCRA Resource Conservation and Recovery Act

RI/FS Remedial Investigation/Feasibility Study

STP Sewage treatment plant

SWMU Solid Waste Management Unit

SWSA Solid Waste Storage Area

TRU Transuranium Processing Plant

TURF Thorium-Uranium Recycle Facility

WOC White Oak Creek

WOD White Oak Dam

WOL White Oak Lake

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EXECUTIVE SUMMARY

During the fourth quarter of 1988, over 2500 samples, which represent more than 9200 analyses and measurements, were collected by the Environmental Monitoring and Compliance Section. A network of real-time monitoring stations that telemeter 10-min averaged readings of radiation levels, total precipitation, flows, water quality parameters, and air quality parameters around Oak Ridge National Laboratory (ORNL) also reported data. In addition, three meteorological towers sent weather data at various heights to a host computer every 15 min.

Radiation doses from long-lived airborne particulate radionuclides measured at air monitoring stations were calculated for the second half of 1988 and found to be well within the Environmental Protection Agency standards.

Real-time measurements of external gamma radiation are now being reported from 15 stations. Measurements this quarter indicate that external gamma radiation around ORNL is close to background, except at station 4, which is located between the Process Waste Treatment Plant (PWTP) and waste treatment ponds and, therefore, experiences higher levels of radiation.

Cesium-137 concentrations at the PWTP were back to normal this quarter after being anomalously high during early September.

The ^{60}Co concentration in Melton Branch was lower than that for the third quarter. The High Flux Isotope Reactor ponds appear to be the source of most of the ^{60}Co that does occur in Melton Branch. There were no discharges from these ponds during this quarter.

Flow-weighted concentrations of radionuclides in surface water were found to be generally much lower than the DOE derived concentration guidelines (DCGs). However, October tritium concentrations at Melton Branch 1 did exceed the DCG for tritium by 20%.

Even though rainfall for this quarter was above normal, the effect of the dry spell during the first half of 1988 is still evident in the flow of the Clinch River, which was only 73% of the flow for the corresponding (fourth) quarter of 1987.

Measurements of polychlorinated biphenyls (PCBs) in surface water and sediment during October 1988 indicated that PCB concentrations were below detection limits in the surface water samples and were also below detection limits in the sediment at most locations. Small amounts (too small to measure accurately) of PCBs were detected in the sediment at three locations in White Oak Creek.

Fifteen noncompliances associated with the National Pollutant Discharge Elimination System permit occurred during the fourth quarter of 1988. This was from a total of 2572 observations, which represents a compliance ratio of greater than 99%. Four of the noncompliances involved suspended solids, oil, and grease from construction activities in the area. Steps have been taken to increase environmental protection around these construction areas. Where appropriate, corrective actions or investigations have been undertaken or are under way to address the other noncompliances.

Groundwater samples from some of the WAG 6 characterization wells and perimeter wells were notably high in tritium concentration, although concentration values were comparable with those of the third quarter. Sampling of groundwater for WAG 1 began this quarter. Radioactive strontium exceeded drinking water limits in samples from four perimeter wells in WAG 1 and was particularly notable in samples from well 812, which is located just to the northwest of Building 2069.

Milk samples from within 80 km of ORNL showed that concentrations of ^{131}I and radioactive strontium were always within the lowest range of the Federal Radiation Council guidelines.

Concentrations of mercury and PCBs in Clinch River bluegill this quarter were all within 10% of Food and Drug Administration tolerance levels. Concentrations of ^{60}Co , ^{137}Cs , and total radioactive strontium in Clinch River bluegill were comparable to concentrations for the previous sampling period (second quarter of 1988).

Radionuclide concentrations in soil and grass samples from around ORNL and on the Oak Ridge Reservation were comparable to concentrations at remote sites, except for ORNL station 4, which is located between the PWTP and some old waste treatment ponds. Elevated levels of certain radionuclides, notably ^{137}Cs and total radioactive strontium, were found in the soil and grass around station 4. This finding is consistent with earlier studies of soil around the ponds in areas around the PWTP.

1. INTRODUCTION

The Environmental Monitoring and Compliance (EMC) Section within the Environmental and Health Protection Division (EHP) at the Oak Ridge National Laboratory (ORNL) is responsible for environmental surveillance to (1) ensure compliance with all federal, state, and Department of Energy (DOE) requirements for the prevention, control, and abatement of environmental pollution; (2) monitor the adequacy of containment and effluent controls; and (3) assess impacts of releases from ORNL facilities on the environment.

To meet these objectives, the EMC Section has implemented a surveillance program that consists of both monitoring and sampling of environmental constituents. Monitoring provides continuous data for rapid screening of parameters. Sampling followed by laboratory analyses, rather than continuous monitoring, is usually recommended for routine surveillance. In general, monitoring systems are less sensitive and as a result have much higher detection levels than laboratory analysis. Laboratory analysis provides a quantitative estimate of concentrations or activities at environmental levels.

The surveillance program for 1988 includes sampling and monitoring of air, water from surface streams and point sources, fish, milk, soil, and vegetation (grass) for radioactive and nonradioactive materials. This report includes data for air, surface water, groundwater, sediments, milk, fish, soil, and grass. Surveillance points are located on site to quantify discharges from ORNL facilities and off site to determine public exposures and to establish background reference levels.

The purpose of this report is to provide Laboratory and Central Management personnel with the most recent information on environmental conditions. It is intended strictly as a data report. Each quarter a report summarizing all environmental monitoring data from the various media will be prepared. Additional sections are occasionally developed for inclusion in subsequent reports in this series. These developments occur as needs dictate and as more types of data become available.

Summaries of data will be presented for each month and quarter where there are multiple observations. The summary tables give the number of samples collected at each station or location and the maximum, minimum, and average values of parameters for which analyses were done. The 95% confidence coefficients (ccs) were calculated and, where possible, average values were compared with applicable guidelines, criteria, or standards as a means of evaluating the impact of effluent releases on environmental concentrations. Some averages have been rounded and reported to only two significant digits.

Because of the intrinsic uncertainties associated with making radiation measurements, it is possible to subtract a statistically determined

instrument background value from a particular sample measurement and get a negative number. This happens frequently when the sample values are close to background values. In the past, such instances were reported as "less than" the instrument background values and the instrument background values were used as if they were the actual values in any further statistical calculations. That procedure led to a bias toward high values. The procedure was therefore changed to take all measurements at face value, thereby increasing the information content of analytical results at or near the detection limit and achieving more consistency with the data-reporting conventions in DOE Draft Order 5400.XY.

2. AIR

2.1 AIRBORNE EMISSIONS

Airborne emissions are monitored at the Oak Ridge National Laboratory for the purpose of complying with the Clean Air Act (CAA) of 1970 and the Tennessee Air Quality Control Act. The gaseous emission point sources for the Laboratory consist of eight stacks. They are as follows:

Building	Description
2026	Radioactive Materials Analytical Laboratory
3020	Radioactive processing plant
3039	Duct 1 - 3500 and 4500 areas cell ventilation systems Duct 2 - Central off-gas and scrubber system Duct 3 - Isotope solid state ventilation system Duct 4 - 3025 and 3026 areas cell ventilation systems
7025	Tritium Target Fabrication Facility
7830	Hydrofracture Facility
7911	Melton Valley Complex [High Flux Isotope Reactor (HFIR), Thorium-Uranium Recycle Facility (TURF), Transuranium Processing Plant (TRU)]
7512	Molten Salt Reactor Facility
6010	Electron Linear Accelerator Facility

The locations of the stacks are shown in Fig. 1. Each of these point sources is provided with a variety of surveillance instrumentation, including radiation alarms, near real-time monitors, and continuous sample collectors. Only data resulting from the analysis of the continuous samples are used in this report. The other equipment does not provide data of sufficient accuracy and precision to support the quantitation of emission source terms.

Data are presented for all the areas except the Electron Linear Accelerator Facility (Building 6010). Continuous sampling equipment is not currently installed at this facility. A stack monitoring improvement project is scheduled for 1989 that will provide continuous samplers at this stack.

The sampling systems generally consist of in-stack sampling probes, sample transport piping, a 47-mm particulate filter, a 47-mm-diam by 25-mm-thick activated charcoal canister, a silica-gel tritium trap, flow measurement and totalizing instruments, a sampling pump, and return piping to the stack. The sampling system for the tritium target facility is configured with a tritium trap only. The sampling systems at 2026, 3020, and 7512 have not been upgraded and do not have tritium traps.

The sampling media are collected and evaluated weekly. The particulate filters are analyzed for gross alpha and gross beta activity. The silica gel samples are analyzed for tritium. The charcoal canisters are analyzed by gamma spectroscopy. Because of the prevalence of iodine isotopes in the point-source emissions, values are reported for ^{131}I and ^{133}I each week. Data for other gamma emitting isotopes are opportunistically captured. If an isotope is present at a concentration above the analytical instrument background, the datum is reported. Consequently, 13 data values are typically associated with gross alpha, gross beta, tritium, ^{131}I , and ^{133}I .

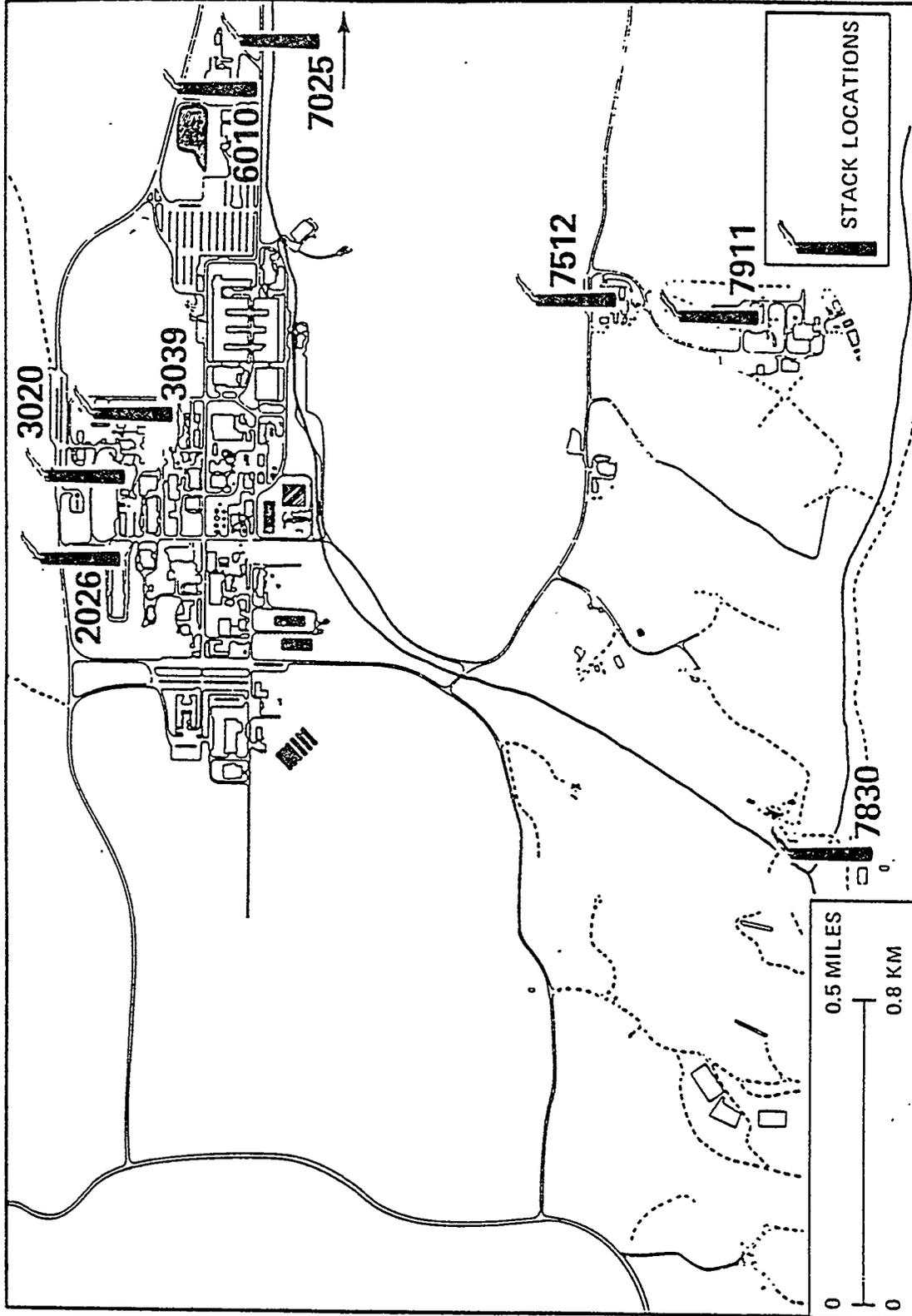


Fig. 1. Location map of major stacks (emission points) at ORNL.

measurements. This is the number of samples for the quarter. Many of the other isotopes reported are represented by less than 13 values because they were not detected in all of the sampling events.

The current convention for data at the instrument detection limit is to treat it in the same manner as all other data. The instrument background is subtracted from the actual instrument signal and the result is reported. This practice can result in negative numbers. Results reported in this manner may be reduced with summary statistics without incurring the difficulties of performing calculations on "less than" values.

Two isotopes of iodine (^{125}I and ^{129}I) cannot be quantified when the samples are initially collected. The gamma signatures of short-lived radionuclides in the same spectral region mask their presence. A second analysis is required after the short-lived interfering isotopes have decayed, typically 1 to 2 months after sample collection. Consequently, fourth-quarter data for ^{125}I and ^{129}I are not included in this report. Commencing with the next report, long-lived isotope data from the previous quarter will be included.

Tables 1 through 10 present summaries of the weekly data. These data are sample results, not stack emissions. Included are the number of samples in which a particular analyte was measured, the maximum and minimum values for the quarter, and the average. Where there are two or more values, the 95% cc is also given. All data are rounded to two significant digits and reported in becquerels (Bq). Data for buildings 2025, 3020, and 7512 include 12 particulate samples instead of 13 because one set of samples was not delivered to the laboratory in time for analysis. The data for 7830 consist of 9 particulate filter samples and 11 charcoal filter samples because of equipment malfunctions and condensation ruining the sampling media.

Monthly and quarterly stack emissions are summarized by stack and analyte in Tables 11 through 20. On upgraded systems where flow totalizers have been installed, weekly data were multiplied by a conversion factor that is the ratio of the stack or duct discharge for the sampling period divided by the total sample flow for the sample period. For the older sampler systems, the conversion factor is the ratio of the average stack discharge rate divided by the average sampling rate. These results were then summed for the months and the quarter. Negative samples values were treated as zeros for the purpose of computing emissions. All data are rounded to two significant digits and presented in megabecquerels (10^6 Bq).

The airborne emissions for the Laboratory consist primarily of ^3H , ^{131}I , ^{133}I , ^{135}I , ^{212}Pb , ^{133}Xe , ^{135}Xe , and ^{191}Os . Tritium came mostly from the Tritium Target Fabrication Facility and the isotope solid state ventilation system. A discrepancy has been identified between the tritium releases from the 3039 area as determined by sample results and tritium releases based on inventory loss calculations. The sample results appear to grossly underestimate the emissions. Sources for this error are being investigated. The Melton Valley Complex emitted 99% of the total ^{131}I . The Melton Valley Complex was the source for virtually all of the ^{133}I and ^{135}I . The 3025 and 3026 cell ventilation systems released 99.9% of the ^{191}Os . Ninety-four percent of the ^{212}Pb came from four locations: the radioactive materials

Table 1. Summary of weekly sample results at the radioactive materials analytical laboratory, Building 2026,^a October-December 1988

Analysis	Number of samples	Total Bq/sample			
		Max	Min	Av	95% cc ^b
Gross alpha	12	20	1.7	7.0	3.1
Gross beta	12	23	2.7	11	4.5
¹³¹ I	13	1.0	-1.2	-0.20	0.38
¹³³ I	12	0.72	-1.4	-0.23	0.40
¹³⁵ I	1	6.4	6.4	6.4	
²¹² P _b	7	15,000	140	9,300	5,900

^aSee Fig. 1.

^b95% cc about the average of more than two samples.

Table 2. Summary of weekly sample results at the radioactive processing plant ventilation stack, Building 3020,^a October-December 1988

Analysis	Number of samples	Total Bq/sample			
		Max	Min	Av	95% cc ^b
Gross alpha	12	0.54	-0.0080	0.14	0.11
Gross beta	12	17	0.15	2.2	3.1
¹³¹ I	13	0.70	-0.20	0.20	0.20
¹³³ I	11	0.53	-0.90	-0.037	0.30
¹³⁵ I	1	-1.0	-1.0	-1.0	
¹⁹¹ Os	1	9.5	9.5	9.5	
²¹² Pb	5	550	20	300	240

^aSee Fig. 1.

^b95% cc about the average of more than two samples.

Table 3. Summary of weekly sample results at the 3500 and 4500 area cell ventilation systems, Building 3039, duct 1,^a October-December 1988

Analysis	Number of samples	Total Bq/sample			
		Max	Min	Av	95% cc ^b
Gross alpha	13	0.14	-0.0090	0.051	0.028
Gross beta	13	19	0.50	4.2	3.1
⁶⁰ Co	5	12	0.94	5.5	5.2
³ H	13	4600	-32	770	740
¹³¹ I	13	0.70	-0.23	0.11	0.14
¹³³ I	11	0.17	-0.35	-0.021	0.11
¹³⁵ I	11	1.1	-1.5	-0.21	0.53
¹⁹¹ Os	1	11	11	11	
²¹² Pb	10	330	40	140	54
¹²⁵ Sb	1	2.4	2.4	2.4	
¹³³ Xe	2	13	0.95	7.0	77

^aSee Fig. 1.

^b95% cc about the average of more than two samples.

Table 4. Summary of weekly sample results at the central off-gas and scrubber system, Building 3039, duct 2,^a October-December 1988

Analysis	Number of samples	Total Bq/sample			
		Max	Min	Av	95% cc ^b
Gross alpha	13	0.18	-0.0010	0.048	0.031
Gross beta	13	25	0.53	5.2	3.9
⁶⁰ Co	2	6.1	1.9	4.0	27
¹³⁷ Cs	4	12	0.39	4.3	8.4
³ H	13	33,000	290	8,600	7,700
¹³¹ I	13	15	-0.10	4.1	2.9
¹³³ I	11	3.5	-3.9	0	1.2
¹³⁵ I	11	4.7	-4.4	-0.15	1.5
¹⁹¹ Os	3	220	5.6	79	300
²¹² Pb	10	12,000	1,800	5,300	2,400
⁷⁵ Se	3	9.9	1.8	4.9	11
¹³³ Xe	1	8.0	8.0	8.0	

^aSee Fig. 1.

^b95% cc about the average of more than two samples.

Table 5. Summary of weekly sample results at the isotope solid state ventilation system, Building 3039, duct 3,^a October-December 1988

Analysis	Number of samples	Total Bq/Sample			
		Max	Min	Av	95% cc ^b
Gross alpha	13	0.16	-0.0080	0.087	0.030
Gross beta	13	4.2	0.58	1.4	0.59
⁸² Br	9	130	9.7	34	30
⁶⁰ Co	12	23	1.4	5.8	4.0
³ H	13	530,000	510	140,000	91,000
¹³¹ I	13	45	-0.40	9.6	8.3
¹³³ I	11	0.30	-0.21	-0.029	0.11
¹³⁵ I	11	0.70	-1.1	-0.045	0.42
¹⁹¹ Os	12	1,300	2.8	170	240
²¹² Pb	9	140	62	100	19
⁷⁵ Se	13	41	2.8	16	6.7
¹³³ Xe	3	33	1.9	16	39
¹³⁵ Xe	1	11	11	11	

^aSee Fig. 1.

^b95% cc about the average of more than two samples.

Table 6. Summary of weekly sample results at the 3035 and 3026 area cell ventilation system, Building 3039, duct 4,^a October-December 1988

Analysis	Number of samples	Total Bq/sample			
		Max	Min	Av	95% cc ^b
Gross alpha	12	25	0.035	3.7	4.9
Gross beta	13	2,000	4.6	410	400
³ H	13	1,200,000	210	99,000	200,000
¹³¹ I	13	22	-6.0	1.3	3.9
¹³³ I	10	0.31	-4.6	-0.38	1.1
¹³⁵ I	10	1.1	-1.6	0.19	0.69
¹⁹¹ Os	13	1,900,000	7100	220,000	310,000
²¹² Pb	3	3.0	1.9	2.6	1.5
¹³³ Xe	1	17	17	17	

^aSee Fig. 1.

^b95% cc about the average of more than two samples.

Table 7. Summary of weekly sample results at the tritium target fabrication facility, Building 7025,^a October-December 1988

Analysis	Number of samples	Total Bq/sample			
		Max	Min	Av	95% cc ^b
³ H	13	1,800,000	45,000	550,000	340,000

^aSee Fig. 1.

^b95% cc about the average of more than two samples.

Table 8. Summary of weekly sample results at the hydrofracture facility,
 Building 7830,^a October-December 1988

Analysis	Number of samples	Total Bq/sample			
		Max	Min	Av	95% cc ^b
Gross alpha	9	0.049	-0.0080	0.0098	0.013
Gross beta	9	0.17	0.093	0.13	0.020
¹³¹ I	11	0.14	-0.080	0.039	0.048
¹³³ I	10	0.19	-0.070	0.047	0.061
¹³⁵ I	10	0.40	-0.30	-0.045	0.18
¹⁹¹ Os	1	4.5	4.5	4.5	
²¹² Pb	9	48	13	26	11
⁷⁵ Se	1	0.49	0.49	0.49	

^aSee Fig. 1.

^b95% cc about the average of more than two samples.

Table 9. Summary of weekly sample results at the Melton Valley Complex, Building 7911,^a October-December 1988

Analysis	Number of samples	Total Bq/sample			
		Max	Min	Av	95% cc ^b
Gross alpha	13	0.18	-0.0010	0.084	0.030
Gross beta	13	5.2	2.5	3.4	0.41
³ H	13	230	-12	55	45
¹³¹ I	13	24,000	870	3,300	3,800
¹³² I	1	170	170	170	
¹³³ I	11	16,000	940	3,200	2,900
¹³⁴ I	2	140	68	100	460
¹³⁵ I	11	2,700	-0.10	1,300	500
²¹² Pb	10	1,200	650	990	170
¹³³ Xe	11	4,300	74	610	820
¹³⁵ Xe	9	3,900	320	1,600	890

^aSee Fig. 1.

^b95% cc about the average of more than two samples.

Table 10. Summary of weekly sample results at the Molten Salt Reactor Facility, Building 7512,^a October-December 1988

Analysis	Number of samples	Total Bq/sample			
		Max	Min	Av	95% cc ^b
Gross alpha	12	0.29	0.020	0.12	0.054
Gross beta	12	0.58	0.053	0.26	0.091
¹³⁷ Cs	1	3.8	3.8	3.8	
¹³¹ I	13	1.4	-0.40	0.30	0.29
¹³³ I	12	0.50	-5.0	-0.37	0.95
¹³⁵ I	1	1.3	1.3	1.3	

^aSee Fig. 1.

^b95% cc about the average of more than two samples.

Table 11. Monthly airborne emissions at the radioactive materials analytical laboratory, Building 2026,^a October-December 1988

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	October	November	December	
Gross alpha	0.48	0.26	0.14	0.88
Gross beta	0.56	0.32	0.48	1.4
^{131}I	0.0021	0.011	0.0075	0.020
^{133}I	0.0097	0.0021	0.0042	0.016
^{135}I	0	0.067	0	0.067
^{212}Pb	250	310	130	690

^aSee Fig. 1.

Table 12. Monthly airborne emissions at the radiochemical process plant ventilation stack, Building 3020,^a October-December 1988

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	October	November	December	
Gross alpha	0.011	0.024	0.0036	0.039
Gross beta	0.049	0.53	0.020	0.60
^{131}I	0.026	0.028	0.020	0.073
^{133}I	0	0.024	0.013	0.037
^{191}Os	0	0.22	0	0.22
^{212}Pb	13	15	5.7	34

^aSee Fig. 1.

Table 13. Monthly airborne emissions at the 3500 and 4500 area cell ventilation systems, Building 3039, duct 1,^a October-December 1988

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	October	November	December	
Gross alpha	0.0070	0.0098	0.0027	0.020
Gross beta	0.57	0.79	0.21	1.6
^{60}Co	0.16	0	0.55	0.71
^3H	13	200	31	240
^{131}I	0.012	0.027	0.015	0.053
^{133}I	0.010	0.0042	0.0015	0.016
^{135}I	0.042	0.023	0	0.065
^{191}Os	0	0.29	0	0.29
^{212}Pb	12	19	6.3	37
^{125}Sb	0	0	0.057	0.057
^{133}Xe	0.025	0	0.25	0.27

^aSee Fig. 1.

Table 14. Monthly airborne emissions at the central off-gas and scrubber system, Building 3039, duct 2,^a October-December 1988

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	October	November	December	
Gross alpha	0.0014	0.00069	0.00022	0.0023
Gross beta	0.18	0.051	0.035	0.27
^{60}Co	0.011	0	0.014	0.025
^{137}Cs	0.075	0.0099	0.00085	0.086
^3H	19	270	46	330
^{131}I	0.030	0.11	0.017	0.16
^{133}I	0.020	0.00030	0.00082	0.021
^{135}I	0.021	0	0.0027	0.023
^{191}Os	0.070	0.63	0.012	0.71
^{212}Pb	45	72	56	170
^{75}Se	0	0.014	0.022	0.036
^{133}Xe	0	0	0.017	0.017

^aSee Fig. 1.

Table 15. Monthly airborne emissions at the isotope solid state ventilation system, Building 3039, duct 3,^a October-December 1988

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	October	November	December	
Gross alpha	0.010	0.0098	0.0047	0.025
Gross beta	0.085	0.19	0.079	0.35
^{82}Br	6.1	1.4	1.2	8.8
^{60}Co	0.35	0.93	0.20	1.5
^3H	21,000	3,500	12,000	37,000
^{131}I	0.80	0.78	1.1	2.7
^{133}I	0.0088	0.0056	0	0.014
^{135}I	0.012	0.031	0.0038	0.047
^{191}Os	6.5	31	0.58	38
^{212}Pb	8.8	6.0	5.3	20
^{75}Se	2.6	1.3	0.43	4.4
^{133}Xe	0	0.61	0.28	0.89
^{135}Xe	0	0	0.21	0.21

^aSee Fig. 1.

Table 16. Monthly airborne emissions at the 3025 and 3026 area cell ventilation systems, Building 3039, duct 4,^a October-December 1988

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	October	November	December	
Gross alpha	0.041	1.6	0.028	1.6
Gross beta	67	100	6.5	170
³ H	35,000	1,700	490	37,000
¹³¹ I	0.66	0.015	0.015	0.69
¹³³ I	0	0.015	0.011	0.026
¹³⁵ I	0.059	0.056	0.031	0.15
¹⁹¹ Os	13,000	94,000	2,700	110,000
²¹² Pb	0.20	0.082	0	0.28
¹³³ Xe	0	0.48	0	0.48

^aSee Fig. 1.

Table 17. Monthly airborne emissions at the tritium target fabrication facility, Building 7025,^a October-December 1988

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	October	November	December	
³ H	580000	1700000	870000	3200000

^aSee Fig. 1.

Table 18. Monthly airborne emissions at the hydrofracture facility,
Building 7830,^a October-December 1988

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	October	November	December	
Gross alpha	0.000022	0.000013	0	0.000035
Gross beta	0.00022	0.00020	0.000033	0.00045
¹³¹ I	0.000018	0.00014	0.000055	0.00021
¹³³ I	0.00015	0.000035	0.000040	0.00023
¹³⁵ I	0.00015	0.00013	0.000053	0.00033
¹⁹¹ Os	0	0.0019	0	0.0019
²¹² Pb	0.022	0.061	0.0059	0.089
⁷⁵ Se	0	0.00021	0	0.00021

^aSee Fig. 1.

Table 19. Monthly airborne emissions at the Melton Valley Complex,
 Building 7911,^a October-December 1988

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	October	November	December	
Gross alpha	0.0022	0.0050	0.0026	0.0098
Gross beta	0.099	0.17	0.11	0.39
^3H	1.0	4.3	1.3	6.6
^{131}I	50	70	250	370
^{132}I	1.4	0	0	1.4
^{133}I	50	100	160	310
^{134}I	1.7	0	0	1.7
^{135}I	35	65	27	130
^{212}Pb	28	42	18	88
^{133}Xe	7.2	5.0	46	58
^{135}Xe	30	47	48	130

^aSee Fig. 1.

Table 20. Monthly airborne emissions at the Molten Salt Reactor Facility, Building 7512,^a October-December 1988

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	October	November	December	
Gross alpha	0.0028	0.0025	0.0011	0.0064
Gross beta	0.0048	0.0062	0.0024	0.013
^{137}Cs	0	0.017	0	0.017
^{131}I	0.0042	0.0072	0.0091	0.021
^{133}I	0.0036	0.00022	0.0040	0.0078
^{135}I	0	0.0057	0	0.0057

^aSee Fig. 1.

analytical laboratory (66%), Melton Valley Complex (8%), 3500 and 4500 areas cell ventilation systems (4%), and the central off-gas and scrubber system (16%).

The xenon results are from gamma spectroscopy of the activated charcoal canisters. Activated charcoal is typically 0.03 and 0.05% efficient at trapping xenon. Therefore, the presence of xenon should be considered significant, but caution must be exercised in using the quantitative results.

Iodine-131 may be present as a fission product and also as an artifact of the method used for testing HEPA filters. Typically, 30 mCi of ^{131}I is released upstream of the filter being tested. The amount of ^{131}I that passes the filter is quantified and that value is used to calculate the filter efficiency.

2.2 AMBIENT AIR

Most gaseous wastes from ORNL are released to the atmosphere through stacks. Radioactivity may be present in gaseous waste streams as a solid (particulates), as an absorbable gas (iodine), or as a nonabsorbable species (noble gas). Gaseous wastes that may contain radioactivity are processed to reduce the radioactivity to acceptable levels before they are discharged. In addition to the monitoring of stack effluents, atmospheric concentrations of materials are monitored continuously at 27 stations around ORNL, the Oak Ridge reservation, and the surrounding vicinity. Locations of these stations are shown in Figs. 2 and 3. These air monitoring stations are categorized into three groups according to their geographical locations.

1. The ORNL perimeter air monitoring network (ORNL PAMs) consists of stations 3, 4, 7, 9, 20, 21, and 22. These stations are located at or near the ORNL boundary (shown in Fig. 2).
2. The DOE Oak Ridge Reservation network (reservation PAMs) consists of stations 8, 23, 31, 33, 34, 36, and 40 through 46 (Fig. 3). Stations 8 and 31 through 45 have the capability to perform both sampling and continuous monitoring. Station 46 is currently being redeveloped to collect real-time data.
3. The remote air monitoring network (RAMs) consists of stations 51 through 53 and 55 through 58. All of these stations are located within a 120-km radius of ORNL outside the DOE Oak Ridge reservation (Fig. 4).

Several of the ORNL and reservation PAMs have real-time monitors for five radiation parameters (gross alpha, gross beta, iodine, gross gamma, and noble gas) and are also equipped with three process sensors that are used to calculate the volume of the sample collected. A central processor collects 10-min average readings and transmits the data to a VAX computer for further analysis and reporting. Local data concentrators check the values against alarm limits. All alarms are reported to a printer as they occur. The primary purpose of the monitoring system is to determine if radiation levels on the

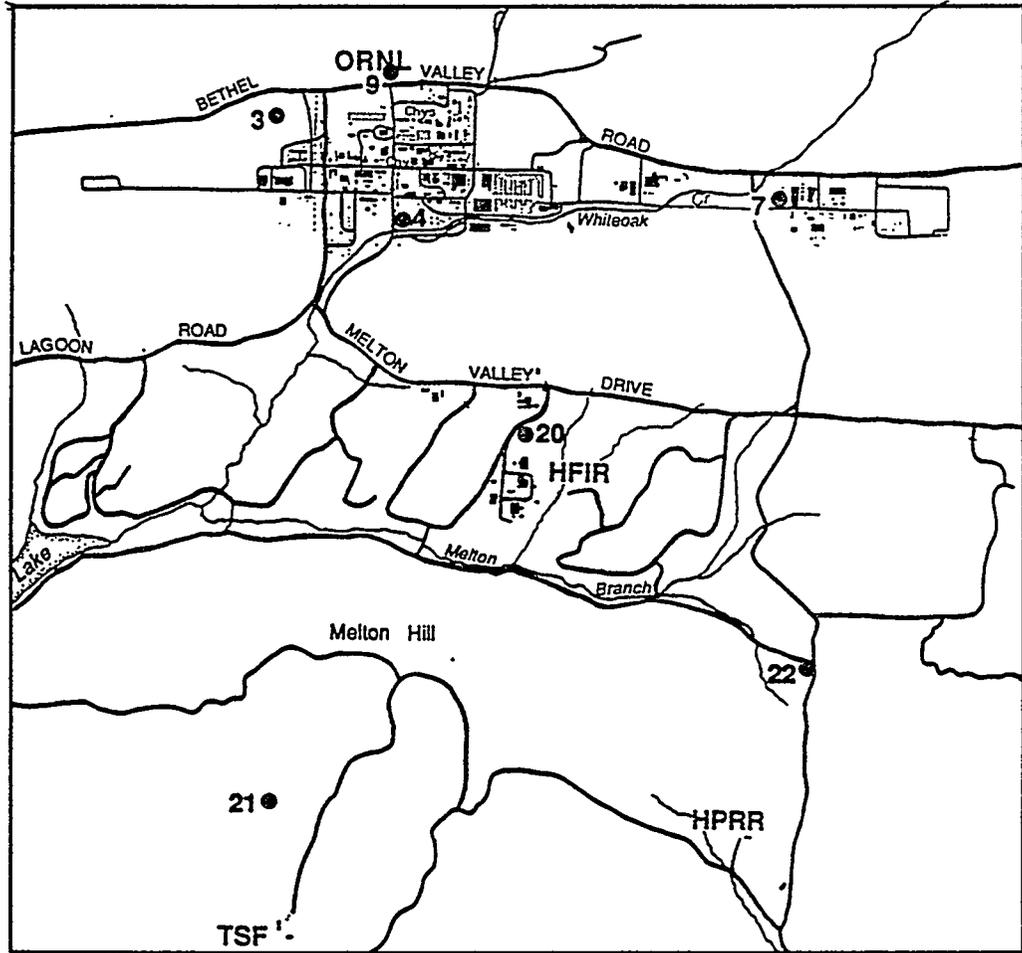


Fig. 2. Location map of ORNL perimeter air monitoring stations.

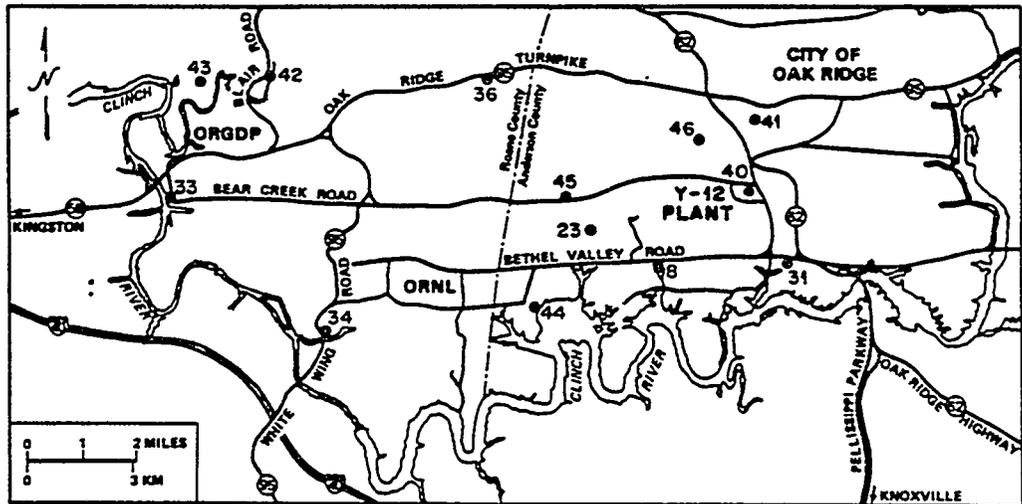


Fig. 3. Location map of Oak Ridge Reservation air monitoring stations.

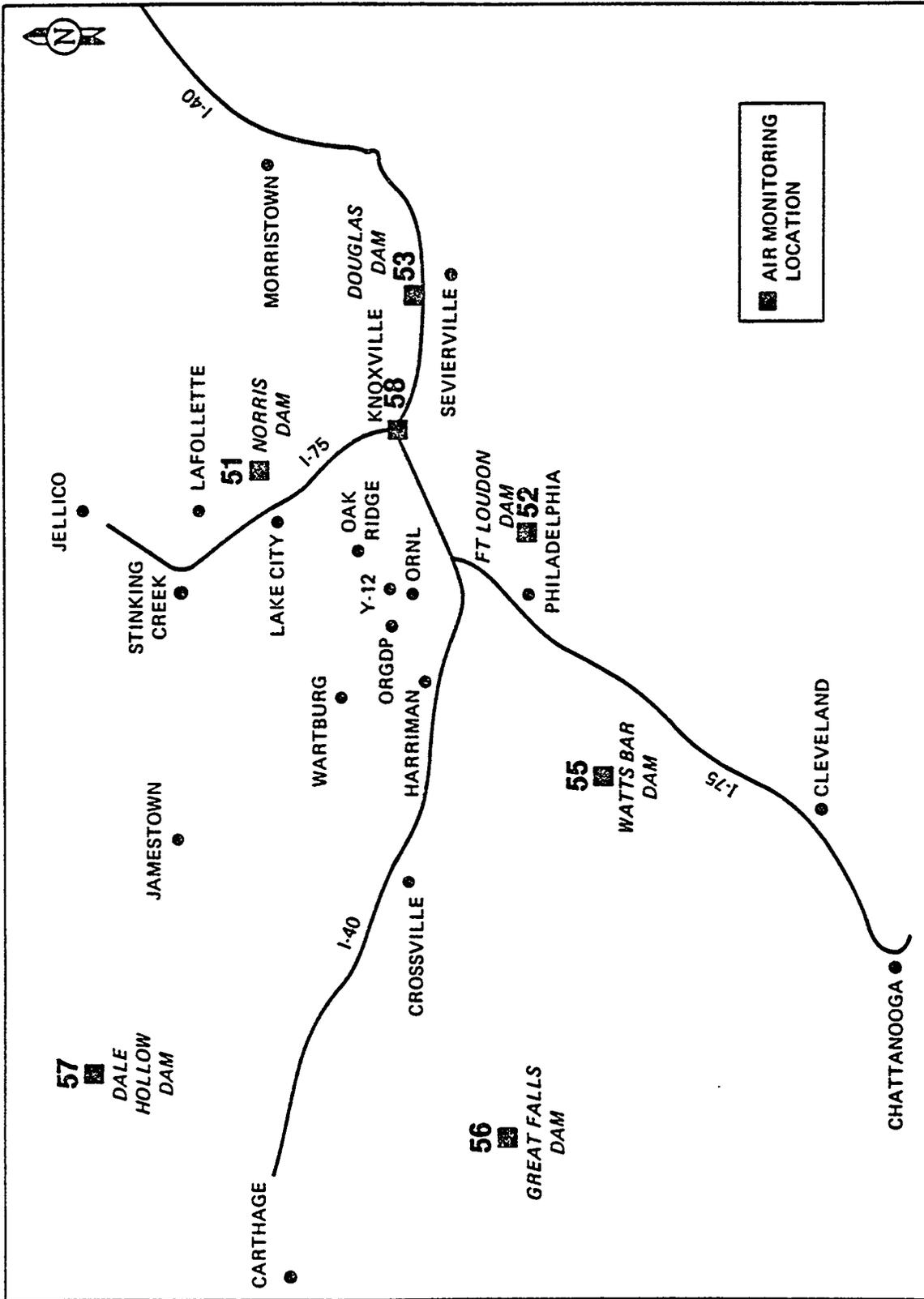


Fig. 4. Location map of the remote air monitoring stations.

reservation are above background levels. If radiation levels appear to be higher than normal, additional sampling can be initiated to provide quantitative measures of concentrations in the atmosphere.

Airborne radioactive particulates are collected by pumping a continuous flow of air through a paper filter and then through a charcoal cartridge. The filter papers are collected and analyzed weekly for gross alpha and gross beta activities. To minimize artifacts from short-lived radionuclides, the filter papers are analyzed 3 to 4 days after collection. The airborne ^{131}I is collected weekly using a cartridge that is packed with activated charcoal. The charcoal cartridges are analyzed within 24 h after collection. The initial and final dates, time on and off, and flow rates are recorded when a sampler is mounted or removed. The total volume of air that flowed through the sampler at each station is calculated using this information. The flow rates at stations 3 through 46 are set between 1.5 and 3.0 ft³/min to minimize artifacts from extremely high or low flow rates. The concentration of radionuclides in air is calculated by dividing the total activity per sample by the total volume of air.

Monthly (October through December) concentrations of gross alpha, gross beta, and atmospheric ^{131}I are summarized in Tables 21 through 29. Instrument background concentrations of ^{131}I , gross alpha, and gross beta have been subtracted from the measured concentrations in Tables 21 through 29. Negative values represent concentrations below the instrument background level.

A pump failed at remote station 58 during this quarter, which prevented measurement of gross alpha and gross beta at the station during November and December.

Alpha activity this quarter was essentially indistinguishable from background. The only time a network average was a positive number was for the remote station network during October.

Average beta activity was essentially unchanged from the preceding quarter. Values for the ORNL stations and for reservation stations were similar to values for the remote stations. An anomalously high value at station 31 during October had little effect on the station average or network average for that month. No such anomalous readings occurred during November or December.

Iodine-131 concentrations (Tables 27 through 29) were essentially unchanged from the previous quarter, with all values reported being less than 0.01% of the derived concentration guide for that isotope.

Monthly samples for atmospheric tritium are routinely collected from ORNL PAM stations 3 and reservation PAM station 8. Atmospheric tritium in the form of water vapor is removed from the air by silica gel. The silica gel is heated in a distillation flask to remove the moisture, and the distillate is counted in a liquid scintillation counter. The concentration of tritium in the air is calculated by dividing total activity accumulated per month by total volume of air sampled. A quarterly summary of the atmospheric tritium concentrations is presented in Table 30. Values are typical for these

Table 21. Long-lived gross alpha activity in air, October 1988

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
<i>ORNL PAM stations^b</i>					
3	5	5.6	-3.3	-0.85	3.3
4	5	3.0	-3.3	-1.2	2.3
7	5	4.1	-4.6	-1.9	3.1
9	5	2.6	-3.6	-1.6	2.6
20	5	2.7	-3.0	-0.61	1.9
21	5	5.1	-4.8	-2.2	3.7
22	5	1.7	-6.0	-2.1	2.5
Network summary	35	5.6	-6.0	-1.5	1.0
<i>Reservation PAM stations^c</i>					
8	5	3.4	-5.5	-3.0	3.3
23	5	3.2	-3.2	-0.32	2.1
31	5	5.0	-3.3	-0.85	3.0
33	5	5.0	-2.8	-0.59	2.9
34	5	2.8	-3.4	-1.1	2.1
36	5	3.0	-1.6	-0.53	1.8
40	5	5.1	-4.1	-0.74	3.1
41	5	2.8	-5.4	-1.4	3.0
42	5	4.1	-4.8	-1.4	3.1
43	5	3.9	-5.2	-2.0	3.1
44	5	5.4	-5.2	-2.0	3.8
45	5	8.2	-0.55	2.2	3.1
46	5	4.0	-5.0	-1.0	2.9
Network summary	65	8.2	-5.5	-0.99	0.79
<i>RAM stations^d</i>					
51	4	3.5	-2.2	1.8	2.7
52	5	13	-6.1	6.2	6.5
53	4	12	0.56	7.2	5.2

Table 21. (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
55	2	6.6	-3.6	1.5	10
56	5	5.9	-5.8	2.5	4.3
57	2	4.9	-12	-3.6	17
58	3	15	-3.1	8.0	11
Network summary	25	15	-12	4.0	2.7
Overall summary	125	15	-12	-0.13	0.81

^a5% cc about the average of more than two samples.

^bSee Fig. 2.

^cSee Fig. 3.

^dsee Fig. 4.

Table 22. Long-lived gross alpha activity in air, November 1988

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
<i>ORNL PAM stations^b</i>					
3	4	3.4	-5.5	-2.0	3.8
4	4	5.7	-3.2	-0.51	4.2
7	4	3.3	-6.2	-2.0	4.0
9	2	0.52	-8.4	-3.9	8.9
20	4	4.1	-5.2	-1.7	4.0
21	4	4.7	-4.2	-0.86	3.8
22	4	3.5	-7.0	-3.0	4.5
Network summary	26	5.7	-8.4	-1.9	1.5
<i>Reservation PAM stations^c</i>					
8	4	5.1	-2.9	-0.33	3.6
23	4	3.5	-4.9	-0.67	3.5
31	4	3.8	-4.8	-1.3	3.7
33	4	4.1	-5.0	-1.1	3.9
34	4	3.3	-5.6	-1.6	3.7
36	4	4.1	-3.6	-1.3	3.6
40	4	6.9	-5.6	-1.4	5.8
41	4	5.5	-6.0	-1.6	5.0
42	4	3.7	-1.9	-0.24	2.7
43	4	1.4	-5.7	-2.2	2.9
44	4	3.4	-4.9	-2.0	3.8
45	4	4.3	-2.6	0.87	3.6
46	4	7.3	-6.0	0.27	5.6
Network summary	52	7.3	-6.0	-0.97	1.0
<i>RAM stations^d</i>					
51	4	1.7	-3.0	-0.73	2.5
52	4	4.4	-9.3	-1.8	6.7
53	2	1.0	-1.5	-0.23	2.5

Table 22. (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
55	2	-2.4	-3.2	-2.8	0.82
56	4	4.7	-4.4	-0.99	3.9
57	4	5.1	-5.2	0.68	4.3
Network summary	20	5.1	-9.3	-0.87	1.7
Overall summary	98	7.3	-9.3	-1.2	0.75

^a95% cc about the average of more than two samples.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 23. Long-lived gross alpha activity in air, December 1988

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
<i>ORNL PAM stations^b</i>					
3	4	-1.0	-3.2	-1.9	0.95
4	4	2.3	-3.7	-1.5	2.6
7	4	-2.5	-4.0	-3.3	0.69
9	4	-1.2	-6.5	-3.8	2.2
20	4	0.85	-2.8	-1.0	1.6
21	4	0	-5.5	-1.7	2.6
22	4	0	-5.7	-3.7	2.7
Network summary	28	2.3	-6.5	-2.4	0.80
<i>Reservation PAM stations^c</i>					
8	4	-0.44	-4.1	-2.2	1.5
23	4	-0.27	-3.7	-2.1	1.4
31	4	2.5	-4.3	-0.90	2.9
33	4	0.89	-3.5	-1.8	2.0
34	4	1.9	-1.9	-0.18	1.9
36	4	-0.25	-3.7	-2.1	1.5
40	4	3.0	-2.4	-0.21	2.3
41	4	-2.5	-4.0	-3.1	0.67
42	4	0.26	-4.8	-2.5	2.1
43	4	0.94	-3.4	-2.3	2.1
44	4	-1.4	-2.4	-1.7	0.44
45	4	2.0	-4.5	-1.0	2.7
46	4	1.6	-3.3	-1.8	2.3
Network summary	52	3.0	-4.8	-1.7	0.53
<i>RAM stations^d</i>					
51	3	-0.65	-3.2	-2.0	1.5
52	4	3.0	-3.0	0.26	2.5
53	3	-0.19	-3.4	-1.5	1.9

Table 23. (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
55	3	-1.9	-6.1	-3.5	2.6
56	4	3.9	-7.0	-1.9	5.0
57	3	4.5	-4.0	-0.21	5.0
Network summary	20	4.5	-7.0	-1.4	1.4
Overall summary	100	4.5	-7.0	-1.8	0.45

^a95% cc about the average of more than two samples.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 24. Long-lived gross beta activity in air, October 1988

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
<i>ORNL PAM stations^b</i>					
3	5	130	91	110	14
4	5	120	110	110	5.1
7	5	130	53	100	25
9	5	100	21	79	29
20	5	120	80	98	16
21	5	130	110	120	8.3
22	5	120	78	110	16
Network summary	35	130	21	100	7.6
<i>Reservation PAM stations^c</i>					
8	5	130	110	120	7.7
23	5	130	110	120	7.1
31	5	350	87	140	100
33	5	130	100	120	8.7
34	5	130	76	100	20
36	5	130	100	120	10
40	5	110	83	97	10
41	5	130	92	120	15
42	5	120	75	99	14
43	5	100	62	84	16
44	5	100	67	88	13
45	5	130	100	110	8.9
46	5	120	61	99	23
Network summary	65	350	61	110	8.7
<i>RAM stations^d</i>					
51	4	95	76	85	8.0
52	5	160	100	140	21
53	4	160	120	140	16

Table 24. (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
55	2	92	88	90	3.4
56	5	120	100	110	5.6
57	2	170	130	150	40
58	3	170	130	150	27
Network summary	25	170	76	120	11
Overall summary	125	350	21	110	5.6

^a95% cc about the average of more than two samples.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 25. Long-lived gross beta activity in air, November 1988

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
<i>ORNL PAM stations^c</i>					
3	4	130	110	130	11
4	4	140	100	120	18
7	4	160	110	130	22
9	2	110	16	62	94
20	4	120	94	110	12
21	4	140	120	130	12
22	4	130	110	120	9.4
Network summary	26	160	16	120	10
<i>Reservation PAM stations^c</i>					
8	4	130	100	110	12
23	4	130	98	120	13
31	4	150	95	120	23
33	4	130	79	110	20
34	4	120	110	120	7.0
36	4	130	59	110	34
40	4	110	59	89	21
41	4	110	42	89	33
42	4	130	100	120	13
43	4	110	43	78	30
44	4	110	94	100	8.0
45	4	120	100	110	9.1
46	4	120	97	110	9.1
Network summary	52	150	42	110	5.9
<i>RAM stations^d</i>					
51	4	100	7.0	73	44
52	4	160	29	110	58
53	2	120	26	72	93

Table 25. (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
55	2	120	110	110	12
56	4	120	98	110	8.3
57	4	150	52	120	46
Network summary	20	160	7.0	100	19
Overall summary	98	160	7.0	110	5.7

^a95% cc about the average of more than two samples.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 26. Long-lived gross beta activity in air, December 1988

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
<i>ORNL PAM stations^b</i>					
3	4	140	90	120	23
4	4	140	91	110	24
7	4	140	77	99	30
9	4	140	76	100	26
20	4	140	92	110	21
21	4	150	110	130	23
22	4	130	98	120	15
Network summary	28	150	76	110	8.7
<i>Reservation PAM stations^c</i>					
8	4	120	90	110	15
23	4	140	88	120	25
31	4	130	75	110	30
33	4	140	70	98	29
34	4	140	83	110	25
36	4	150	100	120	23
40	4	110	52	89	27
41	4	120	87	100	14
42	4	110	79	94	15
43	4	100	53	77	21
44	4	120	81	93	18
45	4	130	90	110	20
46	4	120	81	100	20
Network summary	52	150	52	100	6.3
<i>RAM stations^d</i>					
51	3	100	66	88	22
52	4	130	100	120	13
53	3	150	120	130	21

Table 26. (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95% cc ^a
55	3	170	51	98	70
56	4	160	47	96	47
57	3	140	110	130	17
Network summary	20	170	47	110	15
Overall summary	100	170	47	110	5.1

^a95% cc about the average of more than two samples.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 27. ^{131}I concentrations in air, October 1988

Location	Number of samples	Concentration (10^{-8} Bq/L)				Percent DCG ^b
		Max	Min	Av	95% cc ^a	
<i>ORNL PAM stations^c</i>						
3	5	10	-1.8	3.8	5.1	<0.01
4	5	3.4	-3.6	-0.018	2.5	<0.01
7	5	3.8	-5.7	-0.48	3.6	<0.01
9	5	9.9	-5.6	3.2	5.5	<0.01
20	5	14	0	5.8	6.0	<0.01
21	5	9.6	0	5.9	3.5	<0.01
22	5	2.2	-4.3	-0.43	2.1	<0.01
Network summary	35	14	-5.7	2.5	1.7	<0.01
<i>Reservation PAM stations^d</i>						
8	5	7.2	-4.4	2.6	4.1	<0.01
23	5	9.7	3.9	5.8	2.1	<0.01
31	5	8.4	-3.4	2.0	3.9	<0.01
33	5	15	0	4.5	5.6	<0.01
34	5	4.0	0	2.0	1.3	<0.01
36	5	7.7	-2.1	3.5	3.4	<0.01
40	5	14	-1.9	4.8	5.5	<0.01
41	5	2.2	-6.2	-1.2	3.4	<0.01
42	5	8.5	-2.0	3.3	3.8	<0.01
43	5	4.1	-3.9	0.42	2.6	<0.01
44	5	2.0	-3.7	-1.2	2.0	<0.01
45	5	4.0	-4.3	1.2	2.8	<0.01
46	5	0	-5.5	-2.3	1.8	<0.01
Network summary	65	15	-6.2	2.0	1.1	<0.01
Overall summary	100	15	-6.2	2.2	0.91	<0.01

^a95% cc about the average of more than two samples.

^bPercent DCG = maximum value X 100/derived concentration guide (DCG). The DCG for ^{131}I is 1.5×10^{-2} Bq/L.

^cSee Fig. 2.

^dSee Fig. 3.

Table 28. ^{131}I concentrations in air, November 1988

Location	Number of samples	Concentration (10^{-8} Bq/L)				Percent DCG ^b
		Max	Min	Av	95% cc ^a	
<i>ORNL PAM stations^c</i>						
3	4	12	3.1	7.5	4.0	<0.01
4	4	5.6	-6.0	-1.7	5.2	<0.01
7	4	4.5	-2.2	0.95	3.6	<0.01
9	2	18	2.0	10	16	<0.01
20	4	6.7	-1.5	2.7	3.4	<0.01
21	4	13	-3.4	3.4	7.0	<0.01
22	4	25	-2.6	5.5	13	<0.01
Network summary	26	25	-6.0	3.6	2.8	<0.01
<i>Reservation PAM stations^d</i>						
8	4	12	-3.0	5.6	6.2	<0.01
23	4	7.8	-2.3	1.4	4.4	<0.01
31	4	6.7	2.8	4.7	1.7	<0.01
33	4	18	6.9	10	5.2	<0.01
34	4	3.4	-2.1	0.33	2.3	<0.01
36	4	6.3	-6.9	1.2	5.7	<0.01
40	4	14	-4.9	1.4	9.0	<0.01
41	4	6.6	-3.4	0.79	4.5	<0.01
42	4	13	-1.8	4.4	6.9	<0.01
43	4	7.0	0	2.3	3.3	<0.01
44	4	3.5	1.7	2.4	0.80	<0.01
45	4	6.7	-2.4	1.1	3.9	<0.01
46	4	13	1.6	6.4	5.6	<0.01
Network summary	52	18	-6.9	3.2	1.5	<0.01
Overall summary	78	25	-6.9	3.4	1.3	<0.01

^a95% cc about the average of more than two samples.

^bPercent DCG = maximum value X 100/derived concentration guide (DCG). The DCG for ^{131}I is 1.5×10^{-2} Bq/L.

^cSee Fig. 2.

^dSee Fig. 3.

Table 29. ^{131}I concentrations in air, December 1988

Location	Number of samples	Concentration (10^{-8} Bq/L)				Percent DCG ^b
		Max	Min	Av	95% cc ^a	
<i>ORNL PAM stations^c</i>						
3	4	9.8	-1.5	2.7	5.3	<0.01
4	4	12	-1.7	3.4	6.1	<0.01
7	4	2.2	-12	-3.9	6.1	<0.01
9	4	19	1.7	6.3	8.6	<0.01
20	4	10	-2.7	3.7	5.3	<0.01
21	4	17	0	7.6	6.9	<0.01
22	4	9.3	0	4.3	4.0	<0.01
Network summary	28	19	-12	3.4	2.4	<0.01
<i>Reservation PAM stations^d</i>						
8	4	8.3	-3.2	0.47	5.3	<0.01
23	4	17	2.9	7.7	6.2	<0.01
31	4	2.8	-2.0	0.69	2.1	<0.01
33	4	8.1	-3.3	2.6	5.2	<0.01
34	4	1.8	-3.8	-1.3	2.3	<0.01
36	4	9.6	0	3.4	4.3	<0.01
40	4	3.4	1.6	2.3	0.83	<0.01
41	4	5.6	-3.9	1.3	4.9	<0.01
42	4	11	-3.5	2.0	6.7	<0.01
43	4	13	-4.8	2.9	7.8	<0.01
44	4	9.0	-3.0	2.8	4.9	<0.01
45	4	9.2	-3.3	2.7	5.2	<0.01
46	4	6.1	-2.9	1.3	3.7	<0.01
Network summary	52	17	-4.8	2.2	1.3	<0.01
Overall summary	80	19	-12	2.6	1.2	<0.01

^a95% cc about the average of more than two samples.

^bPercent DCG = maximum value X 100/derived concentration guide (DCG). The DCG for ^{131}I is 1.5×10^{-2} Bq/L.

^cSee Fig. 2.

^dSee Fig. 3.

Table 30. Tritium activity in air, October-December 1988

Location ^a	Number of samples	Concentration (10^{-4} Bq/L)				Percent DCG ^c
		Max	Min	Av	95% cc ^b	
3	3	26	0.66	17	17	0.037
8	3	20	0.21	11	11	0.028
Overall summary	6	26	0.21	14	9.4	0.037

^aSee Figs. 2 and 3.

^b95% cc about the average of more than two samples.

^cPercent DCG = maximum X 100/derived concentration guide (DCG). The DCG for tritium is 3.7 Bq/L. This assumes that 50% of the tritium is absorbed through the skin.

stations during October through December. Station 3 has the higher values, as usual.

Air filters are composited quarterly from ORNL PAMs (stations 3, 7, 9, 21, and 22), reservation PAMs (excluding stations 34, 36, 40, 41, 45, and 46), RAMs (stations 51 through 53 and 55 through 57), and from individual stations (34, 36, 40, 41, 45, and 46) and are analyzed for specific radionuclides. The results for the third quarter of 1988 were not available in time for publication in the third quarter report, so they are presented along with the results for the fourth quarter in Tables 31 through 36. The spectra for ^{235}U falls between that of the other uranium isotopes; this makes it difficult to estimate its activity. As a result, the ^{235}U activity is biased high.

Thorium and uranium isotopes returned to normal levels during the third quarter of 1988, in spite of continued construction activity around sites reporting high levels of those isotopes during the second quarter. Much above normal rainfall in July, plus near-normal rainfall during August and September prevented excessive amounts of soil from becoming airborne. Airborne soil particles from construction activities are believed to be the cause of the increases of thorium and uranium isotopes in air filters during the second quarter of 1988.

Values for thorium and uranium isotopes during the fourth quarter were generally equal to or less than the corresponding values for the third quarter.

During the third quarter, ^{238}Pu increased at stations 40 and 41. The highest concentration of that isotope during the third quarter was 6.3×10^{-10} Bq/L at station 41. During the fourth quarter, levels of ^{238}Pu at these stations returned to more typical levels (near or below detection limits).

2.3 RADIATION DOSES FROM LONG-LIVED AIRBORNE PARTICULATE RADIONUCLIDES

The purpose of this section is to provide some measure of potential radiation dose equivalents from radionuclides filtered from air at locations within the ORNL perimeter, within or near the Oak Ridge Reservation, and (for comparison) at the remote air monitors (Figs. 2 and 3, and 4). The dose calculations that follow are made from measurements of long-lived radioactivity in air filters during the third and fourth quarters of 1988, presented in Table 37. Dose calculations for the first and second quarters were presented in the third quarter report for 1988.

Most biological consequences of radionuclide releases to the environment involve the transfer of energy from radiation to human tissue--a process that may damage the tissue. The radiation may come from radionuclides located outside the body (in or on environmental media or objects) or from radionuclides deposited inside the body (via inhalation, ingestion, and in a few cases, absorption through the skin). Exposures to radiation from nuclides located outside the body are called external exposures. Exposures to radiation from nuclides deposited inside the body are called internal exposures. These two types of exposure differ as follows. External exposures occur only when a person is near or in a radionuclide-containing medium;

Table 31. Long-lived radioactivity in composited air filters from Stations 34, 36, and 40, July-September 1988

Analysis	Concentration (10^{-10} Bq/L)					
	Station 34 ^a	Percent DCG ^b	Station 36 ^a	Percent DCG ^b	Station 40 ^a	Percent DCG ^b
⁶⁰ Co	92	<0.01	14	<0.01	55	<0.01
¹³⁷ Cs	39	<0.01	15	<0.01	70	<0.01
²³⁸ Pu	-1.2	<0.01	0.12	<0.01	2.3	0.015
²³⁹ Pu	0.72	<0.01	-3.0	<0.01	-4.9	<0.01
²²⁸ Th	59	0.39	110	0.73	120	0.80
²³⁰ Th	2.6	0.014	5.8	0.031	3.9	0.021
²³² Th	2.6	0.070	5.0	0.14	6.2	0.17
Total Sr ^c	45	<0.01	-9.5	<0.01	130	<0.01
²³⁴ U	18	0.055	26	0.079	130	0.39
²³⁵ U	2.6	<0.01	1.7	<0.01	7.6	0.021
²³⁸ U	8.2	0.022	27	0.073	30	0.081

^aSee Fig. 3.

^bPercent DCG = value X 100/derived concentration guide (DCG).

The DCG for ⁶⁰Co is 3.0×10^{-3} Bq/L; ¹³⁷Cs is 1.5×10^{-2} Bq/L;

²³⁸Pu is 1.5×10^{-6} Bq/L; ²³⁹Pu is 1.5×10^{-6} Bq/L;

²²⁸Th is 1.5×10^{-6} Bq/L; ²³⁰Th is 1.9×10^{-6} Bq/L;

²³²Th is 3.7×10^{-7} Bq/L; Total Sr is 3.3×10^{-4} Bq/L;

²³⁴U is 3.3×10^{-6} Bq/L; ²³⁵U is 3.7×10^{-6} Bq/L; and

²³⁸U is 3.7×10^{-6} Bq/L.

^cTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

Table 32. Long-lived radioactivity in composited air filters
from Stations 41, 45, and 46, July-September 1988

Analysis	Concentration (10^{-10} Bq/L)					
	Station 41 ^a	Percent DCG ^b	Station 45 ^a	Percent DCG ^b	Station 46 ^a	Percent DCG ^b
⁶⁰ Co	99	<0.01	-36	<0.01	120	<0.01
¹³⁷ Cs	-31	<0.01	-1.1	<0.01	99	<0.01
²³⁸ Pu	6.3	0.042	0.88	<0.01	0.93	<0.01
²³⁹ Pu	-1.1	<0.01	-0.11	<0.01	-2.4	<0.01
²²⁸ Th	130	0.87	100	0.67	120	0.80
²³⁰ Th	8.9	0.047	4.4	0.023	6.3	0.033
²³² Th	4.2	0.11	3.3	0.089	5.1	0.14
Total Sr ^c	-14	<0.01	46	<0.01	28	<0.01
²³⁴ U	62	0.19	170	0.52	200	0.61
²³⁵ U	3.2	<0.01	5.6	0.015	9.3	0.025
²³⁸ U	12	0.032	40	0.11	33	0.089

^aSee Fig. 3.

^bPercent DCG = value X 100/derived concentration guide (DCG).
The DCG for ⁶⁰Co is 3.0×10^{-3} Bq/L; ¹³⁷Cs is 1.5×10^{-2} Bq/L;
²³⁸Pu is 1.5×10^{-6} Bq/L; ²³⁹Pu is 1.5×10^{-6} Bq/L;
²²⁸Th is 1.5×10^{-6} Bq/L; ²³⁰Th is 1.9×10^{-6} Bq/L;
²³²Th is 3.7×10^{-7} Bq/L; Total Sr is 3.3×10^{-4} Bq/L;
²³⁴U is 3.3×10^{-6} Bq/L; ²³⁵U is 3.7×10^{-6} Bq/L; and
²³⁸U is 3.7×10^{-6} Bq/L.

^cTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

Table 33. Long-lived radioactivity in composited air filters from air monitoring networks, July-September 1988

Analysis	Concentration (10^{-10} Bq/L)					
	ORNL PAMs ^a	Percent DCG ^b	Reservation PAMs ^c	Percent DCG ^b	RAMs ^d	Percent DCG ^b
⁶⁰ Co	13	<0.01	11	<0.01	4.7	<0.01
¹³⁷ Cs	54	<0.01	17	<0.01	-7.8	<0.01
²³⁸ Pu	-0.016	<0.01	-0.25	<0.01	-0.062	<0.01
²³⁹ Pu	0.049	<0.01	0.015	<0.01	0.062	<0.01
²²⁸ Th	18	0.12	17	0.11	19	0.13
²³⁰ Th	2.6	0.014	2.0	0.011	3.9	0.021
²³² Th	2.4	0.065	2.2	0.059	4.4	0.12
Total Sr ^e	44	<0.01	12	<0.01	-0.16	<0.01
²³⁴ U	28	0.085	22	0.067	22	0.067
²³⁵ U	1.5	<0.01	1.2	<0.01	0.59	<0.01
²³⁸ U	5.5	0.015	5.5	0.015	6.4	0.017

^aSee Fig. 2.

^bPercent DCG = value X 100/derived concentration guide (DCG).
 The DCG for ⁶⁰Co is 3.0×10^{-3} Bq/L; ¹³⁷Cs is 1.5×10^{-2} Bq/L;
²³⁸Pu is 1.5×10^{-6} Bq/L; ²³⁹Pu is 1.5×10^{-6} Bq/L;
²²⁸Th is 1.5×10^{-6} Bq/L; ²³⁰Th is 1.9×10^{-6} Bq/L;
²³²Th is 3.7×10^{-7} Bq/L; Total Sr is 3.3×10^{-4} Bq/L;
²³⁴U is 3.3×10^{-6} Bq/L; ²³⁵U is 3.7×10^{-6} Bq/L; and
²³⁸U is 3.7×10^{-6} Bq/L.

^cSee Fig. 3.

^dSee Fig. 4.

^eTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

Table 34. Long-lived radioactivity in composited air filters
from Stations 34, 36, and 40, October-December 1988

Analysis	Concentration (10^{-10} Bq/L)					
	Station 34 ^a	Percent DCG ^b	Station 36 ^a	Percent DCG ^b	Station 40 ^a	Percent DCG ^b
⁶⁰ Co	18	<0.01	-13	<0.01	-2.1	<0.01
¹³⁷ Cs	10	<0.01	15	<0.01	16	<0.01
²³⁸ Pu	-1.2	<0.01	-0.32	<0.01	-0.21	<0.01
²³⁹ Pu	-1.4	<0.01	-2.6	<0.01	-0.72	<0.01
²²⁸ Th	24	0.16	31	0.21	27	0.18
²³⁰ Th	2.0	0.011	4.1	0.022	3.6	0.019
²³² Th	2.6	0.070	4.1	0.11	2.7	0.073
Total Sr ^c	22	<0.01	28	<0.01	0	<0.01
²³⁴ U	15	0.045	39	0.12	240	0.73
²³⁵ U	0.5	<0.01	3.7	<0.01	21	0.057
²³⁸ U	8.6	0.023	11	0.030	36	0.097

^aSee Fig. 3.

^bPercent DCG = value X 100/derived concentration guide (DCG).
The DCG for ⁶⁰Co is 3.0×10^{-3} Bq/L; ¹³⁷Cs is 1.5×10^{-2} Bq/L;
²³⁸Pu is 1.5×10^{-6} Bq/L; ²³⁹Pu is 1.5×10^{-6} Bq/L;
²²⁸Th is 1.5×10^{-6} Bq/L; ²³⁰Th is 1.9×10^{-6} Bq/L;
²³²Th is 3.7×10^{-7} Bq/L; Total Sr is 3.3×10^{-4} Bq/L;
²³⁴U is 3.3×10^{-6} Bq/L; ²³⁵U is 3.7×10^{-6} Bq/L; and
²³⁸U is 3.7×10^{-6} Bq/L.

^cTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

Table 35. Long-lived radioactivity in composited air filters
from Stations 41, 45, and 46, October-December 1988

Analysis	Concentration (10^{-10} Bq/L)					
	Station 41 ^a	Percent DCG ^b	Station 45 ^a	Percent DCG ^b	Station 46 ^a	Percent DCG ^b
⁶⁰ Co	-6.6	<0.01	54	<0.01	-31	<0.01
¹³⁷ Cs	3.3	<0.01	8.6	<0.01	16	<0.01
²³⁸ Pu	-1.4	<0.01	-0.21	<0.01	-1.7	<0.01
²³⁹ Pu	-0.98	<0.01	0.011	<0.01	-0.29	<0.01
²²⁸ Th	21	0.14	48	0.32	25	0.17
²³⁰ Th	2.4	0.013	4.3	0.023	5.5	0.029
²³² Th	1.9	0.051	2.6	0.070	3.7	0.10
Total Sr ^c	-9.8	<0.01	7.5	<0.01	-4.2	<0.01
²³⁴ U	96	0.29	270	0.82	200	0.61
²³⁵ U	11	0.030	7.8	0.021	5.4	0.015
²³⁸ U	22	0.059	54	0.15	25	0.068

^aSee Fig. 3.

^bPercent DCG = value X 100/derived concentration guide (DCG).
The DCG for ⁶⁰Co is 3.0×10^{-3} Bq/L; ¹³⁷Cs is 1.5×10^{-2} Bq/L;
²³⁸Pu is 1.5×10^{-6} Bq/L; ²³⁹Pu is 1.5×10^{-6} Bq/L;
²²⁸Th is 1.5×10^{-6} Bq/L; ²³⁰Th is 1.9×10^{-6} Bq/L;
²³²Th is 3.7×10^{-7} Bq/L; Total Sr is 3.3×10^{-4} Bq/L;
²³⁴U is 3.3×10^{-6} Bq/L; ²³⁵U is 3.7×10^{-6} Bq/L; and
²³⁸U is 3.7×10^{-6} Bq/L.

^cTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

Table 36. Long-lived radioactivity in composited air filters
from air monitoring networks, October-December 1988

Analysis	Concentration (10^{-10} Bq/L)					
	ORNL PAMs ^a	Percent PCG ^b	Reservation PAMs ^c	Percent DCG ^b	RAMs ^d	Percent DCG ^b
⁶⁰ Co	17	<0.01	-6.0	<0.01	-4.0	<0.01
¹³⁷ Cs	29	<0.01	3.0	<0.01	-4.0	<0.01
²³⁸ Pu	0.076	<0.01	-0.15	<0.01	-0.040	<0.01
²³⁹ Pu	0.12	<0.01	-0.24	<0.01	-0.16	<0.01
²²⁸ Th	8.7	0.058	6.9	0.046	7.6	0.051
²³⁰ Th	2.9	0.015	3.1	0.016	2.4	0.013
²³² Th	2.3	0.062	3.1	0.084	3.2	0.086
Total Sr ^e	20	<0.01	5.1	<0.01	5.6	<0.01
²³⁴ U	23	0.070	43	0.13	7.0	0.021
²³⁵ U	1.3	<0.01	1.9	<0.01	0.56	<0.01
²³⁸ U	7.8	0.021	11	0.030	4.6	0.012

^aSee Fig. 2.

^bPercent DCG = value X 100/derived concentration guide (DCG).

The DCG for ⁶⁰Co is 3.0×10^{-3} Bq/L; ¹³⁷Cs is 1.5×10^{-2} Bq/L;
²³⁸Pu is 1.5×10^{-6} Bq/L; ²³⁹Pu is 1.5×10^{-6} Bq/L;
²²⁸Th is 1.5×10^{-6} Bq/L; ²³⁰Th is 1.9×10^{-6} Bq/L;
²³²Th is 3.7×10^{-7} Bq/L; Total Sr is 3.3×10^{-4} Bq/L;
²³⁴U is 3.3×10^{-6} Bq/L; ²³⁵U is 3.7×10^{-6} Bq/L; and
²³⁸U is 3.7×10^{-6} Bq/L.

^cSee Fig. 3.

^dSee Fig. 4.

^eTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

Table 37. Estimated dose from airborne particulate radionuclides, July-December 1988

Station number	Organ or body part	50-Year committed dose equivalent (mrem)		
		Jul.-Sept.	Oct.-Dec.	1988 Total
34	Effective	0.10	0.047	0.71
	Lungs	0.74	0.35	4.7
	Endosteal bone	0.22	0.13	3.6
	Whole body ^a	0.00055	0.00010	0.00075
36	Effective	0.18	0.072	0.98
	Lungs	1.4	0.51	6.6
	Endosteal bone	0.41	0.21	4.5
	Whole body ^a	0.00019	0.00015	0.00086
40	Effective	0.23	0.12	0.92
	Lungs	1.7	0.95	6.3
	Endosteal bone	0.48	0.20	3.9
	Whole body ^a	0.00046	0.00016	0.00090
41	Effective	0.23	0.069	1.1
	Lungs	1.7	0.52	7.9
	Endosteal bone	0.60	0.13	4.5
	Whole body ^a	0.00063	0.000016	0.00073
45	Effective	0.21	0.16	1.3
	Lungs	1.6	1.3	8.9
	Endosteal bone	0.37	0.26	4.2
	Whole body ^a	0.000096	0.00030	0.00044
46	Effective	0.25	0.11	0.96
	Lungs	1.9	0.82	6.8
	Endosteal bone	0.48	0.24	3.1
	Whole body ^a	0.00068	0.000089	0.00087
ORNL PAMs	Effective	0.044	0.032	0.26
	Lungs	0.31	0.20	1.7
	Endosteal bone	0.13	0.11	1.1
	Whole body ^a	0.00023	0.00024	0.00060
Reservation PAMS	Effective	0.039	0.035	0.26
	Lungs	0.28	0.24	1.8
	Endosteal bone	0.11	0.13	1.1
	Whole body ^a	0.00017	0.00015	0.00042

Table 37. (continued)

Station number	Organ or body part	50-Year committed dose equivalent (mrem)		
		Jul.-Sept.	Oct.-Dec.	1988 Total
RAMs	Effective	0.048	0.023	0.21
	Lungs	0.34	0.15	1.4
	Endosteal bone	0.18	0.11	1.1
	Whole body ^a	0.000019	0.000000	0.000074

^aWhole-body dose equivalents are from external exposures that occur during the quarter of interest. They do not include cumulative doses from exposures to ground-deposited nuclides.

internal exposures continue as long as the radionuclides remain inside the person. External exposures usually result in uniform irradiation of the entire body and all its components; internal exposures usually result in nonuniform irradiation of the body. Most radionuclides, when taken into the body, deposit preferentially in specific organs or tissue and thus do not irradiate the body uniformly.

Several specialized units have been defined for characterizing exposures to ionizing radiation. Damage associated with such exposures results primarily from the deposition of radiant energy in tissue. Therefore, the units are defined in terms of the amount of incident radiant energy absorbed by tissue and the biological consequences of the absorbed energy. Some of these units are as follows:

The *absorbed dose* is a physical quantity that defines the amount of incident radiant energy absorbed per unit mass of an irradiated material. Its unit of measure is the rad. The absorbed dose depends on the type and energy of the incident radiation and on the atomic number of the absorbing material.

The *dose equivalent* is a quantity that expresses the biological effectiveness of an absorbed dose in a specified human organ or tissue. Its unit of measure is the rem (or Sievert, sv; 1 sv = 100 rem). The dose equivalent is numerically equal to the absorbed dose multiplied by modifying factors that relate the absorbed dose to biological effects. In this report, as in many others, the term dose equivalent is often shortened to dose.

The *effective dose equivalent* is a measure of the overall carcinogenic and genetic risk resulting from exposures to radiations. It is a weighted sum of dose equivalents to eleven organs. The weighting factors and specific organs are described in Publications 26 and 30 of the International Commission on Radiological Protection (ICRP 1977, 1978).

The *whole-body dose equivalent* is the dose equivalent received when the entire body is placed in a uniform radiation field. This condition can be achieved if the body is in a uniform external radiation field or if internally deposited radionuclides distribute uniformly throughout the body. For most radionuclides, the latter condition is not met.

The *committed (effective) dose equivalent* is the total (effective) dose equivalent that will be received over a specified time period (50 years in this report) because of exposures to and intakes of radionuclides during the year of interest.

Estimation of potential dose equivalents from airborne radionuclides at a specified air station was accomplished by calculating internal and external doses to a hypothetical, or reference, individual residing continually at the air station. In other cases, the reference individual was assumed to reside continually at a hypothetical location having airborne radionuclide concentrations representing the average situation for several air monitoring sites. Doses were calculated using a suite of computer codes developed under EPA sponsorship for use in demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants. The atmospheric transport code AIRDOS-EPA was used to calculate radionuclide concentrations on the ground and

in foodstuffs (meat, milk, and vegetables) resulting from the settling of contaminated particles at each location. Through the DARTAB computer code, conversion factors in the RADRISK data base were applied to the calculated radionuclide concentrations to give estimates of dose contributions from inhalation of and immersion in contaminated air, from exposure to contaminated ground surfaces and from ingestion of locally grown foodstuffs (milk, meat, and vegetables). Beef, milk, and food crop production were assumed to be the maximum possible for the available ground area. It was further assumed that one-third of all foodstuff consumed were grown locally throughout the year. Because these doses are calculated from only those radionuclides measured on air filters, the contributions from tritium and noble gases are not included.

Whole-body and 50-year committed dose equivalents resulting from measured quantities of airborne radioactive particulates are presented in Table 37. Calculations are for stations 34, 36, 40, 41, 45, and 46; the average of the remaining reservation PAMs, the average of the ORNL PAMs, and the average of the remote (or background) air monitors the RAMs. Also presented are doses for the two organs [the lungs and endosteal (or surface) bone] that receive the highest doses from the measured mixes of airborne radionuclides. These results are presented for the first two quarters of 1988. Subsequent results will be presented in forthcoming quarterly reports.

At most locations, isotopes of thorium are the greatest airborne particulate contributors to the doses for lungs and endosteal bone. These isotopes are commonly found in natural soils and therefore commonly occur in airborne dust. Thorium isotopes also often provide the greatest airborne particulate contributions to the effective dose. At some locations, however, uranium isotopes represent a greater contribution to the dose for lungs and occasionally to the effective dose. This especially tends to be the case at station 45, which is located near the Y-12 Plant burial grounds. If ^{131}I is present in appreciable amounts, it will contribute the greatest dose to the thyroid.

Generally speaking, the calculated dose decreased during the third and fourth quarters. Decreases in thorium isotopes were mainly responsible for the decreased effective doses and also for the decreased doses to the lungs and endosteal bone. Decreased thorium isotopes would be expected during the third and fourth quarter as rainfall returned to normal and summer construction activities were reduced or discontinued. Thorium is a natural component of soil, and the combination of dry conditions and unusually high amounts of construction activity near the air monitors contributed to markedly increased thorium concentrations and, thus, to increased dose equivalents during the second quarter. The decreases in calculated dose during the third and fourth quarters of 1988 represent a return to more normal conditions.

The highest committed dose from radionuclides in airborne particulates (1.3 mrem/year at station 45) is less than 6% of the EPA whole-body standard (25 mrem/year) from all sources. The highest committed dose from radionuclides in airborne particulates to a single organ (8.9 mrem/year to the lungs at station 45) is less than 12% of the EPA standard (75 mrem/year) from all sources to any single organ. In both of these cases, the calculated dose components correspond to an individual living continuously very near the Y-12 Plant burial ground with one-third of the food supply provided by products grown year-round at that same location.

2.4 EXTERNAL GAMMA RADIATION

External gamma radiation measurements are made to determine if routine radioactive effluents from ORNL are increasing external gamma radiation levels significantly above normal background.

Average gamma radiation measurements are recorded at 10-min intervals at ORNL and ORR PAMs, except for stations 9, 20 through 23, and 46 (Fig. 2). From these data, hourly averages are computed. Table 38 summarizes the valid hourly measurements for the fourth quarter of 1988. Typical values for cities in the United States are usually between 50 and 200 nGy/h according to the recent issues of *EPA Environmental Radiation Data*. The most recent value for Knoxville, published in these EPA quarterly reports (EPA 1987), was 177 nGy/h for the second quarter of 1987. All of the values given in Table 38 are close to the range of background values as given above, except for PAM 4, which is located very close to the PWTP and treatment ponds. Values for station 4 are more than 10 times the typical background values, which is to be expected considering the location of that particular monitor. The decrease, from the third quarter, in average gamma radiation at the ORNL PAMs is primarily the result of the decrease at station 4.

Table 38. External gamma radiation measurements at ORNL
and reservation perimeter air monitoring
stations, October-December 1988

Location	Number of samples ^a	Concentration (nGy/h)		
		Max	Min	Av
<i>ORNL PAM stations^b</i>				
3	1672	103	67	72
4	1222	2340	103	1503
7	2066	122	40	85
20	2053	120	83	89
Network summary	7013	2340	40	330
<i>Reservation PAM stations^c</i>				
8	1120	104	69	75
31	2031	105	75	80
33	1711	116	70	83
34	2195	121	75	90
36	2177	109	66	76
40	1490	111	66	83
41	1684	95	62	79
42	2110	108	62	74
43	1741	296	63	72
44	925	104	56	74
45	1747	111	67	74
Network summary	18931	296	56	79

^aReal-time readings were collected at all stations at 10-minute intervals. The number of samples indicate the total number of valid hourly averages during the quarter.

^bSee Fig. 2.

^cSee Fig. 3.

3. WATER

The ORNL site is drained by two main streams, White Oak Creek (WOC) and Melton Branch. With the exception of two small discharges from the 7600 area that discharge to Melton Hill Lake, all ORNL effluents discharge to these two streams or their tributaries. WOC flows through Bethel Valley where Fifth Creek, First Creek, and the Northwest Tributary enter it. WOC continues through a gap in Chestnut Ridge into Melton Valley where it is joined by Melton Branch, which drains Melton Valley. WOC empties into White Oak Lake (WOL), which is controlled by White Oak Dam (WOD), and is the last sampling point before effluents leave the ORNL site. The majority of the drainage or liquid effluent from ORNL flows into the Clinch River by way of WOC. The Clinch River flows southwest from Virginia to its mouth near Kingston, Tennessee, where it joins with the Tennessee River. Process effluents discharged to these streams are handled in a number of ways, including treatment (PWTP, coal yard runoff), holding basins (190 ponds, HFIR/TRU ponds), and direct discharge to the stream. Sanitary effluent is discharged to WOC after treatment at the sewage treatment plant (STP). Below WOD, WOC is affected by water levels in the Clinch River, which are controlled by Melton Hill Dam (Fig. 5).

Surveillance of the water environment consists of the collection of surface water, effluent and sediment samples required under the NPDES permit, and groundwater from WAG 1 and WAG 6. Samples are analyzed for radionuclides and nonradioactive chemicals.

3.1 SURFACE WATER

WOC drains an area of 17 km² in Bethel and Melton valleys and is the largest stream flowing through ORNL. Run-off from sites at ORNL reaches WOC either directly or via one of its tributaries. After entering Melton Valley, WOC is joined by its major tributary, Melton Branch (MB), at WOC kilometer 2.49. WOD, located 1 km above the mouth of WOC, forms WOL and serves as a point for monitoring flow and discharges of contaminants from the ORNL site. Because facilities located near these creeks may discharge material to the creeks, sampling and analysis of the facility discharges are included in this section. ORNL's nonradiological sampling of these areas is specified in the NPDES permit (see Sect. 3.2). This section is limited to a discussion of the radiological sampling that is performed by ORNL. Major discharges to WOC include (1) treated domestic (sanitary) waste from the STP; (2) cooling tower blowdown; (3) cooling water from various sources; (4) surface and groundwater drainage from the main Laboratory area, including drainage from SWSAs 3, 4, and 6; (5) discharges from the process waste collection (190 ponds) and PWTP (3544); and (6) discharges from process building areas. Major discharges to MB include discharges from SWSA 5, blowdown from the recirculating cooling water system at the HFIR, and discharges from the 7900 waste pond system.

To determine discharges of radionuclides from ORNL processes, flow and concentration data from ORNL streams were recorded. Water samples were collected regularly from the following stations: 1500 area, 190 ponds, First Creek, 2000 area, Acid Neutralization Facility (3518), PWTP (3544), Fifth Creek, 7500 bridge, HFIR ponds, WOC headwaters, Melton Branch 1 (MB1), Melton Branch 2 (MB2), Melton Hill Dam, Northwest Tributary (NWT), Raccoon Creek, STP, TRU ponds, WOC, and WOD (Figs. 5 and 6). Real-time monitoring was performed at MB, WOC, and WOD. The parameters monitored include pH, dissolved oxygen, turbidity, conductivity, temperature, flow, beta and gamma activity (in

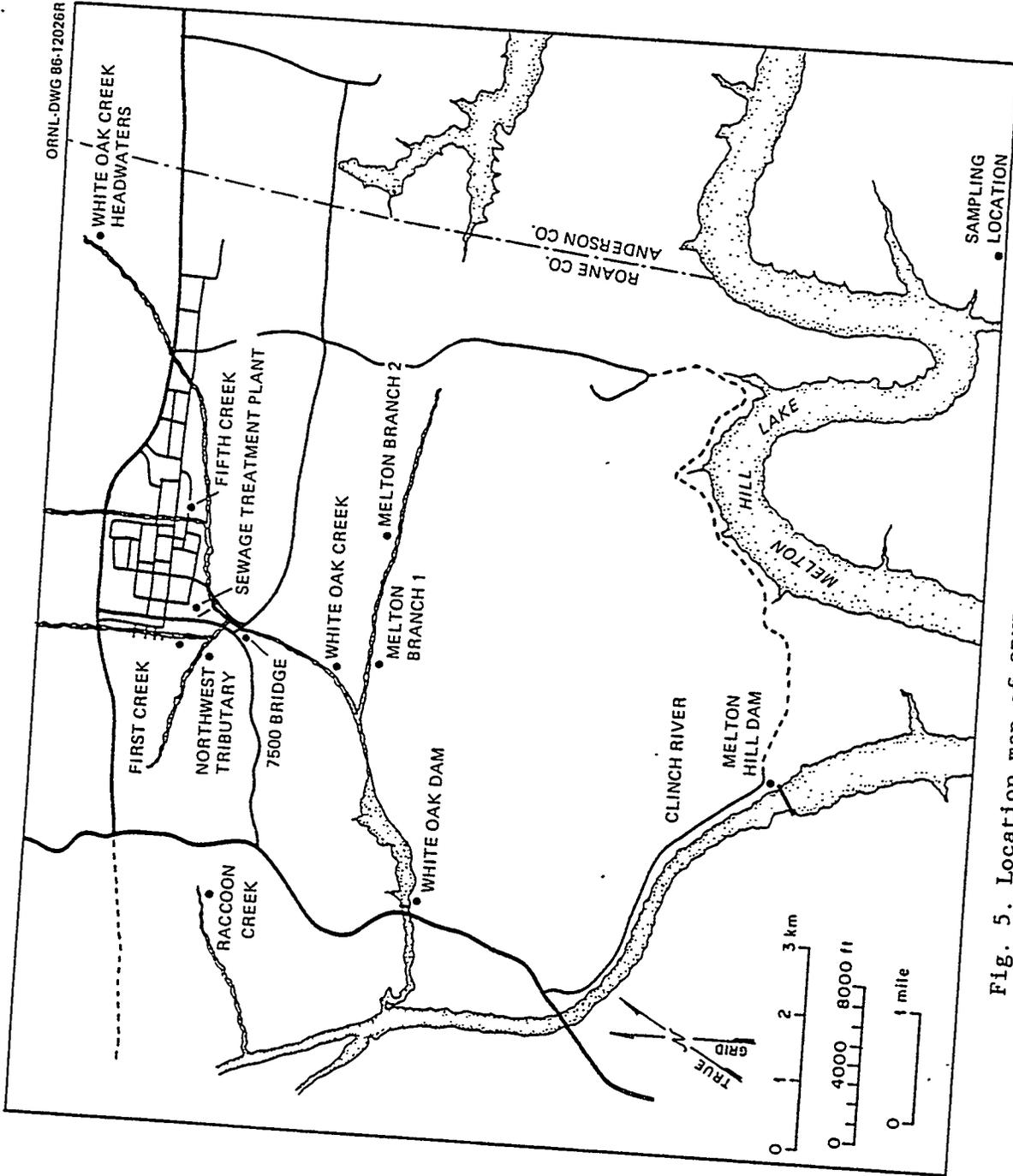


Fig. 5. Location map of ORNL streams and sampling stations.

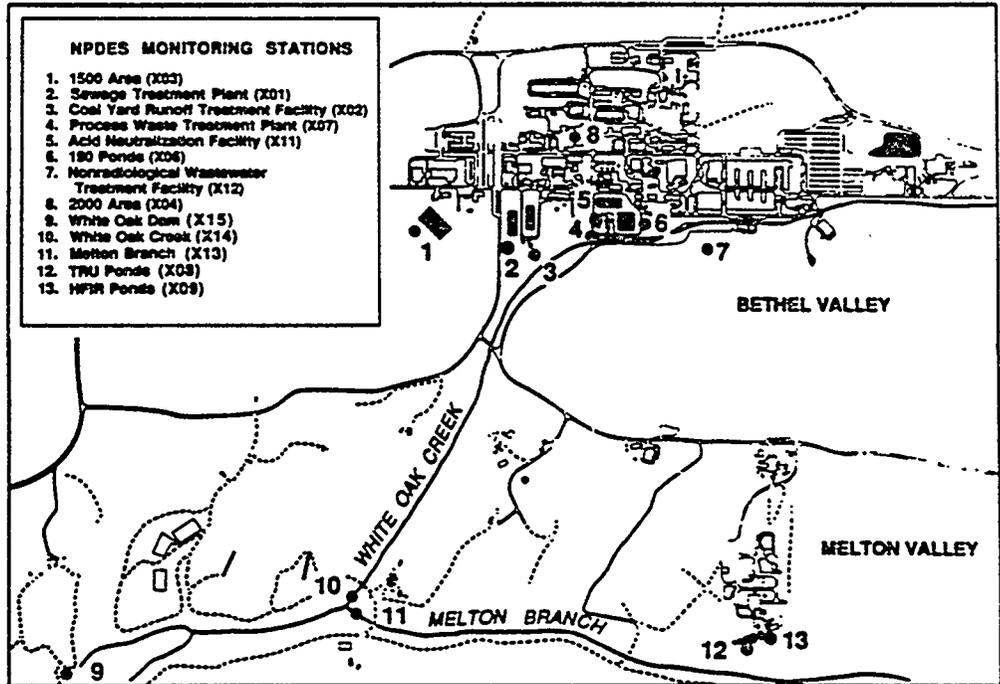


Fig. 6. Location map of NPDES monitoring points.

counts per minute), and a gamma spectrum at WOD. Previously, samples collected and analyzed daily at the 7500 bridge were used as an early warning of discharges of radioactivity from ORNL processes. However, this early warning capability is now provided by the real-time monitor at the WOC station, so the analysis of daily samples from the 7500 bridge was discontinued at the start of the third quarter of 1988. Radiological monitoring at stations in the 1500 area, 190 ponds, 3518, and 3544 was initiated in February 1987 to comply with the requirements of the NPDES Radiological Monitoring Plan.

Water samples are collected weekly at Kingston and the Oak Ridge Gaseous Diffusion Plant (ORGDP) (Gallaher) water treatment plants and are analyzed quarterly for radionuclides (Fig. 7). For comparison, samples are collected daily from the ORNL potable water system (tap water) in Building 4500-S and analyzed quarterly for radionuclides. In addition, flow-proportional samples are collected weekly from Melton Hill Dam (Fig. 7) and analyzed quarterly for radionuclides. This sampling location, on the Clinch River, is above ORNL's discharge point to the Clinch River and serves as a local background or reference station for ORNL.

Table 39 summarizes the sampling and analysis frequencies, the parameters analyzed, and the type of sample collected at each of these stations. Summaries of radionuclide concentrations are presented in Tables 40 and 41. All determinations for "total Sr" are for total radioactive strontium, which is the sum of ^{89}Sr and ^{90}Sr . The 95% cc about the average values have not been presented for stations with less than three samples.

Gross alpha and gross beta values from the 1500 area have returned to normal after an unusually large departure in September (Table 41).

The highest total radioactive Sr concentrations observed during this quarter were in First Creek, with values ranging from 16 to 23 Bq/L (Table 41). These are typical values for October through December at First Creek. Strontium values at the PWTP returned to normal after being slightly elevated during the previous quarter. Total radioactive Sr concentrations in MB1 ranged from 12 to 13 Bq/L. At the Melton Hill Dam background station, total radioactive Sr ranged from 0.040 to 0.85 Bq/L. Most of the total radioactive Sr appears to be coming from the main ORNL plant area. Unlike the ^{60}Co and ^{137}Cs discharges, which are primarily process related, the total radioactive Sr releases are more diffuse and are probably the result of surface and groundwater drainage rather than discharges from process facilities.

Cesium-137 concentrations at the PWTP returned to normal this quarter.

Concentrations of tritium are highest (44,000 to 88,000 Bq/L) at the MB1 station, probably because of releases from SWSA 5. Characterization of SWSA 5, particularly the tritium releases, is one of the highest priorities of the Remedial Investigation/Feasibility Study (RI/FS) subcontract.

Flows in the Clinch river (as measured at Melton Hill Dam) and in WOC (as measured at WOD) and the ratios of these flows are presented in Table 42. The average ratios presented in the table were calculated weekly and averaged for the month. Even though rainfall for the quarter was above normal, the effect of the dry spell during the first half of the year is still evident in the flow of the Clinch River, which was 73% of the flow for the fourth quarter of 1988.

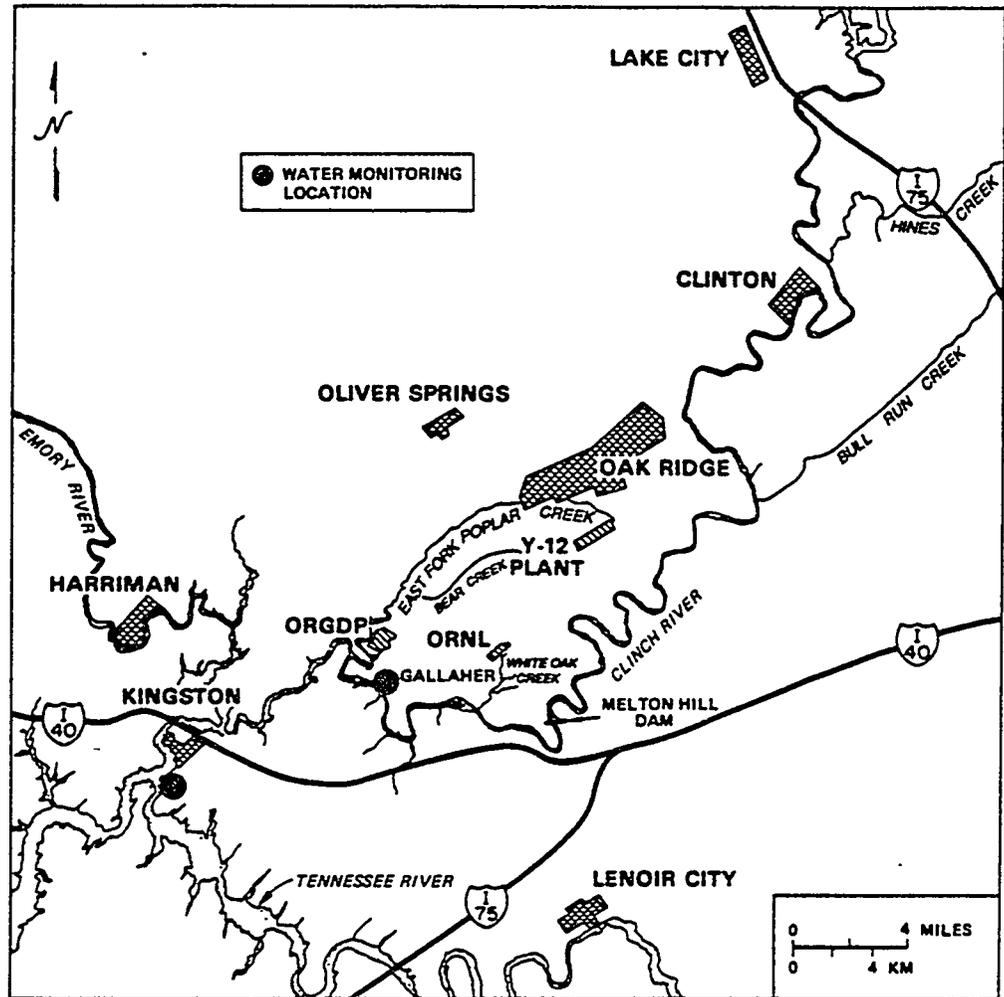


Fig. 7. Location map of Gallaher and Kingston sampling points.

Table 39. Summary of collection and analysis frequencies of surface and tap water samples

Station	Parameter	Collection frequency	Type	Analysis frequency
190 ponds	Gamma scan, gross alpha, gross beta	Weekly	Flow proportional	Monthly
1500 area, 3518	Gross alpha, gross beta,	Weekly	Flow proportional	Monthly
2000 area, STP	Gamma scan, gross beta, Total Sr ^a	Weekly	Flow proportional	Monthly
3544	Gross alpha, gross beta, gamma scan, total Sr	Weekly	Flow proportional	Monthly
7500 bridge, MB1 WOC, MB2	Gamma scan, total Sr, ³ H	Weekly	Flow proportional	Monthly
First Creek, Fifth Creek, Raccoon Creek	Gamma scan, total Sr	Weekly	Grab	Monthly
Gallaher	³ H, gamma scan, gross alpha, gross beta, Pu, total Sr	Weekly	Flow proportional	Quarterly
Kingston	³ H, gamma scan, gross alpha, gross beta, Pu, total Sr	Weekly	Grab	Quarterly
HFIR ponds	Gamma scan, gross alpha, gross beta	After discharge	Flow proportional	Monthly
Melton Hill Dam	²⁴¹ Am, ²⁴⁴ Cm, gamma scan, gross alpha, Pu, Th, U, total Sr, ³ H	Weekly	Flow proportional	Quarterly
NWT	Gamma scan, total Sr	Weekly	Flow proportional	Monthly
ORNL tap	Gamma scan, gross alpha, gross beta, Pu, total Sr, U	Daily	Grab	Quarterly
WOC headwaters	²⁴¹ Am, ²⁴⁴ Cm, gamma scan, gross alpha, total Sr, ³ H, Pu, Th, U	Weekly	Grab	Monthly

Table 39. (continued)

Station	Parameter	Collection Frequency	Type	Analysis Frequency
WOD	^{241}Am , ^{244}Cm , gamma scan, gross alpha, total Sr, ^3H , Pu, Th, U	Weekly	Flow proportional	Weekly
TRU ponds	Gross beta	After discharge	Flow proportional	Monthly

^aTotal radioactive Sr (^{89}Sr + ^{90}Sr).

Table 40. Quarterly summary of radionuclide concentrations in surface streams and tap water, October-December 1988

Radionuclide	Concentration (Bq/L)
<i>Gallaher^a</i>	
⁶⁰ Co	0.030
¹³⁷ Cs	0.010
Gross alpha	0.011
Gross beta	0.43
Total Pu ^b	<0.00011
Total Sr ^c	0.0040
²³⁴ U	0.0050
²³⁵ U	0.00015
²³⁶ U	0.0000037
²³⁸ U	0.0032
<i>Kingston^a</i>	
⁶⁰ Co	0.011
¹³⁷ Cs	0.016
Gross alpha	0.028
Gross beta	0.16
Total Pu	<0.00011
Total Sr	0.010
²³⁴ U	0.0031
²³⁵ U	0.00010
²³⁶ U	0.000018
²³⁸ U	0.0020
<i>Melton Hill Dam^a</i>	
⁶⁰ Co	0.068
¹³⁷ Cs	0.065
Gross alpha	0.037
Gross beta	0.10
Total Pu	<0.00011
Total Sr	0.0040
²³⁴ U	0.0046
²³⁵ U	0.00014
²³⁶ U	0.0000035
²³⁸ U	0.0030

Table 40. (continued)

Radionuclide	Concentration (Bq/L)
<i>ORNL tap water</i>	
^{60}Co	0.0060
^{137}Cs	0.010
Gross alpha	0.044
Gross beta	0.16
Total Pu	<0.00011
Total Sr	0.0010
^{234}U	0.0044
^{235}U	0.00014
^{236}U	<0.0000011
^{238}U	0.0029

^aSee Fig. 7.

^bTotal Pu (^{239}Pu + ^{240}Pu).

^cTotal radioactive Sr (^{89}Sr + ^{90}Sr).

Table 41. Radionuclide concentrations in water around ORNL,
October-December 1988

Radionuclide	Number of samples	Concentration (Bq/L)			
		Max	Min	Av	95% cc ^a
<i>1500 area^b</i>					
Gross alpha	3	1.1	0.0	0.45	0.67
Gross beta	3	1.5	0.32	0.73	0.77
<i>190 ponds^b</i>					
⁶⁰ Co	3	1.1	0.060	0.51	0.62
¹³⁷ Cs	3	0.42	0.10	0.24	0.19
Gross alpha	3	0.22	0.0	0.097	0.13
Gross beta	3	1.8	0.91	1.4	0.54
<i>First Creek^c</i>					
⁶⁰ Co	3	0.50	-0.030	0.19	0.32
¹³⁷ Cs	3	0.70	-0.020	0.22	0.48
Total Sr ^d	3	23	16	19	4.2
<i>2000 area^b</i>					
⁶⁰ Co	3	0.40	-0.51	0.033	0.55
¹³⁷ Cs	3	0.60	-0.15	0.11	0.49
Gross beta	3	2.6	0.0	1.1	1.5
Total Sr	3	0.36	0.030	0.14	0.22
<i>Acid neutralization facility^b</i>					
Gross alpha	3	0.70	0.0	0.26	0.44
Gross beta	3	2.1	0.0	1.4	1.4
<i>Process waste treatment plant^b</i>					
⁶⁰ Co	3	1.9	1.1	1.5	0.46
¹³⁷ Cs	3	190	88	130	60
Gross alpha	3	0.90	0.42	0.67	0.28
Gross beta	3	200	98	140	62
Total Sr	3	1.9	0.10	0.89	1.1

Table 41. (continued)

Radionuclide	Number of samples	Concentration (Bq/L)			
		Max	Min	Av	95% cc ^a
<i>Fifth Creek^c</i>					
⁶⁰ Co	3	0.30	-0.18	0.080	0.28
¹³⁷ Cs	3	0.90	0.11	0.43	0.48
Total Sr	3	5.0	3.1	4.1	1.1
<i>7500 bridge^c</i>					
⁶⁰ Co	3	0.60	0.040	0.25	0.36
¹³⁷ Cs	3	7.4	3.0	4.9	2.6
Total Sr	3	4.6	2.4	3.3	1.3
³ H	3	4400	120	2300	2500
<i>HFIR^b</i>					
⁶⁰ Co	3	110	78	93	19
¹³⁷ Cs	3	0.50	-0.70	-0.027	0.71
Gross alpha	3	0.31	0.17	0.23	0.083
Gross beta	3	92	62	81	19
⁵⁴ Mn	2	0.42	-0.12	0.15	0.54
<i>White Oak Creek headwaters^c</i>					
²⁴¹ Am	3	0.012	-0.033	-0.0053	0.028
⁶⁰ Co	3	0.80	-0.40	0.12	0.71
¹³⁷ Cs	3	0.58	-0.50	0.010	0.63
Gross alpha	3	0.65	0.0	0.30	0.38
Gross beta	3	1.4	0.0	0.78	0.82
²³⁸ Pu	3	0.00090	0.00049	0.00070	0.00024
²³⁹ Pu	3	0.0010	-0.0023	-0.00033	0.0020
Total Sr	3	0.20	0.010	0.11	0.11
³ H	3	26	-14	10	25
<i>Melton Branch 1^c</i>					
⁶⁰ Co	3	2.2	0.46	1.2	1.1
¹³⁷ Cs	3	0.080	-0.010	0.030	0.053
Total Sr	3	13	12	13	0.67
³ H	3	88,000	44,000	67,000	26,000

Table 41. (continued)

Radionuclide	Number of samples	Concentration (Bq/L)			
		Max	Min	Av	95% cc ^a
<i>Melton Branch 2^c</i>					
⁶⁰ Co	3	1.3	0.12	0.66	0.69
¹³⁷ Cs	3	0.090	0.010	0.040	0.050
Total Sr	3	0.21	-0.070	0.077	0.16
³ H	3	1700	300	860	860
<i>Melton Hill Dam^c</i>					
²⁴¹ Am	3	0.012	0.0028	0.0064	0.0057
⁶⁰ Co	3	5.5	-0.28	1.8	3.7
¹³⁷ Cs	3	0.080	-0.11	-0.030	0.11
Gross alpha	3	0.44	0.14	0.31	0.18
Gross beta	3	3.7	0.43	1.8	2.0
²³⁸ Pu	3	0.00090	-0.00060	0.00020	0.00087
²³⁹ Pu	3	0.0010	-0.0059	-0.0015	0.0044
Total Sr	3	0.85	0.040	0.36	0.50
³ H	3	27	-48	-8.0	44
<i>Northwest Tributary^c</i>					
⁶⁰ Co	3	1.1	-0.090	0.32	0.78
¹³⁷ Cs	3	0.20	0.020	0.14	0.12
Total Sr	3	2.3	0.15	1.3	1.3
<i>Raccoon Creek^c</i>					
⁶⁰ Co	3	0.22	0.030	0.15	0.12
¹³⁷ Cs	3	0.11	0.060	0.090	0.031
Total Sr	2	2.5	1.0	1.8	1.5
<i>Sewage treatment plant^c</i>					
⁶⁰ Co	3	0.55	0.070	0.27	0.29
¹³⁷ Cs	3	0.32	0.14	0.23	0.10
Gross alpha	1	0.0	0.0	0.0	N/A
Gross beta	3	7.8	2.7	6.0	3.3
Total Sr	3	3.0	1.7	2.5	0.84

Table 41. (continued)

Radionuclide	Number of samples	Concentration (Bq/L)				95% cc ^a
		Max	Min	Av		
<i>TRU ponds^b</i>						
Gross beta	3	2.0	1.7	1.9	0.18	
<i>White Oak Creek^c</i>						
⁶⁰ Co	3	1.6	0.060	0.68	0.94	
¹³⁷ Cs	3	5.3	3.0	3.9	1.4	
Total Sr	3	5.5	2.2	4.1	2.0	
³ H	3	4,300	170	2,500	2,500	
<i>White Oak Dam^c</i>						
²⁴¹ Am	13	0.097	-0.052	0.013	0.018	
²⁴⁴ Cm	5	0.019	0.0041	0.0096	0.0050	
⁶⁰ Co	13	0.49	0.010	0.26	0.065	
¹³⁷ Cs	13	3.9	0.45	1.4	0.55	
Gross beta	6	21	7.6	12	4.1	
²³⁸ Pu	13	0.0072	-0.031	-0.00036	0.0055	
²³⁹ Pu	13	0.016	-0.00010	0.0045	0.0023	
Total Sr	13	11	2.4	5.6	1.4	
³ H	13	14,000	2,500	8,700	2,400	

^a95% cc about the average of more than two samples.

^bSee Fig. 6.

^cSee Fig. 5.

^dTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

Table 42. Flows for Clinch River and White Oak Creek,
October-December 1988

Month	Flow (10^9 L)		
	Clinch River ^a	White Oak Creek ^a	Average ratio ^b
October	140	0.46	310
November	100	0.72	170
December	140	0.66	230

^aSee Fig. 7.

^bFlow ratios Clinch River : White Oak Creek are calculated daily and averaged for the month.

The total hourly flows at WOC, MB, and WOD were calculated by multiplying the average 10-min flow rate (gallons per minute) transmitted via the real-time monitoring system by the number of minutes per hour. Low and high readings are recorded at WOC and MB; low, medium, and high flow readings are recorded at WOD.

Total flows per day at the STP are calculated by subtracting consecutive daily flow recorder readings and multiplying by a factor for conversion to millions of liters. The weekly flows are determined by averaging the total flows for the week and multiplying by the number of days in the week.

The discharges of radionuclides at WOD, WOC, MB1, and the STP are calculated by multiplying the concentration by the flow. At WOC, MB1, and the STP, a single flow-proportional sample is analyzed monthly to estimate radionuclide concentrations. At WOD, weekly flow-proportional samples are analyzed. At WOD, weekly radionuclide discharges are calculated by multiplying the weekly composite sample concentration by the total weekly flow. Monthly discharges of radionuclides at WOD are then calculated by averaging the weekly discharges and multiplying by the number of weeks per month (Tables 43 through 45). A flow-weighted concentration at WOD for the month is calculated by dividing the total radionuclide discharge for the month by the total monthly flow (Tables 43 through 45).

Each average flow-weighted concentration is compared to a corresponding derived concentration guide. For water, DCG is the concentration of a particular radionuclide for which a "reference man" under continuous exposure (ingestion) for 1 year would receive the most restrictive of (1) an effective dose equivalent of 1 mSv (1 mSv = 100 mrem) or (2) a dose equivalent of 50 mSv to any particular tissue (DOE draft Order 5400.XX). In almost all cases, the actual values are a small percentage of the corresponding DCGs. However, the percentages for strontium and tritium at MB1 are higher. Concentrations at MB1 were 32 to 35% of the DCG for strontium and 59 to 120% of the DCG for tritium. The 120% ratio for tritium occurred in October (Tables 43 through 45).

Monthly surface water samples were collected at two sampling locations for the purpose of determining background concentrations before the influence of ORNL. Samples were taken at Melton Hill Dam above ORNL's discharge point into the Clinch River (Fig. 5). The other sample location was at WOC headwaters, above the point where ORNL discharges to WOC (Fig. 5). Analyses were performed to detect both organic and inorganic compounds that may be present in the water. The results of these analyses will help determine which compounds ORNL may be discharging and help in the minimization of potentially hazardous discharges. No sample was taken for the month of May at any location during a re-evaluation of the sampling plan. The parameters with seven samples were new analyses begun in June after the re-evaluation. The parameters with three samples are pesticides, which were sampled only from June through August. Based on these results, further analyses were discontinued.

The samples taken at WOC headwaters were all taken by the manual grab method. A new weir and sampling station will be used for future sampling at this location. The organics and PCBs at Melton Hill Dam were collected by the manual grab method. The inorganics, oil and grease and dissolved solids, were collected flow-proportionally by a sampling station at this location. All grab samples were taken once per month.

Table 43. Radionuclide concentrations and releases at ORNL, October 1988.

Radionuclide	Flow (10 ⁶ L)	Discharge (10 ¹⁰ Bq)	Concentration (Bq/L)	Derived concentration guide (DCG) (Bq/L)	Percent of DCG
<i>Melton Branch 1^a</i>					
⁶⁰ Co	6.9	0.0015	2.2	190	1.2
¹³⁷ Cs	6.9	0.000014	0.020	110	0.018
Total Sr ^b	6.9	0.0090	13	37	35
³ H	6.9	61	88,000	74,000	120
<i>Sewage treatment plant^a</i>					
⁶⁰ Co	21	0.00015	0.070	190	0.038
¹³⁷ Cs	21	0.00030	0.14	110	0.13
Gross alpha	21	0.0	0.0	NA ^c	NA
Gross beta	21	0.0057	2.7	NA	NA
Total Sr	21	0.0036	1.7	37	4.6
<i>White Oak Creek^a</i>					
⁶⁰ Co	560	0.089	1.6	190	0.86
¹³⁷ Cs	560	0.30	5.3	110	4.8
Total Sr	560	0.12	2.2	37	5.9
³ H	560	9.5	170	74,000	0.23
<i>White Oak Dam^{a, d}</i>					
²⁴¹ Am	460	0.00068	0.015	1.1	1.3
²⁴⁴ Cm	460	0.00045	0.0097	2.2	0.44
⁶⁰ Co	460	0.014	0.31	190	0.17
¹³⁷ Cs	460	0.064	1.4	110	1.2
Gross beta	460	0.53	11	NA	NA
²³⁸ Pu	460	0.000056	0.0012	1.5	0.081
²³⁹ Pu	460	0.00022	0.0047	1.1	0.43
Total Sr	460	0.15	3.1	37	8.5
³ H	460	190	4200	74000	5.6

^aSee Fig. 5.

^bTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

^cNA = not applicable.

^dConcentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

Table 44. Radionuclide concentrations and releases at ORNL, November 1988

Radionuclide	Flow (10 ⁶ L)	Discharge (10 ¹⁰ Mega Bq)	Concentration (Bq/L)	Derived concentration guide (DCG) (Bq/L)	Percent of DCG
<i>Melton Branch 1^a</i>					
⁶⁰ Co	120	0.0099	0.83	190	0.45
¹³⁷ Cs	120	0.00095	0.080	110	0.072
Total Sr ^b	120	0.16	13	37	35
³ H	120	520	44,000	74,000	59
<i>Sewage Treatment Plant^a</i>					
⁶⁰ Co	19	0.0011	0.55	190	0.30
¹³⁷ Cs	19	0.00061	0.32	110	0.29
Gross beta	19	0.014	7.5	NA ^c	NA
Total Sr	19	0.0056	2.9	37	7.8
<i>White Oak Creek^a</i>					
⁶⁰ Co	820	0.030	0.37	190	0.20
¹³⁷ Cs	820	0.27	3.3	110	3.0
Total Sr	820	0.45	5.5	37	15
³ H	820	250	3100	74000	4.2
<i>White Oak Dam^{a, b}</i>					
²⁴¹ Am	720	0.00070	0.0098	1.1	0.88
²⁴⁴ Cm	720	0.00065	0.0090	2.2	0.41
⁶⁰ Co	720	0.017	0.24	190	0.13
¹³⁷ Cs	720	0.11	1.5	110	1.3
Gross beta	720	1.1	15	NA	NA
²³⁸ Pu	720	0.000027	0.00037	1.5	0.025
²³⁹ Pu	720	0.00027	0.0037	1.1	0.33
Total Sr	720	0.52	7.2	37	19
³ H	720	730	10,000	74,000	14

^aSee Fig. 5.

^bTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

^cNA = not applicable.

^dConcentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

Table 45. Radionuclide concentrations and releases at ORNL, December 1988

Radionuclide	Flow (10 ⁶ L)	Discharge (10 ¹⁰ Bq)	Concentration (Bq/L)	Derived concentration Guide (DCG) (Bq/L)	Percent of DCG
<i>Melton Branch 1^a</i>					
⁶⁰ Co	110	0.0051	0.46	190	0.25
¹³⁷ Cs	110	-0.00011	-0.010	110	<0.001
Total Sr ^b	110	0.13	12	37	32
³ H	110	770	70,000	74,000	95
<i>Sewage treatment plant^a</i>					
⁶⁰ Co	21	0.00037	0.18	190	0.097
¹³⁷ Cs	21	0.00050	0.24	110	0.22
Gross beta	21	0.016	7.8	NA ^c	NA
Total Sr	21	0.0062	3.0	37	8.1
<i>White Oak Creek^a</i>					
⁶⁰ Co	630	0.0038	0.060	190	0.032
¹³⁷ Cs	630	0.19	3.0	110	2.7
Total Sr	630	0.29	4.6	37	12
³ H	630	270	4,300	74,000	5.8
<i>White Oak Dam^{a, b}</i>					
²⁴¹ Am	660	0.0010	0.016	1.1	1.4
⁶⁰ Co	660	0.014	0.21	190	0.11
¹³⁷ Cs	660	0.079	1.2	110	1.1
²³⁸ Pu	660	-0.00014	-0.0021	1.5	<0.001
²³⁹ Pu	660	0.00035	0.0054	1.1	0.49
Total Sr	660	0.44	6.7	37	18
³ H	660	790	12,000	74,000	16

^aSee Fig. 5.

^bTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

^cNA = not applicable.

^dConcentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

Tables 46 and 47 contain a summary of the analytical results. Table 46 displays an inorganic compound list, and Table 47 displays an organic compound list. The column entitled "Percent DWL" is included to show the average concentration as a percentage of the EPA's national primary or secondary drinking water standard, where available. No abnormally high levels of organic compounds were found at either location. Inorganic compounds were also below the national primary and secondary drinking water standards. The average concentration of manganese at Melton Hill Dam was found to be 173% of the national secondary drinking water standard of 0.05 mg/L. Because the standard error of this average is high, the drinking water limit falls within a 95% confidence interval about the average. More samples would be required to determine if the drinking water standard has actually been exceeded.

3.2 National Pollutant Discharge Elimination System Requirements

ORNL's current NPDES permit requires that 10 point-source outfalls be sampled prior to their discharge into receiving waters or before mixing with any other wastewater stream. One of these points, the nonradiological wastewater treatment plant, will not be in operation until March 1990. In addition, there are three sampling locations that are located in the streams as reference points or for additional information and one [the Oak Ridge Research Reactor (ORR) Resin Regeneration Facility) that was taken out of operation in December 1986. These 13 sampling locations are shown in Fig. 5. There are approximately 150 additional locations that include storm drains, parking lot and roof drains, cooling tower drains, storage area drains, condensate drains, untreated process drains, and miscellaneous facilities that are sampled less frequently than the point-source outfalls or surface streams.

Quarterly summary statistics for the fourth quarter of 1988 are given for each sampling location in Tables 48 through 62. Monitoring of the ORR Resin Regeneration Facility is no longer required because the permitted operation has been discontinued.

Data collected for the NPDES permit are also summarized monthly for reporting to DOE and the state of Tennessee. These summaries are submitted to DOE in the Monthly Discharge Monitoring Reports and are available upon request. Noncompliances are provided in Tables 63 through 65. A brief summary of the noncompliances follows.

3.2.1 October 1988

The visible sheen at Category II, pipe 217, on October 18 was apparently an isolated incident. No recurrence of the problem has been observed. Category II outfalls include parking lot drains, storage area drains, cooling water, and steam condensate discharges. Pipe 217 discharges steam condensate to White Oak Creek south of Building 4500-S. In an attempt to identify the reason for visible sheen, EMC personnel are checking sources that may discharge through pipe 217.

A foamy discharge was reported at Category III, pipe 313, on October 19. Category III outfalls include effluents that may contain process and/or laboratory discharges. EMC personnel collected a sample of pipe 313 effluent, which is being analyzed to determine the chemical character of the discharge. Pipe 313 contains parking lot runoff and the overflow from the ORNL swan pond on the west-northwest side of the ORNL 6000 area.

Table 46. Inorganic surface water analysis at background locations,
January-December 1988

Parameter	Number of Samples	Concentration (mg/L)				Percent ^b DWL
		Max	Min	Av	95cc ^a	
<i>Melton Hill Dam^c</i>						
Aluminum-Total	12	0.70	0.082	0.34	0.11	
Ammonia (as N)	11	0.080	0.024	0.056	0.011	
Antimony-Total	8	<0.050	<0.030	<0.043	0.0073	
Arsenic-Total	12	<0.060	<0.018	<0.049	0.0099	98
Barium-Total	8	0.046	0.024	0.037	0.0049	3.7
Beryllium-Total	8	0.0045	0.0011	0.0020	0.00079	
Biochemical oxygen demand	11	6.0	<5.0	<5.1	0.18	
Cadmium-Total	12	<0.0020	<0.0010	<0.0017	0.00027	16
Calcium-Total	8	41	32	37	2.3	
Chromium-Total	12	0.0070	<0.0036	<0.0050	0.00061	10
Cobalt-Total	8	<0.0030	<0.0020	<0.0025	0.00038	
Copper-Total	12	0.011	<0.0060	<0.0088	0.0012	0.87
Dissolved solids-Total	11	220	89	160	24	
Iron-Total	12	0.66	0.055	0.28	0.12	93
Lead-Total	12	<0.050	<0.0040	<0.028	0.011	56
Magnesium-Total	8	12	8.4	10	0.81	
Manganese-Total	12	0.24	0.017	0.087	0.045	173
Nickel-Total	12	<0.0060	<0.0036	<0.0050	0.00062	
Oil and grease	11	11	2.0	3.1	1.6	
Organic carbon-Total	11	3.5	1.8	2.4	0.29	
Phosphorus-Total	11	0.20	<0.10	<0.11	0.018	
Recoverable Phenolics-Tot.	11	<0.0020	<0.0010	<0.0011	0.00018	
Selenium-Total	8	<0.060	<0.050	<0.055	0.0038	550
Silicon-Total	7	2.3	0.80	1.6	0.37	
Silver-Total	12	<0.0060	<0.0050	<0.0054	0.00030	10
Sodium-Total	8	6.8	5.1	5.8	0.39	
Strontium-Total	7	0.14	0.094	0.11	0.012	
Sulfate(as SO ₄)	11	48	24	29	4.0	11
Suspended solids-Total	11	23	<5.0	<8.0	3.4	
Vanadium-Total	8	0.012	0.0068	0.0084	0.0011	
Zinc-Total	12	0.039	<0.0018	<0.010	0.0057	0.20
<i>White Oak Creek Headwaters^c</i>						
Aluminum-Total	11	0.61	<0.036	<0.24	0.083	
Ammonia (as N)	11	0.069	0.020	0.047	0.0088	
Antimony-Total	7	<0.050	<0.030	<0.044	0.0074	
Arsenic-Total	11	<0.060	<0.018	<0.048	0.011	96
Barium-Total	7	0.12	0.055	0.10	0.017	10

Table 46. (continued)

Parameter	Number of Samples	Concentration (mg/L)				Percent ^b DWL
		Max	Min	Av	95cc ^a	
Beryllium-Total	7	0.0021	<0.0003	<0.0014	0.00056	
Cadmium-Total	11	<0.0020	<0.0010	<0.0016	0.00030	16
Calcium-Total	7	35	15	30	5.0	
Chromium-Total	11	0.052	<0.0036	<0.0090	0.0086	18
Cobalt-Total	7	<0.0030	<0.0020	<0.0024	0.00040	
Copper-Total	11	<0.010	<0.0060	<0.0085	0.0012	0.85
Dissolved solids-Total	11	180	68	130	23	
Iron-Total	11	0.56	0.048	0.20	0.099	65
Lead-Total	11	<0.050	<0.0040	<0.026	0.012	52
Magnesium-Total	7	19	7.0	16	3.1	
Manganese-Total	11	0.11	0.0093	0.037	0.019	74
Nickel-Total	11	<0.0060	<0.0036	<0.0049	0.00068	
Organic carbon-Total	11	2.0	0.90	1.3	0.20	
Phosphorus-Total	11	0.20	0.10	0.11	0.018	
Recoverable Phenolics-Tot.	11	<0.0020	<0.0010	<0.0011	0.00018	
Selenium-Total	7	<0.060	<0.050	<0.054	0.0040	542
Silicon-Total	7	3.7	2.9	3.5	0.25	
Silver-Total	11	<0.0060	<0.0050	<0.0055	0.00031	10
Sodium-Total	7	0.59	<0.17	<0.38	0.12	
Strontium-Total	7	0.041	0.020	0.035	0.0057	
Suspended solids-Total	11	21	<5.0	<7.4	3.0	
Vanadium-Total	7	0.013	0.0053	0.010	0.0021	
Zinc-Total	11	0.032	<0.0018	<0.010	0.0054	0.20

^a95% confidence coefficient about the average of more than two samples.

^bAverage concentration as a percentage of National Primary or Secondary Drinking Water Regulation level.

^cSee Fig. 5.

Table 47. Organic surface water analysis at background locations,
January-December 1988

Parameter	Number of Samples	Concentration ($\mu\text{g/L}$)				Percent ^b DWL
		Max	Min	Av	95cc ^a	
<i>Melton Hill Dam^c</i>						
4,4'-DDD	3	<0.11	<0.10	<0.11	0.0067	
4,4'-DDE	3	<0.11	<0.10	<0.11	0.0067	
4,4'-DDT	3	<0.11	<0.10	<0.11	0.0067	
Acetone	11	15	-2.0	-9.6	1.8	
Aldrin	3	<0.060	<0.050	<0.057	0.0067	
Chlordane	3	<0.60	<0.50	<0.55	0.058	
Chlordane	3	<0.60	<0.50	<0.55	0.058	
Dieldrin	3	<0.11	<0.10	<0.11	0.0067	
Endosulfan I	3	<0.060	<0.050	<0.057	0.0067	
Endosulfan II	3	<0.11	<0.10	<0.11	0.0067	
Endosulfan sulfate	3	<0.11	<0.10	<0.11	0.0067	
Endrin	3	<0.11	<0.10	<0.11	0.0067	53
Endrin ketone	3	<0.11	<0.10	<0.11	0.0067	
Heptachlor	3	<0.060	<0.050	<0.057	0.0067	
Heptachlor epoxide	3	<0.060	<0.050	<0.057	0.0067	
Methoxychlor	3	<0.60	<0.50	<0.55	0.058	0.55
Methylene chloride	11	10	-1.0 ^d	-3.7	1.8	
PCB-1016	10	<0.60	<0.50	<0.54	0.030	
PCB-1221	10	<0.60	<0.50	<0.54	0.030	
PCB-1232	10	<0.60	<0.50	<0.54	0.030	
PCB-1242	10	<0.60	<0.50	<0.54	0.030	
PCB-1248	10	<0.60	<0.50	<0.54	0.030	
PCB-1254	10	<1.1	<0.50	<0.99	0.11	
PCB-1260	10	<1.1	<0.50	<0.99	0.11	
Toluene	11	<5.0	-1.0	-4.6	0.73	
Toxaphene	3	<1.1	<1.0	<1.1	0.067	21
alpha-BHC	3	<0.060	<0.050	<0.057	0.0067	
beta-BHC	3	<0.060	<0.050	<0.057	0.0067	
delta-BHC	3	<0.060	<0.050	<0.057	0.0067	
gamma-BHC (Lindane)	3	<0.060	<0.050	<0.057	0.0067	
<i>White Oak Creek Headwaters^c</i>						
4,4'-DDD	3	<0.11	<0.10	<0.11	0.0067	
4,4'-DDE	3	<0.11	<0.10	<0.11	0.0067	
4,4'-DDT	3	<0.11	<0.10	<0.11	0.0067	
Acetone	11	<10	-1.0	-8.5	2.0	
Aldrin	3	<0.060	<0.050	<0.057	0.0067	
Chlordane	3	<0.60	<0.50	<0.55	0.058	
Chlordane	3	<0.60	<0.50	<0.55	0.058	
Dieldrin	3	<0.11	<0.10	<0.11	0.0067	

Table 47. (continued)

Parameter	Number of Samples	Concentration ($\mu\text{g/L}$)				Percent ^b DWL
		Max	Min	Av	95cc ^a	
Endosulfan I	3	<0.060	<0.050	<0.057	0.0067	
Endosulfan II	3	<0.11	<0.10	<0.11	0.0067	
Endosulfan sulfate	3	<0.11	<0.10	<0.11	0.0067	
Endrin	3	<0.11	<0.10	<0.11	0.0067	53
Endrin ketone	3	<0.11	<0.10	<0.11	0.0067	
Heptachlor	3	<0.060	<0.050	<0.057	0.0067	
Heptachlor epoxide	3	<0.060	<0.050	<0.057	0.0067	
Methoxychlor	3	<0.60	<0.50	<0.55	0.058	0.55
Methylene chloride	11	<5.0	-0.90	-2.9	1.2	
PCB-1016	10	<0.60	<0.50	<0.54	0.030	
PCB-1221	10	<0.60	<0.50	<0.54	0.030	
PCB-1232	10	<0.60	<0.50	<0.54	0.030	
PCB-1242	10	<0.60	<0.50	<0.54	0.030	
PCB-1248	10	<0.60	<0.50	<0.54	0.030	
PCB-1254	10	<1.1	<0.50	<0.99	0.11	
PCB-1260	10	<1.1	<0.50	<0.99	0.11	
Tetrachloroethene	11	<5.0	-2.0	-4.7	0.55	
Toluene	11	<5.0	-1.0	-4.6	0.73	
Toxaphene	3	<1.1	<1.0	<1.1	0.067	21
alpha-BHC	3	<0.060	<0.050	<0.057	0.0067	
beta-BHC	3	<0.060	<0.050	<0.057	0.0067	
delta-BHC	3	<0.060	<0.050	<0.057	0.0067	
gamma-BHC (Lindane)	3	<0.060	<0.050	<0.057	0.0067	

^a95% confidence coefficient about the average of more than two samples.

^bAverage concentration as a percentage of National Primary or Secondary Drinking Water Regulation Level.

^cSee Fig. 5.

^dEstimated value below the detection limit.

Table 48. NPDES discharge point X01,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
Ag	3	<0.0060	<0.0050	<0.0053	0.00067
BOD ^c	39	<5.0	<5.0	<5.0	0
Bromodichloromethane	3	-0.0020	-0.0020	-0.0020	0
Cl	39	0.68	<0.010	<0.30	0.037
Cyanide	3	0.0030	<0.0020	<0.0023	0.00067
Cu	3	0.013	<0.010	<0.011	0.0020
DO ^d	61	13	6.7	8.9	0.34
Downstream pH ^e	13	7.7	6.5	NA ^f	NA
Fecal coliform ^{g,h}	39	130	<1.0	<4.7	6.6
Flow ⁱ	61	0.39	0.11	0.17	0.011
Hg	3	<0.00020	<0.00020	<0.00020	0
NH ₄ (as N)	39	1.0	0.020	0.13	0.068
Oil and grease	39	9.0	<2.0	<2.9	0.61
pH ^e	13	7.4	6.6	NA	NA
Phenols	3	<0.0010	<0.0010	<0.0010	0
Trichloroethylene	3	<0.0050	-0.0020	-0.0040	0.0020
TSS ^j	39	13	<5.0	<5.2	0.41
Zn	3	0.068	0.051	0.061	0.011

^aSewage treatment plant, ORNL.

^b95% confidence coefficient about the average.

^cBiochemical oxygen demand.

^dDissolved oxygen.

^eExpressed in standard units; average not applicable.

^fNA = not applicable.

^gExpressed in colonies per 100 mL.

^hGeometric mean.

ⁱMeasured in millions of gallons per day.

^jTotal suspended solids.

Table 49. NPDES discharge point X02,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
Ag	13	0.0090	<0.0050	<0.0056	0.00062
As	13	0.11	<0.060	<0.075	0.0077
Cd	13	0.0031	<0.0010	<0.0019	0.00028
Cr	13	0.014	<0.0050	<0.0077	0.0019
Cu	13	0.018	<0.010	<0.011	0.0012
Downstream pH ^c	61	8.2	6.4	NA ^d	NA
Fe	13	0.67	0.070	0.24	0.095
Flow ^e	61	0.023	0	0.0023	0.00094
Mn	13	0.081	0.010	0.025	0.010
Ni	13	0.022	<0.0050	<0.0092	0.0030
Oil and grease	13	9.0	<2.0	<2.9	1.1
Pb	13	<0.050	<0.030	<0.044	0.0050
pH ^c	61	8.8	6.2	NA	NA
Se	13	0.10	<0.050	<0.061	0.0070
SO ₄	3	2000	1200	1700	500
Temperature ^f	61	21	4.3	11	0.94
TSS ^g	13	21	<5.0	<8.5	2.3
Zn	13	0.045	<0.0080	<0.022	0.0051

^aCoal yard runoff facility, ORNL.

^b95% confidence coefficient about the average.

^cExpressed in standard units; average not applicable.

^dNA = not applicable.

^eMeasured in millions of gallons per day.

^fMeasured in degrees centigrade.

^gTotal suspended solids.

Table 50. NPDES discharge point X03,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
As	6	<0.060	<0.060	<0.060	0
Cd	6	<0.0020	<0.0010	<0.0017	0.00042
Cr	6	0.0067	<0.0050	<0.0057	0.00064
Cu	6	<0.010	<0.010	<0.010	0
Downstream pH ^c	13	7.9	6.8	NA ^d	NA
Fe	6	0.099	<0.020	<0.058	0.026
Flow ^e	4	0.039	0.035	0.038	0.0018
Ni	6	<0.0060	<0.0050	<0.0055	0.00045
Oil and grease	6	9.0	<2.0	<5.5	2.4
P	6	0.80	0.30	0.48	0.14
Pb	6	<0.050	<0.030	<0.043	0.0084
pH ^c	13	7.8	6.6	NA	NA
Temperature ^f	13	24	14	18	1.7
TOC ^g	6	6.7	2.8	4.4	1.1
TSS ^h	6	<5.0	<5.0	<5.0	0
Zn	6	0.15	0.043	0.11	0.032

^a1500 area, ORNL.

^b95% confidence coefficient about the average.

^cExpressed in standard units; average not applicable.

^dNA - not applicable.

^eMeasured in millions of gallons per day.

^fMeasured in degrees centigrade.

^gTotal organic carbon.

^hTotal suspended solids.

Table 51. NPDES discharge point X04,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
Ag	6	0.014	<0.0050	<0.0075	0.0030
As	6	<0.060	<0.060	<0.060	0
Cd	6	0.0021	<0.0010	<0.0017	0.00043
Cr	6	0.022	<0.0050	<0.0080	0.0056
Cu	6	0.012	<0.010	<0.011	0.00068
Downstream pH ^c	13	7.9	6.5	NA ^d	NA
Flow ^e	3	0.018	0.010	0.014	0.0044
Ni	6	<0.0060	<0.0050	<0.0055	0.00045
Oil and grease	6	8.0	<2.0	<3.7	2.0
P	6	0.50	0.20	0.33	0.084
Pb	6	<0.050	<0.030	<0.043	0.0084
pH ^c	13	8.1	6.1	NA	NA
Temperature ^f	13	20	12	15	1.3
TOC ^g	6	1.9	1.3	1.7	0.18
TSS ^h	6	<5.0	<5.0	<5.0	0
Zn	6	0.13	0.10	0.12	0.010

^a2000 area, ORNL.

^b95% confidence coefficient about the average.

^cExpressed in standard units; average not applicable.

^dNA = not applicable..

^eMeasured in millions of gallons per day.

^fMeasured in degrees centigrade.

^gTotal organic carbon.

^hTotal suspended solids.

Table 52. NPDES discharge point X06,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
As	6	<0.060	<0.060	<0.060	0
Cd	6	<0.0020	<0.0010	<0.0017	0.00042
Cr	6	0.023	0.0066	0.013	0.0053
Cu	6	0.13	0.026	0.065	0.032
Downstream pH ^c	13	8.1	6.6	NA ^d	NA
Flow ^e	3	0.16	0.16	0.16	0.00042
Ni	6	0.0072	<0.0050	<0.0059	0.00067
Oil and grease	6	5.0	<2.0	<2.7	0.99
Pb	6	0.086	<0.030	<0.049	0.017
pH ^c	13	7.7	6.0	NA	NA
Se	6	<0.060	<0.050	<0.057	0.0042
SO ₄	6	33	26	29	2.6
Temperature ^f	13	21	9.7	15	1.9
TOC ^g	6	5.0	3.0	4.0	0.62
TSS ^h	6	16	<5.0	<8.7	4.6
Zn	6	0.14	0.074	0.10	0.018

^a3539/40 ponds, ORNL.

^b95% confidence coefficient about the average.

^cExpressed in standard units; average not applicable.

^dNA = not applicable.

^eMeasured in millions of gallons per day.

^fMeasured in degrees centigrade.

^gTotal organic carbon.

^hTotal suspended solids.

Table 53. NPDES discharge point X07,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
Ag	6	<0.0060	<0.0050	<0.0055	0.00045
As	6	<0.060	<0.060	<0.060	0
Cd	6	<0.0020	<0.0010	<0.0017	0.00042
Cr	6	0.013	<0.0050	<0.0068	0.0026
Cu	6	0.035	<0.010	<0.017	0.0078
Downstream pH ^c	13	8.1	6.5	NA ^d	NA
Flow ^e	61	0.26	0.20	0.24	0.0028
Ni	6	<0.0060	<0.0050	<0.0055	0.00045
NO ₃	6	8.0	<5.0	<6.0	1.3
Oil and grease	6	9.0	<2.0	<3.7	2.3
Pb	6	<0.050	<0.030	<0.043	0.0084
pH ^c	13	8.5	6.0	NA	NA
SO ₄	6	310	200	240	36
Temperature ^f	13	21	7.5	14	2.1
TOC ^g	6	2.4	1.4	1.9	0.31
TSS ^h	6	<5.0	<5.0	<5.0	0
TTO ⁱ	6	0.072	<0.010	<0.041	0.022
Zn	6	0.050	<0.0080	<0.020	0.015

^aProcess waste treatment plant (3544), ORNL.

^b95% confidence coefficient about the average.

^cExpressed in standard units; average not applicable.

^dNA = not applicable.

^eMeasured in millions of gallons per day.

^fMeasured in degrees centigrade.

^gTotal organic carbon.

^hTotal suspended solids.

ⁱTotal toxic organics.

Table 54. NPDES discharge point X11,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
As	6	0.067	<0.060	<0.062	0.0023
Cd	6	0.0023	<0.0010	<0.0017	0.00046
Cr	6	0.013	<0.0060	<0.0084	0.0021
Cu	6	0.12	<0.010	<0.031	0.036
Downstream pH ^c	13	8.1	7.0	NA ^d	NA
Flow ^e	3	0.051	0.039	0.044	0.0073
Ni	6	0.018	<0.0050	<0.010	0.0048
NO ₃	13	<100	<5.0	<12	15
Oil and grease	6	6.0	<2.0	<3.2	1.5
P	6	5.1	0.90	3.1	1.4
Pb	6	<0.050	<0.030	<0.043	0.0084
pH ^c	13	8.3	6.8	NA	NA
SO ₄	13	2900	540	1500	380
Temperature ^f	13	20	14	17	1.1
TOC ^g	13	10	2.4	4.7	1.1
TSS ^h	6	78	5.0	23	23
Zn	6	0.79	0.14	0.46	0.21

^a3518 acid neutralization plant, ORNL.

^b95% confidence coefficient about the average.

^cExpressed in standard units; average not applicable.

^dNA = not applicable.

^eMeasured in millions of gallons per day.

^fMeasured in degrees centigrade.

^gTotal organic carbon.

^hTotal suspended solids.

Table 55. NPDES discharge point X13,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
Ag	3	<0.0050	<0.0050	<0.0050	0
Al	3	0.68	0.46	0.57	0.13
As	3	<0.060	<0.060	<0.060	0
BOD ^c	3	<5.0	<5.0	<5.0	0
Cd	3	<0.0020	<0.0020	<0.0020	0
Chloroform	3	<0.0050	<0.0050	<0.0050	0
Cl	13	<0.010	<0.010	<0.010	0
Conductivity ^d	3	0.70	0.36	0.48	0.22
Cr	3	0.0067	<0.0050	<0.0056	0.0011
Cu	3	<0.010	<0.010	<0.010	0
DO ^e	13	19	6.6	10	1.8
F	3	1.0	<1.0	<1.0	0
Fe	3	0.44	0.28	0.38	0.099
Flow ^f	61	3.5	0.10	0.56	0.18
Hg	3	<0.00005	<0.00005	<0.00005	0
Mn	3	0.10	0.090	0.095	0.0056
NH ₄ (as N)	3	0.060	0.031	0.050	0.019
Ni	3	<0.0060	<0.0050	<0.0053	0.00067
NO ₃	3	<5.0	<5.0	<5.0	0
Oil and grease	13	7.0	<2.0	<3.0	0.85
P	3	0.30	<0.10	<0.20	0.12
Pb	3	<0.0040	<0.0040	<0.0040	0
PCB	3	<0.00050	<0.00050	<0.00050	0
pH ^g	3	7.3	6.7	NA ^h	NA
Phenols	3	<0.0010	<0.0010	<0.0010	0
SO ₄	3	34	32	33	1.2
TDS ⁱ	3	220	140	180	47
Temperature ^j	16	16	4.1	9.6	1.6
TOC ^k	3	4.2	2.9	3.7	0.79
Trichloroethylene	3	<0.0050	<0.0050	<0.0050	0

Table 55. (continued)

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
TSS ^l	3	9.0	<5.0	<6.3	2.7
Turburbidity ^m	3	240	20	93	150
Zn	3	0.018	0.014	0.016	0.0023

^aMelton Branch, ORNL.

^b95% confidence coefficient about the average.

^cBiochemical oxygen demand.

^dExpressed in mS/cm.

^eDissolved oxygen.

^fMeasured in millions of gallons per day.

^gExpressed in standard units; average not applicable.

^hNA - not applicable.

ⁱTotal dissolved solids.

^jMeasured in degrees centigrade.

^kTotal organic carbon.

^lTotal suspended solids.

^mMeasured in Jackson turbidity units.

Table 56. NPDES discharge point X14,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
Ag	3	<0.0050	<0.0050	<0.0050	0
Al	3	1.2	0.33	0.72	0.51
As	3	<0.060	<0.060	<0.060	0
BOD	3	<5.0	<5.0	<5.0	0
Cd	3	<0.0020	<0.0020	<0.0020	0
Chloroform	3	~0.0050	~0.0040	~0.0047	0.00067
Cl	13	<0.010	<0.010	<0.010	0
Conductivity ^d	3	0.70	0.42	0.52	0.18
Cr	3	0.0063	<0.0050	<0.0054	0.00087
Cu	3	0.015	<0.010	<0.012	0.0030
DO ^e	13	13	5.1	9.6	1.2
F	3	1.1	<1.0	<1.0	0.067
Fe	3	0.88	0.14	0.51	0.43
Flow ^f	61	15	3.0	5.5	0.61
Hg	3	0.00010	0.00008	0.000093	0.000013
Mn	3	0.058	0.021	0.045	0.024
NH ₄ (as N)	3	0.070	0.020	0.041	0.030
Ni	3	0.0069	<0.0050	<0.0060	0.0011
NO ₃	3	<5.0	<5.0	<5.0	0
Oil and grease	13	14	<2.0	<3.1	1.8
P	3	0.40	<0.10	<0.27	0.18
Pb	3	<0.0040	<0.0040	<0.0040	0
PCB	3	<0.00050	<0.00050	<0.00050	0
pH ^g	3	8.3	7.4	NA ^h	NA
Phenols	3	<0.0010	<0.0010	<0.0010	0
SO ₄	3	66	47	59	12
TDS ⁱ	3	280	170	240	67
Temperature ^j	16	19	9.4	14	1.3
TOC ^k	3	2.9	2.1	2.6	0.50
Trichloroethylene	3	<0.0050	<0.0050	<0.0050	0

Table 56. (continued)

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
TSS ^l	3	17	6.0	11	6.6
Turbidity ^m	3	28	5.0	14	14
Zn	3	0.068	0.049	0.060	0.011

^aWhite Oak Creek, ORNL.

^b95% confidence coefficient about the average.

^cBiochemical oxygen demand.

^dExpressed in mS/cm.

^eDissolved oxygen.

^fMeasured in millions of gallons per day.

^gExpressed in standard units; average not applicable.

^hNA = not applicable.

ⁱTotal dissolved solids.

^jMeasured in degrees centigrade.

^kTotal organic carbon.

^lTotal suspended solids.

^mMeasured in Jackson turbidity units.

Table 57. NPDES discharge point X15,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
Ag	3	<0.0050	<0.0050	<0.0050	0
Al	3	1.0	0.51	0.76	0.31
As	3	<0.060	<0.060	<0.060	0
BOD ^c	3	<5.0	<5.0	<5.0	0
Cd	3	<0.0020	<0.0020	<0.0020	0
Chloroform	3	<0.0050	-0.0020	-0.0030	0.0020
Cl	13	<0.010	<0.010	<0.010	0
Conductivity ^d	3	0.80	0.39	0.53	0.27
Cr	3	0.015	0.012	0.014	0.0016
Cu	3	0.013	<0.010	<0.011	0.0020
DO ^e	13	16	6.5	10	1.6
F	3	1.1	<1.0	<1.0	0.067
Fe	3	0.72	0.52	0.62	0.12
Flow ^f	61	16	3.4	6.1	0.70
Hg	3	0.00005	<0.00005	<0.00005	0
Mn	3	0.054	0.044	0.048	0.0058
NH ⁴ (as N)	3	0.060	0.020	0.037	0.024
Ni	3	<0.0060	<0.0050	<0.0053	0.00067
NO ³	3	<5.0	<5.0	<5.0	0
Oil and grease	13	4.0	<2.0	<2.4	0.43
P	3	0.30	0.20	0.27	0.067
Pb	3	<0.0040	<0.0040	<0.0040	0
PCB	3	<0.0050	<0.00050	<0.0020	0.0030
pH ^g	3	8.6	6.5	NA ^h	NA
SO ⁴	3	63	58	60	2.9
TDS ⁱ	3	270	200	230	45
Temperature ^j	16	19	4.9	12	1.9
TOC ^k	3	3.4	2.5	3.1	0.57
Trichloroethylene	3	<0.0050	<0.0050	<0.0050	0

Table 57. (continued)

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
TSS ^l	3	17	<5.0	<11	7.0
Turbidity ^m	3	40	20	28	12
Zn	3	0.037	0.030	0.032	0.0048

^aWhite Oak Dam, ORNL.

^b95% confidence coefficient about the average.

^cBiochemical oxygen demand.

^dExpressed in mS/cm.

^eDissolved oxygen.

^fMeasured in millions of gallons per day.

^gExpressed in standard units; average not applicable.

^hNA = not applicable.

ⁱTotal dissolved solids.

^jMeasured in degrees centigrade.

^kTotal organic carbon.

^lTotal suspended solids.

^mMeasured in Jackson turbidity units.

Table 58. NPDES miscellaneous source VC7002,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
BOD ^c	3	5.0	5.0	5.0	0
Fecal coliform ^d	3	600	45	420	370
Oil and grease	3	6.0	2.0	3.3	2.7
pH ^e	4	7.6	6.5	NA ^f	NA
Phenols	3	0.0010	0.0010	0.0010	0
TSS ^g	3	9.0	5.0	6.3	2.7

^aVehicle and equipment cleaning facility, Building 7002.

^b95% confidence and coefficient about the average.

^cBiochemical oxygen demand.

^dExpressed in colonies per 100 mL.

^eExpressed in standard units; average not applicable.

^fNA - not applicable.

^gTotal suspended solids.

Table 59. NPDES cooling towers,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
Cl	17	2.7	<0.010	<0.20	0.32
Cr	17	0.023	0.0050	0.011	0.0026
Cu	17	0.36	<0.010	<0.090	0.048
Downstream pH ^c	14	7.8	7.0	NA ^d	NA
Flow ^e	17	0.19	0.0010	0.026	0.029
pH ^c	17	8.3	7.4	NA	NA
Temperature ^f	17	33	9.1	18	3.2
Zn	17	1.6	0.050	0.45	0.18

^aORNL.

^b95% confidence coefficient about the average.

^cExpressed in standard units; average not applicable.

^dNA = not applicable.

^eMeasured in millions of gallons per day.

^fMeasured in degrees centigrade.

Table 60. NPDES miscellaneous outfalls,
October-December 1988

Parameter	Concentration (mg/L)
<i>EF7002^a</i>	
Flow ^b	
Oil and grease	2.0
pH ^c	6.8
Temperature ^d	28
<i>SP2519^e</i>	
Flow	0.000094
Oil and grease	
pH	9.7
Temperature	28

^aVehicle and equipment maintenance facility,
Building 7002.

^bMeasured in millions of gallons per day.

^cExpressed in standard units.

^dMeasured in degrees centigrade.

^eCentral steam plant, Building 2519.

Table 61. NPDES discharge point Category II outfalls,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
Downstream pH ^c	30	8.3	7.1	NA ^d	NA
Flow ^e	30	0.10	0.00012	0.016	0.0091
Oil and grease	30	6.0	<2.0	<2.4	0.34
pH ^c	30	8.3	6.0	NA	NA
Temperature ^f	30	65	13	25	4.9
TSS ^g	30	32	<5.0	<6.6	1.9

^aORNL.

^b95% confidence coefficient about the average.

^cExpressed in standard units; average not applicable.

^dNA - not applicable.

^eMeasured in millions of gallons per day.

^fMeasured in degrees centigrade.

^gTotal suspended solids.

Table 62. NPDES discharge point category III outfalls,^a October-December 1988

Parameter	Number of samples	Concentration (mg/L)			95% cc ^b
		Max	Min	Av	
Flow ^c	14	4.0	0.0029	0.79	0.69
pH ^d	15	7.9	5.0	NA ^e	NA

^aORNL.

^b95% confidence coefficient about the average.

^cMeasured in millions of gallons per day.

^dStandard units; average not applicable.

^eNA - not applicable.

Table 63. NPDES noncompliances, October 1988

Station	Parameter	Observation	Permit limit
Category II Outfall 217	Sheen on water surface; floating solids	Sheen, floating solids not acceptable	Visible sheen; visible solids
Category III Outfall 313	Foam in effluent	Foamy discharge not acceptable	Foam in effluent
Category III Outfall 304	Foam in effluent	Foamy discharge not acceptable	Foam in effluent

Table 64. NPDES noncompliances, November 1988

Station	Parameter	Concentration (mg/L)		Permit limit (mg/L)
		Daily	Maximum	
Category I Outfall 102	Total suspended solids		175	50
Category I Outfall 102	Oil and grease		20	15
Category I Outfall 111	Total suspended solids		51	50
Category I Outfall 113	Oil and grease		18	15
Vehicle cleaning (VC7002)	Fecal coliform ^a		>600 ^b	200 ^b
Cooling systems (CS2000)	Chlorine		0.48	0.2
Cooling systems (CS3525W)	Zinc		1.6	1.0
Cooling systems (CS6000)	Chlorine		2.7	0.2
Sewage treatment Plant (X01)	Chlorine		0.68	0.5
Steam plant (SP2519)	pH		9.7 ^c	9.0 ^c

^aDaily average.

^bMeasured in colonies per 100 mL.

^cMeasured in standard units.

Table 65. NPDES noncompliances, December 1988

Station	Parameter	Concentration (mg/L)		Permit limit (mg/L)
		Daily	Maximum	
Category I Outfall 109	Oil and grease		16	15
Category I Outfall 109	Total suspended solids		226	50
Category I Outfall 114	Total suspended solids		699	50
Category I Outfall 116	Total suspended solids		447	50
Category I Outfall 164	Total suspended solids		95	50
Category I Outfall 168	Total suspended solids		622	50
Category I Outfall 172	Total suspended solids		64	50
Vehicle Cleaning (VC7002)	Fecal coliform ^a		>600 ^b	200 ^b

^aDaily average.

^bMeasured in colonies per 100 mL.

Foam was also detected in the effluent discharge from Category III, pipe 304, on October 19. The foam was visible only in trace amounts upon revisit on October 24. An investigation is currently in progress by EMC personnel to determine the source of the discharge.

3.2.2 November 1988

The noncompliances at outfall 102 on November 10 were attributed to the suspended solids and oil and grease in runoff from the nonradiological waste treatment plant (NRWTP) construction site. EMC will contact NRWTP personnel to ensure the protection of Category I drains at the NRWTP site.

The total suspended solids (TSS) violations on November 10 at outfall 111 are thought to be only the results of normal road surface particulate accumulation flushed away during a rain.

The noncompliances at outfall 113 on November 10 were attributed to oil and grease in the runoff from the steam distribution system construction site. Measures have been implemented to protect the Category I drain in that area.

The suspected cause for the fecal coliform noncompliance at the vehicle cleaning facility (VC7002) on November 17 was infiltration from underground sanitary sewer piping. EMC is currently conducting dye tests in an attempt to verify this.

The cause of the CS2000 chlorine violation on November 18 is still being determined by ORNL personnel.

No cause has been determined for the November 18 zinc noncompliance at CS3525W. ORNL personnel are currently investigating the incident.

The CS6000 chlorine violation on November 18 was caused by the improper electrical connection of a pump associated with chlorine feed. The problem has been corrected.

The chlorine noncompliance at the sewage treatment plant (X01) on November 22 was attributed to an upward chlorine concentration excursion in the X01 effluent. No operational problems or unusual conditions occurred. ORNL is preparing plans to install an ozone disinfection unit at X01 to replace the existing chlorinator in the event that NPDES limits cannot be met in the future with existing equipment.

The pH violation at the steam plant (SP2519) on November 28 was attributed to the high water pH that must be maintained in the boilers. ORNL personnel are currently characterizing the in-stream effect of this discharge to determine an appropriate treatment mechanism.

3.2.3 December 1988

Construction work in the area was the cause of the outfall 109 oil and grease violation and the total suspended solids violations at outfalls 109, 114, 116, 164, 168, and 172 on December 21. EMC has advised construction workers in additional environmental protection measures.

Sanitary sewer pipeline infiltration was the suspected cause of the fecal coliform noncompliance at the vehicle cleaning facility on December 21. EMC has conducted dye tests to investigate the situation.

3.3 POLYCHLORINATED BIPHENYLS (PCBs) IN THE AQUATIC ENVIRONMENT

Water and sediment samples were collected from various locations along WOC, MB, and the Clinch River (CR) to determine PCB concentrations in these areas (see Fig. 8). This was done to comply with the Clean Water Act (CWA) and is an integral part of ORNL's NPDES activities. Sediment samples were collected and analyzed in addition to water because PCBs are relatively insoluble in water and tend to accumulate in stream sediments. Water sampling is being performed quarterly and sediment sampling is being performed semiannually.

Water from the building areas containing either equipment or storage drums with PCB concentrations >500 ppm were sampled at five locations along NWT and WOC. In addition, water samples were taken on MB, WOL near WOD, and the CR. Sediment samples were taken from WOC, MB, WOD, and the CR.

No regulatory guidelines currently exist for PCB concentrations in water or stream sediment. The results from these samples will be used to help detect sources of PCB contamination and provide a history of PCB concentrations in the ORNL area.

The concentrations of PCBs in water during October 1988 were below the analytical detection limit at all sampling sites. Analyses were performed for seven aroclors of PCBs, all of which were below their detection limit. The detection limit for PCB aroclors 1016, 1221, 1232, 1242, and 1248 is 0.6 $\mu\text{g/L}$. The detection limit for PCB aroclors 1254 and 1260 is 1.2 $\mu\text{g/L}$.

Table 66 contains a summary of the sediment sample results. All samples had results below their detection limits. Concentrations of aroclor 1254 were below the detection limits but were estimated at WOC 6, WOC 10, WOD 13.

3.4 MERCURY IN THE AQUATIC ENVIRONMENT

During 1988, 157 surface water samples were analyzed for mercury content from 73 locations in the ORNL area. This was done to comply with the Clean Water Act and ORNL's National Pollutant Discharge Elimination System permit. The primary purpose of this effort is to identify and locate all sources of mercury contamination in ORNL discharges to the aquatic environment. Follow up actions will involve reducing any mercury discharges.

Currently, effluents from the laboratories at ORNL are treated and subsequently monitored before discharging into the receiving streams at permissible concentrations. In previous years, before stringent regulations, some contaminants reached various streams, primarily as the result of accidental spills or leakages. The majority of the mercury spills occurred from 1954 through 1963, during a period when ORNL was involved with the OREX and METALLEX separation processes. Most of this activity was in and around buildings 4501, 4505, and 3592 (Figs. 9 and 10). These processes are no longer in operation at ORNL.

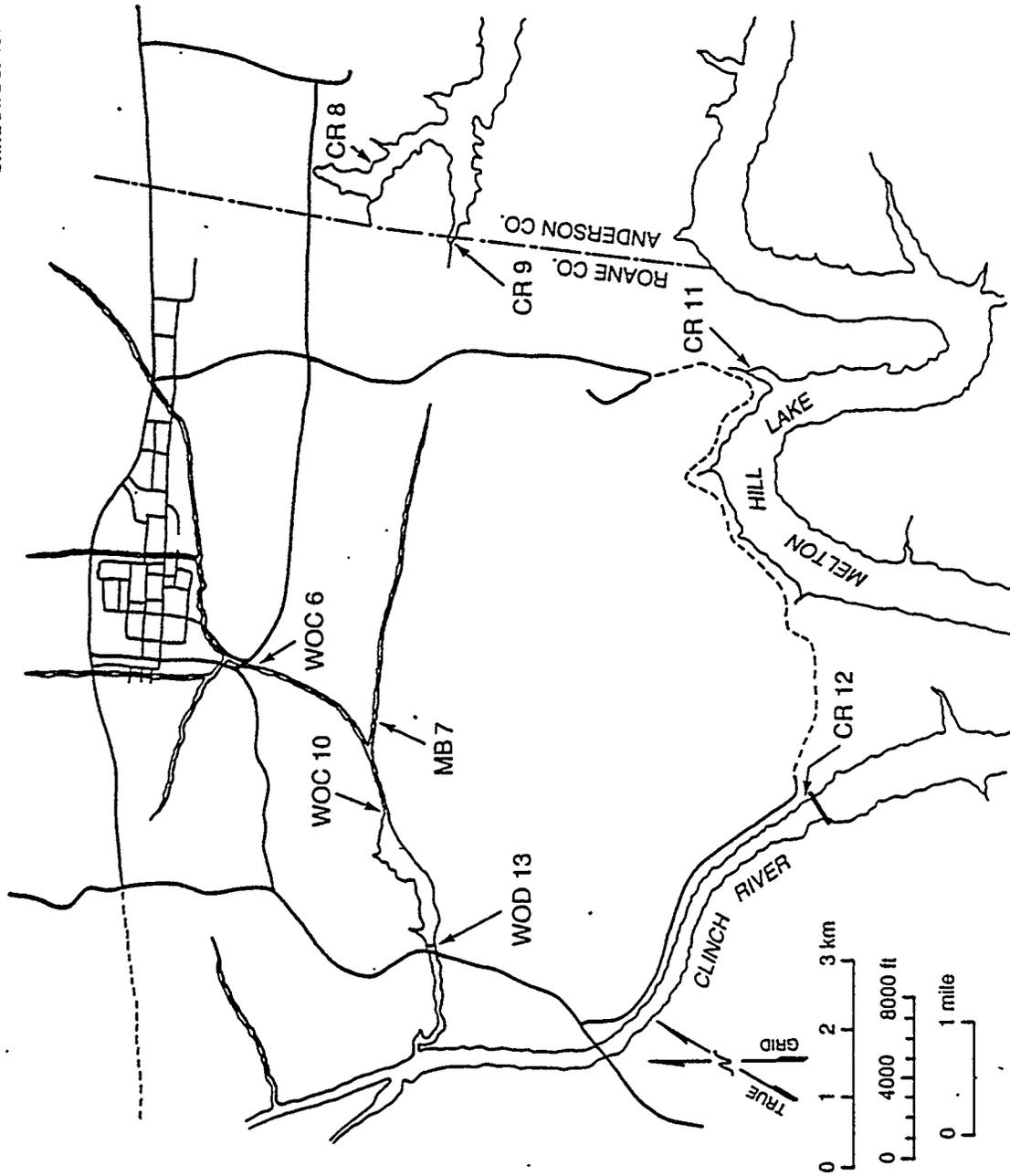


Fig. 8. Location map of PCB sampling points.

Table 66. PCB concentrations in sediment, October 1988

Location ^a	Analysis	Number of samples	Concentration ($\mu\text{g}/\text{kg}$)			95% cc ^b
			Max	Min	Av	
WOC 6	Aroclor-1016	2	<400	<400	<400	0
	Aroclor-1221	2	<400	<400	<400	0
	Aroclor-1232	2	<400	<400	<400	0
	Aroclor-1242	2	<400	<400	<400	0
	Aroclor-1248	2	<400	<400	<400	0
	Aroclor-1254	2	^c ~260	~200	~230	61
	Aroclor-1260	2	<800	<800	<800	0
WOC 10	Aroclor-1016	2	<80	<80	<80	0
	Aroclor-1221	2	<80	<80	<80	0
	Aroclor-1232	2	<80	<80	<80	0
	Aroclor-1242	2	<80	<80	<80	0
	Aroclor-1248	2	<80	<80	<80	0
	Aroclor-1254	2	~77	~50	~64	27
	Aroclor-1260	2	<160	<160	<160	0
WOC 14	Aroclor-1016	2	<160	<80	<120	80
	Aroclor-1221	2	<160	<80	<120	80
	Aroclor-1232	2	<160	<80	<120	80
	Aroclor-1242	2	<160	<80	<120	80
	Aroclor-1248	2	<160	<80	<120	80
	Aroclor-1254	2	<320	<160	<240	160
	Aroclor-1260	2	<320	<160	<240	160
WOD 13	Aroclor-1016	2	<80	<80	<80	0
	Aroclor-1221	2	<80	<80	<80	0
	Aroclor-1232	2	<80	<80	<80	0
	Aroclor-1242	2	<80	<80	<80	0
	Aroclor-1248	2	<80	<80	<80	0
	Aroclor-1254	2	~21	~19	~20	2.0
	Aroclor-1260	2	<160	<160	<160	0
MB 7	Aroclor-1016	2	<400	<80	<240	320
	Aroclor-1221	2	<400	<80	<240	320
	Aroclor-1232	2	<400	<80	<240	320
	Aroclor-1242	2	<400	<80	<240	320
	Aroclor-1248	2	<400	<80	<240	320
	Aroclor-1254	2	<800	<160	<480	640
	Aroclor-1260	2	<800	<160	<480	640

Table 66. (continued)

Location ^a	Analysis	Number of samples	Concentration ($\mu\text{g}/\text{kg}$)			95% cc ^b
			Max	Min	Av	
CR 8	Aroclor-1016	2	<400	<80	<240	320
	Aroclor-1221	2	<400	<80	<240	320
	Aroclor-1232	2	<400	<80	<240	320
	Aroclor-1242	2	<400	<80	<240	320
	Aroclor-1248	2	<400	<80	<240	320
	Aroclor-1254	2	<800	<160	<480	640
	Aroclor-1260	2	<800	<160	<480	640
CR 9	Aroclor-1016	2	<80	<80	<80	0
	Aroclor-1221	2	<80	<80	<80	0
	Aroclor-1232	2	<80	<80	<80	0
	Aroclor-1242	2	<80	<80	<80	0
	Aroclor-1248	2	<80	<80	<80	0
	Aroclor-1254	2	<160	<160	<160	0
	Aroclor-1260	2	<160	<160	<160	0
CR 11	Aroclor-1016	2	<80	<80	<80	0
	Aroclor-1221	2	<80	<80	<80	0
	Aroclor-1232	2	<80	<80	<80	0
	Aroclor-1242	2	<80	<80	<80	0
	Aroclor-1248	2	<80	<80	<80	0
	Aroclor-1254	2	<160	<160	<160	0
	Aroclor-1260	2	<160	<160	<160	0
CR 12	Aroclor-1016	2	<80	<80	<80	0
	Aroclor-1221	2	<80	<80	<80	0
	Aroclor-1232	2	<80	<80	<80	0
	Aroclor-1242	2	<80	<80	<80	0
	Aroclor-1248	2	<80	<80	<80	0
	Aroclor-1254	2	<160	<160	<160	0
	Aroclor-1260	2	<160	<160	<160	0

^aSee Fig. 8.

^b95% confidence coefficient about the average of more than two samples.

^c- means that the value was below the detection limit but was believed to be present. It is an estimated value.

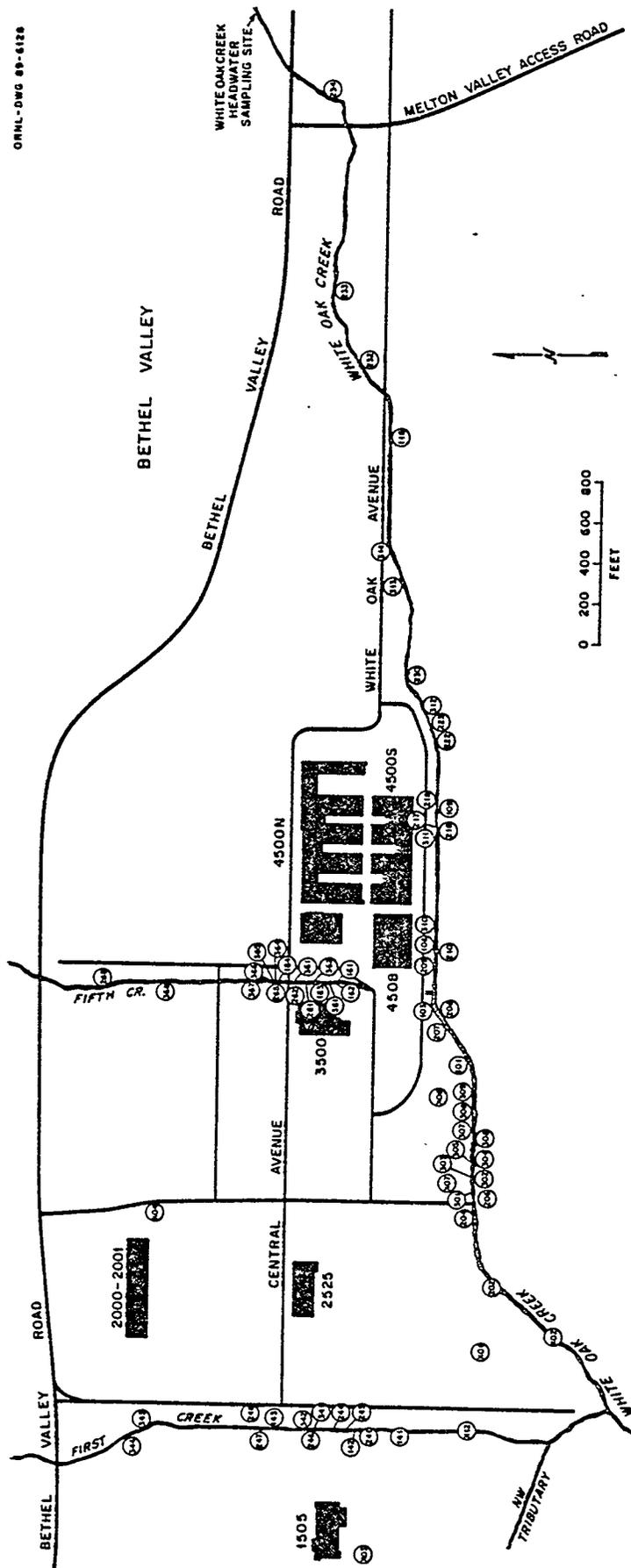


Fig. 9. Location map of mercury sampling points around ORNL.

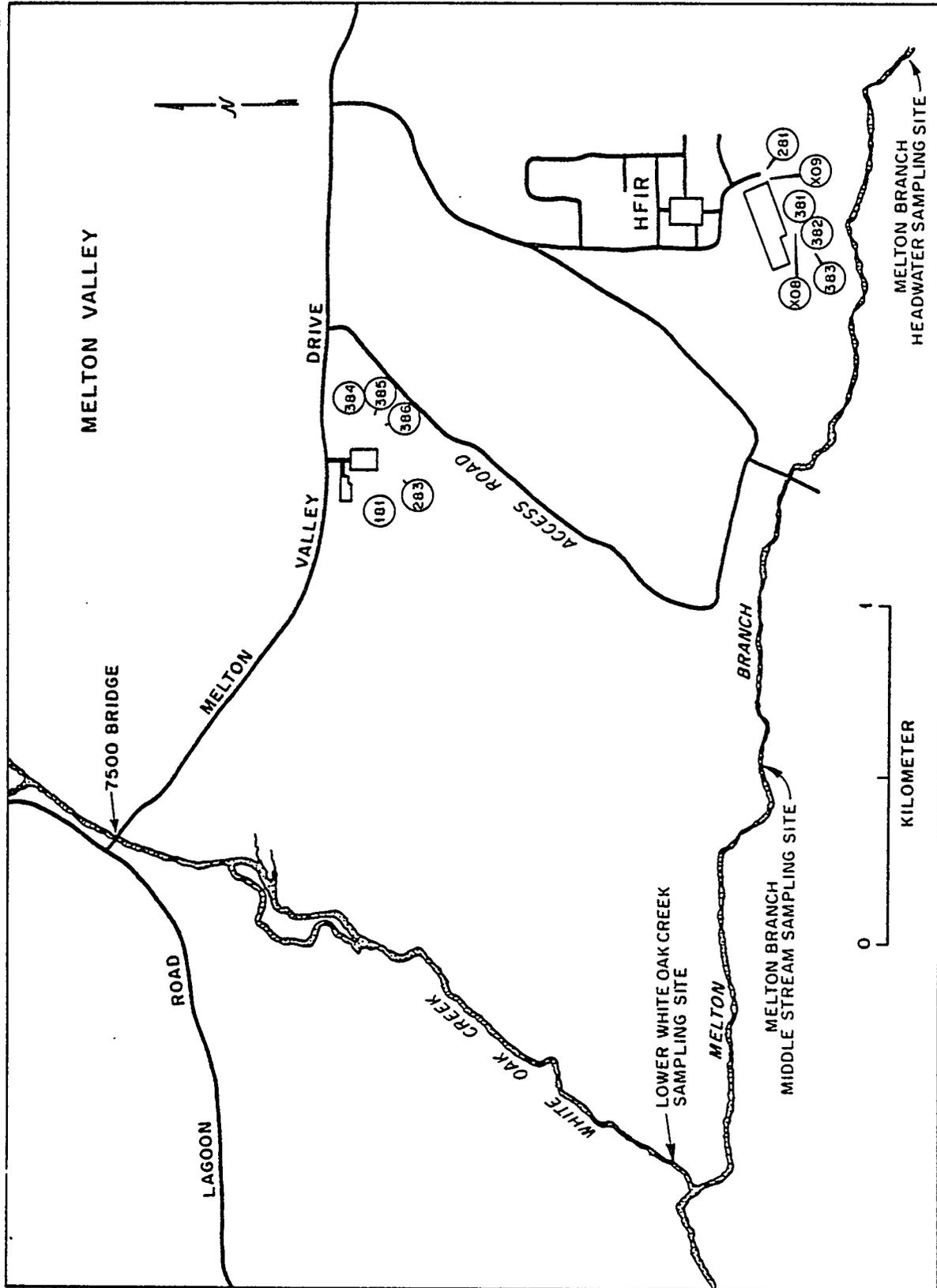


Fig. 10. Location map of mercury sampling points remote from ORNL.

Table 67 shows the maximum, minimum, and average values for the period of January through December 1988. A 95% confidence coefficient about the average is included. The EPA primary drinking water standard for mercury is 2 µg/L (ppb). The last column reports the average concentration as a percentage of this regulatory limit. During 1988, stations 309 and 367 had the highest concentrations of mercury. Station 309, having an average concentration of 1.1 µg/L, is located at a waste discharge from the 4500-S Research Complex holding basins. Station 367, having an average concentration of 1.5 µg/L, is located near the isotopes area storage and service Building 3036. The average concentration over all 73 locations was less than 0.21 µg/L during 1988, which is 10% of the regulatory level.

3.5 GROUNDWATER

Groundwater in waste area groupings (WAGs) 1 and 6 is monitored in order to comply with Federal Regulation 40 CFR, Part 265 and Tennessee's Hazardous Waste Management Rule 1200-1-11.05 for interim status facilities. This monitoring is also necessary to meet data needs for remediation activities. WAGs are geographically contiguous and/or hydrologically defined areas, and each WAG contains small, distinct drainage areas within which similar contaminants may have been introduced. A WAG may contain one or more solid waste management units (SWMUs).

WAG 1 consists of an area covering much of the ORNL main site (Fig. 11). It contains 99 solid waste management units (tanks, ponds, waste treatment facilities, leak sites, spill sites, landfills) listed by EPA in the definition of a SWMU. WAG 6 is located about 1.5 km southwest of the ORNL main site (Fig. 11). It consists of three SWMUs: (1) solid waste storage area 6 (SWSA 6), (2) the emergency waste basin; and (3) the explosives detonation trench. SWSA 6 was opened for limited disposal in 1969, began full-scale operation in 1973, and is still active. In the course of its operation, SWSA 6 has received a broad spectrum of low-level waste materials, including radioactive and chemical hazardous wastes. The emergency waste basin was constructed for the purpose of providing storage of waste that could not be released from ORNL to White Oak Creek. The basin has not been used since its construction was completed in 1962. The explosives detonation trench is used for explosive and shock-sensitive chemicals requiring disposal.

The wells in the WAGs are divided into three types: (1) upgradient wells, which are intended to provide reference information; (2) perimeter wells, which are intended to serve as downgradient boundary wells; and (3) internal site-characterization wells, which provide information about conditions within the site. Data from WAG 6 include all three types of wells, and data from WAG 1 include only upgradient and perimeter wells.

Data summaries for WAG 1 for the sampling period ending during the fourth quarter of 1988 are presented in Table 68. Analyses for which no results were detected in any of the wells in the WAG were excluded from the summary tables. Table 69 is a summary of the wells in WAG 1, where one of the primary drinking water standards was exceeded. Similar tables are given for WAG 6 (Tables 70 and 71). EPA guidelines require, for each well, four measurements of conductivity, pH,

Table 67. Mercury concentrations in ORNL area surface water,
January-December 1988

Station ^a	Number of samples	Concentration ($\mu\text{g/L}$)			95% cc ^b	Percent DWL ^c
		Max	Min	Av		
101	3	0.20	0.20	0.20	0	10
103	3	0.20	0.20	0.20	0	10
106	6	0.30	<0.10	<0.18	0.080	9.2
116	3	0.10	0.10	0.10	0	5.0
143	6	<0.10	<0.050	<0.075	0.022	3.8
162	3	0.10	0.10	0.10	0	5.0
163	3	0.10	0.10	0.10	0	5.0
164	3	0.20	0.10	0.13	0.067	6.7
181	6	0.20	<0.050	<0.092	0.048	4.6
202	6	0.30	0.10	0.18	0.061	9.2
204	6	0.20	<0.10	<0.15	0.045	7.5
206	3	0.20	0.20	0.20	0	10
207	6	0.20	0.10	0.17	0.042	8.3
208	3	0.20	0.20	0.20	0	10
209	3	0.20	0.20	0.20	0	10
217	6	0.20	<0.10	<0.12	0.033	5.8
218	6	<0.10	<0.050	<0.075	0.022	3.8
222	3	0.20	0.10	0.13	0.067	6.7
232	3	0.10	0.10	0.10	0	5.0
241	3	0.10	0.10	0.10	0	5.0
243	3	0.10	0.10	0.10	0	5.0
244	3	0.10	0.10	0.10	0	5.0
246	3	0.10	0.10	0.10	0	5.0
247	6	0.20	<0.10	<0.15	0.045	7.5
248	6	0.20	<0.10	<0.15	0.045	7.5
261	3	0.30	0.10	0.17	0.13	8.3
262	6	<0.10	<0.050	<0.075	0.022	3.8
265	6	<0.10	<0.050	<0.075	0.022	3.8
268	6	<0.10	<0.050	<0.075	0.022	3.8
281	6	<0.10	<0.050	<0.075	0.022	3.8
301	6	0.10	0.10	0.10	0	5.0
302	6	0.30	<0.10	<0.20	0.089	10
303	3	0.30	0.20	0.27	0.067	13
304	6	0.20	0.10	0.15	0.045	7.5
305	6	0.30	<0.10	<0.20	0.089	10
306	3	0.20	0.20	0.20	0	10
307	3	0.10	0.10	0.10	0	5.0
308	3	0.10	0.10	0.10	0	5.0
309	6	2.2	0.10	1.1	0.90	55
310	6	0.20	<0.10	<0.15	0.045	7.5
311	6	<0.10	<0.050	<0.083	0.021	4.2

Table 67. (continued)

Station ^a	Number of samples	Concentration ($\mu\text{g/L}$)			95% cc ^b	Percent DWL ^c
		Max	Min	Av		
313	6	0.20	<0.10	<0.15	0.045	7.5
314	6	0.20	<0.10	<0.12	0.033	5.8
341	6	0.50	0.20	0.37	0.12	18
343	6	<0.10	<0.050	<0.075	0.022	3.8
361	3	0.10	0.10	0.10	0	5.0
362	3	0.10	0.10	0.10	0	5.0
363	6	0.30	<0.050	<0.11	0.079	5.4
364	3	0.10	0.10	0.10	0	5.0
367	6	2.2	1.1	1.5	0.35	76
368	6	0.40	<0.050	<0.14	0.10	7.1
381	6	<0.10	<0.050	<0.075	0.022	3.8
382	6	<0.10	<0.050	<0.075	0.022	3.8
384	6	<0.10	<0.050	<0.075	0.022	3.8
386	6	<0.10	<0.050	<0.075	0.022	3.8
750	6	0.20	0.10	0.15	0.045	7.5
FLU	6	0.40	0.20	0.30	0.089	15
HDW	3	0.10	0.10	0.10	0	5.0
LCS	3	0.20	0.10	0.17	0.067	8.3
MBS	6	<0.10	<0.050	<0.075	0.022	3.8
MHD	5	<0.10	<0.050	<0.070	0.024	3.5
MHO	1	<0.10	<0.10	<0.10	0	5.0
WOD	6	<0.10	<0.050	<0.075	0.022	3.8
X01	8	<0.10	<0.050	<0.081	0.018	4.1
X02	6	0.30	<0.10	<0.20	0.089	10
X03	6	0.20	0.10	0.15	0.045	7.5
X04	6	0.50	0.10	0.33	0.15	17
X06	6	0.30	<0.10	<0.17	0.067	8.3
X07	6	<0.10	<0.050	<0.083	0.021	4.2
X08	4	0.10	<0.050	<0.063	0.025	3.1
X09	6	<0.10	<0.050	<0.075	0.022	3.8
X11	3	0.30	0.30	0.30	0	15
X12	6	<0.10	<0.050	<0.075	0.022	3.8
Overall summary 157		2.2	<0.050	<0.21	0.058	10

^aSee Figs. 9 and 10.

^b95% confidence coefficient about the average of more than two samples.

^cAverage concentration as a percentage of National Primary Drinking Water Regulation level (2 $\mu\text{g/L}$).

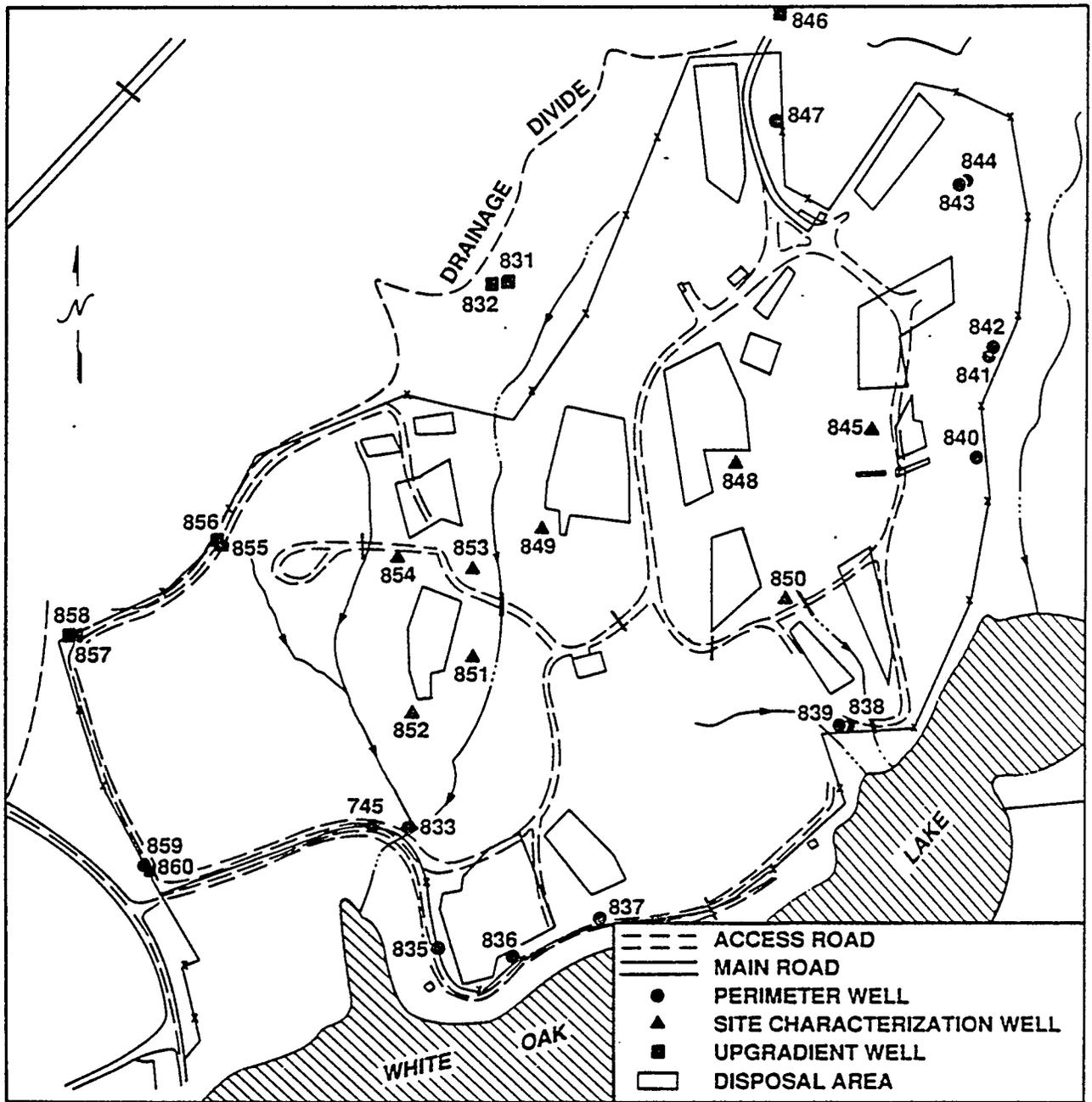


Fig. 11. Location map of ORNL waste area groupings.

Table 68. WAG 1 groundwater summary statistics, October-December 1988

Parameter	Number of samples	Min	Value qualifier ^a	Av	Max	Value qualifier ^a
<i>Perimeter wells^b</i>						
Anions (mg/L)						
Chloride	17	5.9	U	28	79	
Fluoride	17	1.0	U	1.2	3.8	
Nitrate (as N)	17	0.050	U	0.53	1.1	
Sulfate(as SO ₄)	17	5.0	U	68	250	
Field measurements						
Conductivity(mS/cm)	119	0.24		0.63	1.1	
Temperature(°C)	119	10		15	32	
pH(standard units)	119	6.7		7.4	9.2	
Metals (mg/L)						
Aluminum, total	17	0.095		0.53	2.1	
Arsenic, total	17	0.010	U	0.012	0.050	
Beryllium, total	17	0.00030	U	0.0009	0.0030	
Boron, total	17	0.080	U.	0.18	0.77	
Calcium, total	17	1.2		98	200	
Cobalt, total	17	0.0030	U	0.0030	0.0034	
Iron, total	17	0.050		2.3	15	
Magnesium, total	17	0.43		16	26	
Manganese, total	17	0.010	U	1.2	6.5	

Table 68. (continued)

Parameter	Number of samples	Value			Max	Value Qualifier ^a
		Min	Value Qualifier ^a	Av		
<i>Perimeter wells (continued)</i>						
Nickel, total	17	0.0050	U	0.0067	0.026	
Silicon, total	17	3.4		5.1	6.9	
Sodium, total	17	3.5		42	260	
Strontium, total	17	0.056		0.64	2.5	
Titanium, total	17	0.020	U	0.022	0.045	
Vanadium, total	17	0.0040	U	0.010	0.014	
Zinc, total	17	0.0080	U	0.029	0.37	
Miscellaneous						
Fecal Coliform(col./100mL)	17	1.0	U	1.2	3.0	
Turbidity(NTU)	17	0.18		9.1	55	
Radioactivity measurements (Bq/L)						
⁶⁰ Co	17	-0.22		0.021	0.24	
¹³⁷ Cs	17	-0.14		0.037	0.22	
Gross alpha	17	0		0.58	8.6	
Gross beta	17	0		39	660	
Radioactive strontium, total ^c	17	0.020		17	280	
Radium, total	17	0		0.032	0.090	
Tritium	17	-16		190	2000	

Table 68. (continued)

Parameter	Number of samples	Min	Value Qualifier ^a	AV	Max	Value Qualifier ^a
<i>Perimeter wells (continued)</i>						
Extractable organics (mg/L)						
Organic carbon, total	68	0.60		1.7	4.4	
Organic halides, total	75	0.00090		0.023	0.16	
<i>Upgradient wells^b</i>						
Anions (mg/L)						
Chloride	6	2.9		8.3	18	
Fluoride	6	1.0	U	1.0	1.0	U
Nitrate (as N)	6	0.50	U	0.80	2.3	
Sulfate(as SO ₄)	6	5.3		23	37	
Field measurements						
Conductivity(mS/cm)	42	0.33		0.47	0.59	
Temperature(°C)	42	10		14	17	
pH(standard units)	42	7.0		7.5	8.2	

Table 68. (continued)

Parameter	Number of samples	Min	Value Qualifier ^a	Av	Max	Value Qualifier ^a
<i>Upgradient Wells (continued)</i>						
Metals (mg/L)						
Aluminum, total	6	0.26		0.85	2.1	
Arsenic, total	6	0.010	U	0.010	0.010	U
Beryllium, total	6	0.00030	U	0.0017	0.0028	
Boron, total	6	0.080	U	0.14	0.31	
Calcium, total	6	44		82	130	
Cobalt, total	6	0.0030	U	0.0030	0.0030	U
Iron, total	6	0.080		0.57	1.4	
Magnesium, total	6	10		25	29	
Manganese, total	6	0.010		0.040	0.060	
Nickel, total	6	0.0050	U	0.0062	0.0091	
Silicon, total	6	3.6		5.7	6.8	
Sodium, total	6	4.0		13	26	
Strontium, total	6	0.13		0.70	1.7	
Titanium, total	6	0.020		0.028	0.056	
Vanadium, total	6	0.0084		0.013	0.016	
Zinc, total	6	0.0080	U	0.0088	0.013	
Miscellaneous						
Fecal coliform(col./100mL)	6	1.0	U	1.0	1.0	U
Turbidity(NTU)	6	0.33		3.6	9.3	

Table 68. (continued)

Parameter	Number of samples	Min	Value Qualifier ^a	Av	Max	Value Qualifier ^a
<i>Upgradient Wells (continued)</i>						
Radioactivity measurements (Bq/L)						
⁶⁰ Co	6	-0.18		0.0067	0.15	
¹³⁷ Cs	6	-0.080		-0.0050	0.060	
Gross alpha	6	0		0.052	0.17	
Gross beta	6	0		0.065	0.18	
Radioactive strontium, total ^c	6	-0.050		0.10	0.25	
Radium, total	6	0.010		0.038	0.080	
Tritium	6	-24		16	81	
Extractable organics (mg/L)						
Organic carbon, total	24	0.80		1.1	1.3	
Organic halides, total	24	0.0050	U	0.015	0.094	

^aOrganics: U=undetected; B=present in blank; J=below detection limit, but estimated; E=concentration exceeds the calibration range of the instrument.

Inorganics: U=undetected; B=value < contract-required detection limit > Instrument detection limit; E=value is estimated because of the presence of interference.

^bSee Fig. 11.

^cRadioactive strontium, total (⁸⁹Sr + ⁹⁰Sr).

Table 69. Groundwater sample analyses from monitoring wells in WAG 1, October-December 1988, whose values exceeded allowable concentrations under the primary drinking water standards

Well identifier	Parameter	Concentration	Primary limit ^{a,b}	Units of measurement
<i>Perimeter wells^c</i>				
811	Arsenic, total	0.050	0.050	mg/L
822	Fecal coliform	3.0	1.0	Col/100 mL
827	Fecal coliform	3.0	1.0	Col/100 mL
811	Fluoride	3.8	1.4	mg/L
808	Fluoride	1.7	1.4	mg/L
812	Gross alpha	8.6	0.56	Bq/L
812	Radioactive strontium, total ^d	280	0.30	Bq/L
806	Radioactive strontium, total ^d	3.0	0.30	Bq/L
830	Radioactive strontium, total ^d	0.90	0.30	Bq/L
829	Radioactive strontium, total ^d	0.72	0.30	Bq/L
830	Tritium	2000	740	Bq/L

^aSafe Drinking Water Act-National Primary Drinking Water Regulations, 40 CFR 141, as amended.

^bState of Tennessee Hazardous Waste Regulations TN 1200-1-11-05, Appendix 05/B.

^cSee Fig. 11.

^dRadioactive strontium, total (⁸⁹Sr + ⁹⁰Sr).

Table 70. WAG 6 groundwater summary statistics, October-December 1988

Parameter	Number of samples	Min	Value qualifier ^a	AV	Max	Value qualifier ^a
<i>Perimeter wells^b</i>						
Anions (mg/L)						
Chloride	13	1.1		6.1	15	
Fluoride	13	1.0		1.0	1.0	
Nitrate (as N)	13	0.50	U	0.55	0.97	
Sulfate(as SO ₄)	13	5.0	U	31	210	
Field measurements						
Conductivity(mS/cm)	91	0.060		0.35	0.91	
Temperature(°C)	91	13		15	17	
pH(standard units)	91	4.9		6.8	7.6	
Metals (mg/L)						
Aluminum, total	13	0.050	U	0.21	0.50	U
Arsenic, dissolved	13	0.010	U	0.010	0.010	U
Arsenic, total	13	0.010	U	0.010	0.010	U
Barium, dissolved	13	1.0	U	1.0	1.0	U
Barium, total	13	1.0	U	1.0	1.0	U
Beryllium, total	13	0.00033		0.0020	0.0032	
Boron, total	13	0.080	U	0.080	0.080	U
Calcium, total	13	2.8		79	150	
Chromium, total	13	0.020	U	0.020	0.020	U

Table 70. (continued)

Parameter	Number of samples	Min	Value qualifier ^a	AV	Max	Value qualifier ^a
<i>Perimeter wells (continued)</i>						
Cobalt, total	13	0.0020	U	0.0022	0.0030	U
Copper, total	13	0.010	U	0.010	0.010	U
Iron, dissolved	13	0.050	U	0.063	0.18	U
Iron, total	13	0.17	U	0.43	1.3	U
Lead, total	13	0.020	U	0.020	0.020	U
Magnesium, total	13	0.51		13	31	
Manganese, dissolved	13	0.010		0.033	0.080	
Manganese, total	13	0.010		0.049	0.070	
Mercury, dissolved	13	0.00010	U	0.0001	0.00010	U
Mercury, total	13	0.00010	U	0.0001	0.00010	U
Nickel, total	13	0.0060	U	0.0062	0.0085	U
Selenium, dissolved	13	0.0050	U	0.0050	0.0050	U
Silicon, total	13	3.9		8.4	12	
Sodium, dissolved	13	1.2		11	54	
Sodium, total	13	1.2		11	54	
Strontium, total	13	0.0094		0.32	1.1	
Vanadium, total	13	0.0040	U	0.0079	0.013	
Zinc, total	13	0.0070	U	0.0082	0.012	
Miscellaneous						
Alkalinity, as CaCO ₃	13	7.5		220	430	
Turbidity(NFU)	13	0.040		2.6	11	

Table 70. (continued)

Parameter	Number of samples	Min	Value qualifier ^a	Av	Max	Value qualifier ^a
<i>Perimeter wells (continued)</i>						
Radioactivity measurements (Bq/L)						
⁶⁰ Co	13	-0.14		0.98	12	
¹³⁷ Cs	13	-0.13		0.0088	0.22	
Gross alpha	13	0		0.093	0.36	
Gross beta	13	0		0.72	7.6	
Radioactive strontium, total ^c	13	-0.10		0.077	0.25	
Radium, total	13	0.010		0.044	0.10	
Tritium	13	-15		6100	34000	
Extractable organics (mg/L)						
Bis(2-ethylhexyl) phthalate	13	0.00070	B	0.0072	0.011	U
Di-n-butylphthalate	13	0.00060	J	0.0070	0.011	U
Diethyl phthalate	13	0.0010	JB	0.010	0.011	U
Naphthalene	13	0.0030	J	0.010	0.011	U
Organic carbon, total	52	0.50	U	1.7	7.3	
Organic halides, total	52	0.0050	U	0.048	0.59	
Recoverable phenolics, total	13	0.0010	U	0.0010	0.0010	U
Volatile organics (mg/L)						
1,1-Dichloroethane	13	0.0050	U	0.0052	0.0080	
1,2-Dichloroethane	13	0.0050	U	0.0075	0.038	

Table 70. (continued)

Parameter	Number of samples	Min	Value qualifier ^a	Av	Max	Value qualifier ^a
<i>Perimeter wells (continued)</i>						
1,2-Dichloroethene	13	0.0040	J	0.0076	0.027	
Acetone	13	0.0020	JB	0.0094	0.010	U
Benzene	13	0.0020	J	0.0048	0.0050	U
Carbon tetrachloride	13	0.0050	U	0.012	0.092	
Chloroform	13	0.0050	U	0.012	0.097	
Ethylbenzene	13	0.0050	U	0.0050	0.0050	U
Methylene chloride	13	0.0020	JB	0.0040	0.0080	B
Tetrachloroethene	13	0.0050	U	0.0065	0.016	
Toluene	13	0.0050	U	0.0050	0.0050	U
Trichloroethene	13	0.0050	U	0.045	0.51	E
Vinyl chloride	13	0.010	U	0.010	0.010	U
Xylene, total	13	0.0050	U	0.0050	0.0050	U
<i>Site characterization wells^b</i>						
Anions (mg/L)						
Chloride	8	8.2		17	40	
Fluoride	8	1.0		1.0	1.0	
Nitrate (as N)	8	0.50	U	0.50	0.50	U
Sulfate (as SO ₄)	8	5.0	U	19	52	

Table 70. (continued)

Parameter	Number of samples	Min	Value qualifier ^a	AV	Max	Value qualifier ^a
<i>Site characterization wells (continued)</i>						
<i>Field measurements</i>						
Conductivity(mS/cm)	56	0.24		0.48	0.77	
Temperature(°C)	56	14		16	17	
pH(standard units)	56	6.6		7.0	7.4	
<i>Metals (mg/L)</i>						
Aluminum, total	8	0.097		0.41	0.53	
Arsenic, dissolved	8	0.010	U	0.011	0.020	
Arsenic, total	8	0.010	U	0.011	0.020	
Barium, dissolved	8	1.0	U	1.3	3.4	
Barium, total	8	1.0	U	1.4	3.3	
Beryllium, total	8	0.0020		0.0025	0.0031	
Boron, total	8	0.080	U	0.086	0.13	
Calcium, total	8	63		130	180	
Chromium, total	8	0.020	U	0.020	0.020	U
Cobalt, total	8	0.0020	U	0.0032	0.0069	
Copper, total	8	0.010	U	0.010	0.013	
Iron, dissolved	8	0.050	U	5.0	35	
Iron, total	8	0.10		5.8	38	
Lead, total	8	0.020	U	0.020	0.020	U
Magnesium, total	8	8.8		17	31	
Manganese, dissolved	8	0.020		1.5	9.3	
Manganese, total	8	0.020		1.6	9.8	

Table 70. (continued)

Parameter	Number of samples	Min	Value qualifier ^a	Av	Max	Value qualifier ^a
Site characterization wells (continued)						
Mercury, dissolved	8	0.00010	U	0.0001	0.00060	U
Mercury, total	8	0.00010	U	0.0001	0.00010	U
Nickel, total	8	0.0060	U	0.0060	0.0060	U
Selenium, dissolved	8	0.0050	U	0.0050	0.0050	U
Silicon, total	8	6.6		9.7	12	
Sodium, dissolved	8	4.8		6.7	11	
Sodium, total	8	4.4		6.7	11	
Strontium, total	8	0.13		0.22	0.31	
Vanadium, total	8	0.0069		0.010	0.012	
Zinc, total	8	0.0070	U	0.0074	0.0080	U
Miscellaneous						
Alkalinity, as CaCO ₃	8	200		360	530	
Turbidity(NTU)	8	0.18		8.9	36	
Radioactivity measurements (Bq/L)						
⁶⁰ Co	8	-0.020		0.083	0.26	
¹³⁷ Cs	8	-0.10		0.016	0.17	
Gross alpha	8	0		0.060	0.25	
Gross beta	8	0.040		0.52	1.3	

Table 70. (continued)

Parameter	Number of samples	Min	Value qualifier ^a	AV	Max	Value qualifier ^a
<i>Site characterization wells (continued)</i>						
Radioactive strontium, total ^c	8	-0.050		0.073	0.42	
Radium, total	8	0		0.029	0.060	
Tritium	8	-14	36000		160000	
Extractable organics (mg/L)						
Bis(2-ethylhexyl) phthalate	8	0.00080	JB	0.0072	0.011	U
Di-n-butylphthalate	8	0.00060	JB	0.0059	0.011	U
Diethyl phthalate	8	0.011	U	0.011	0.011	U
Naphthalene	8	0.011	U	0.013	0.023	
Organic carbon, total	32	0.90		4.0	10	
Organic halides, total	32	0.0033		0.15	1.2	
Recoverable phenolics, total	8	0.0010	U	0.0023	0.011	
Volatile organics (mg/L)						
1,1-Dichloroethane	8	0.0050	U	0.0055	0.0090	
1,2-Dichloroethane	8	0.0050	U	0.0050	0.0050	U
1,2-Dichloroethene	8	0.0050	U	0.027	0.18	
Acetone	8	0.0030	JB	0.0091	0.010	U
Benzene	8	0.0050	U	0.020	0.11	
Carbon tetrachloride	8	0.0050	U	0.0050	0.0050	U
Chloroform	8	0.0050	U	0.0050	0.0050	U

Table 70. (continued)

Parameter	Number of samples	Min	Value qualifier ^a	Av	Max	Value qualifier ^a
<i>Site characterization wells (continued)</i>						
Ethylbenzene	8	0.0050	U	0.017	0.098	U
Methylene chloride	8	0.0020	JB	0.0028	0.0070	B
Tetrachloroethene	8	0.0050	U	0.0050	0.0050	U
Toluene	8	0.0050	U	0.051	0.37	E
Trichloroethene	8	0.0050	U	0.17	1.3	E
Vinyl chloride	8	0.010	U	0.014	0.045	E
Xylene, total	8	0.0050	U	0.094	0.72	E
<i>Upgradient wells^b</i>						
Anions (mg/L)	6	1.0		2.4	8.5	U
Chloride	6	1.0	U	1.0	1.0	U
Fluoride	6	0.50	U	0.50	0.50	U
Nitrate (as N)	6	5.0	U	73	310	U
Sulfate (as SO ₄)	6					
<i>Field measurements</i>						
Conductivity (mS/cm)	42	0.010		0.29	0.80	
Temperature (°C)	42	13		14	16	
pH (standard units)	42	5.3		7.5	8.4	

Table 70. (continued)

Parameter	Number of samples	Min	Value qualifier ^a	AV	Max	Value qualifier ^a
<i>Upgradient wells (continued)</i>						
Metals (mg/L)						
Aluminum, total	6	0.17		0.33	0.52	
Arsenic, dissolved	6	0.010	U	0.010	0.010	U
Arsenic, total	6	0.010	U	0.010	0.010	U
Barium, dissolved	6	1.0	U	1.0	1.0	U
Barium, total	6	1.0	U	1.0	1.0	U
Beryllium, total	6	0.0021		0.0023	0.0030	
Boron, total	6	0.080	U	0.080	0.080	U
Calcium, total	6	36		81	180	
Chromium, total	6	0.020	U	0.020	0.020	U
Cobalt, total	6	0.0020	U	0.0020	0.0020	U
Copper, total	6	0.010	U	0.010	0.010	U
Iron, dissolved	6	0.050	U	0.053	0.070	
Iron, total	6	0.050	U	0.54	1.9	
Lead, total	6	0.020	U	0.027	0.060	
Magnesium, total	6	2.3		18	48	
Manganese, dissolved	6	0.010		0.013	0.020	
Manganese, total	6	0.010	U	0.043	0.15	
Mercury, dissolved	6	0.00010	U	0.0001	0.00010	U
Mercury, total	6	0.00010	U	0.0001	0.00010	U
Nickel, total	6	0.0060	U	0.0062	0.0072	
Selenium, dissolved	6	0.0050	U	0.0050	0.0050	U
Silicon, total	6	7.3		8.6	13	
Sodium, dissolved	6	0.72		7.2	18	

Table 70. (continued)

Parameter	Number of samples	Min	Value qualifier ^a	Av	Max	Value qualifier ^a
<i>Upgradient wells (continued)</i>						
Sodium, total	6	0.76		7.1	19	
Strontium, total	6	0.054		0.16	0.35	
Vanadium, total	6	0.0040	U	0.0060	0.0095	
Zinc, total	6	0.0080	U	0.011	0.025	
Miscellaneous						
Alkalinity, as CaCO ₃	6	6.8		180	430	
Turbidity(NTU)	6	0.12		1.1	3.1	
Radioactivity measurements (Bq/L)						
⁶⁰ Co	6	-0.050		0.013	0.080	
¹³⁷ Cs	6	-0.17		-0.055	0.090	
Gross alpha	6	0		0.43	0.80	
Gross beta	6	0.32		0.95	1.9	
Radioactive strontium, total ^c	6	-0.010		0.21	0.56	
Radium, total	6	0.0070		0.038	0.070	
Tritium	6	-1.0		10	36	

Table 70. (continued)

Parameter	Number of samples	Min	Value qualifier ^a	AV	Max	Value qualifier ^a
<i>Upgradient wells (continued)</i>						
Extractable organics (mg/L)						
Bis(2-ethylhexyl) phthalate	6	0.010	U	0.010	0.011	U
Di-n-butylphthalate	6	0.00040	JB	0.0072	0.011	U
Diethyl phthalate	6	0.00050	JB	0.0088	0.011	U
Naphthalene	6	0.010	U	0.010	0.011	U
Organic carbon, total	24	0.50		0.82	1.6	
Organic halides, total	24	0.0050	U	0.0050	0.0050	U
Recoverable phenolics, total	6	0.0010	U	0.0010	0.0010	U
<i>Volatile organics (mg/L)</i>						
1,1-Dichloroethane	6	0.0050	U	0.0050	0.0050	U
1,2-Dichloroethane	6	0.0050	U	0.0050	0.0050	U
1,2-Dichloroethene	6	0.0050	U	0.0050	0.0050	U
Acetone	6	0.0010	JB	0.025	0.14	B
Benzene	6	0.0050	U	0.0050	0.0050	U
Carbon tetrachloride	6	0.0050	U	0.0050	0.0050	U
Chloroform	6	0.0050	U	0.0050	0.0050	U
Ethylbenzene	6	0.0050	U	0.0050	0.0050	U
Methylene chloride	6	0.0010	JB	0.0018	0.0050	JB
Tetrachloroethene	6	0.0040	J	0.0048	0.0050	U

Table 70. (continued)

Parameter	Number of samples	Min	Value qualifier ^a	Av	Max	Value qualifier ^a
<i>Upgradient wells (continued)</i>						
Toluene	6	0.0050	U	0.0050	0.0050	U
Trichloroethene	6	0.0050	U	0.0050	0.0050	U
Vinyl chloride	6	0.010	U	0.010	0.010	U
Xylene, total	6	0.0050	U	0.0050	0.0050	U

^aOrganics: U=undetected; B=present in blank; J=below detection limit, but estimated; E=concentration exceeds the calibration range of the instrument.

Inorganics: U=undetected; B=value < contract-required detection limit > instrument detection limit; E=value is estimated because of the presence of interference.

^bSee Fig. 12.

^cRadioactive Strontium, total (⁸⁹Sr + ⁹⁰Sr).

Table 71. Groundwater sample analyses from monitoring wells in WAG 6, October-December 1988, whose values exceeded allowable concentrations under the primary drinking water standards

Well identifier	Parameter	Concentration	Primary limit ^{a,b}	Units of measurement
Site characterization wells ^c				
852	Barium, dissolved	3.4	1.0	mG/L
851	Barium, dissolved	1.2	1.0	mG/L
850	Barium, dissolved	1.1	1.0	mG/L
852	Barium, total	3.3	1.0	mG/L
851	Barium, total	1.4	1.0	mG/L
850	Barium, total	1.2	1.0	mG/L
848	Radioactive strontium, total ^d	0.42	0.30	Bq/L
848	Tritium	160,000	740	Bq/L
849	Tritium	11,000	740	Bq/L
854	Tritium	11,000	740	Bq/L
852	Tritium	2,200	740	Bq/L
850	Tritium	1,400	740	Bq/L
Perimeter wells ^c				
843	Tritium	34,000	740	Bq/L
842	Tritium	25,000	740	Bq/L
841	Tritium	9,000	740	Bq/L
847	Tritium	3,300	740	Bq/L
844	Tritium	2,800	740	Bq/L
745	Tritium	1,300	740	Bq/L
835	Tritium	1,200	740	Bq/L
840	Tritium	790	740	Bq/L

Table 71. (continued)

Well identifier	Parameter	Concentration	Primary limit ^{a,b}	Units of measurement
<i>Upgradient wells^c</i>				
857	Gross alpha	0.80	0.56	Bq/L
832	Gross alpha	0.71	0.56	Bq/L
857	Lead, total	0.060	0.050	mg/L
846	Radioactive strontium, total ^d	0.56	0.30	Bq/L
858	Radioactive strontium, total ^d	0.39	0.30	Bq/L

^aSafe Drinking Water Act-National Primary Drinking Water Regulations, 40 CFR 141, as amended.

^bState of Tennessee Hazardous Waste Regulations TN 1200-1-11-05, Appendix 05/B.

^cSee Fig. 12.

^dRadioactive strontium, total (⁸⁹Sr + ⁹⁰Sr).

temperature, total organic carbon, and total organic halogens. In addition, three field measurements (of conductivity, pH, and temperature) are made to verify that a well has stabilized after purging and before sampling. Thus, the number of samples listed will be 4, or 7, times the number of samples listed for the other contaminant indicators. Some additional samples were also run for one of the perimeter wells in WAG 1.

Most parameters of interest were at low or undetectable levels during the sampling period. Exceedances of primary drinking water standards for WAG 1 all involved perimeter wells (Table 69). WAG 1 perimeter well number 811 had an arsenic level that was just at the drinking water limit and a fluoride level that exceeded the limit. Fluoride also exceeded the limit at perimeter well 808. Perimeter wells 822 and 827 exceeded the limit for fecal coliform. Exceedances were also recorded for gross alpha at perimeter well 812 and tritium at perimeter well 830. A notable strontium exceedance occurred at perimeter well 812 (located just northwest of Building 2069) and much lower strontium exceedances occurred at perimeter wells 806, 830, and 829.

For WAG 6 site-characterization wells, total and dissolved barium exceeded the primary drinking water limit at wells 850, 851, and 852 (Table 71). Tritium exceedances were recorded at wells 848, 849, 850, 852, and 854. The tritium concentrations at wells 848 and 849 were especially high, being more than two orders of magnitude greater than the primary drinking water limit. These concentration values were comparable to corresponding values for the previous quarter. Radioactive strontium also slightly exceeded the primary drinking water limit at well 848.

Eight perimeter wells from WAG 6 had tritium exceedances of the primary drinking water limit during this quarter (Table 71). Tritium concentrations at wells 842 and 843 were by far the highest of the perimeter wells, but still only about 20 to 25% of the two highest tritium concentrations for the site-characterization wells (wells 848 and 849).

Slight exceedances of the EPA primary drinking water limits were noted in some of the upgradient wells. These included gross alpha at wells 832 and 857, lead (total) at well 857, and radioactive strontium (total) at wells 846 and 858.

4. METEOROLOGICAL PROCESSES

Meteorological processes are continuously monitored at ORNL so that current weather conditions may be taken into account, as needed, in responding to emergencies that may arise. Weather records are also kept for climatological studies and for supportive information in hydrologic modeling and monitoring, facility design, scheduling of construction activities, and interpretation of nonmeteorological data (e.g., total suspended solids in surface water) that may depend on recent weather conditions.

4.1 PRECIPITATION

Monthly precipitation totals for several sites are averaged to obtain representative monthly values for ORNL and the surrounding area. The stations included are indicated by three-character identifiers on the location map in Fig. 12. These stations provide data for climatological studies. Most of the other sites in Fig. 12 are represented by five-character identifiers, with the last two digits identifying the air monitoring station at which each gauge is located. Precipitation gauges located at the air monitoring stations report real-time data for short-term studies and emergency response situations. Much of the data summarized in this report comes from the precipitation measuring network of the Environmental Sciences Division of ORNL. In addition, the Atmospheric Turbulence and Diffusion Division (ATDD) of the National Oceanic and Atmospheric Administration (NOAA) maintains a weather station in the city of Oak Ridge. Observations have been made at that station for a long enough period to provide 30-year (1951 through 1980) normals for comparison with amounts for the current year. Table 72 shows the total precipitation at ATDD and departure from ATDD long-term normal, along with the ORNL representative value, for each of the first 9 months of 1988. Annual totals are also given.

4.2 WIND

The ORNL wind tower network consists of towers A and B, each with sensors mounted at 10 and 30 m, and tower C with sensors mounted at 10, 30, and 100 m. Locations of these towers are shown in Fig. 13. Data from the sensors are acquired, stored, edited, and formatted by a data collection system consisting of a central processor and remote data logger. One-minute vector averages of wind velocity are calculated in the conventional way and retained for 24 h. These velocities are processed into 15-min averages using a procedure that avoids the unrealistically low wind-speed values obtained when appreciable winds of nearly opposite direction are vector averaged in the conventional way. This alternative averaging procedure involves calculating the mean (scalar) wind speed and multiplying it by a unit vector having the same direction as the conventionally calculated vector sum of the individual velocities. A similar calculation is used to convert the 15-min averages into hourly averages. The 15-min averages are retained for 1 day, and the hourly averages, from which the wind roses in Figs. 14 through 20 are obtained, are stored for at least 1 year and eventually archived.

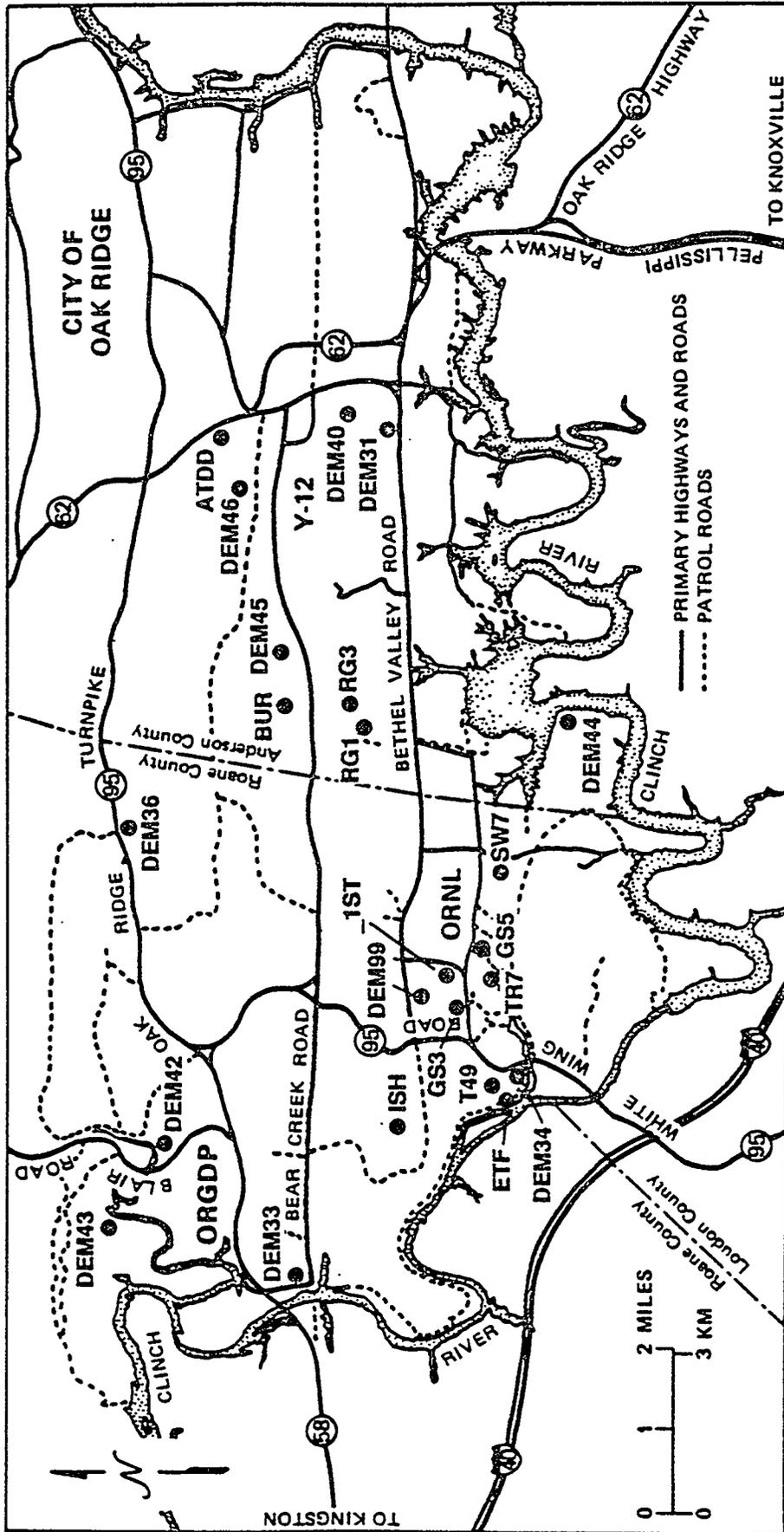


Fig. 12. Location map of precipitation gauges on or near the Oak Ridge Reservation.

Table 72. Precipitation for ORNL and nearby sites^a
October-December 1988

Month	Number of sites reporting	Precipitation (mm)		
		ORNL average ^b	ATDD	ATDD departure from normal
January	11	132.3	138.2	+4.8
February	11	73.0	87.1	-29.7
March	11	81.6	96.5	-61.2
April	11	77.7	86.9	-25.1
May	11	56.5	67.3	-40.1
June	11	33.1	13.5	-94.7
July	9	172.9	193.0	+60.7
August	9	54.9	60.7	-34.5
September	9	128.9	143.0	+46.5
October	10	48.7	50.0	-23.4
November	10	154.1	166.6	+52.3
December	10	110.0	140.5	-3.0
1988 Total		1123.7	1243.8 ^c	-147.1

^aORNL data are stored in the ORNL Remedial Action Program data base; Larry Vorhees, Coordinator, 574-7309.

^bAverage of ORNL sites reporting for each month; ATDD not included.

^cAnnual totals for ATDD, in millimeters, are converted directly from annual totals as measured in units of 0.01 in. and are therefore free of roundoff error that accumulates when summing monthly amounts that have each been converted to millimeters.

ORNL-DWG 89-5835
with 80.9% of possible data

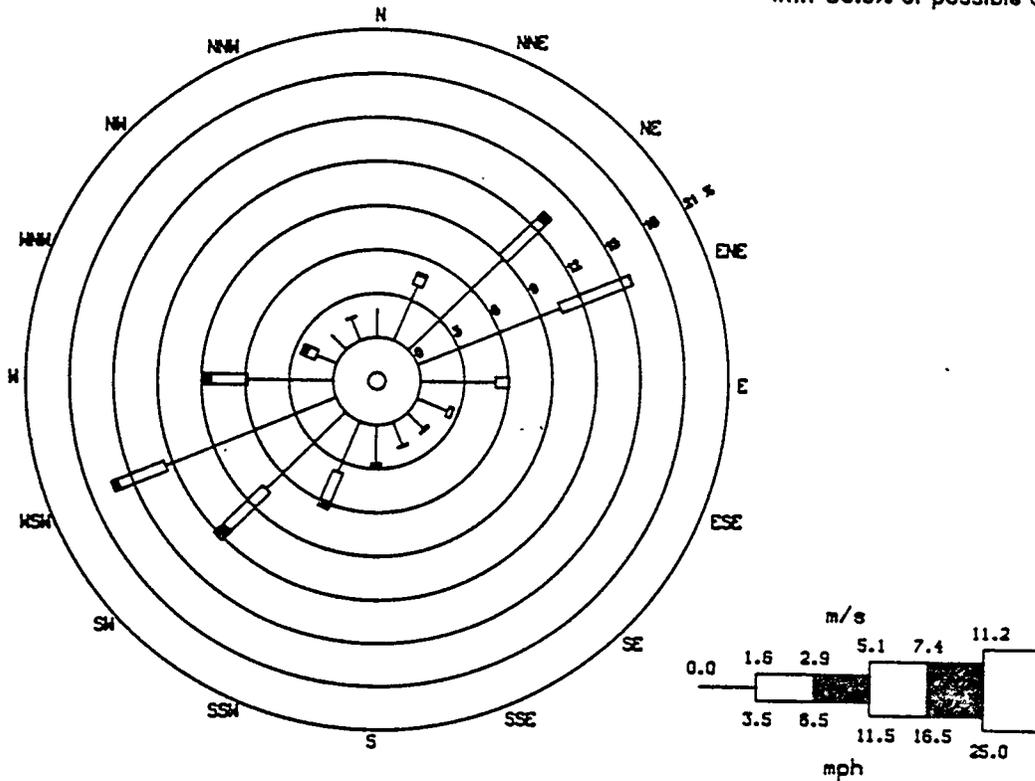


Fig. 14. Wind rose at 10-m level of meteorological tower A, October-December 1988.

ORNL-DWG 89-5836
with 82.2% of possible data

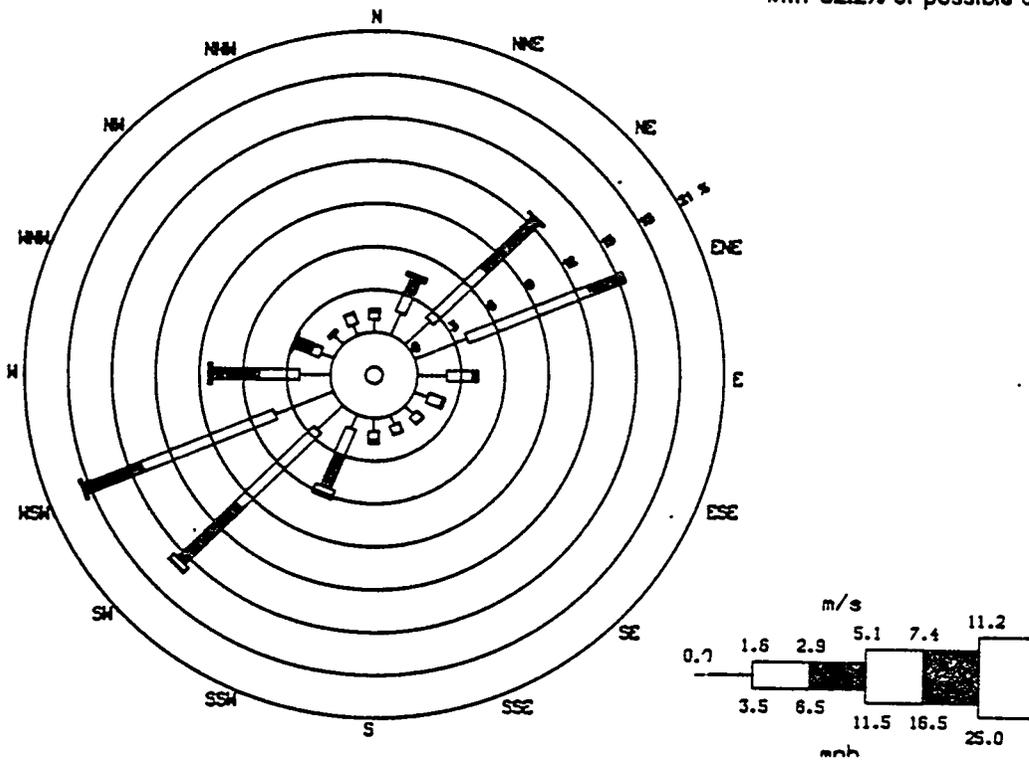


Fig. 15. Wind rose at 30-m level of meteorological tower A, October-December 1988.

ORNL-DWG 89-5837
with 93.1% of possible data

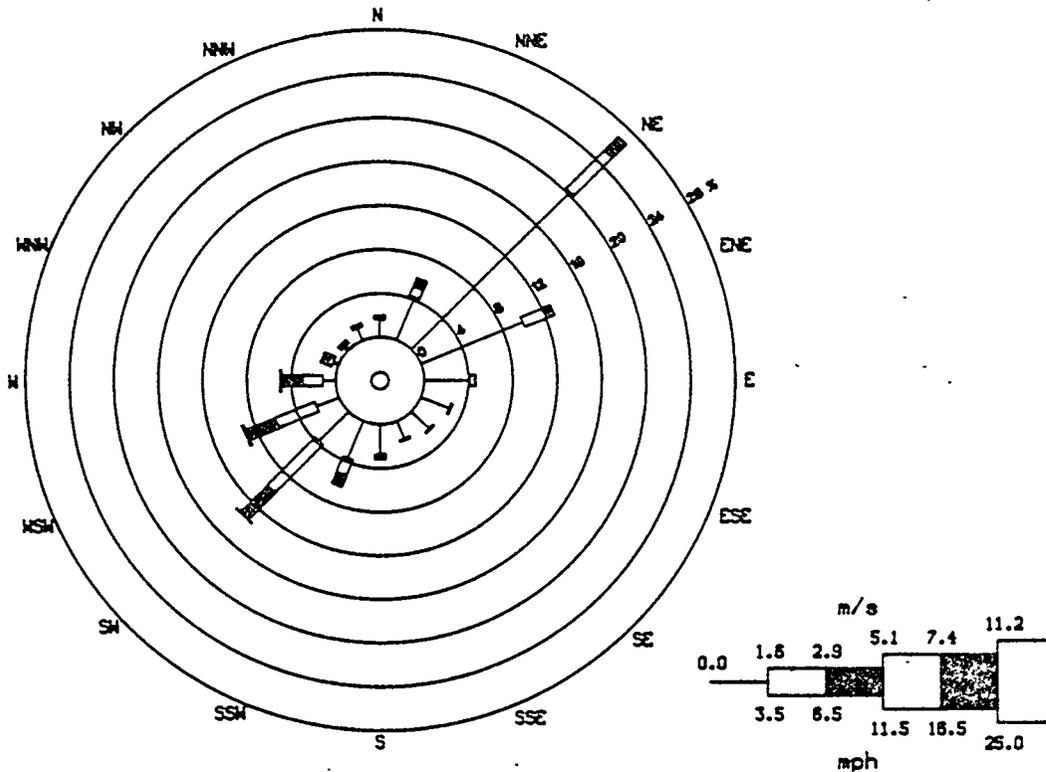


Fig. 16. Wind rose at 10-m level of meteorological tower B, October-December 1988.

ORNL-DWG 89-5838
with 93.9% of possible data

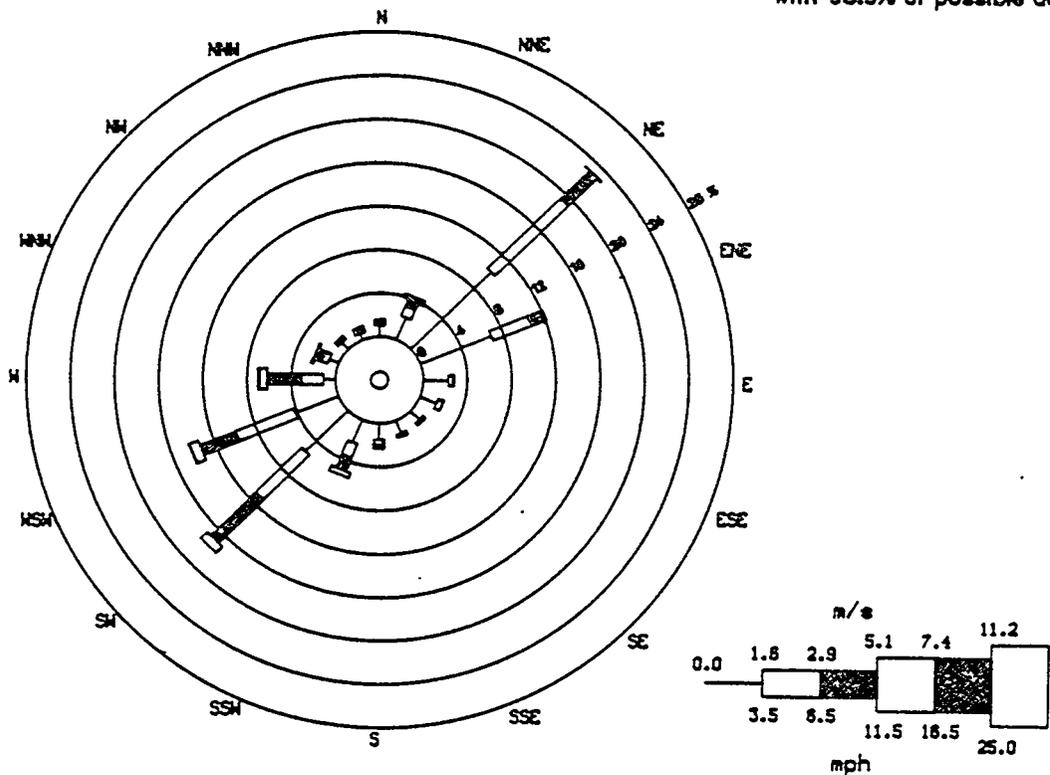


Fig. 17. Wind rose at 30-m level of meteorological tower B, October-December 1988.

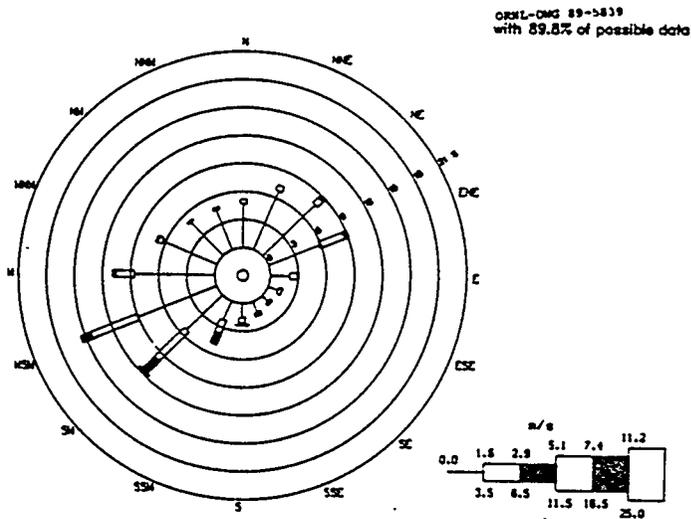


Fig. 18. Wind rose at 10-m level of meteorological tower C, October-December 1988.

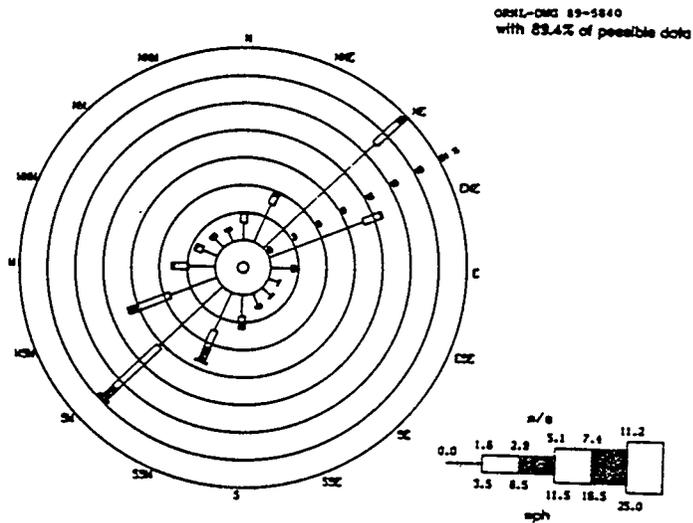


Fig. 19. Wind rose at 30-m level of meteorological tower C, October-December 1988.

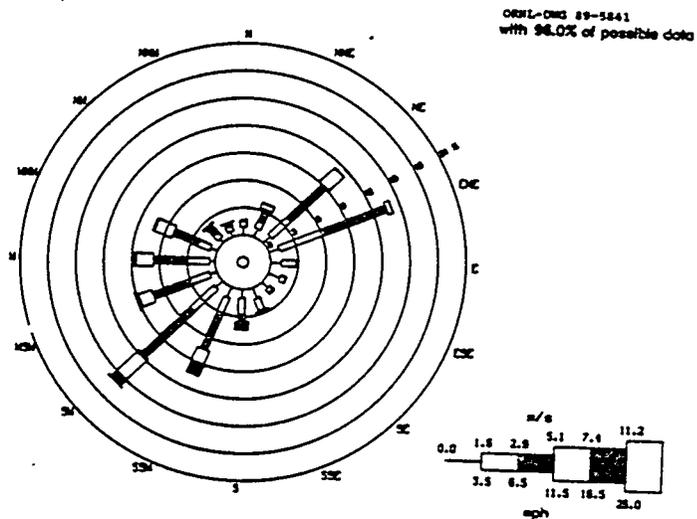


Fig. 20. Wind rose at 100-m level of meteorological tower C, October-December 1988.

Examination of quarterly wind roses reveals that the prevailing winds are almost equally split into two directions that are 180° apart: one prevailing direction is from the SW to WSW sector and the other prevailing direction is from the NE to ENE sector. The winds are strongly aligned along these directions because of the channeling effect induced by the ridge and valley structure of the area. This channeling effect is least evident at 100-m elevation, where the winds are more south-southwesterly. Another feature observed from the wind roses is that the wind speeds increase with height (tower level) at each of the towers. On the average, the wind speeds can be expected to increase steadily from ground level to 100 m.

5. BIOLOGICAL MONITORING

5.1 MILK

Raw milk from five locations, including one dairy, within a radius of 80 km of Oak Ridge, is monitored for ^{131}I and total radioactive strontium. Samples are collected every two weeks from the stations located near the Oak Ridge area (Fig. 21). Three other stations are more remote with respect to the Oak Ridge facilities and are usually sampled semiannually (Fig. 22). Samples were analyzed for ^{131}I by gamma spectroscopy and for total radioactive strontium by chemical separation and low-level beta counting. The results (Tables 73 and 74) are compared with intake guidelines specified by the Federal Radiation Council (FRC).

Beginning with this quarter, instrument background values are subtracted from the measured values of ^{131}I in milk samples and actual results are reported. Previously, "less than detectable" values (e.g., <0.1) were reported and were handled statistically as if the upper limit (e.g., 0.1) were the actual value. Values of ^{131}I reported for this quarter were often less than instrument background, as is indicated by negative values in Table 73. All measured values were well within the FRC Range I guidelines for ^{131}I in milk.

Concentrations of total radioactive Sr are shown in Table 74. The average concentration of total radioactive Sr at all stations in the immediate Oak Ridge area was 0.18 Bq/L. This average was practically unchanged from its third quarter value (0.17 Bq/L). Average radioactive Sr concentration for each location is within Range I of the FRC guidelines. Concentration values for stations in the immediate environs are also quite close to values for remote stations.

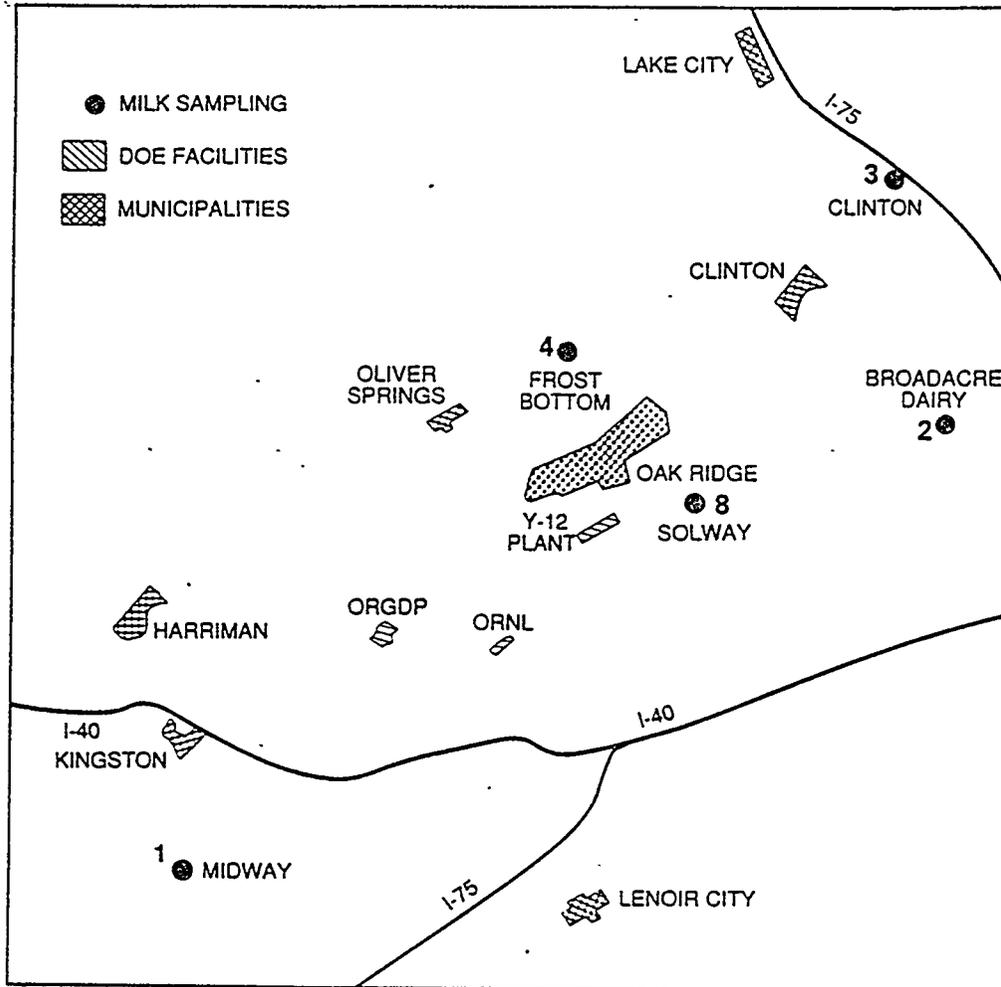


Fig. 21. Locations of milk sampling stations near the Oak Ridge facilities

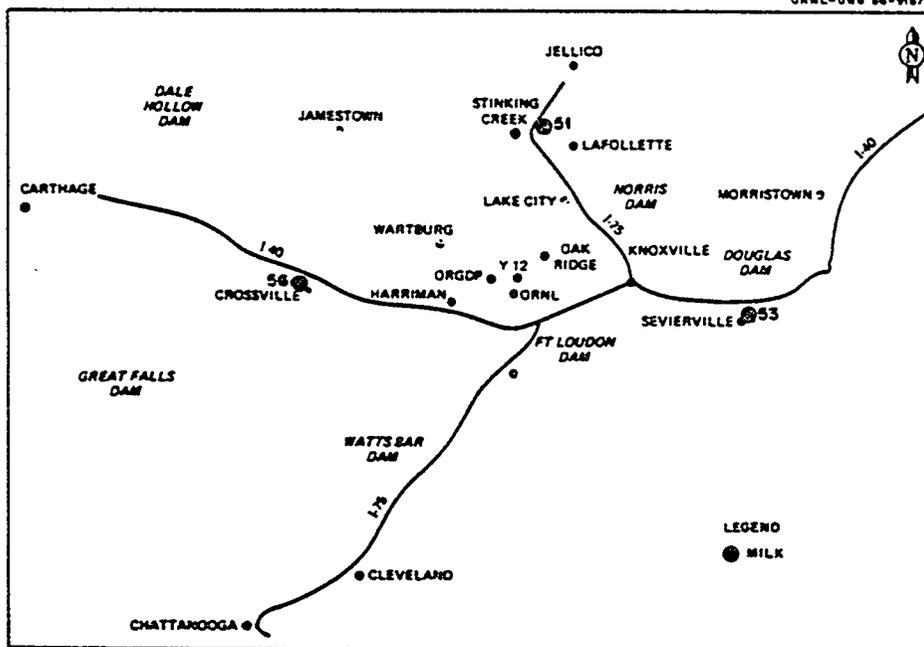


Fig. 22. Locations of milk sampling stations remote from the Oak Ridge facilities

Table 73. Concentrations of ^{131}I in milk,^a October-December 1988

Station	Number of samples	Concentration (Bq/L)			95% cc ^b	Percent of guideline ^c
		Max	Min	Av		
<i>Immediate environs^d</i>						
1	3	0.020	-0.040	0	0.040	0
2	5	0.080	-0.050	0	0.045	0
3	5	0.030	-0.030	0.0074	0.021	2.0
4	5	0.030	-0.040	-0.0040	0.027	-1.1
8	5	0.050	-0.040	0.0060	0.030	1.6
Network summary	23	0.080	-0.050	0.0020	0.013	0.55
<i>Remote environs^e</i>						
51	2	0.020	-0.0080	0.0060	0.028	1.6
53	2	0.010	-0.030	-0.010	0.040	-2.7
56	1	-0.040	-0.040	-0.040		-11
Network summary	5	0.020	-0.040	-0.0096	0.023	-2.6

^aRaw milk samples; station 2 is a dairy.

^b95% confidence coefficient about the average.

^cPercent of applicable FRC standard assuming 1 L/d intake: Range I, 0-0.37 Bq/L; adequate surveillance required to confirm calculated intakes.

^dSee Fig. 21.

^eSee Fig. 22.

Table 74. Concentrations of total radioactive Sr in milk^a, October-December 1988

Station	Number of samples	Concentration (Bq/L)			95% cc ^b	Percent of guideline ^c
		Max	Min	Av		
<i>Immediate environs^d</i>						
1	3	0.14	0.10	0.12	0.024	17
2	5	0.10	0.029	0.064	0.024	8.6
3	5	0.87	0.099	0.29	0.29	39
4	5	0.24	0.13	0.17	0.038	23
8	5	0.32	0.072	0.21	0.10	29
Network summary	23	0.87	0.029	0.18	0.071	24
<i>Remote environs^e</i>						
51	2	0.27	0.086	0.18	0.18	24
53	2	0.37	0.19	0.28	0.18	38
56	1	0.14	0.14	0.14		19
Network summary	5	0.37	0.086	0.21	0.10	29

^aRaw milk samples; station 2 is a dairy.

^b95% confidence coefficient about the average.

^cPercent of applicable FRC standard assuming 1 L/d intake: Range I, 0-0.74 Bq/L; adequate surveillance required to confirm calculated intakes.

^dSee Fig. 21.

^eSee Fig. 22.

5.2 FISH

Bluegill from three Clinch River locations were collected during this quarter for tissue analyses of radionuclides, mercury, and PCBs (Fig. 23). Sampling is performed semiannually. The last sampling was reported in the second quarter of 1988. Sampling locations include the following Clinch River kilometers (CRK): (1) 40.0, which is above Melton Hill Dam and most of the Oak Ridge DOE facilities' outfalls serves as a background location; (2) 33.3, which is ORNL's discharge point from White Oak Creek to the Clinch River; and (3) 8.0, which is downstream from both ORNL and ORGDP.

The primary radionuclides of concern at ORNL, because of fish consumption, are total radioactive Sr and ^{137}Cs . These two result in the highest dose to humans from ingestion of fish. Radionuclide concentrations are determined on three composites of 6 to 10 fish per sampling period. Mercury and PCB concentrations are measured in six individual fish from each sampling location. Scales, head, and entrails are removed from each fish before samples are obtained. Composite samples were ashed and analyzed by gamma spectroscopy and radiochemical techniques for the radionuclide that contribute most of the potential radionuclide dose to humans.

Average mercury concentrations in fish from each of the three locations were not appreciably different from the second quarter of 1988 (Table 75). The average concentration of mercury in fish from each location was less than 10% of the FDA's action level of 1.0 $\mu\text{g/g}$ wet weight.

The concentrations of PCBs in fish during the fourth quarter of 1988 were slightly lower than those measured during the second quarter, except for PCB-1260 at CRK 40.0, which was slightly higher (Table 76). All concentrations of PCBs (individual types and the sum) were less than 5% of the FDA's tolerance level of 2 $\mu\text{g/g}$ wet weight for fish.

Summary statistics of radionuclides found in bluegill during the quarter are given in Table 77. Concentrations of ^{60}Co are highest at CRK 40.0. Concentrations of ^{137}Cs and total strontium are highest at CRK 33.3. Radionuclide concentrations in bluegill during the fourth quarter are generally comparable to concentrations for the previous sampling period (the second quarter of 1988).

5.3 GRASS

Grass samples were collected during this quarter for the annual sampling at ORNL perimeter locations (Fig. 2), the ORR locations (Fig. 3), and at the remote locations (Fig. 4). At all locations, samples were collected at 90° angles to the air monitoring station for a total of four samples per location. After initial preparation, the samples were analyzed by gamma spectrometry and radiochemical techniques for a wide variety of radionuclides.

Tables 78 through 85 give summary statistics for concentrations of radionuclides in grass samples from the ORNL perimeter locations, the ORR locations, and the remote locations. Average concentrations of ^{60}Co and ^{137}Cs were near the analytical detection limits. Average concentrations of the plutonium isotopes for all stations, except station 4, were near or below detection limits.

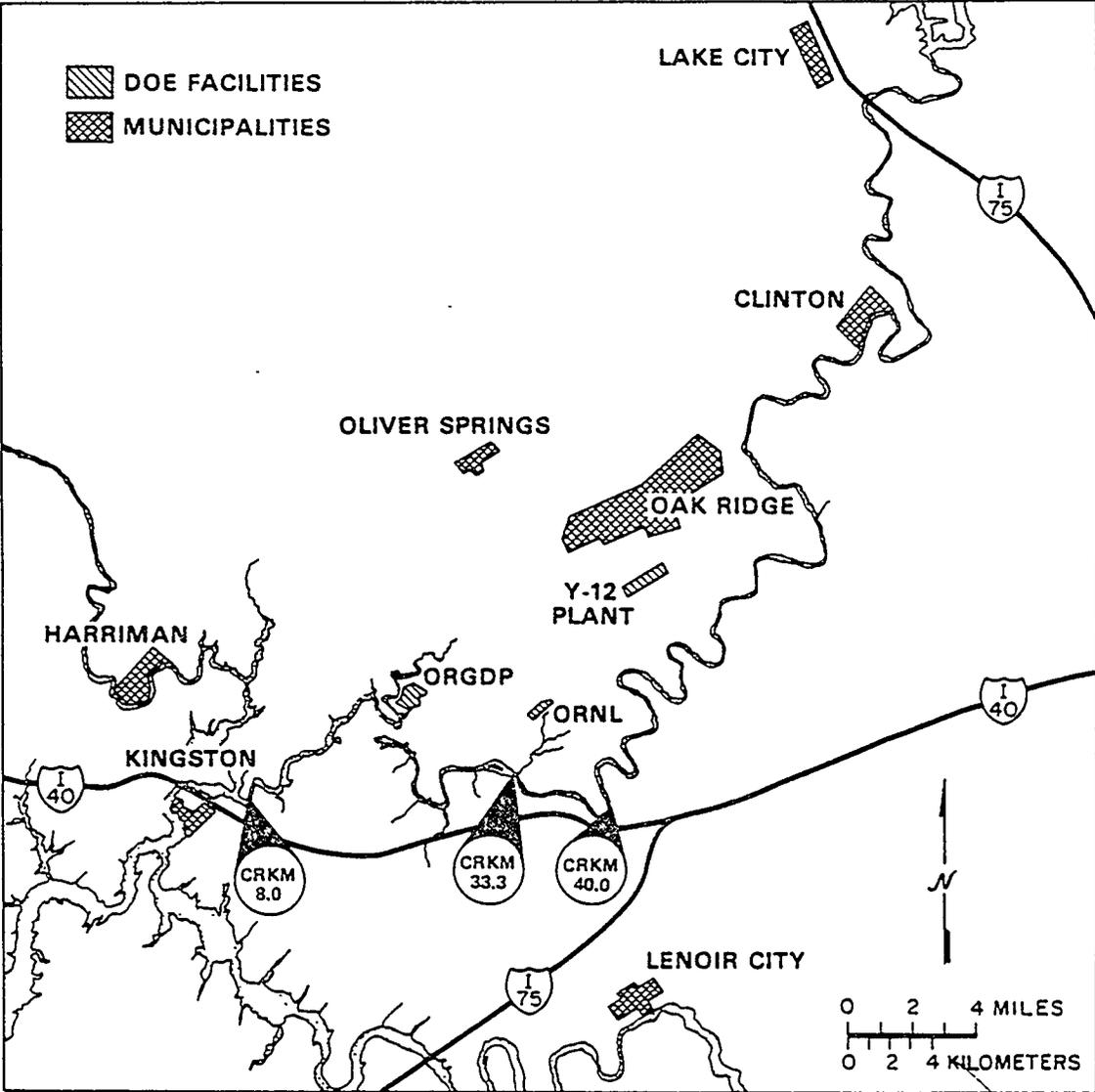


Fig. 23. Location map of fish sampling points.

Table 75. Mercury concentrations in Clinch River bluegill, October-December 1988

Location ^a	Number of fish sampled	Concentration ($\mu\text{g/g}$ wet wt)			95% cc ^b	Percent of action level ^c
		Max	Min	Av		
CRK 8.0	6	0.14	0.051	0.087	0.025	8.7
CRK 33.3	6	0.14	0.027	0.060	0.033	6.0
CRK 40.0	6	0.089	0.019	0.050	0.022	5.0

^aSee Fig. 23.

^b95% confidence coefficient about the average.

^cPercent of the Food and Drug Administration action level of mercury in fish ($1.0 \mu/\text{g}$) for the average concentration.

Table 76. PCB concentrations in Clinch River bluegill, October-December 1988

Location ^a	PCB aroclor	Number of fish sampled	Concentration ($\mu\text{g/g}$ wet wt)			95% cc ^b	Percent of tolerance ^c
			Max	Min	Av		
CRK 8.0	1254	6	0.050	<0.010	<0.020	0.013	1.0
	1260	6	0.030	<0.010	<0.020	0.0084	1.0
CRK 33.3	1254	6	0.010	<0.010	<0.010	0	0.50
	1260	6	0.060	0.010	0.020	0.016	1.0
CRK 40.0	1254	6	0.020	<0.010	<0.010	0.0033	0.50
	1260	6	0.10	0.010	0.040	0.027	2.0

^aSee Fig. 23.

^b95% confidence coefficient about the average.

^cPercent of the Food and Drug Administration tolerance level for PCBs in fish ($2 \mu\text{g/g}$ wet wt) for the average.

Table 77. Radionuclide concentrations in Clinch River bluegill, October-December 1988

Location ^a	Radionuclide	Number of samples ^b	Concentration (Bq/kg wet wt)			
			Max	Min	Av	95% cc ^c
CRK 8.0	⁶⁰ Co	3	0.11	-0.036	0.023	0.091
	¹³⁷ Cs	3	0.26	0.10	0.20	0.097
	Total Sr	3	0.098	-0.014	0.030	0.069
CRK 33.3	⁶⁰ Co	3	0.10	-0.073	0.024	0.10
	¹³⁷ Cs	3	9.6	1.4	5.2	4.8
	Total Sr	3	0.29	0.087	0.17	0.13
CRK 40.0	⁶⁰ Co	3	0.19	-0.011	0.10	0.12
	¹³⁷ Cs	3	1.8	1.5	1.7	0.21
	Total Sr ^d	3	0.085	0.027	0.065	0.038

^aSee Fig. 23.

^bA sample is a composite of 6 to 10 fish.

^c95% confidence coefficient about the average.

^dTotal radioactive Sr (⁸⁹Sr and ⁹⁰Sr).

Table 78. ^{60}Co concentrations in grass, June-December 1988

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	0.27	-0.99	-0.34	0.62
4	4	2.3	0.72	1.5	0.82
7	4	1.5	-1.1	-0.16	1.2
9	4	4.0	0.33	1.6	1.7
20	4	0.76	-0.77	-0.016	0.74
21	4	0.94	0.076	0.42	0.37
22	4	1.1	-0.61	0.23	0.81
Network summary	28	4.0	-1.1	0.45	0.42
<i>Oak Ridge Reservation stations^c</i>					
8	4	1.0	-2.7	-0.23	1.7
23	4	0.70	-0.19	0.31	0.42
31	4	3.1	-0.044	1.4	1.5
33	4	0.42	-0.98	-0.023	0.65
34	4	3.0	-0.27	0.87	1.5
36	4	3.2	0.34	1.7	1.2
40	4	1.8	-0.75	0.34	1.1
41	4	0.85	0.039	0.63	0.39
42	4	0.88	0.24	0.51	0.29
43	4	0.17	-1.2	-0.50	0.56
44	4	0.99	0.039	0.36	0.43
45	4	1.1	-2.1	-0.14	1.4
46	4	0.15	-0.67	-0.13	0.37
Network summary	52	3.2	-2.7	0.39	0.30
<i>Remote stations^d</i>					
51	4	0.67	-0.67	0.14	0.57
52	4	1.2	-3.7	-0.27	2.3
53	4	1.6	-0.71	0.28	1.0
55	4	1.6	-2.1	-0.29	1.6

Table 78. (continued)

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
56	4	<1.6	<0.84	<1.3	0.35
57	4	<1.8	<1.3	<1.5	0.29
58	4	0.67	-0.042	0.32	0.33
Network summary	28	1.6	-3.7	0.43	0.46

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 79. ^{137}Cs concentrations in grass, June-December 1988

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	2.4	0.81	1.6	0.69
4	4	83	43	68	18
7	4	2.6	-0.062	1.4	1.1
9	4	2.8	-3.3	0.78	2.8
20	4	1.6	-0.13	0.49	0.76
21	4	0.49	-0.43	0.087	0.41
22	4	1.7	-0.20	0.42	0.89
Network summary	28	83	-3.3	10	9.4
<i>Oak Ridge Reservation stations^c</i>					
8	4	3.5	-0.069	1.2	1.6
23	4	0.78	-0.25	0.17	0.44
31	4	3.6	-0.35	0.83	1.9
33	4	4.2	-0.30	1.1	2.1
34	4	0.47	-1.5	-0.19	0.90
36	4	2.8	0.35	1.2	1.1
40	4	3.2	-0.16	1.4	1.5
41	4	1.6	-0.85	0.50	1.0
42	4	0.17	-0.21	-0.022	0.21
43	4	0.77	0.27	0.52	0.25
44	4	0.69	-0.76	-0.13	0.72
45	4	1.9	-0.52	0.92	1.1
46	4	0.070	-1.1	-0.36	0.53
Network summary	52	4.2	-1.5	0.54	0.33
<i>Remote stations^d</i>					
51	4	1.3	0.13	0.65	0.56
52	4	1.3	0.039	0.64	0.53
53	4	0.71	-0.55	0.15	0.59
55	4	1.6	-0.40	0.33	0.88

Table 79. (continued)

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
56	4	<1.6	<0.84	<1.2	0.33
57	4	<1.5	<0.96	<1.2	0.21
58	4	0.34	-1.5	-0.42	0.91
Network summary	28	1.6	-1.5	0.55	0.30

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 80. ^{238}Pu concentrations in grass, June-December 1988

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	0.040	-0.11	-0.041	0.065
4	4	0.11	0.010	0.068	0.043
7	4	-0.0028	-0.070	-0.023	0.032
9	4	0.045	-0.040	-0.0073	0.039
20	4	0.050	-0.038	-0.0060	0.041
21	4	0.016	-0.0054	0.0037	0.0093
22	4	0.030	-0.067	-0.022	0.040
Network summary	28	0.11	-0.11	-0.0038	0.019
<i>Oak Ridge Reservation stations^c</i>					
8	4	0.040	-0.040	0.0065	0.038
23	4	0.014	-0.066	-0.042	0.038
31	4	-0.0050	-0.059	-0.020	0.026
33	4	0.020	-0.040	-0.0025	0.026
34	4	0.053	-0.027	0.010	0.035
36	4	0.030	0.016	0.027	0.0070
40	4	0.067	-0.090	-0.011	0.064
41	4	0.10	-0.013	0.042	0.056
42	4	0.030	0.020	0.026	0.0051
43	4	0.13	-0.010	0.025	0.070
44	4	0.0060	-0.051	-0.016	0.026
45	4	0.090	0.010	0.055	0.037
46	4	0.070	-0.050	0.017	0.051
Network summary	52	0.13	-0.090	0.0090	0.012
<i>Remote stations^d</i>					
51	4	0.049	-0.022	0.015	0.031
52	4	0.060	0	0.033	0.028
53	4	0.018	-0.0050	0.0078	0.011
55	4	0.050	0	0.028	0.022

Table 80. (continued)

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
56	4	0.090	-0.080	0.017	0.071
57	4	0.0060	-0.51	-0.14	0.25
58	4	0.0080	-0.12	-0.041	0.058
Network summary	28	0.090	-0.51	-0.011	0.040

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 81. ^{239}Pu concentrations in grass, June-December 1988

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	0.010	-0.033	-0.016	0.018
4	4	0.81	0.060	0.41	0.31
7	4	0.023	-0.16	-0.062	0.079
9	4	0.20	-0.078	0.0070	0.13
20	4	0.0090	-0.029	-0.0068	0.016
21	4	-0.0050	-0.097	-0.052	0.051
22	4	0.091	-0.076	-0.014	0.073
Network summary	28	0.81	-0.16	0.038	0.074
<i>Oak Ridge Reservation stations^c</i>					
8	4	0.019	-0.18	-0.048	0.090
23	4	-0.0090	-0.13	-0.070	0.053
31	4	-0.012	-0.19	-0.074	0.080
33	4	-0.010	-0.15	-0.053	0.066
34	4	-0.022	-0.084	-0.048	0.028
36	4	0.019	-0.19	-0.086	0.096
40	4	0.0050	-0.20	-0.062	0.096
41	4	0.020	-0.12	-0.045	0.070
42	4	-0.036	-0.11	-0.068	0.033
43	4	-0.030	-0.37	-0.15	0.16
44	4	0.0050	-0.067	-0.034	0.033
45	4	0.050	-0.15	-0.058	0.11
46	4	0.080	-0.28	-0.060	0.15
Network summary	52	0.080	-0.37	-0.065	0.023
<i>Remote stations^d</i>					
51	4	-0.016	-0.10	-0.055	0.040
52	4	0.010	-0.12	-0.043	0.055
53	4	0.016	-0.071	-0.018	0.037
55	4	-0.060	-0.17	-0.12	0.056

Table 81. (continued)

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
56	4	-0.041	-0.17	-0.11	0.064
57	4	0.019	-0.050	-0.014	0.028
58	4	-0.024	-0.056	-0.041	0.016
Network summary	28	0.019	-0.17	-0.057	0.021

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 82. Total radioactive Sr concentrations in grass, June-December 1988

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	12	3.3	6.4	3.9
4	4	810	330	540	230
7	4	8.3	3.4	4.9	2.3
9	4	13	0.70	8.2	5.6
20	4	4.6	1.7	3.1	1.2
21	4	9.4	5.2	7.4	1.8
22	4	8.5	3.5	5.4	2.2
Network summary	28	810	0.70	81	77
<i>Oak Ridge Reservation stations^c</i>					
8	4	3.8	1.5	3.0	1.0
23	4	19	2.7	8.9	7.3
31	4	10	3.7	7.3	3.2
33	4	6.2	2.9	4.1	1.5
34	4	4.3	-0.10	1.9	2.3
36	4	18	14	17	1.7
40	4	12	9.8	11	1.0
41	4	8.7	1.7	4.5	3.2
42	4	12	-0.30	3.7	5.6
43	4	4.4	2.0	3.2	0.98
44	4	4.9	-4.1	0.53	4.1
45	4	6.2	3.9	5.4	1.1
46	4	9.5	4.7	7.2	2.1
Network summary	52	19	-4.1	5.9	1.4
<i>Remote stations^d</i>					
51	4	4.6	4.1	4.4	0.29
52	4	12	8.0	11	2.0
53	4	11	3.3	7.0	3.2
55	4	9.7	3.9	6.1	2.5

Table 82. (continued)

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
56	4	22	13	17	3.9
57	4	3.8	1.2	2.5	1.1
58	4	3.9	2.6	3.1	0.59
Network summary	28	22	1.2	7.3	2.0

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 83. ^{234}U concentrations in grass, June-December 1988

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	2.2	0.37	0.89	0.88
4	4	1.9	0.71	1.4	0.50
7	4	3.8	0.94	2.0	1.2
9	4	1.1	0.27	0.60	0.37
20	4	2.5	1.1	1.9	0.70
21	4	1.3	0.36	0.73	0.43
22	4	0.56	0.29	0.41	0.11
Network summary	28	3.8	0.27	1.1	0.32
<i>Oak Ridge Reservation stations^c</i>					
8	4	0.50	0.25	0.38	0.12
23	4	0.93	0.42	0.72	0.21
31	4	1.6	0.33	0.81	0.60
33	4	0.90	0.41	0.58	0.22
34	4	0.85	0.55	0.65	0.13
36	4	0.95	0.43	0.78	0.24
40	4	5.2	2.8	3.6	1.1
41	4	2.1	0.58	1.0	0.73
42	4	1.3	0.35	0.67	0.43
43	4	0.79	0.37	0.54	0.18
44	4	1.5	0.36	0.73	0.53
45	4	5.5	2.5	3.6	1.4
46	4	2.4	1.5	1.9	0.41
Network summary	52	5.5	0.25	1.2	0.34
<i>Remote stations^d</i>					
51	4	0.43	0.24	0.30	0.088
52	4	1.2	0.40	0.77	0.39
53	4	0.70	0.34	0.54	0.15
55	4	1.7	0.46	0.93	0.54

Table 83. (continued)

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
56	4	2.2	0.25	0.77	0.95
57	4	1.8	0.57	1.1	0.60
58	4	0.49	0.25	0.37	0.11
Network summary	28	2.2	0.24	0.68	0.20

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 84. ^{235}U concentrations in grass, June-December 1988

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	0.40	0.015	0.13	0.18
4	4	0.18	-0.0040	0.087	0.091
7	4	0.26	0.15	0.21	0.050
9	4	0.082	-0.010	0.038	0.038
20	4	0.26	0.13	0.21	0.063
21	4	0.11	0.026	0.053	0.039
22	4	0.043	-0.056	0.0015	0.042
Network summary	28	0.40	-0.056	0.10	0.041
<i>Oak Ridge Reservation stations^c</i>					
8	4	0.086	0.0010	0.030	0.038
23	4	0.079	0.0050	0.058	0.036
31	4	0.090	0.027	0.056	0.031
33	4	0.080	0.040	0.060	0.016
34	4	0.099	0.012	0.056	0.036
36	4	0.12	0.031	0.085	0.040
40	4	0.48	0.15	0.32	0.13
41	4	0.21	0.091	0.13	0.054
42	4	0.35	0.026	0.12	0.16
43	4	0.15	-0.020	0.060	0.070
44	4	0.19	0.050	0.11	0.068
45	4	0.42	0.17	0.32	0.12
46	4	0.11	0.085	0.098	0.010
Network summary	52	0.48	-0.020	0.12	0.032
<i>Remote stations^d</i>					
51	4	0.016	-0.011	0.0075	0.013
52	4	0.41	0.010	0.19	0.19
53	4	0.066	0.042	0.055	0.012
55	4	0.080	-0.020	0.053	0.049

Table 84. (continued)

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
56	4	0.48	-0.024	0.13	0.23
57	4	0.085	0.023	0.049	0.026
58	4	0.048	0.012	0.031	0.016
Network summary	28	0.48	-0.024	0.073	0.045

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 85. ^{238}U concentrations in grass, June-December 1988

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	1.2	0.19	0.49	0.48
4	4	1.5	0.48	0.78	0.49
7	4	3.3	0.37	1.5	1.3
9	4	0.91	0.15	0.50	0.34
20	4	1.7	0.48	1.1	0.67
21	4	0.74	0.20	0.40	0.24
22	4	0.28	0.099	0.19	0.074
Network summary	28	3.3	0.099	0.70	0.26
<i>Oak Ridge Reservation stations^c</i>					
8	4	0.36	0.20	0.26	0.073
23	4	0.74	0.32	0.51	0.18
31	4	0.82	0.24	0.52	0.32
33	4	0.37	0.13	0.23	0.11
34	4	0.64	0.31	0.41	0.16
36	4	0.47	0.18	0.35	0.12
40	4	0.88	0.73	0.80	0.076
41	4	0.59	0.16	0.30	0.20
42	4	0.46	0.073	0.24	0.17
43	4	0.27	0.15	0.22	0.064
44	4	0.90	0.094	0.33	0.38
45	4	5.3	3.0	4.5	1.0
46	4	0.48	0.34	0.41	0.059
Network summary	52	5.3	0.073	0.69	0.32
<i>Remote stations^d</i>					
51	4	0.28	0.11	0.18	0.076
52	4	0.37	0.12	0.25	0.12
53	4	0.36	0.19	0.26	0.072
55	4	0.27	0.10	0.16	0.078

Table 85. (continued)

Location	Number of samples	Concentration (Bq/kg ash wt)			95% cc ^a
		Max	Min	Av	
56	4	0.35	0.077	0.17	0.12
57	4	1.1	0.16	0.62	0.39
58	4	0.21	0.12	0.18	0.039
Network summary	28	1.1	0.077	0.26	0.082

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Radionuclide concentrations at the ORNL perimeter stations and ORR stations were similar to those at the remote (or background) stations, with the following exceptions (Tables 78 through 85).

Grass at station 4, which is very close to the PWTP and the treatment ponds, had concentrations of ^{137}Cs and total radioactive Sr that were about two orders of magnitude greater than typical values at the other stations. Concentrations of ^{239}Pu were also anomalously high in the grass around station 4. Such high concentrations in the samples around station 4 are to be expected considering the specific locations from which these samples were taken.

Results of analyses for ^{235}U were biased high due to the inability to discriminate its peak from the other uranium isotopes. Concentrations of ^{234}U and ^{235}U were highest around stations 40 and 45, which are close to the Y-12 Plant site. The concentration of ^{238}U at station 45 was high compared with the other stations.

5.4 SOIL

Soil samples were collected during the quarter for the annual sampling at the ORNL perimeter locations (Fig. 2), the ORR locations (Fig. 3), and the remote locations (Fig. 4). At all locations, samples were collected at 90° angles to the air monitoring stations and designated as the north, south, east, and west areas. From each of the areas, two 1-m^2 plots were sampled. From each plot, five aliquots were taken with an 8-cm cup setter (used on golf courses). Aliquots from the two plots were composited for analysis for a total of four samples per location. Only the top 2 cm of soil was analyzed for radionuclides. All samples were dried prior to analysis.

Radionuclide concentrations at the ORNL perimeter stations and ORR stations were similar to those at the remote stations, with the following exceptions.

Concentrations of ^{60}Co , ^{137}Cs , ^{238}Pu , ^{239}Pu , and total radioactive strontium ($^{89}\text{Sr} + ^{90}\text{Sr}$) at perimeter station 4 were about an order of magnitude greater than typical values for those respective isotopes at the other stations in the three sampling networks (Tables 86 through 90). Perimeter station 4 is very close to the PWTP and the treatment ponds, so exceptionally high concentrations of certain radionuclides there would be expected. Because station 4 was not included in the 1987 sampling network, radionuclides having anomalously high concentrations there show an increase (from 1987 values) in means and standard deviations for the perimeter network.

Radioactive strontium concentrations are above average (for the perimeter network) at station 22 and include an anomalously high (maximum) value. This was also the case in the 1987 samples.

Concentrations of ^{235}U were biased high because of the inability to easily distinguish its peak from that of the other uranium isotopes. Concentrations of uranium isotopes in the soil at the ORNL perimeter stations (including station 4) were generally about equal to or less than the average concentrations at the remote sites (Tables 91 through 93). Uranium isotopes are generally highest at stations near the Y-12 Plant, especially station 45, which is just west of the main plant. Uranium concentrations at station 40 were about an order of

Table 86. ⁶⁰Co concentrations in soil, June-December 1988

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	0.70	-0.10	0.35	0.37
4	4	15	2.8	6.5	5.7
7	4	1.7	0.20	0.80	0.65
9	4	1.2	-0.10	0.33	0.59
20	4	2.3	-1.3	1.2	1.7
21	4	4.1	-1.1	0.70	2.5
22	4	2.8	0.10	1.5	1.1
Network summary	28	15	-1.3	1.6	1.1
<i>Oak Ridge Reservation stations^c</i>					
8	4	1.1	-1.4	-0.025	1.1
23	4	-0.20	-1.1	-0.55	0.40
31	4	1.4	0.40	1.0	0.48
33	4	2.9	-0.20	1.6	1.5
34	4	4.2	1.3	2.4	1.3
36	4	0.30	-0.90	-0.10	0.54
40	4	1.5	0.30	0.78	0.53
41	4	4.5	-1.1	1.1	2.6
42	4	2.8	-0.80	1.0	1.5
43	4	2.2	-0.50	1.1	1.2
44	4	0.80	-0.90	0.025	0.77
45	4	1.2	-1.5	0.38	1.3
46	4	1.3	-0.50	0.55	0.75
Network summary	52	4.5	-1.5	0.71	0.36
<i>Remote stations^d</i>					
51	4	1.3	-0.90	0.45	0.97
52	4	1.7	-0.30	0.95	0.90
53	4	2.5	0.60	1.6	0.99
55	4	3.2	-0.90	1.2	1.9

Table 86. (continued)

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
56	4	<2.0	<1.0	<1.8	0.50
57	4	<2.0	<2.0	<2.0	0
58	4	0.40	-1.6	-0.63	0.93
Network summary	28	3.2	-1.6	1.0	0.47

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 87. ^{137}Cs concentrations in soil, June-December 1988

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	60	37	47	12
4	4	1100	40	380	490
7	4	89	1.0	44	38
9	4	60	4.7	28	24
20	4	15	1.3	7.0	6.1
21	4	12	2.7	7.6	5.1
22	4	35	25	30	5.8
Network summary	28	1100	1.0	78	78
<i>Oak Ridge Reservation stations^c</i>					
8	4	21	15	18	2.8
23	4	36	11	24	14
31	4	48	21	34	12
33	4	70	11	37	25
34	4	39	1.4	21	18
36	4	46	5.2	21	19
40	4	43	27	35	8.4
41	4	77	26	43	23
42	4	6.3	4.6	5.5	0.71
43	4	35	5.6	21	15
44	4	26	2.3	14	11
45	4	57	3.5	25	24
46	4	16	7.4	12	3.5
Network summary	52	77	1.4	24	4.8
<i>Remote stations^d</i>					
51	4	17	11	15	2.7
52	4	48	25	38	10
53	4	80	20	49	29
55	4	52	25	36	13

Table 87. (continued)

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
56	4	27	13	20	5.9
57	4	85	50	63	15
58	4	5.1	1.2	2.5	1.7
Network summary	28	85	1.2	32	8.8

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 88. ^{238}Pu concentrations in soil, June-December 1988

Location	Number of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95% cc ^a
<i>ORNL perimeter stations^b</i>					
3	4	0.45	-0.066	0.12	0.24
4	4	0.43	-0.070	0.14	0.22
7	4	0.14	-0.040	0.053	0.076
9	4	0.056	-0.063	0.0033	0.049
20	4	0.015	-0.060	-0.016	0.037
21	4	0.040	-0.060	0.0083	0.046
22	4	0.062	-0.027	0.011	0.042
Network summary	28	0.45	-0.070	0.045	0.048
<i>Oak Ridge Reservation stations^c</i>					
8	4	0.056	-0.0060	0.026	0.029
23	4	0.039	-0.032	0.0043	0.029
31	4	0.56	-0.050	0.15	0.28
33	4	0.11	0.0080	0.044	0.046
34	4	-0.010	-0.040	-0.025	0.013
36	4	0.054	0.0040	0.031	0.021
40	4	0.085	-0.12	-0.019	0.097
41	4	0.11	-0.022	0.041	0.055
42	4	0.010	-0.014	0.0010	0.011
43	4	0.052	-0.039	0.0088	0.037
44	4	0.20	-0.074	0.033	0.12
45	4	0.16	-0.043	0.061	0.084
46	4	0.027	-0.10	-0.028	0.058
Network summary	52	0.56	-0.12	0.025	0.027
<i>Remote stations^d</i>					
51	4	0.080	-0.013	0.016	0.044
52	4	0.10	-0.080	-0.0025	0.080
53	4	0.080	-0.040	0.030	0.050
55	4	0.15	-0.0070	0.079	0.083

Table 88. (continued)

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
56	4	0.080	0.021	0.048	0.026
57	4	0.045	-0.86	-0.18	0.45
58	4	0.17	0.010	0.070	0.077
Network summary	28	0.17	-0.86	0.0079	0.068

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 89. ^{239}Pu concentrations in soil, June-December 1988

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	1.8	1.0	1.4	0.37
4	4	27	1.8	9.1	12
7	4	1.3	0.058	0.54	0.57
9	4	1.3	0.070	0.74	0.60
20	4	0.15	-0.10	0.016	0.12
21	4	0.14	-0.056	0.041	0.084
22	4	0.77	0.41	0.57	0.15
Network summary	28	27	-0.10	1.8	1.9
<i>Oak Ridge Reservation stations^c</i>					
8	4	0.43	0.17	0.34	0.12
23	4	0.77	0.18	0.49	0.29
31	4	0.87	0.40	0.67	0.21
33	4	1.5	0.24	0.84	0.54
34	4	0.38	0.072	0.22	0.14
36	4	0.97	0.032	0.38	0.43
40	4	1.5	0.42	0.95	0.53
41	4	1.3	0.50	0.90	0.33
42	4	0.13	0.060	0.087	0.030
43	4	0.86	-0.016	0.44	0.41
44	4	0.38	-0.24	0.15	0.28
45	4	1.4	0.11	0.59	0.61
46	4	0.23	0.070	0.15	0.067
Network summary	52	1.5	-0.24	0.48	0.12
<i>Remote stations^d</i>					
51	4	0.41	0.15	0.33	0.12
52	4	1.2	0.48	0.74	0.33
53	4	1.5	0.44	0.99	0.59
55	4	0.98	0.24	0.70	0.32

Table 89. (continued)

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
56	4	0.51	0.34	0.46	0.079
57	4	2.0	0.94	1.4	0.44
58	4	0.060	-0.20	-0.048	0.11
Network summary	28	2.0	-0.20	0.65	0.20

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 90. Total radioactive Sr^a concentrations in soil, June-December 1988

Location	Number of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95% cc ^a
<i>ORNL perimeter stations^c</i>					
3	4	17	6.2	11	5.1
4	4	380	110	210	120
7	4	10	-0.90	4.7	4.5
9	4	15	5.3	8.6	4.5
20	4	2.8	0.80	1.6	0.87
21	4	7.9	2.4	4.3	2.6
22	4	57	1.6	25	26
Network summary	28	380	-0.90	37	31
<i>Oak Ridge Reservation stations^d</i>					
8	4	1.4	0.16	0.76	0.51
23	4	0.94	0.22	0.72	0.34
31	4	24	1.4	9.7	10
33	4	9.5	2.0	4.5	3.4
34	4	5.7	-0.70	2.5	2.7
36	4	8.2	0.79	3.4	3.4
40	4	7.1	2.6	4.9	1.8
41	4	9.6	1.1	4.2	3.8
42	4	4.2	0.30	2.2	2.1
43	4	3.8	1.5	2.7	1.2
44	4	7.4	1.4	3.6	2.6
45	4	6.6	2.2	4.2	2.0
46	4	5.9	3.0	5.1	1.4
Network summary	52	24	-0.70	3.7	1.1
<i>Remote stations^e</i>					
51	4	8.0	2.8	4.8	2.3
52	4	11	8.0	9.3	1.4
53	4	7.3	6.4	7.0	0.43
55	4	12	4.7	7.7	3.1

Table 90. (continued)

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
56	4	17	4.9	11	5.7
57	4	10	2.8	6.3	2.9
58	4	23	-0.70	5.8	12
Network summary	28	23	-0.70	7.4	1.9

^aTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr)

^b95% confidence coefficient about the average.

^cSee Fig. 2.

^dSee Fig. 3.

^eSee Fig. 4.

Table 91. ^{234}U concentrations in soil, June-December 1988

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	13	7.8	10	2.2
4	4	12	10	11	0.96
7	4	15	10	12	2.2
9	4	14	10	12	1.6
20	4	16	8.5	12	3.6
21	4	35	14	26	9.2
22	4	12	10	11	0.82
Network summary	28	35	7.8	13	2.4
<i>Oak Ridge Reservation stations^c</i>					
8	4	17	11	13	2.6
23	4	31	17	24	7.3
31	4	27	12	19	6.5
33	4	17	7.4	13	4.2
34	4	15	7.9	12	3.0
36	4	12	7.3	9.8	2.1
40	4	41	28	34	5.7
41	4	32	15	24	7.0
42	4	12	10	11	1.0
43	4	17	9.1	12	3.6
44	4	12	6.3	8.9	2.4
45	4	190	27	91	70
46	4	28	22	25	2.4
Network summary	52	190	6.3	23	7.6
<i>Remote stations^d</i>					
51	4	11	7.2	9.4	1.6
52	4	22	15	19	3.2
53	4	28	23	26	2.2
55	4	27	13	18	6.4

Table 91. (continued)

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
56	4	11	7.5	9.3	1.5
57	4	27	14	22	5.7
58	4	17	14	15	1.5
Network summary	28	28	7.2	17	2.5

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 92. ^{235}U concentrations in soil, June-December 1988

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	0.50	0.38	0.43	0.057
4	4	0.63	0.39	0.50	0.10
7	4	1.1	0.43	0.77	0.27
9	4	0.90	0.38	0.60	0.24
20	4	0.85	0.39	0.61	0.20
21	4	1.3	1.1	1.2	0.082
22	4	0.53	0.43	0.48	0.042
Network summary	28	1.3	0.38	0.66	0.11
<i>Oak Ridge Reservation stations^c</i>					
8	4	1.6	0.43	0.81	0.55
23	4	1.3	0.76	1.1	0.25
31	4	1.2	0.59	0.85	0.31
33	4	0.97	0.34	0.79	0.30
34	4	0.86	0.36	0.58	0.21
36	4	0.75	0.41	0.56	0.14
40	4	2.5	1.7	2.1	0.34
41	4	1.5	1.2	1.3	0.15
42	4	0.79	0.47	0.60	0.14
43	4	1.7	0.42	0.91	0.58
44	4	0.81	0.30	0.49	0.23
45	4	18	1.2	8.2	7.1
46	4	2.6	1.8	2.3	0.34
Network summary	52	18	0.30	1.6	0.74
<i>Remote stations^d</i>					
51	4	0.38	0.27	0.34	0.053
52	4	2.3	0.92	1.7	0.58
53	4	1.7	1.2	1.4	0.22
55	4	1.7	1.0	1.4	0.33

Table 92. (continued)

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
56	4	0.79	0.25	0.45	0.24
57	4	2.6	0.89	1.6	0.75
58	4	0.92	0.57	0.75	0.17
Network summary	28	2.6	0.25	1.1	0.24

^a95% confidence coefficient about the average.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 93. ^{238}U concentrations in soil, June-December 1988

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
<i>ORNL perimeter stations^b</i>					
3	4	10	5.6	7.3	1.9
4	4	8.4	7.3	7.9	0.49
7	4	12	8.4	9.6	1.6
9	4	11	7.4	9.1	1.7
20	4	14	5.1	8.6	4.3
21	4	21	10	15	4.7
22	4	9.8	6.9	8.4	1.5
Network summary	28	21	5.1	9.4	1.3
<i>Oak Ridge Reservation stations^c</i>					
8	4	9.6	7.1	8.0	1.1
23	4	35	18	27	8.5
31	4	15	7.1	11	3.3
33	4	12	5.3	9.5	3.0
34	4	11	5.6	9.4	2.6
36	4	9.7	5.9	8.2	1.8
40	4	23	17	20	2.6
41	4	20	8.3	15	5.0
42	4	8.8	7.3	8.0	0.69
43	4	12	7.5	8.8	2.1
44	4	8.0	4.6	6.1	1.5
45	4	320	25	130	130
46	4	14	12	13	0.96
Network summary	52	320	4.6	21	13
<i>Remote stations^d</i>					
51	4	10	5.8	7.9	1.7
52	4	20	13	17	3.5
53	4	22	16	20	2.9
55	4	20	11	15	3.9

Table 93. (continued)

Location	Number of samples	Concentration (Bq/kg dry wt)			95% cc ^a
		Max	Min	Av	
56	4	8.7	6.4	7.6	1.1
57	4	21	12	19	4.4
58	4	12	9.2	10	1.2
Network summary	28	22	5.8	14	2.0

^a95% confidence coefficient about the average.

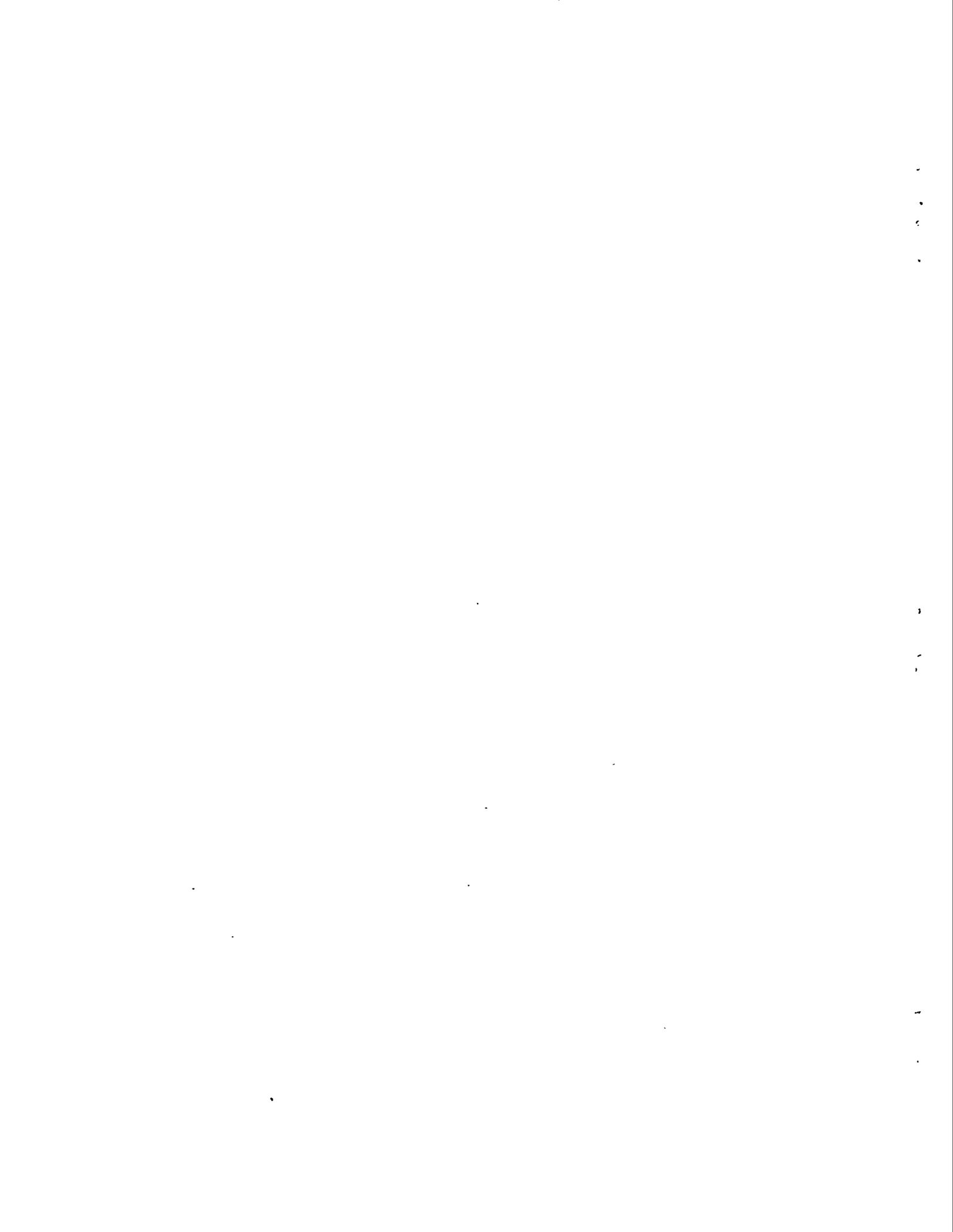
^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

magnitude lower than the 1987 values. This is probably because of a difference in sampling location. The 1987 samples were taken near the corresponding meteorological station, but the 1988 samples were taken at a different location because of construction activity in the vicinity of the meteorological station. For future reference, also note that the construction activity included considerable earth movement and probably altered the concentrations of many substances in the soil in the immediate vicinity of station 40.

Anomalous values of ^{238}Pu in individual samples at stations 3, 4, and 31 caused elevated mean values there but also led to elevated values of the 95% confidence coefficients.



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**OAK RIDGE
NATIONAL
LABORATORY**

**Environmental Surveillance
Data Report for the
Second Quarter of 1986**

MARTIN MARIETTA

**MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY**

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ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR
THE SECOND QUARTER OF 1986

Date Published: September 1986

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EXECUTIVE SUMMARY

During the second quarter of 1986, over 2,200 samples were collected by the Department of Environmental Management which represented over 6,700 analyses and measurements.

Increased I-131 concentrations were detected in mid-May in air and milk samples as a result of the Chernobyl nuclear incident that began with an explosion and fire on April 26, 1986. Iodine-131 concentrations in both air and milk samples were elevated above background for a period of four weeks. Concentrations were so low that there was no significant dose to the public.

In mid June, a local increase in I-131 was observed for one week at four air sampling stations around ORNL. It did not contribute significantly to an increase in the dose to the public.

During the second quarter, ten real-time air monitoring stations were put into operation. These monitors collect 10-minute averages of radiation levels and total rainfall around ORNL, the Oak Ridge Reservation, and in Oak Ridge.

In the second quarter of 1986, greater than 80% of the tritium discharges over White Oak Dam could be attributed to releases from the Solid Waste Storage Area (SWSA 5). Characterization of SWSA 5, particularly the tritium problem there, will be one of the highest priorities of the Remedial Investigation Feasibility Study subcontract which is to be awarded in early 1987.

A new National Pollutant Discharge Elimination System (NPDES) permit was issued to ORNL by the State of Tennessee and the EPA in April. Under the requirements of this permit, for the period April 1 through June 31, 1986, approximately 900 samples were collected from 104 physical locations and approximately 3,000 analyses were performed. During this period, there were 29 violations of the permit limits. Most of these were for oil and grease and suspended solids from parking lot and roof drains. These violations appear to be the result of heavy rains following very dry periods.

The first year of quarterly groundwater sampling from wells around the ORNL surface impoundment areas 3524, 3539-3540, and 7900 was completed in June. The sampling is required by the Tennessee Department of Health and Environment under interim status provisions for RCRA facilities. Further sampling of these sites will be determined based on an evaluation of these results.

INTRODUCTION

The Department of Environmental Management (DEM) within the Environmental and Occupational Safety Division (E&OS) at the Oak Ridge National Laboratory (ORNL) is responsible for environmental surveillance to: (1) assure compliance with all Federal, State, and local standards for the prevention, control, and abatement of environmental pollution, (2) monitor the adequacy of containment and effluent controls, and (3) assess impacts on the environment of releases from ORNL facilities.

To meet these objectives, the DEM has implemented a surveillance program that consists of both monitoring and sampling of the environment. Monitoring provides continuous data at a more gross level for rapid screening of media. Sampling followed by laboratory analyses are usually recommended for routine surveillance rather than constant monitoring. In general, monitoring systems are less sensitive and as a result have much higher detection levels than laboratory analysis. Sampling followed by laboratory analysis provides a quantitative estimate of concentrations or activities which are useful at the lower environmental levels.

The surveillance program for 1986 includes sampling and monitoring of air, water from surface streams and point source process discharges, groundwater, fish, grass, soil, and milk for radioactive and nonradioactive materials. Surveillance points are located on-site to quantify discharges from ORNL facilities around the perimeter of ORNL, and off-site to determine public exposures and to measure background reference levels.

The purpose of this report is to provide personnel in the Laboratory and in Central Management with recent data and to identify additional available sources of information. It is intended strictly as a data report. Each quarter a report will be prepared that summarizes all environmental monitoring data from the various media. At the end of the calendar year, the data will be consolidated in an annual report which will be submitted to DOE containing information on all three Oak Ridge facilities.

Summaries of data will be presented for each month where there are multiple observations per month. For samples collected monthly, quarterly statistics will be presented. In general, the summary tables give the number of samples collected at each station or location and the maximum, minimum, and average values of substances detected. The 95% confidence coefficients (CCs) were calculated from the standard deviation of the sample average (assuming a normal frequency distribution). Where possible, average values were compared with applicable guidelines, criteria, or standards as a means of evaluating the impact of effluent releases and environmental concentrations.

During 1986, the Low-Level Counting Facility at ORNL began reporting radionuclide measurements in a manner different from that of previous years. Prior to 1986, data below the minimum detectable limit were reported as "less than (<)" the detection limit. This year, results that are negative (samples less than instrument background) are reported.

Apparent decreases may be attributed to the reporting of negative values and the subsequent averaging of this data.

Nonradionuclide results that are below the analytical detection limit are expressed as less than (<) the limit. In computing average values, sample results below the limit are assigned the limit, and the resulting average value is expressed as less than the computed value.

The Four-Plant Analytical Committee is reviewing the standardization of reporting of less than detectable values. Their recommendations will be incorporated in these reports as they become policy.

AIR

Most gaseous wastes from ORNL are released to the atmosphere through stacks. Radioactivity may be present in gaseous waste streams as a solid (particulates), as an absorbable gas (iodine), or as a nonabsorbable species (noble gas). Gaseous wastes that may contain radioactivity are processed to reduce the radioactivity to acceptable levels before they are discharged. In addition to monitoring stack discharges to the atmosphere, atmospheric concentrations of materials occurring in the general environment around ORNL, the Oak Ridge Reservation, and the vicinity are monitored continuously by an air monitoring network of 23 stations. Relative locations of these stations are shown in Figures 1-2. These air monitoring stations are categorized into three groups according to their geographical locations:

- (1) The ORNL perimeter air monitoring stations (ORNL PAMs) consist of numbers 3, 7, 9, 21, and 22. These stations are located off-site, but near the ORNL boundary (shown in Figure 1). Stations 21 and 22 are only used for external gamma radiation measurements; there is no sampling equipment. These stations are currently being upgraded to provide sampling capability.
- (2) The DOE Oak Ridge reservation stations (Reservation PAMs) consists of stations 8, 23, 31, 33, 34, 36, 40-45 shown in Figure 1.
- (3) The remote air monitors (RAMs) consists of numbers 51-53 and 55-57. These stations are located within a 120 km radius of ORNL, but outside of the DOE Oak Ridge Reservation (shown in Figure 2).

During the latter part of 1985 and early 1986, ten of the Reservation PAMs were upgraded. Each air station has the capability to perform both sampling and continuous monitoring. At each station, there are monitors for five radiation parameters (gross alpha, gross beta, iodine, gross gamma, and noble gas), a rain gauge, and three process sensors that are used to calculate the volume of the sample collected. A central processor collects 10-minute average readings and transmits them to a VAX computer for further analysis and reporting. The central processor checks the values against alarm limits. All alarms are reported to a printer as they occur. The primary purpose of the monitoring system is to determine if radiation levels on the Reservation are above background levels. If radiation levels appear to be higher than normal, additional sampling can be initiated in order to provide quantitative measures of concentrations in the atmosphere. In addition, sampling is done at each station to quantify levels of iodine, tritium, gross alpha, and gross beta. The real-time monitoring system is the only measure of noble gas in the area.

Airborne radioactive particulates are collected weekly by pumping a continuous flow of air through a paper filter. Between February and April, the air particulate sampling apparatus at all sampling stations was upgraded. The new apparatus is easier to handle and gives a higher

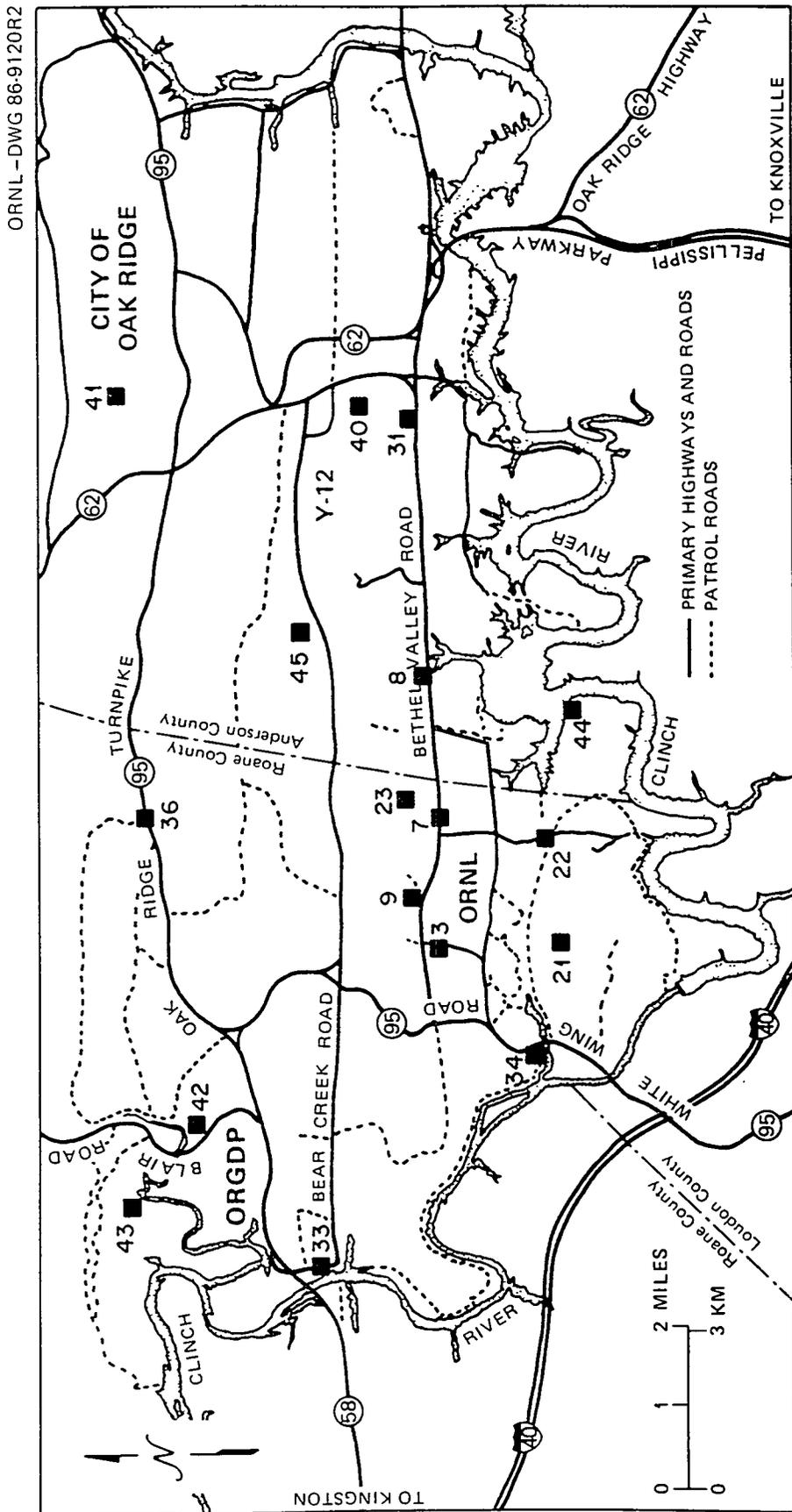


Fig. 1. Location map of the Oak Ridge Reservation air monitoring stations

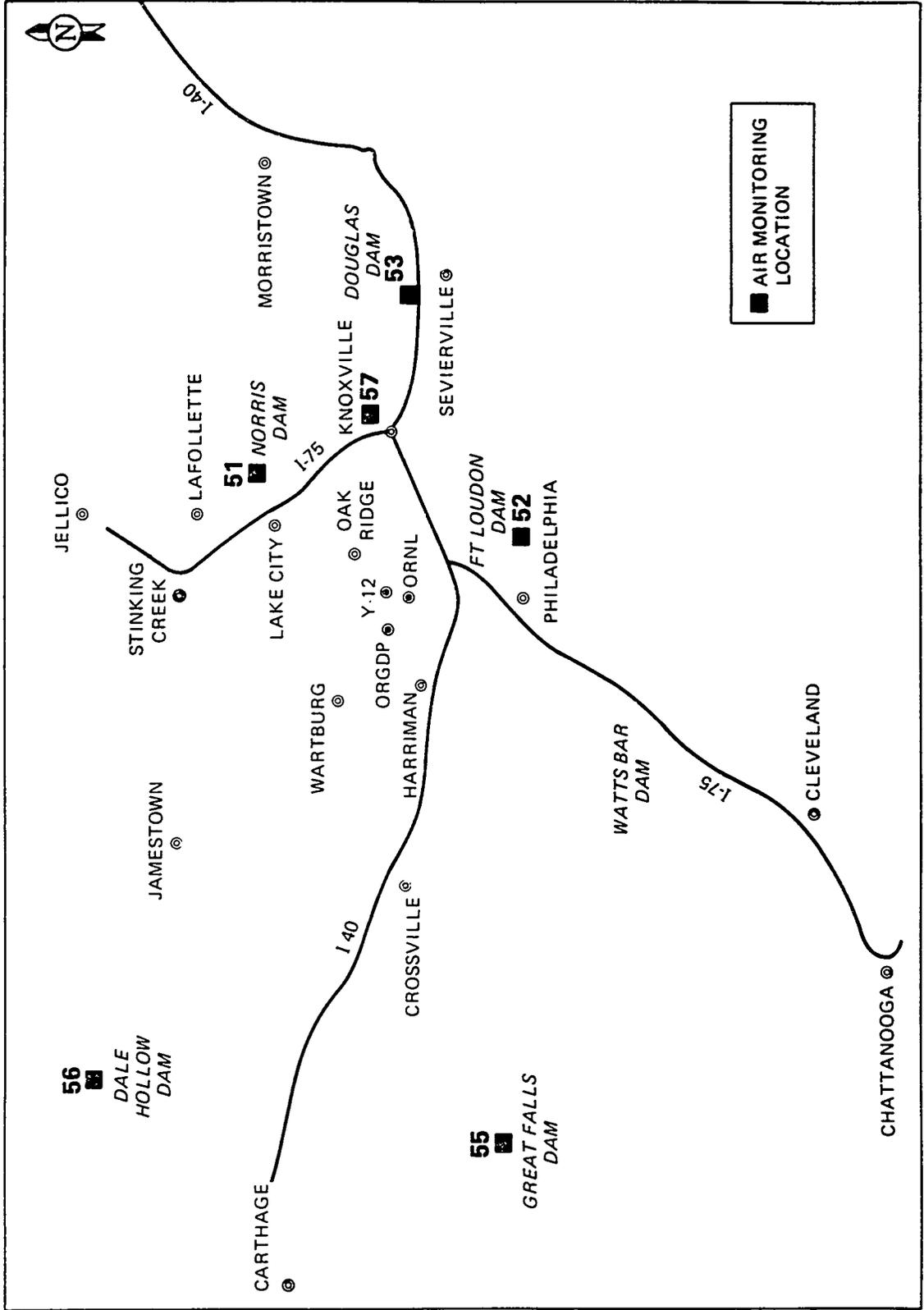


Fig. 2. Location map of the RAM stations

counting efficiency. The filter papers are collected and analyzed weekly for gross alpha and gross beta activity. To minimize artifacts from short-lived radionuclides, the filter papers are analyzed 3-4 days after collection. The airborne ^{131}I is collected weekly in the same fashion but using a cartridge that is packed with active charcoal, instead of using filter paper. The charcoal cartridges are analyzed within 24 hours after collection. The initial and final dates, time on and off, and flow rates are recorded when a sampler is mounted or removed. From this information, total volume of air flow through the sampler at each station is calculated. The concentration of radioactivity in air is calculated by dividing the total activity per sample by the total volume of air.

Monthly (April-June) concentrations of gross alpha, gross beta, and atmospheric ^{131}I are summarized in Tables 1-6. Instrument background concentrations of ^{131}I have been subtracted from the measured concentrations in Tables 4-6. Negative ^{131}I values represent concentrations below the instrument background level. The large "less than" and negative values for gross beta and ^{131}I for station 9 in June are due to pump problems. Most of the radioactivity measured on the sampler was near the minimum detectable level. Pump problems caused the sample volumes to be low, which caused the calculated concentration to be large.

The charcoal samples collected weekly at the air monitoring stations showed an increase in ^{131}I concentrations during the world wide dispersion of a radioactive cloud due to the Chernobyl accident. Figures 3 and 4 plot the weekly averages of ^{131}I concentrations at the ORNL PAMs and the Reservation PAMs. The first peak (week of May 12-19) on both profiles corresponds to the Chernobyl accident whereas the second peak (week of June 16-23) is believed to be caused by a local discharge from ORNL since it was found only in stations 3, 7, 8, and 44. The ORNL stack discharges during this period (June 16-22) do not indicate an increase in ^{131}I released to the atmosphere.

The average peak concentration of ^{131}I from the first peak is about $20\text{E}-7$ Bq/L ($5\text{E}-14$ $\mu\text{Ci}/\text{mL}$). The annual dose equivalent to the total body is about $3\text{E}-4$ mrem and to the thyroid (critical organ) is about 0.5 mrem, assuming that this concentration was the same all year long, that the standard breathing rate for Standard Man was used, and that the air at these stations was breathed for 24-hours per day for 365 days per year. The National Emission Standards for Hazardous Air Pollutants are 25 mrem to the total body and 75 mrem to the critical organ. Although ^{131}I was detected on our charcoal samplers, it was not detected on the real-time perimeter air monitors due to the low concentrations present and the lower sensitivity of these monitors. These concentrations caused no significant dose to the population.

Monthly samples for atmospheric tritium are collected from two ORNL PAM stations (numbers 3 and 7) and one Reservation PAM station (number 8). Atmospheric tritium in the form of water vapor is removed from the air by silica gel. The silica gel is heated in a distillation flask to remove the moisture and the distillate is counted in a liquid scintillation counter. The concentration of tritium in the air is calculated by dividing total activity accumulated per month by total volume of air sampled. Quarterly summaries of atmospheric tritium concentrations are found in Table 7.

Table 1. Long-lived gross alpha and gross beta activities in air

April 1986

Location	Gross alpha						Gross beta					
	No. of samples	Max	Min	AV	95%cc ^a	No. of samples	Max	Min	AV	95%cc ^a		
Concentration (10 ⁻⁸ Bq/L)												
3	4	< 100	< 91	< 93	5.0	4	100	< 91	< 93	5.0		
7	4	< 41	< 41	< 41	0	4	< 41	< 41	< 41	0		
9	4	< 110	< 100	< 100	6.3	4	< 110	< 100	< 100	6.3		
Network summary	12	< 110	< 41	< 79	17	12	< 110	< 41	< 79	17		
ORNL PAM Stations ^b												
8	4	< 35	< 34	< 34	0.75	4	< 35	< 34	< 34	0.75		
23	4	< 18	< 18	< 18	0	4	< 18	< 18	< 18	0		
31	4	36	< 36	< 36	0	4	36	< 36	< 36	0		
33	4	< 45	< 36	< 40	4.4	4	< 45	< 36	< 40	4.4		
34	4	< 36	< 36	< 36	0	4	62	< 36	< 49	11		
36	4	< 45	< 45	< 45	0	4	< 45	< 45	< 45	0		
40	4	36	< 36	< 36	0	4	36	< 36	< 36	0		
41	4	45	< 36	< 41	9.1	4	83	< 45	< 64	38		
42	4	36	< 36	< 36	0	4	47	< 36	< 39	5.2		
43	4	36	< 36	< 36	0	4	36	< 36	< 36	0		
44	4	36	< 36	< 36	0	4	73	< 36	< 45	18		
45	4	36	< 36	< 36	0	4	78	< 36	< 48	20		
Network summary	48	45	< 18	< 36	1.9	48	83	< 18	< 40	3.8		
Reservation PAM Stations ^b												

Table 1. (Continued)

Location	Concentration (10^{-8} Bq/L)									
	Gross alpha					Gross beta				
	No. of samples	Max	Min	Av	95%cca	No. of samples	Max	Min	Av	95%cca
	RAM Stations ^c									
51	4	< 14	< 14	< 14	0	4	30	< 14	< 21	8.2
52	4	< 22	< 16	< 19	2.5	4	22	< 16	< 19	2.5
53	3	< 19	< 19	< 19	0.27	3	39	< 19	< 25	12
55	3	< 21	< 19	< 20	1.3	3	24	< 20	< 22	2.3
56	4	< 18	< 18	< 18	0.18	4	31	< 18	< 21	6.7
57	4	< 15	< 15	< 15	0	4	24	< 15	< 18	4.1
Network summary	22	< 22	< 14	< 17	1.0	22	39	< 14	< 21	2.5
Overall summary	82	< 110	< 14	< 37	5.1	82	< 110	< 14	< 41	5.3

^a 95% confidence coefficient about the mean.

^b See Figure 1.

^c See Figure 2.

Table 2. Long-lived gross alpha and gross beta activities in air

May 1986

Concentration (10^{-8} Bq/L)

Location	Gross alpha				Gross beta				
	No. of samples	Max	Min	AV	No. of samples	Max	Min	AV	95%cc ^a
3	5	< 100	< 100	< 100	5	< 100	< 100	< 100	0
7	5	< 41	< 41	< 41	5	110	< 41	< 55	28
9	5	< 100	< 100	< 110	5	150	< 100	< 110	17
Network summary	15	< 110	< 41	< 83	15	150	< 41	< 89	17
ORNL PAM Stations ^b									
8	5	< 36	< 35	< 35	5	80	< 35	< 50	18
23	4	< 18	< 18	< 18	4	< 18	< 18	< 18	0
31	5	< 36	< 36	< 36	5	170	< 36	< 66	50
33	5	< 45	< 45	< 45	5	450	< 45	< 150	160
34	5	< 36	< 34	< 36	5	350	< 34	< 120	120
36	5	< 45	< 45	< 45	5	190	< 45	< 74	57
40	5	< 84	< 36	< 46	5	650	< 36	< 200	230
41	5	< 91	< 36	< 51	5	800	< 36	< 270	280
42	5	< 73	< 36	< 44	5	200	< 36	< 97	74
43	4	< 91	< 36	< 52	4	250	< 36	< 110	100
44	5	< 85	< 36	< 46	5	500	< 36	< 170	180
45	5	< 73	< 36	< 44	5	680	< 36	< 260	240
Network summary	48	< 91	< 18	< 42	58	800	< 18	< 140	47
Reservation PAM Stations ^b									
						0.68			
						0			
						0			
						1.1			
						0			
						19			
						20			
						15			
						26			
						19			
						15			
						4.1			

Table 3. Long-lived gross alpha and gross beta activities in air

June 1986

Location	Gross alpha						Gross beta					
	No. of samples	Max	Min	Av	95%cc ^a	No. of samples	Max	Min	Av	95%cc ^a		
Concentration (10 ⁻⁸ Bq/L)												
3	4	100	0	33	46	4	100	- 14	32	54		
7	4	41	5.9	16	17	4	41	- 18	1.7	27		
9	4	130	0	44	58	4	130	- 160	- 22	120		
Network summary	12	130	0	31	24	12	130	- 160	4.0	42		
ORNL PAM Stations ^b												
8	4	36	0	10	17	4	36	- 10	4.7	21		
23	4	18	0	10	8.3	4	18	- 3.5	2.9	10		
31	4	36	5.2	16	15	4	130	60	98	37		
33	4	45	- 1.3	12	22	4	130	35	70	44		
34	4	36	- 1.0	9.9	18	4	140	10	68	58		
36	4	45	- 1.3	12	22	4	190	43	110	65		
40	4	36	- .98	15	17	4	230	34	150	83		
41	4	45	6.5	26	39	4	150	53	100	96		
42	4	36	- 1.0	8.4	19	4	120	34	87	39		
43	4	45	- 1.2	12	22	4	150	61	89	40		
44	4	36	- .52	14	16	4	180	58	120	53		
45	4	36	- 1.0	14	16	4	190	21	100	68		
Network summary	48	45	- 1.3	13	4.8	48	230	- 10	82	18		
Reservation PAM Stations ^b												

Table 4. Iodine - 131 in Air

April 1986

Location	No. of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95%cc ^a
ORNL PAM Stations ^b					
3	4	3.5	-12	-2.0	6.6
7	4	13	-6.4	2.8	11
9	4	18	-19	-0.49	15
Network Summary	12	18	-19	0.86	6.1
Reservation PAM Stations ^b					
8	4	9.1	0	4.9	4.9
23	4	4.9	-2.1	2.1	3.0
31	4	4.2	-4.2	-0.35	3.5
33	4	7.0	1.4	4.7	2.4
34	4	4.2	-5.6	-2.5	4.5
36	4	23	0	7.4	10
40	4	5.6	-5.6	-0.35	4.6
41	2	12	0	6.1	12
42	4	9.8	0	4.2	4.4
43	4	1.4	-4.2	-1.4	3.2
44	4	9.8	0	4.2	4.4
45	4	4.2	-4.2	0	3.6
Network summary	46	23	-5.6	2.3	1.6
Overall summary	58	23	-19	1.8	1.8

^a 95% confidence coefficient about the mean.

^b See Figure 1.

Table 5. Iodine - 131 in air
May 1986

Location	No. of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95%cc ^a
ORNL PAM Stations ^b					
3	5	210	0	92	84
7	5	240	-4.8	110	110
9	5	330	12	190	120
Network summary	15	330	-4.8	130	61
Reservation PAM Stations ^b					
8	5	300	8.4	130	110
23	3	77	2.1	33	45
31	4	210	1.4	82	94
33	5	130	-5.3	64	52
34	5	250	0	91	91
36	5	260	-3.5	77	97
40	5	220	0	110	80
41	5	420	4.2	170	170
42	5	160	20	73	51
43	4	230	-8.4	85	120
44	5	310	1.4	120	120
45	5	220	0	110	89
Network summary	56	420	-8.4	99	28
Overall summary	71	420	-8.4	110	26

^a 95% confidence coefficient about the mean.

^b See Figure 1.

Table 6. Iodine - 131 in air

June 1986

Location	No. of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95%cc ^a
ORNL PAM Stations ^b					
3	4	2100	0	580	1000
7	4	430	2.3	120	210
9	4	30	-21	5.6	22
Network summary	12	2100	-21	230	350
Reservation PAM Stations ^b					
8	4	1200	3.6	300	570
23	4	36	4.2	15	15
31	4	17	-2.1	6.2	7.9
33	4	26	0	6.6	13
34	4	21	5.8	13	6.5
36	4	96	8.8	36	41
40	4	22	0	7.0	10
41	2	18	18	18	0
42	4	18	-2.1	7.9	10
43	4	21	0	8.6	9.4
44	4	760	9.8	200	370
45	4	25	2.1	11	10
Network summary	46	1200	-2.1	53	59
Overall summary	58	2100	-21	91	86

^a 95% confidence coefficient about the mean.

^b See Figure 1.

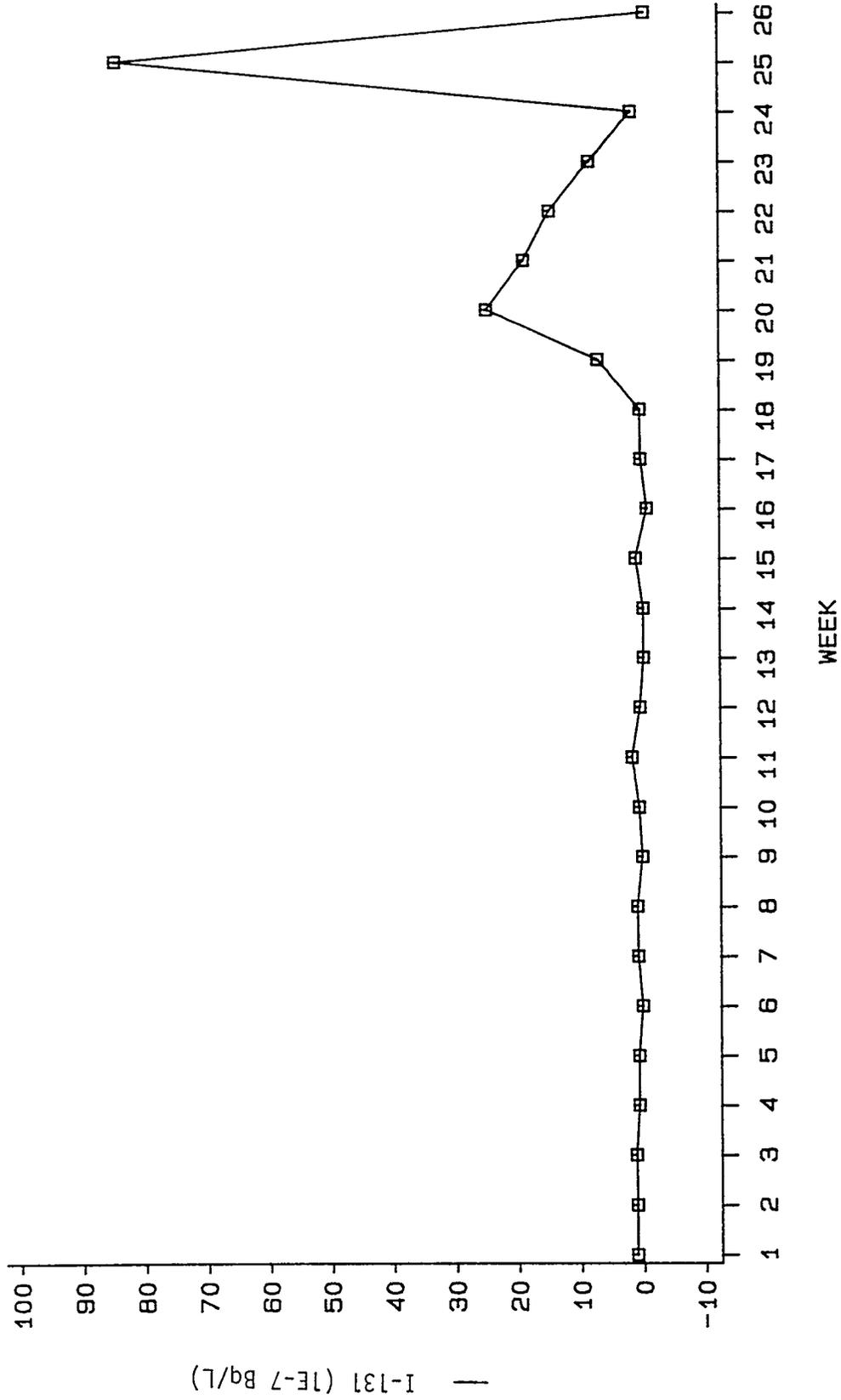


Fig. 3. Weekly average ¹³¹I concentrations for the ORNL PAM stations

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I-131 (1E-7 Bq/L)

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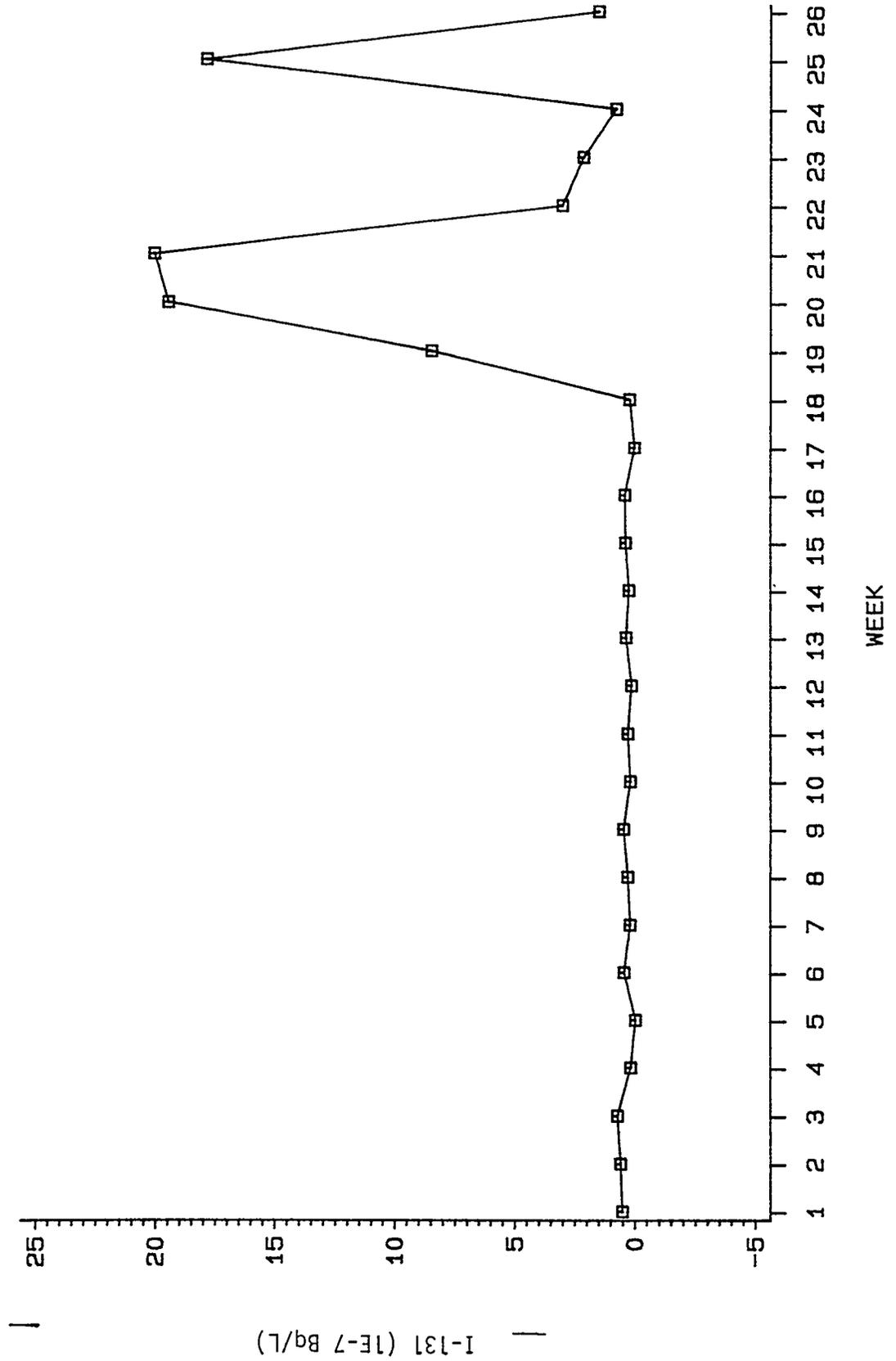


Fig. 4. Weekly average ¹³¹I concentrations for the Reservation PAM stations

Table 7. Tritium activity in air
April - June 1986

Location ^b	No. of samples	Concentration (10^{-4} Bq/L)			
		Max	Min	Av	95%cc ^a
3	3	2.7	2.0	2.4	0.4
7	3	12	0.3	6.3	6.9
8	3	1.4	0.2	0.9	0.7
Overall summary	9	12	0.2	3.2	2.6

^a 95% confidence coefficient about the mean.

^b See Figure 1.

In the past, the weekly air filters from 2 groups (Reservation PAMs and ORNL RAMs) were composited quarterly for analysis of specific radionuclides. For the first quarter of 1986, composite filters were analyzed from ORNL PAMs (stations 3, 7, and 9), Reservation PAMs (excluding stations 36, 40, and 41), RAMs (stations 51-53, and 55-57), and from individual stations (36, 40, and 41). Filters from both the old and the new sampling apparatus were combined for subsequent analysis. The results of specific radionuclide analyses of composited filters are given in Table 8 for the first quarter of 1986. Some of the radionuclide concentrations at the RAMs are higher than at the ORR PAMs. This is probably due to instrument problems since the flowrates at the ORR PAMs are usually 2-4 times lower than at the RAMs and most of the activities measured at the RAMs are close to the detectable limit. The high ^{239}Pu value at station 41 is unusual. This value is being reanalyzed to verify the reliability. The same analysis for the second quarter is approximately $8\text{E}-10$ Bq/L which is comparable with other PAM and RAM stations.

Table 8. Long-lived radioactivity in composited paper filters for the first quarter

January - March 1986

Radionuclide	Concentration (10^{-10} Bq/L)						
	ORNL PAMS	Reservation PAMS	RAMs	Station 36	Station 40	Station 41	Station 41
^{137}Cs	< 1000	< 9.5	37	< 34	< 54	< 40	< 40
^{238}Pu	0.34	0.009	0.068	0.10	0.14	0.13	0.13
^{239}Pu	2.6	0.066	0.80	0.62	0.81	2.7	2.7
^{90}Sr	1200	15	16	55	95	160	160
^{228}Th	21	8.1	5.4	18	32	39	39
^{230}Th	17	6.8	4.6	14	38	32	32
^{232}Th	21	7.4	5.1	15	41	31	31
^{234}U	22	0.9	14	10	39	8.6	8.6
^{235}U	1.6	0.095	1.3	0.51	6.5	0.54	0.54
^{238}U	6.5	0.69	2.9	2.2	6.5	4.3	4.3

^a See Figure 1 and 2.

EXTERNAL GAMMA RADIATION

External gamma radiation measurements are made to confirm that routine radioactive effluents from ORNL are not significantly increasing external radiation levels above normal background.

Currently, external gamma radiation measurements are made monthly at the ORNL PAM stations (Figure 1) and at Reservation PAM station number 8 (Figure 1), quarterly at sites along the bank of the Clinch River (Figure 5), and semiannually at the RAM stations (Figure 2). Measurements along the bank of the Clinch River from the mouth of White Oak Creek for several hundred yards downstream are made in order to evaluate gamma radiation levels resulting from ORNL effluent releases and "sky shine" from an experimental radioactive cesium plot located near the river bank. Measurements at these sites are made using thermoluminescent dosimeters (TLDs) suspended one meter above the ground. Three dosimeters are placed in each container at the remote air monitoring stations and two are placed in containers at the other locations. Measurements from each dosimeter are averaged for the month, quarter, or semiannual period. Since April, real-time readings of external gamma radiation are collected at 10-minute intervals for all Reservation PAM stations (except station 8 which is still measured monthly) and monthly averages are calculated based on the real-time readings. Quarterly summaries of external gamma radiation are found in tables 9 and 10. The average second quarter value for the stations along the Clinch River was elevated 50% above the first quarter value. While the reasons for this increase are not clear, it should be noted that a different TLD reader, a Victoreen vs an Eberline, was used in reading the second quarter TLDs. Fallout from the Chernobyl incident also occurred in the second quarter. The reasons for this difference are being investigated.

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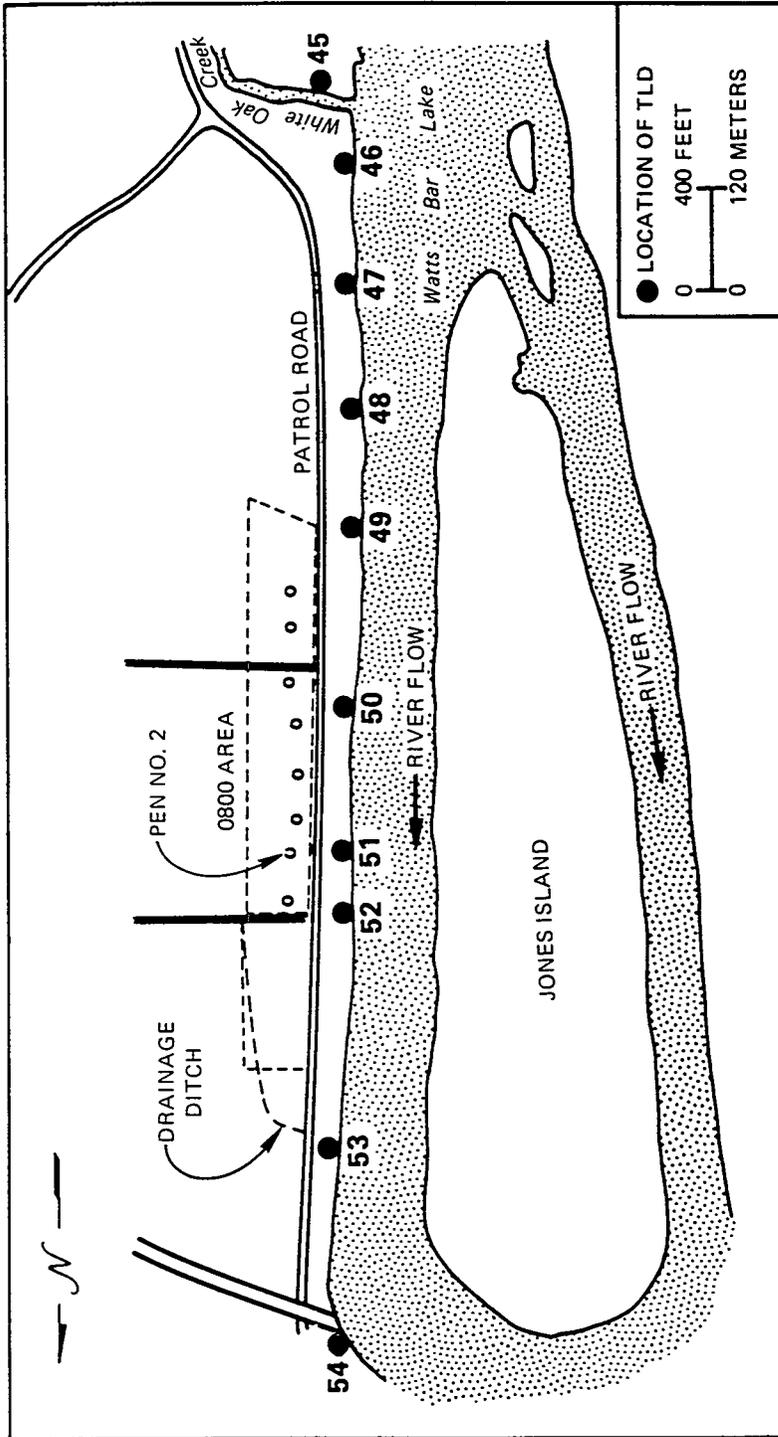


Fig. 5 Location map of TLDs along the Clinch River

Table 9. External gamma radiation measurement

April - June 1986

Location	No. of samples ^a	$\mu\text{R/h}$			
		Max	Min	Av	95%cc
ORNL PAM Stations					
3	3	14	11	13	2.2
7	3	13	10	11	2.1
9	3	16	12	13	2.6
21	3	14	10	13	2.4
22	3	18	12	16	3.5
Network summary	15	18	10	13	1.2
Reservation PAM Stations					
8	2	12	10	11	1.8
31	85	12	7.3	7.8	0.11
33	8	7.7	4.0	6.9	0.85
34	70	11	9.0	10	0.14
36	87	8.1	7.0	7.3	0.03
40	74	9.0	7.7	8.2	0.06
41	91	9.2	7.9	8.4	0.04
42	81	9.2	6.1	7.5	0.07
43	77	9.0	6.4	7.0	0.08
44	89	14	5.9	7.4	0.21
45	85	8.3	4.3	7.3	0.08
Network summary	749	14	4.0	7.9	0.08

^a For locations 3,7,8,9,21,22, each month individual dosimeters are first averaged for each station. The number of samples indicate the number of months of data.

For locations 31,33,34,36,40-45, real-time readings were collected from these stations at 10-minute intervals. The number of samples indicate the total number of days.

Table 10. External gamma radiation measurements
along the Clinch River

Location ^a	No. of samples ^b	$\mu\text{R/h}$		
		Jan.-March	April-June	Av
45	2	15	29	22
46	2	20	33	27
47	2	23	40	31
48	2	24	35	30
49	2	26	35	30
50	2	35	56	45
51	2	39	50	45
52	2	31	47	39
53	2	24	47	36
54	2	26	30	28
Quarterly Average		— 26	— 40	

^a See Figure 5.

^b For each quarter, individual dosimeters are first averaged for each station. The number of samples indicates the number of quarters of data.

WATER

Most of the drainage or liquid effluent from the Oak Ridge Reservation flows into the Clinch River by way of its principal tributary, White Oak Creek (WOC). The Clinch River flows southwest from Virginia to its mouth near Kingston, Tennessee, where it joins with the Tennessee River.

Runoff from the majority of the sites at ORNL, including that from the burial grounds, reaches WOC either directly or via one of its tributaries, such as Melton Branch. Concentrations of contaminants in WOC are affected by White Oak Dam (WOD) which controls the stream's flow. Flow in WOC may also be augmented by discharges from the ORNL cooling towers and Sewage Treatment Plant. Below WOD, WOC is affected by water levels in the Clinch River which are controlled by Melton Hill Dam, shown in Figure 6.

Surveillance of the water environment consists of the collection of surface water samples, samples required under the National Pollutant Discharge Elimination System (NPDES) permit, and water from wells around surface impoundments. Samples are analyzed for radionuclides and nonradioactive chemicals.

ORNL DWG 86 12026R

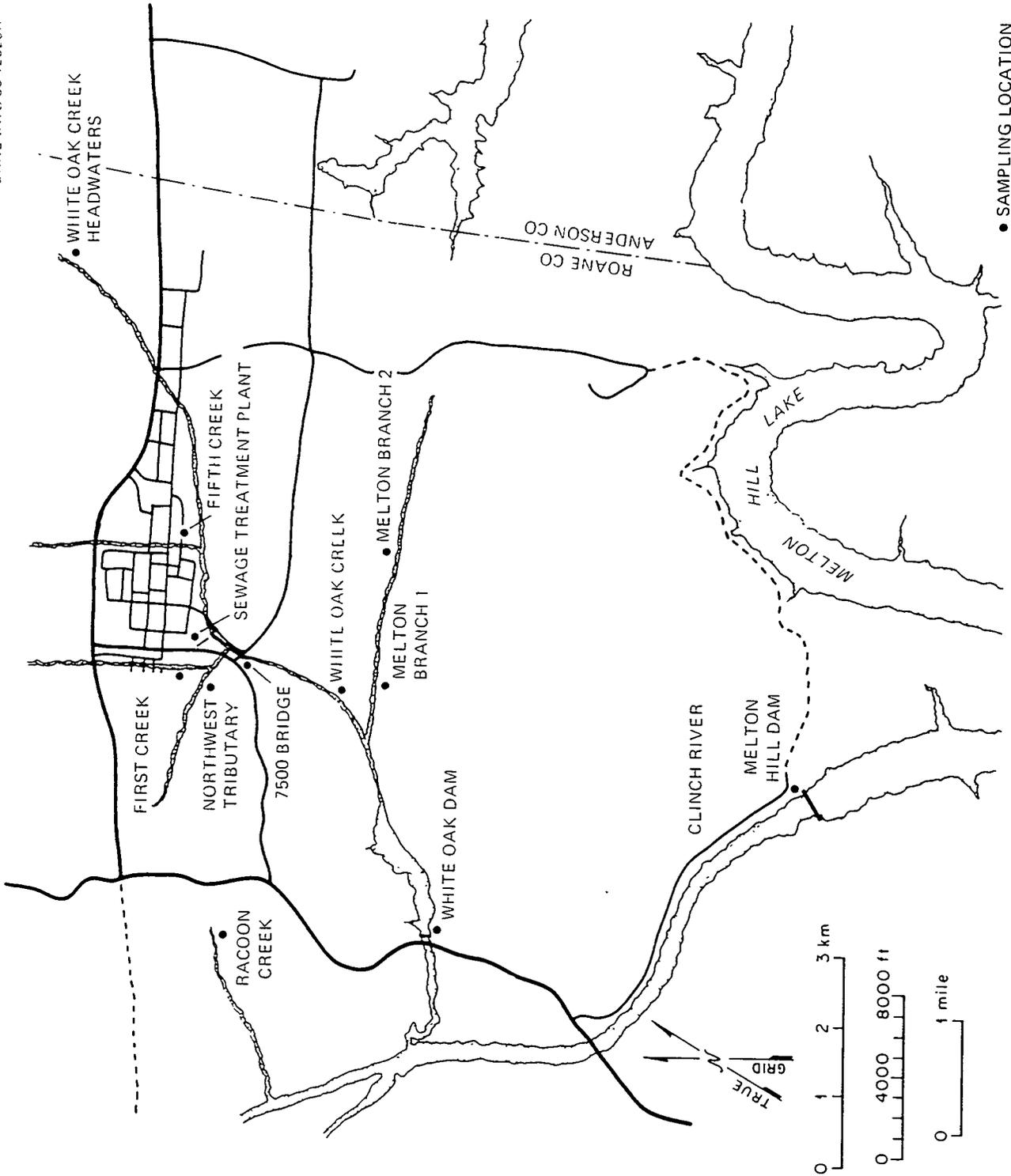


Fig. 6 Location map of ORNL streams

● SAMPLING LOCATION

Surface Water

White Oak Creek drains an area of 17 Km² in Bethel and Melton Valleys and is the largest stream flowing through ORNL. Run-off from sites at ORNL reaches WOC either directly or via one of its tributaries. After entering Melton Valley, White Oak Creek is joined by its major tributary, Melton Branch, at WOC kilometer 2.49. White Oak Dam, located one kilometer above the mouth of WOC, forms White Oak Lake and serves as a point for monitoring flow and discharges of contaminants from the ORNL site. Major discharges to WOC include (1) treated domestic (sanitary) waste from the Sewage Treatment Plant; (2) cooling tower blowdown; (3) cooling water; (4) demineralizer regeneration waste; (5) surface drainage from the main Laboratory area (including drainage from several Solid Waste Storage Areas, SWSAs); (6) discharges from the low-level radioactive waste collection and ion exchange treatment system; and (7) discharges from process building areas. Major discharges to Melton Branch include discharges from Solid Waste Storage Area 5, blowdown from the recirculating cooling water system at the High Flux Isotope Reactor, and discharges from the 7900 waste pond system.

To determine discharges of radionuclides from ORNL processes, flow and concentration data from ORNL streams are recorded. Water samples are collected regularly from the following stations: First Creek, Fifth Creek, 7500 Bridge, Melton Branch 1 (MB1), Melton Branch 2 (MB2), Melton Hill Dam, Northwest Tributary (NWT), Raccoon Creek, Sewage Treatment Plant (STP), White Oak Creek (WOC), White Oak Creek Headwaters, and White Oak Dam (WOD) (Figure 6). In addition, processed water samples are collected from the sanitary waste treatment plants at the Oak Ridge Gaseous Diffusion Plant (ORGDP - Gallaher) and at Kingston (Figure 7). ORNL tap water is also sampled. Samples collected from Melton Hill Dam, WOC Headwaters, and ORNL tap are considered as background or reference samples.

Table 11 summarizes the sampling and analysis frequencies, the parameters analyzed, and the type of sample collected at each of these stations. Flow proportional samples at 7500 Bridge are collected and analyzed daily as an early warning of discharges of radioactivity from ORNL processes. Another sample is collected weekly and analyzed monthly for additional parameters. The flow proportional samples from WOD are collected and analyzed weekly while those from WOC, MB1, STP, and Melton Hill Dam are collected weekly, composited, and analyzed monthly. Grab samples from First Creek, Fifth Creek, MB2, NWT, Raccoon Creek, and WOC Headwaters are collected weekly, composited, and analyzed monthly. The time proportional samples from ORGDP and the grab samples from Kingston and ORNL tap water are composited and analyzed quarterly. Summaries of radionuclide concentrations are presented in Tables 12-14.

Flow in the Clinch River and in WOC as measured at WOD and the ratio of these flows are presented in Table 15. Total flow per day at MB1, WOC, and WOD, are calculated by subtracting consecutive daily flow recorder readings and multiplying by a factor for conversion to liters. Clinch River flow is recorded daily by personnel of the Tennessee Valley Authority and forwarded monthly to the Department of Environmental Management. Low and high readings are recorded for WOC and MB1 and are summed to estimate total flow. Three readings: low, medium, and high are recorded at WOD and summed to

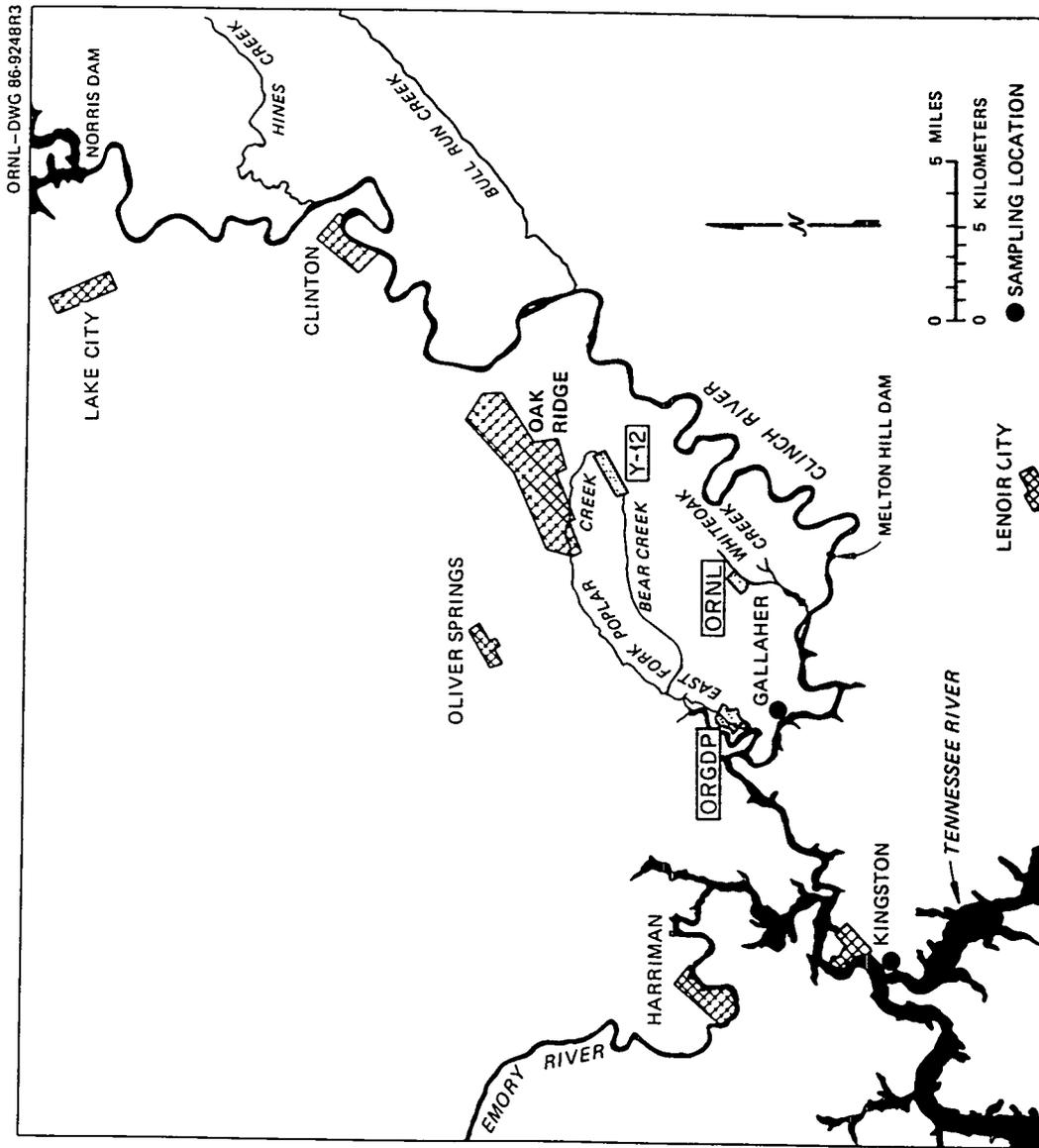


Fig. 7 Location map of Gallaher and Kingston sampling points

Table 11. Summary of collection and analysis frequencies of surface and tap water samples

Station	Parameter	Collection frequency	Type	Analysis frequency
7500 Bridge	Gross alpha, gross beta, gamma scan, ^{90}Sr	Daily	Flow Proportional	Daily
7500 Bridge, MB1,	Gamma scan, ^{90}Sr , ^3H	Weekly	Flow Proportional	Monthly
First Creek, Fifth Creek, NWT, Raccoon Creek,	Gamma scan, ^{90}Sr	Weekly	Grab	Monthly
Kingston	^3H	Weekly	Grab	Monthly
	Gamma scan, ^{90}Sr , Pu, transPu, U	Monthly	Grab	Quarterly
MB2	Gamma scan, ^{90}Sr , ^3H	Weekly	Grab	Monthly
Melton Hill Dam	Gamma scan, ^{90}Sr , Pu, transPu, ^3H , Th, U	Weekly	Flow Proportional	Monthly
ORGDP	^3H	Weekly	Time Proportional	Monthly
	Gamma scan, ^{90}Sr , Pu	Monthly	Time Proportional	Quarterly
ORNL tap	Gamma scan, ^{90}Sr , Pu, transPu, U	Daily	Grab	Quarterly
STP	Gamma scan, ^{90}Sr	Weekly	Flow Proportional	Monthly
WOC	Gamma scan, ^{90}Sr , ^3H	Weekly	Flow Proportional	Monthly
WOC Headwaters	Gamma scan, ^{90}Sr , Pu, transPu, ^3H	Weekly	Grab	Monthly
WOD	Gross alpha, gross beta, gamma scan, ^{90}Sr , Pu, transPu, ^3H	Weekly	Flow Proportional	Weekly

Table 12. Radionuclide concentrations in water
April - June 1986

Radionuclide	No. of samples	Concentration (Bq/L)			
		Max	Min	Av	95%cc ^a
First Creek ^b					
⁶⁰ Co	3	0.47	0.12	0.26	0.21
¹³⁷ Cs	3	< 0.20	< 0.090	< 0.13	0.070
⁹⁰ Sr	3	27	17	22	5.8
Fifth Creek ^b					
⁶⁰ Co	3	< 0.20	< 0.060	< 0.11	0.093
¹³⁷ Cs	3	< 0.10	< 0.050	< 0.073	0.029
⁹⁰ Sr	3	1.6	1.4	1.5	0.13
7500 Bridge ^b					
⁶⁰ Co	3	0.21	0.18	0.20	0.018
¹³⁷ Cs	3	8.6	6.4	7.4	1.3
³ H	3	300	150	250	99
⁹⁰ Sr	3	3	2.5	2.7	0.29
Melton Branch 1 ^b					
⁶⁰ Co	3	14	12	13	1.2
¹³⁷ Cs	3	0.14	< 0.10	< 0.12	0.024
³ H	3	120000	67000	91000	29000
⁹⁰ Sr	3	11	7.9	9.2	1.9
Melton Branch 2 ^b					
⁶⁰ Co	3	7.0	4.6	5.5	1.5
¹³⁷ Cs	3	< 0.10	< 0.060	< 0.080	0.024
³ H	3	3000	1400	2400	960
⁹⁰ Sr	3	0.62	0.14	0.32	0.31

Table 12. Continued

April - June 1986

Radionuclide	No. of samples	Concentration (Bq/L)			
		Max	Min	Av	95%cc ^a
Melton Hill Dam ^b					
⁶⁰ Co	3	< 0.070	< 0.060	< 0.067	0.0070
¹³⁷ Cs	3	< 0.060	< 0.050	< 0.053	0.0070
³ H	3	180	120	139	44
Pu	3	0.0010	0.00050	0.0010	0.00012
⁹⁰ Sr	3	0.26	0.10	0.17	0.096
²²⁸ Th	3	0.0010	< 0.0010	< 0.0010	0.0
²³⁰ Th	3	0.0010	< 0.0010	< 0.0010	0.0
²³² Th	3	0.0010	< 0.00050	< 0.0010	0.00033
Trans Pu	3	0.0010	0.00050	0.0010	0.00029
²³⁴ U	3	0.018	0.00020	0.0080	0.010
²³⁵ U	3	0.0080	0.000070	0.003	0.0053
²³⁸ U	3	0.011	0.00040	0.0048	0.0064
Northwest Tributary ^b					
⁶⁰ Co	3	0.11	< 0.060	< 0.077	0.033
¹³⁷ Cs	3	0.12	< 0.050	< 0.087	0.041
⁹⁰ Sr	3	1.8	0.78	1.3	0.59
Raccoon Creek ^b					
⁶⁰ Co	3	< 0.10	< 0.070	< 0.082	0.018
¹³⁷ Cs	3	< 0.10	< 0.050	< 0.067	0.033
⁹⁰ Sr	3	4.0	1.7	3.1	1.4
Sewage Treatment Plant ^b					
⁶⁰ Co	3	< 0.30	< 0.070	< 0.19	0.13
¹³⁷ Cs	3	0.35	< 0.20	< 0.28	0.087
⁹⁰ Sr	3	8.1	4.7	6.2	2.0
White Oak Creek ^b					
⁶⁰ Co	3	0.22	< 0.070	< 0.17	0.097
¹³⁷ Cs	3	6.3	4.8	5.7	0.94
³ H	3	990	310	650	390
⁹⁰ Sr	3	6.0	3.4	4.4	1.6

Table 12. Continued

April - June 1986

Radionuclide	No. of samples	Concentration (Bq/L)			
		Max	Min	Av	95%cc ^a
White Oak Creek Headwaters ^b					
⁶⁰ Co	3	< 0.10	< 0.080	< 0.093	0.013
¹³⁷ Cs	3	< 0.080	< 0.060	< 0.070	0.013
³ H	3	2600	120	970	1600
Pu	3	0.0010	0.00040	0.00063	0.00037
⁹⁰ Sr	3	0.26	0.013	0.11	0.15
²²⁸ Th	3	0.0010	< 0.0010	< 0.0010	0.0
²³⁰ Th	3	0.0010	< 0.0010	< 0.0010	0.0
²³² Th	3	0.0010	< 0.0010	< 0.0010	0.0
TrPu	3	0.0020	0.0011	0.0017	0.00060
²³⁴ U	3	0.011	0.00030	0.0041	0.0069
²³⁵ U	3	0.0010	0.000050	0.00065	0.00060
²³⁸ U	3	0.0039	0.00050	0.0018	0.0021
White Oak Dam ^b					
⁶⁰ Co	13	1.1	0.29	0.70	0.13
¹³⁷ Cs	13	3.2	0.80	2.0	0.47
Gross alpha	13	5.3	0.40	2.6	0.85
Gross beta	13	27	13	19	2.4
³ H	13	20000	3600	11000	2700
Pu	13	0.024	0.0016	0.0065	0.0032
⁹⁰ Sr	13	9.1	0.15	5.7	1.3
TrPu	13	0.085	0.016	0.042	0.012

^a 95% Confidence coefficient about the mean.

^b See Figure 6.

Table 13. Radionuclide concentrations in water at 7500 Bridge^a
January - June 1986

Radionuclide	No. of samples	Concentration (Bq/L)			
		Max	Min	Av	95% cc ^b
January					
¹³⁷ Cs	30	83	1.3	11	5.9
¹⁵² Eu	4	5.0	1.9	2.7	1.5
Gross Alpha	28	53	<1.0	<12	3.5
Gross Beta	30	130	8.0	32	8.2
⁹⁰ Sr	32	8.6	2.7	4.4	0.54
February					
⁶⁰ Co	3	0.83	<0.20	<0.44	0.39
¹³⁷ Cs	5	2.7	1.0	1.8	0.75
¹⁵² Eu	4	50	0.78	27	22
¹⁵⁴ Eu	3	15	5.8	11	5.4
¹⁵⁵ Eu	3	4.1	0.83	2.4	1.9
¹⁵⁶ Eu	3	45	20	34	15
⁹⁰ Sr	27	8.9	2.5	4.1	0.48
March					
⁹⁰ Sr	20	10	2.1	4.2	1.0
April					
⁹⁰ Sr	22	11	2.4	4.7	0.82
May					
⁶⁰ Co	12	0.42	<0.10	<0.21	0.049
¹³⁷ Cs	12	14	4.8	8.5	1.3
⁴⁰ K	2	<1.0	<1.0	<1.0	0.0
²⁴ Na	4	1.8	0.86	1.4	0.42
⁹⁰ Sr	21	4.0	1.9	3.0	0.25
June					
⁶⁰ Co	19	0.49	0.12	0.29	0.047
¹³⁷ Cs	19	18	4.6	9.3	1.6
⁹⁰ Sr	21	3.6	1.5	2.5	0.22

^a See Figure 6.

^b 95% confidence coefficient about the average.

Table 14. Quarterly concentrations of radionuclides in surface streams and tap water

January - March 1986

Radionuclide	Concentration Bq/L
Gallahe ^a	
⁶⁰ Co	< 0.0090
¹³⁷ Cs	< 0.0070
³ H	43
Pu ^b	< 0.00011
⁹⁰ Sr	0.058
²³⁴ U	0.0039
²³⁵ U	0.00013
²³⁶ U	0.0000053
²³⁸ U	0.0027
Kingston ^a	
⁶⁰ Co	< 0.0070
¹³⁷ Cs	< 0.0060
³ H	0.0
Pu ^b	< 0.00011
⁹⁰ Sr	0.020
²³⁴ U	0.0043
²³⁵ U	0.00013
²³⁶ U	0.000017
²³⁸ U	0.0025
ORNL Tap Water	
⁶⁰ Co	< 0.010
¹³⁷ Cs	< 0.010
Pu ^b	< 0.00011
⁹⁰ Sr	0.0070
²³⁴ U	0.0013
²³⁵ U	0.000035
²³⁶ U	0.0000014
²³⁸ U	0.00071

^a See Figure 7.

^b Total Pu (²³⁹Pu + ²⁴⁰Pu)

Table 15. Flow for Clinch River and White Oak Creek
January - June 1986

Month	Flow (10 ⁹ Liters)		Average ratio ^b
	Clinch River ^a	White Oak Creek ^a	
January	300	0.83	360
February	200	1.5	170
March	200	1.2	200
April	90	0.71	130
May	180	0.54	330
June	180	0.55	320

^aSee Figure 6.

^bRatio of Clinch River to White Oak Creek flow is calculated weekly and averaged for the month.

give total flow. The weekly total flow is determined by averaging the total flow for the week and multiplying by the number of days in the week. WOD discharge is the average of weekly discharges multiplied by the number of weeks in the month. The discharges at MBI and WOC are based on a monthly sample and daily flows. The average flow proportional monthly concentrations are based on the total discharges divided by the total flow for the month. Monthly discharges are given in Tables 16-18.

Tritium and strontium-90 are the radionuclides of greatest concern in terms of radiation doses to the public from ORNL surface water discharges. In the second quarter of 1986, greater than 80% of the tritium discharges over White Oak Dam could be accounted for by the discharges of tritium over the Melton Branch 1 weir. The tritium values measured at Melton Branch 1 appear to be due primarily to releases from SWSA 5. Tritium values measured at the Melton Branch 1 weir, which is below the area where SWSA 5 discharges to Melton Branch, are generally more than an order of magnitude higher than values measured at the Melton Branch 2 weir above the SWSA 5 area.

Characterization of SWSA 5 and particularly the tritium problem in SWSA 5 will be one of the highest priorities of the Remedial Investigation Feasibility Study (RI/FS) subcontract. This characterization which is scheduled to begin in April, 1987, is necessary in order to comply with Resource Conservation and Recovery Act (RCRA) requirements and to determine the measures necessary to most effectively reduce the flow of tritium and/or other contaminants from SWSA 5.

Second quarter tritium discharges at both White Oak Dam and Melton Branch 1 were significantly lower (less than 50%) than their respective first quarter discharges. However, the decreases were primarily the result of decreased rainfall resulting in lower than normal flows, instead of decreases in the measured concentrations of tritium. Both the concentrations and discharges of strontium-90 were below normal in the second quarter of 1986. This can be attributed primarily to the lower than normal levels of precipitation, since it is believed that a significant portion (> 50%) of the strontium-90 discharges, during periods of normal rainfall, are the result of runoff.

Table 16. Discharges of radionuclides in water

April 1986

Radionuclide	Flow (10 ⁶ Liters)	Concentration (Bq/L)	Discharge (10 ⁴ mega Bq)
Melton Branch 1 ^a			
⁶⁰ Co	83	12	0.10
¹³⁷ Cs	83	0.11	0.00091
³ H	83	120000	970
⁹⁰ Sr	83	11	0.091
Sewage Treatment Plant ^a			
⁶⁰ Co	32	< 0.20	< 0.00064
¹³⁷ Cs	32	0.28	0.00089
⁹⁰ Sr	32	8.1	0.026
White Oak Creek ^a			
⁶⁰ Co	530	0.21	0.011
¹³⁷ Cs	530	6.3	0.33
³ H	530	990	52
⁹⁰ Sr	530	6.0	0.32
White Oak Dam ^{a, b}			
⁶⁰ Co	710	0.7	0.05
¹³⁷ Cs	710	2.0	0.14
Gross alpha	710	3.4	0.24
Gross beta	710	22	1.6
³ H	710	16000	1200
⁹⁰ Sr	710	7.8	0.56
Transuranics	710	0.10	0.0040

^a See Figure 6.

^b Concentration is a flow weighted average of the weekly samples.
Discharge is the total for the month.

Table 17. Discharges of radionuclides in water

May 1986

Radionuclide	Flow (10 ⁶ Liters)	Concentration (Bq/L)	Discharge (10 ⁴ mega Bq)
Melton Branch 1 ^a			
⁶⁰ Co	59	14	0.083
¹³⁷ Cs	59	< 0.10	< 0.00060
³ H	59	90000	530
⁹⁰ Sr	59	8.7	0.051
Sewage Treatment Plant ^a			
⁶⁰ Co	29	< 0.070	< 0.00020
¹³⁷ Cs	29	0.35	0.0010
⁹⁰ Sr	29	5.8	0.017
White Oak Creek ^a			
⁶⁰ Co	460	0.22	0.010
¹³⁷ Cs	460	6.1	0.28
³ H	460	640	29
⁹⁰ Sr	460	3.7	0.17
White Oak Dam ^{a, b}			
⁶⁰ Co	540	0.87	0.048
¹³⁷ Cs	540	2.5	0.13
Gross alpha	540	2.1	0.12
Gross beta	540	17	0.90
³ H	540	9600	520
⁹⁰ Sr	540	4.1	0.22
Transuranics	540	0.060	0.0034

^a See Figure 6.

^b Concentration is a flow weighted average of the weekly samples.
Discharge is the total for the month.

Table 18. Discharges of radionuclides in water

June 1986

Radionuclide	Flow (10 ⁶ Liters)	Concentration (Bq/L)	Discharge (10 ⁴ mega Bq)
Melton Branch 1 ^a			
⁶⁰ Co	44	13	0.057
¹³⁷ Cs	44	0.10	0.00060
³ H	44	67000	290
⁹⁰ Sr	44	7.9	0.035
Sewage Treatment Plant ^a			
⁶⁰ Co	15	< 0.30	< 0.00044
¹³⁷ Cs	15	< 0.20	< 0.00030
⁹⁰ Sr	15	4.7	0.0070
White Oak Creek ^a			
⁶⁰ Co	510	< 0.070	< 0.0036
¹³⁷ Cs	510	4.8	0.25
³ H	510	320	16
⁹⁰ Sr	510	3.4	0.17
White Oak Dam ^{a, b}			
⁶⁰ Co	550	0.63	0.035
¹³⁷ Cs	550	1.6	0.086
Gross alpha	550	2.2	0.12
Gross beta	550	17	0.92
³ H	550	6000	330
⁹⁰ Sr	550	4.8	0.26
Transuranics	550	0.030	0.0016

^a See Figure 6.

^b Concentration is a flow weighted average of the weekly samples.
Discharge is the total for the month.

National Pollutant Discharge Elimination System (NPDES) Requirements

Under the requirements of the Clean Water Act, a new NPDES permit was issued to ORNL and became effective on April 1, 1986. Prior to that time, only three stations were sampled for compliance with permit limits. These points were in two major drainage areas (White Oak Creek and Melton Branch) and at the Sewage Treatment Plant. The new permit has over 183 stations and is designed to monitor point sources at their point of discharge into receiving streams (Figure 8). In addition, there are some sampling locations that are located in the streams as reference points or for additional information. The sampling locations and permit requirements are described below:

1. Point Source Outfalls - These outfalls are discernable, confined, and discrete conveyances from which a process stream is discharged to receiving waters. The effluent must be monitored before it reaches the receiving water, or mixes with any other wastewater stream. Point source outfalls include:

<u>NPDES Number</u>	<u>Location</u>	<u>M*</u>	<u>L*</u>
X01	Sewage Treatment Plant		X
X02	Coal Yard Runoff Treatment Facility		X
X03	1500 Area	X**	
X04	2000 Area	X**	
X06	190 Ponds (3539 and 3540)	X**	
X07	Process Waste Treatment Plant	X**	
X08	TRU Ponds	X**	
X09	HFIR Ponds	X**	
X10	ORR Resin Regeneration Facility	X**	
X11	Acid Neutralization Facility	X**	
X12	Nonradiological Wastewater Treatment Plant		X***

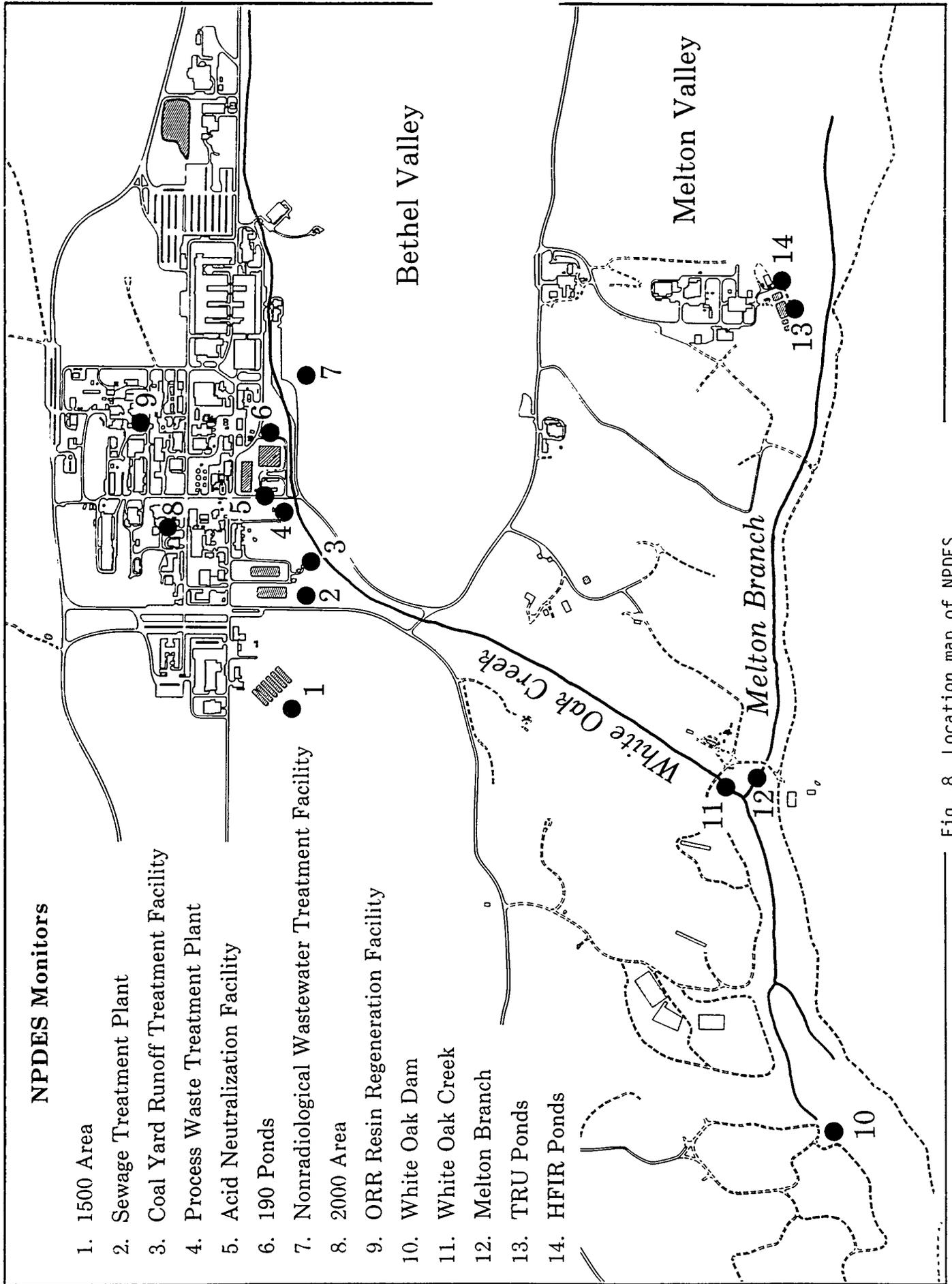
* M = monitoring only, L = concentration or mass limits

** pH is limited at all outfalls

*** March 1990 compliance

Composite samples are collected by either automatic samplers or as grab samples. New monitoring stations were installed at X02, X04, X06, X08, X09, X10, and X11.

2. Ambient Monitoring Stations - Because of historical data and in order to obtain information on total ORNL discharges before they enter the Clinch River, Melton Branch 1, White Oak Creek and White Oak Dam have been placed on the permit for monitoring purposes only. All three of these ambient stations have newly constructed (1984) weirs and monitoring stations. White Oak Dam has two gates which can be lowered in case of potentially hazardous releases.
3. Category I Outfalls - Storm Drains - There are 35 discharge pipes to receiving streams which have been characterized by ORNL and identified in the NPDES permit as storm drains. These outfalls are uncontaminated by any activity and do not discharge through any



NPDES Monitors

- 1. 1500 Area
- 2. Sewage Treatment Plant
- 3. Coal Yard Runoff Treatment Facility
- 4. Process Waste Treatment Plant
- 5. Acid Neutralization Facility
- 6. 190 Ponds
- 7. Nonradiological Wastewater Treatment Facility
- 8. 2000 Area
- 9. ORR Resin Regeneration Facility
- 10. White Oak Dam
- 11. White Oak Creek
- 12. Melton Branch
- 13. TRU Ponds
- 14. HFIR Ponds

Fig. 8 Location map of NPDES monitoring points

oil/water separator or other treatment equipment or facility. Limits have been placed on the following parameters: pH, temperature, oil and grease, and total suspended solids. Samples are taken from the nearest accessible point prior to actual discharge or mixing with receiving waters.

4. Category II Outfalls - The following discharge pipes have been characterized by ORNL and identified in the NPDES permit as Category II Outfalls:

44 parking lot and roof drains
8 condensate drains
7 cooling tower drains
2 storage area drains

These outfalls are considered to be contaminated by ORNL activities, but are not discharged through any oil/water separator or other treatment equipment or facility. Limits have been placed on the following parameters: pH, temperature, oil and grease, and total suspended solids.

5. Category III Outfalls - Untreated Process Drains - There are 32 discharge pipes which have been characterized by ORNL and identified in the NPDES permit as untreated process drains. These outfalls are actually either Category I or Category II Outfalls, but because of inflow/infiltration, cross-connects, or improper disposal of chemicals, have become contaminated with pollutants. Further characterization and determination of the source of the pollutants is underway, with the goal of eliminating any untreated process discharge to receiving waters. The only limitation placed on these outfalls is pH.
6. Miscellaneous Source Discharges - These discharges are those which have not been identified in the NPDES permit as a serial numbered discharge, and they are specific to special categories identified by the EPA. Limitations have been placed on all Miscellaneous Source Outfalls. ORNL has the following facilities which have been placed in those categories:

Twenty-six cooling towers
1 Boiler (Building 2519, Central Steam Plant)
1 Vehicle and Equipment Cleaning Facility (Building 7002)
1 Painting and Corrosion Control Facility (Building 7007)
1 Vehicle and Equipment Maintenance Facility (Building 7002)
4 Photographic Laboratories (Buildings 1500, 4500N, 7934, 7601)
1 Firefighter Training Area (outside Building 2500)

7. The NPDES permit contains provisions for designing and implementing a number of "special" monitoring plans. These are the Mercury Assessment Plan, Radiological Monitoring Plan, Monitoring Plan for PCBs in the Aquatic Environment, and the ORNL Biological Monitoring and Abatement Plan.

The mercury, PCB, and radiological monitoring plan have been developed. Their implementation is pending approval by DOE and the state of Tennessee. The Biological Monitoring Plan is being conducted by the Environmental Sciences Division.

Data collected for the NPDES permit are summarized monthly and submitted quarterly to DOE. These data are available upon request. Values outside the specified permit limits (noncompliances) are given in Table 19.

All total suspended solids and oil and grease noncompliances at Category II Outfalls can be attributed to the extremely dry weather experienced during the second quarter. Flow from these outfalls is entirely dependent upon rainfall via parking lot drains, and samples must be collected either during or right after a rain event. All Category II Outfalls were sampled on April 8 or on May 23, 1986. According to the U.S. Department of Commerce data, the last rainfall preceding April 8 occurred on March 19 (20 days), and the last rainfall preceding May 23 occurred on April 28 (25 days). Due to the lack of rainfall, sufficient buildup of dirt, dust, oil, etc., will occur which increases the potential for total suspended solids and oil and grease violations. A check was made by the Department of Environmental Management after the April 8 violations were reported and each of the oil and grease violations could be directly related to a parking lot grate near an area where a considerable amount of motor oil/grease had accumulated.

Table 19. Parameters whose values exceed
NPDES noncompliance limits

Station	Parameter	Quantity (kg/d)		Concentration (mg/L)	
		Daily average	Daily maximum	Daily average	Daily maximum
April 1986					
Category II-204	pH			9.5	
Category II-204	Total suspended solids			1600	
Category II-206	Total suspended solids			81	
Category II-209	Total suspended solids			450	
Category II-216	Oil & grease			740	1500
Category II-216	Total suspended solids			75	
Category II-221	Total suspended solids			140	
Category II-226	Total suspended solids			590	
Category II-227	Total suspended solids			160	
Category II-248	Total suspended solids			720	
Category II-268	Total suspended solids			35	
Category II-281	Total suspended solids			57	
Cooling System-4509	Zinc			0.51	

Table 19. (Continued)

Station	Parameter	Quantity (kg/d)		Concentration (mg/L)		
		Daily average	Daily maximum	Daily minimum	Daily average	Daily maximum
May 1986						
X01 (Sewage Treatment Plant)	Oil and grease	11	72		11	72
X01 (Sewage Treatment Plant)	Total suspended solids		46			
Category II-224	Total suspended solids				2000	
Category II-243	Oil and grease				16	
Category II-243	Total suspended solids				100	
Category II-245	Oil and grease				18	
Category II-262	Oil and grease				25	
Category II-272	Oil and grease				28	
X09 (HFIR PWB)	pH			9.0	9.3	9.6
June 1986						
X01 (Sewage Treatment Plant)	Residual chlorine					0.72

Groundwater

The Environmental Protection Agency (EPA) has established regulations in 40 CFR, Part 265, Subpart F, which requires the owners/operators of hazardous waste facilities to monitor the groundwater beneath those facilities. The ORNL facility has a groundwater network consisting of 22 wells located within three impoundment areas: 3524, 7900, and 3539-40 (Figures 9-10). The 3524 area consists of wells 31-001, 31-002, 31-003, 31-004, 31-013, and 31-015. The 7900 area consists of wells 32-001, 32-002, 32-003, 32-004, 32-005, 33-001, 33-002, and 33-003. The 3539-40 area consists of wells 31-005, 31-006, 31-007, 31-008, 31-009, 31-010, 31-011, and 31-012. The wells are also classified as upgradient (reference) or downgradient depending on their location relative to the waste management facility and the general direction of groundwater flow. The upgradient wells (31-001, 31-007, 31-009, 32-001, 33-001) were located so as to provide groundwater samples that would not be affected significantly by possible leakage from the facility. The downgradient wells (those not listed as upgradient) were located immediately adjacent to the waste management facility. Information on the well installation is given in Table 20. All elevations (ground surface, bottom of bore hole, bottom and top of well screen) are given in meters above sea level. The pipe and screen materials were of threaded stainless steel and the diameter of each ranged from 5cm to 10cm. Three volumes of water were pumped from each well before sampling. Samples collected at these wells represent the quality of groundwater at the point of compliance.

During this period, water samples were collected from 18 wells and analyzed for the parameters listed in the categories below. The sampling of wells 31-013, 31-015, 32-004 or 31-011 is now in process. The data required by EPA and the State of Tennessee fall into one of three categories:

- (1) Drinking water parameters (As, Ba, Cd, Cr, F, Pb, Hg, NO₃, Se, Ag, endrin, lindane, methoxychlor, toxaphene, 2,4-D, 2,4,5-TP Silvex, Ra, gross alpha, gross beta, and fecal coliform);
- (2) Water quality parameters (Cl, Fe, Mn, phenols, Na, and SO₄); or
- (3) Groundwater contamination parameters (pH, specific conductance total organic carbon, and total organic halides).

In accordance with the regulations, a minimum of four measurements per well were recorded for pH, specific conductance, and temperature. Only one measurement was recorded for temperature at well 31-007. Four measurements were recorded for total organic carbon and total organic halides while only one measurement was recorded on the other parameters. Summary concentrations for each parameter and each impoundment area are given in Tables 21-23.

The analytical values were compared to the EPA Interim Primary Drinking Water Standards. The values for several of the upgradient and downgradient wells exceeded the standards for gross alpha, radium, endrin, and NO₃ (Table 24). A value of 0.0005 mg/L was reported for endrin at well 33-002. It was believed that this sample was contaminated because endrin

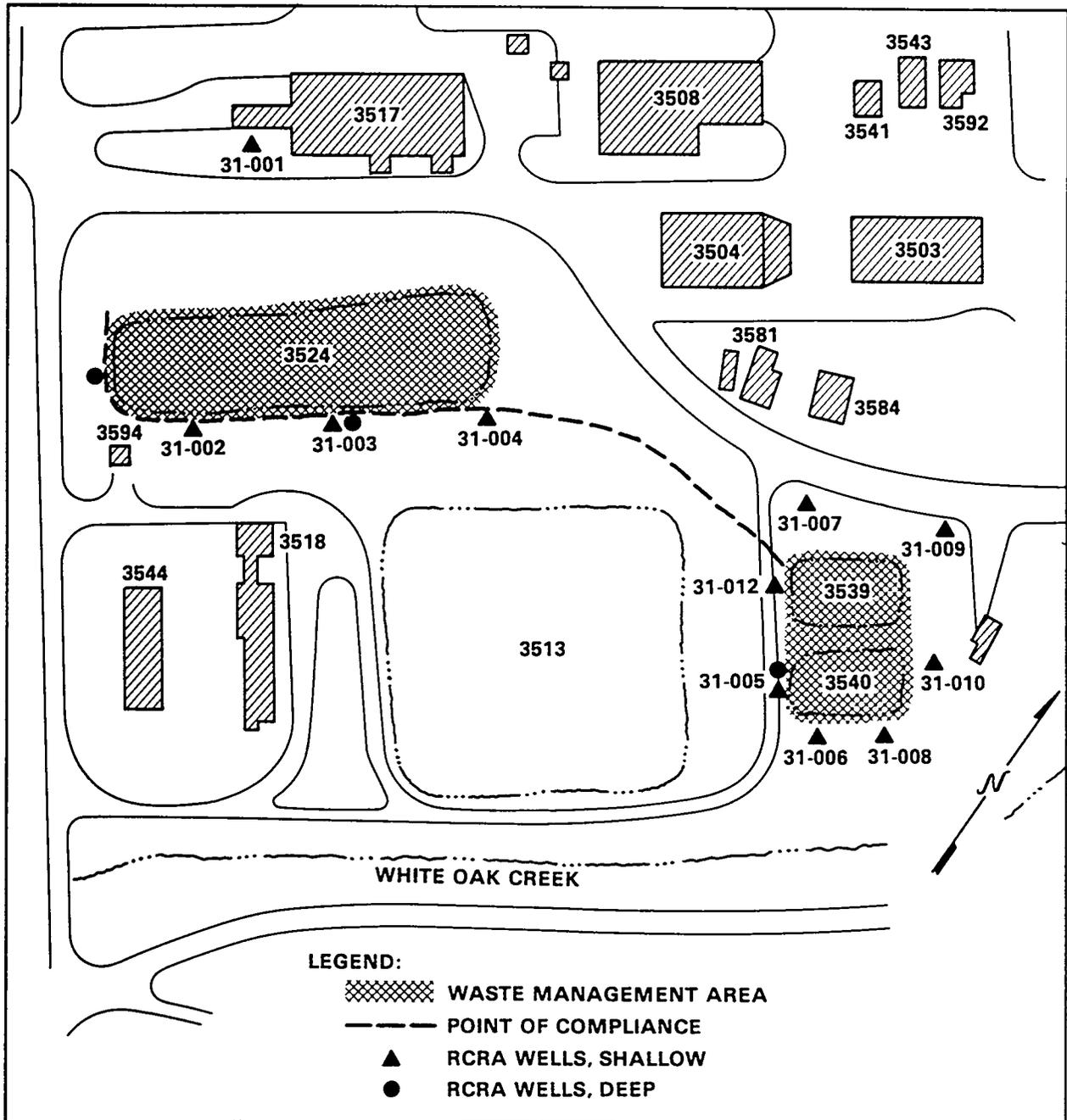
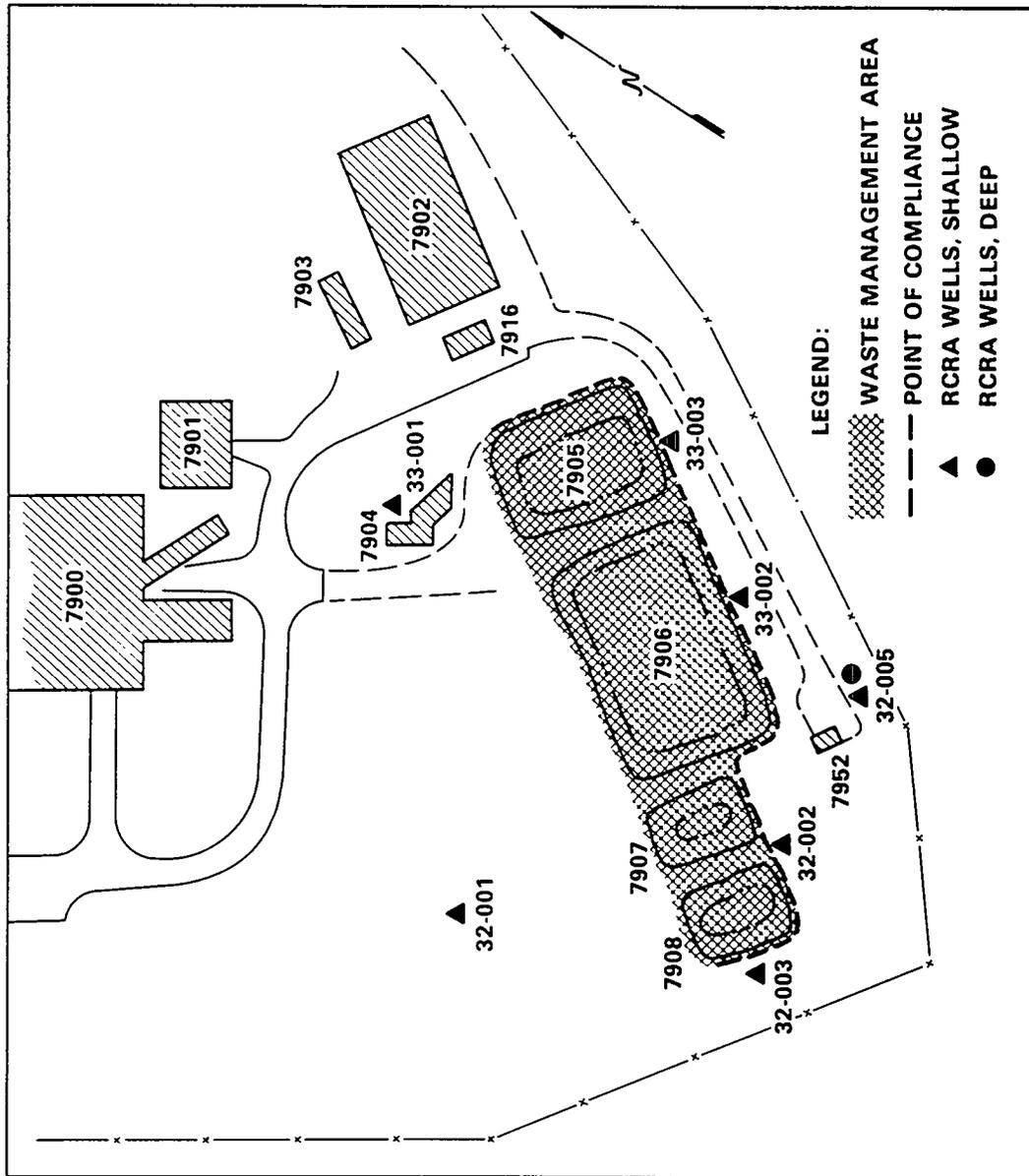


Fig. 9 Locations of sampling wells around ponds 3524, 3539, and 3540

ORNL DWG 86 8932R



- Fig. 10 locations of sampling wells around ponds 7905, 7906, 7907 and 7908 -

Table 20. RCRA well specifications

Well ID	Installation date	Geological unit formation	Ground surface elevation (M)	Bottom of bore hole elevation (M)	Bottom of wells screen elevation (M)	Top of wells Screen elevation (M)
3524 Area						
31-001	08/14/85	Chickamauga	242.3	235.4	235.4	237.0
31-002	08/13/85	Chickamauga	238.6	234.8	234.8	236.4
31-003	08/18/85	Chickamauga	239.4	235.4	235.4	237.0
31-004	08/11/85	Chickamauga	238.9	235.0	235.2	236.8
31-013	11/08/85	Chickamauga	238.8	223.2	223.5	226.6
31-015	10/26/85	Chickamauga	242.3	233.3	233.3	234.8
3539-40 Area						
31-005	08/09/85	Chickamauga	240.0	235.1	235.2	236.9
31-006	08/09/85	Chickamauga	240.2	234.8	235.1	236.7
31-007	08/08/85	Chickamauga	241.7	235.3	235.5	237.2
31-008	08/08/85	Chickamauga	240.3	235.4	235.5	237.1
31-009	08/07/85	Chickamauga	241.5	235.0	235.1	236.7
31-010	08/21/85	Chickamauga	241.2	235.6	235.7	237.3
31-011	10/24/85	Chickamauga	240.2	224.7	224.7	228.2
31-012	08/20/85	Chickamauga	240.2	234.9	235.0	236.6
7900 Area						
32-001	07/19/85	Conasauga	248.2	239.4	240.1	241.8
32-002	08/05/85	Conasauga	244.2	238.1	238.1	239.7
32-003	08/23/85	Conasauga	246.0	239.5	239.6	241.3
32-004	11/06/85	Conasauga	245.1	229.6	229.9	232.9
32-005	08/22/85	Conasauga	244.5	237.2	237.2	238.9
33-001	07/29/85	Conasauga	247.3	239.8	240.4	242.0
33-002	08/05/85	Conasauga	245.2	238.8	238.8	240.4
33-003	08/01/85	Conasauga	246.0	239.6	239.6	241.3

Table 21. Concentrations of parameters in wells around 3524^a
June 1986

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% cc ^b
2,4,5-TP Silvex	4	< 0.010	< 0.010	< 0.010	0.0
2,4-D	4	< 0.010	< 0.010	< 0.010	0.0
Ag	4	< 0.0050	< 0.0050	< 0.0050	0.0
As	4	< 0.010	< 0.010	< 0.010	0.0
Ba	4	< 1.0	< 1.0	< 1.0	0.0
Cd	4	< 0.0020	< 0.0020	< 0.0020	0.0
Cl	4	9.8	5.9	8.2	1.9
Cr	4	< 0.020	< 0.020	< 0.020	0.0
Endrin	4	< 0.00020	< 0.00020	< 0.00020	0.0
F	4	< 1.0	< 1.0	< 1.0	0.0
Fe	4	1.7	0.080	0.86	0.84
Fecal coliform ^c	4	< 1.0	< 1.0	< 1.0	0.0
Gross alpha ^d	4	0.17	0.12	0.15	0.024
Gross beta ^d	4	83	1.2	30	37
Hg	4	0.00010	< 0.00010	< 0.00010	0.0
Lindane	4	< 0.0020	< 0.0020	< 0.0020	0.0
Methoxychlor	4	< 0.0080	< 0.0080	< 0.0080	0.0
Mn	4	3.3	0.3	1.1	1.5
Na	4	26	15	20	5.1
NO ₃	4	< 5.0	< 5.0	< 5.0	0.0
Pb	4	0.040	< 0.020	< 0.025	0.010
pH ^e	28	7.4	7.1	7.2	0.036
Phenols	4	0.0010	< 0.0010	< 0.0010	0.0
Ra (Total) ^d	4	0.21	0.0040	0.065	0.097
Se	4	< 0.0050	< 0.0050	< 0.0050	0.0
SO ₄	4	90	11	47	34
Specific conductance ^f	28	0.58	0.18	0.27	0.043
Temperature ^g	28	25	18	20	0.86
Total organic carbon	16	2.6	0.84	1.8	0.26
Total organic halides	16	0.20	0.010	0.071	0.036
Toxaphene	4	< 0.005	< 0.005	< 0.005	0.0

a. See Figure 9.

b. 95% confidence coefficient about the average.

c. Units are colonies per 100 mL.

d. Units are Bq/L.

e. Value in pH units.

f. Units are in mmhos/cm.

g. Units are in °C.

Table 22. Concentrations of parameters in wells around 3539-40^a
June 1986

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% cc ^b
2,4,5-TP Silvex	7	< 0.010	< 0.010	< 0.010	0.0
2,4-D	7	< 0.010	< 0.010	< 0.010	0.0
Ag	7	< 0.0050	< 0.0050	< 0.0050	0.0
As	7	< 0.010	< 0.010	< 0.010	0.0
Ba	7	< 1.0	< 1.0	< 1.0	0.0
Cd	7	< 0.0020	< 0.0020	< 0.0020	0.0
Cl	7	17	6.9	9.4	2.7
Cr	7	< 0.020	< 0.020	< 0.020	0.0
Endrin	7	< 0.00020	< 0.00020	< 0.00020	0.0
F	7	< 1.0	< 1.0	< 1.0	0.0
Fe	7	9.7	0.18	3.2	2.7
Fecal coliform ^c	7	< 1.0	< 1.0	< 1.0	0.0
Gross alpha ^d	7	0.26	0.082	0.16	0.059
Gross beta ^d	7	4.1	0.13	1.5	1.2
Hg	7	< 0.00010	< 0.00010	< 0.00010	0.0
Lindane	7	< 0.0020	< 0.0020	< 0.0020	0.0
Methoxychlor	7	< 0.0080	< 0.0080	< 0.0080	0.0
Mn	7	8.7	0.50	5.1	2.6
Na	7	30	4.6	11	6.7
NO ₃	7	< 5.0	< 5.0	< 5.0	0.0
Pb	7	< 0.020	< 0.020	< 0.020	0.0
pH ^e	49	7.4	6.8	7.1	0.036
Phenols	7	0.0010	< 0.0010	< 0.0010	0.0
Ra (Total) ^d	7	1.4	0.011	0.25	0.39
Se	7	< 0.0050	< 0.0050	< 0.0050	0.0
SO ₄	7	210	< 5.0	< 59	53
Specific conductance ^f	49	0.65	0.010	0.27	0.048
Temperature ^g	49	22	18	19	0.33
Total organic carbon	28	3.8	1.8	2.6	0.22
Total organic halides	28	0.066	< 0.010	< 0.022	0.0072
Toxaphene	7	< 0.0050	< 0.0050	< 0.0050	0.0

a. See Figure 9.

b. 95% confidence coefficient about the average.

c. Units are colonies per 100 mL.

d. Units are Bq/L.

e. Value in pH units.

f. Units are in mmhos/cm.

g. Units are in °C.

Table 23. Concentrations of parameters in wells around 7900a
June 1986

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% cc ^b
2,4,5-TP Silvex	7	< 0.010	< 0.010	< 0.010	0.0
2,4-D	7	< 0.010	< 0.010	< 0.010	0.0
Ag	7	< 0.0050	< 0.0050	< 0.0050	0.0
As	7	< 0.010	< 0.010	< 0.010	0.0
Ba	7	< 1.0	< 1.0	< 1.0	0.0
Cd	7	< 0.0020	< 0.0020	< 0.0020	0.0
Cl	7	62	2.4	19	15
Cr	7	0.15	< 0.020	< 0.039	0.037
Endrin	7	0.0010	< 0.00020	< 0.00020	0.00010
F	7	1.1	< 1.0	< 1.0	0.029
Fe	7	0.51	0.050	0.29	0.14
Fecal coliform ^c	7	< 1.0	< 1.0	< 1.0	0.0
Gross alpha ^d	7	2.0	0.066	0.45	0.54
Gross beta ^d	7	37	0.24	7.3	10
Hg	7	< 0.00010	< 0.00010	< 0.00010	0.0
Lindane	7	< 0.0020	< 0.0020	< 0.0020	0.0
Methoxychlor	7	< 0.0080	< 0.0080	< 0.0080	0.0
Mn	7	0.45	0.040	0.17	0.12
Na	7	43	3.3	12	11
NO ₃	7	57	< 5.0	< 19	18
Pb	7	< 0.020	< 0.020	< 0.020	0.0
pH ^e	49	7.8	7.0	7.4	0.068
Phenols	7	0.0010	< 0.0010	< 0.0010	0.0
Ra (Total) ^d	7	1.5	0.0021	0.23	0.42
Se	7	< 0.0050	< 0.0050	< 0.0050	0.0
SO ₄	7	140	5.0	51	35
Specific conductance ^f	49	0.23	0.010	0.11	0.021
Temperature ^g	49	23	17	18	0.38
Total organic carbon	28	1.0	0.52	0.68	0.043
Total organic halides	28	< 0.010	< 0.010	< 0.010	0.0
Toxaphene	7	< 0.0050	< 0.0050	< 0.0050	0.0

a. See Figure 10.

b. 95% confidence coefficient about the average.

c. Units are colonies per 100 mL.

d. Units are Bq/L.

e. Value in pH units.

f. Units are in mmhos/cm.

g. Units are in °C.

Table 24. Concentrations of parameters whose values exceed standards in groundwater wells on the ORNL site

June 1986

Well ID	Date	Parameters					
		Gross Beta (Bq/L)	Gross Alpha (Bq/L)	Ra (Bq/L)	Cr (mg/L)	Endrin (mg/L)	NO ₃ (mg/L)
Standard ^b		0.13	0.56	0.19	0.050	0.00020	10
31-001	6/25/86	7.0		0.21			
31-002	6/26/86	29					
31-003	6/06/86	83					
31-004	6/27/86	1.2					
31-005	6/17/86	4.1					
31-007	6/17/85	0.36					
31-008	6/17/86	2.2		1.4			
31-009	6/25/86	0.36					
31-010	6/25/86	2.8					
31-012	6/25/86	0.21					
32-001	6/24/86	2.0					
32-002	6/28/86	0.24					
32-003	6/18/86	0.34					
32-005	6/24/86	4.5					
33-001	6/18/86	0.24			0.15		
33-002	6/18/86	11	0.66			0.00050	49
33-003	6/24/86	37	2.0	1.5			57

a See Figure 9 and 10.

b EPA Interim Primary Drinking Water Standard.

has not been found historically in groundwater at ORNL. An additional sample was collected and analyzed for endrin and determined to be less than the detection limit (<0.0002 mg/L). The values for gross beta at all wells exceeded the standard.

The EPA Interim Primary Drinking Water Standard for gross beta is an annual dose equivalent of four millirem. A concentration was calculated from this dose based on ingestion of 2.2 l of water per day. We assumed that all gross beta was ^{90}Sr which is a worst case analysis. Its dose conversion factor of 1.438 rem per microcurie was used to calculate the concentration.

METEOROLOGICAL PROCESSES

The ORNL meteorological system consists of three towers (A, B, and C) with sensors mounted at two levels (10 and 30 meters) for Towers A and B and at three levels (10, 30, and 100 meters) for Tower C. Locations of meteorological towers at ORNL are shown in Figure 11. Data from the sensors is acquired, stored, edited, and formatted by a data collection system consisting of a central processor and remote data logger. One-minute averages are processed into fifteen-minute averages which are kept for one day. The fifteen-minute averages are processed into hourly averages which are stored for at least one year.

Examination of quarterly wind roses (Figures 12-18) reveals that the prevailing winds are almost equally split into two directions that are 180° apart; one prevailing direction is from the SW to WSW sector, and the other prevailing direction is from the NE to ENE sector. The winds are so strongly aligned along these directions because of the channeling effect induced by the ridge and valley structure of the area. Another feature observed from the wind roses is that the wind speeds increase with height (tower level) at each of the towers. On the average, the wind speeds can be expected to increase steadily from ground level to 100 m.

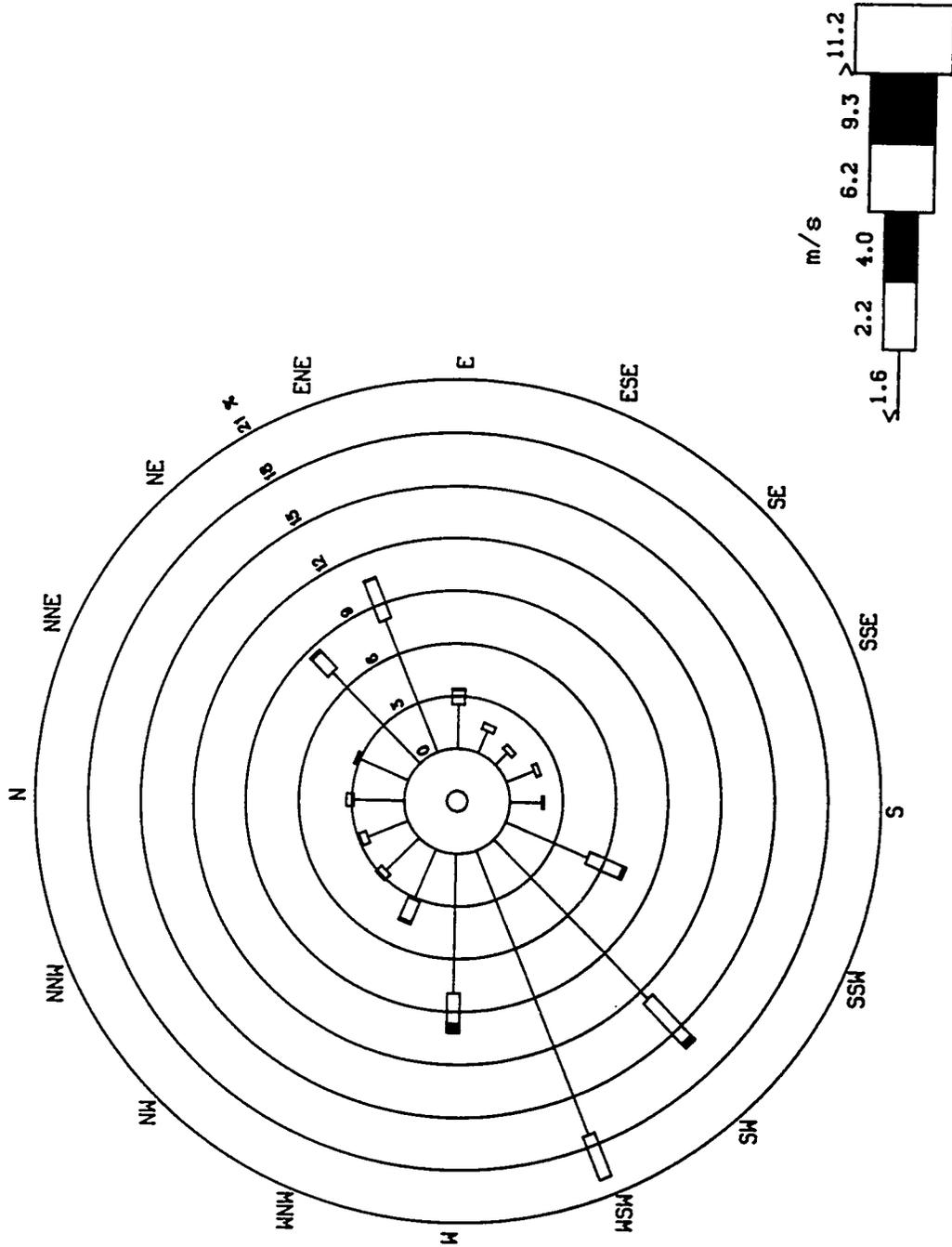


Fig. 12 Wind rose at 10-m level of meteorological tower A, April-June 1986

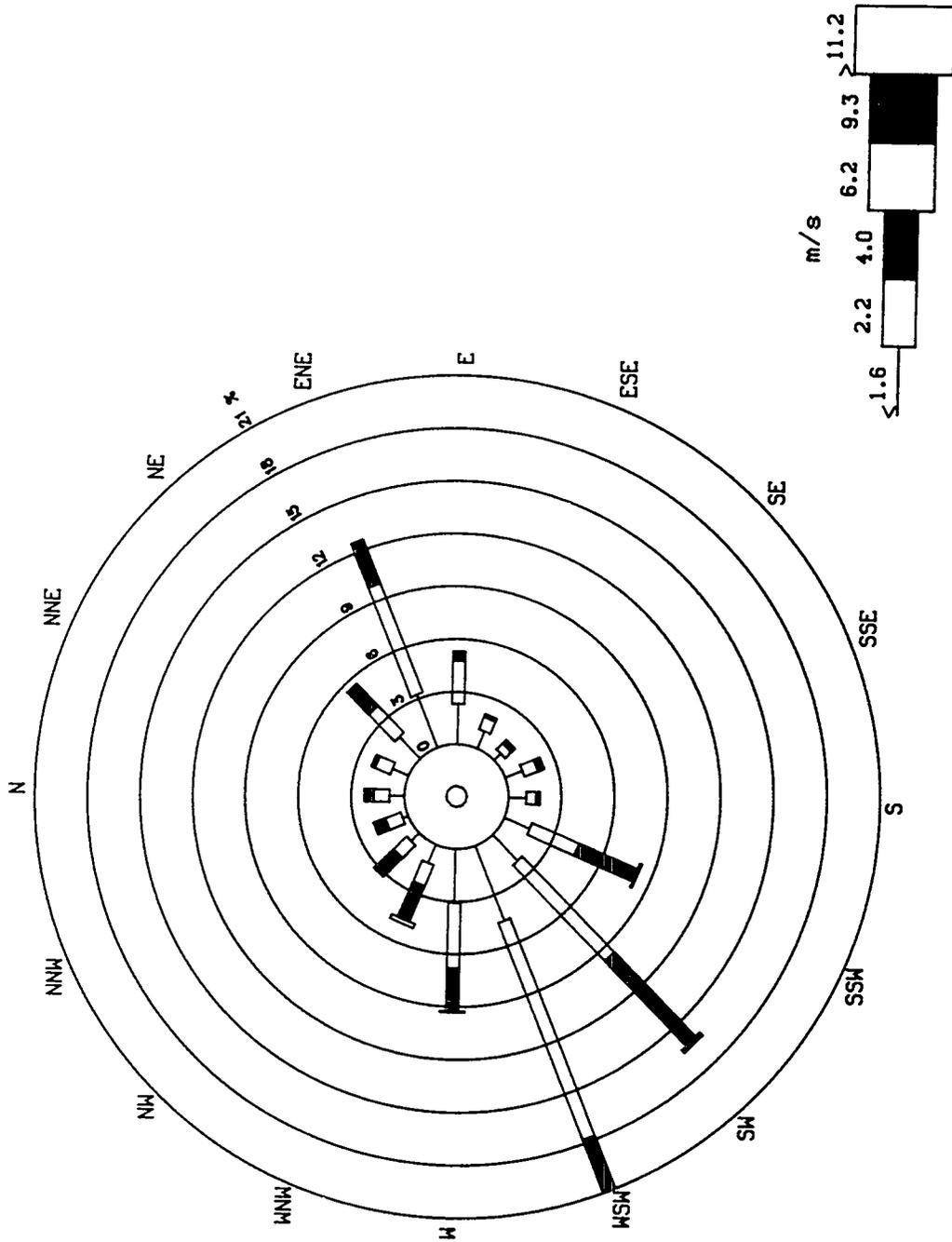


Fig. 13 Wind rose at 30-m level of meteorological tower A, April-June 1986

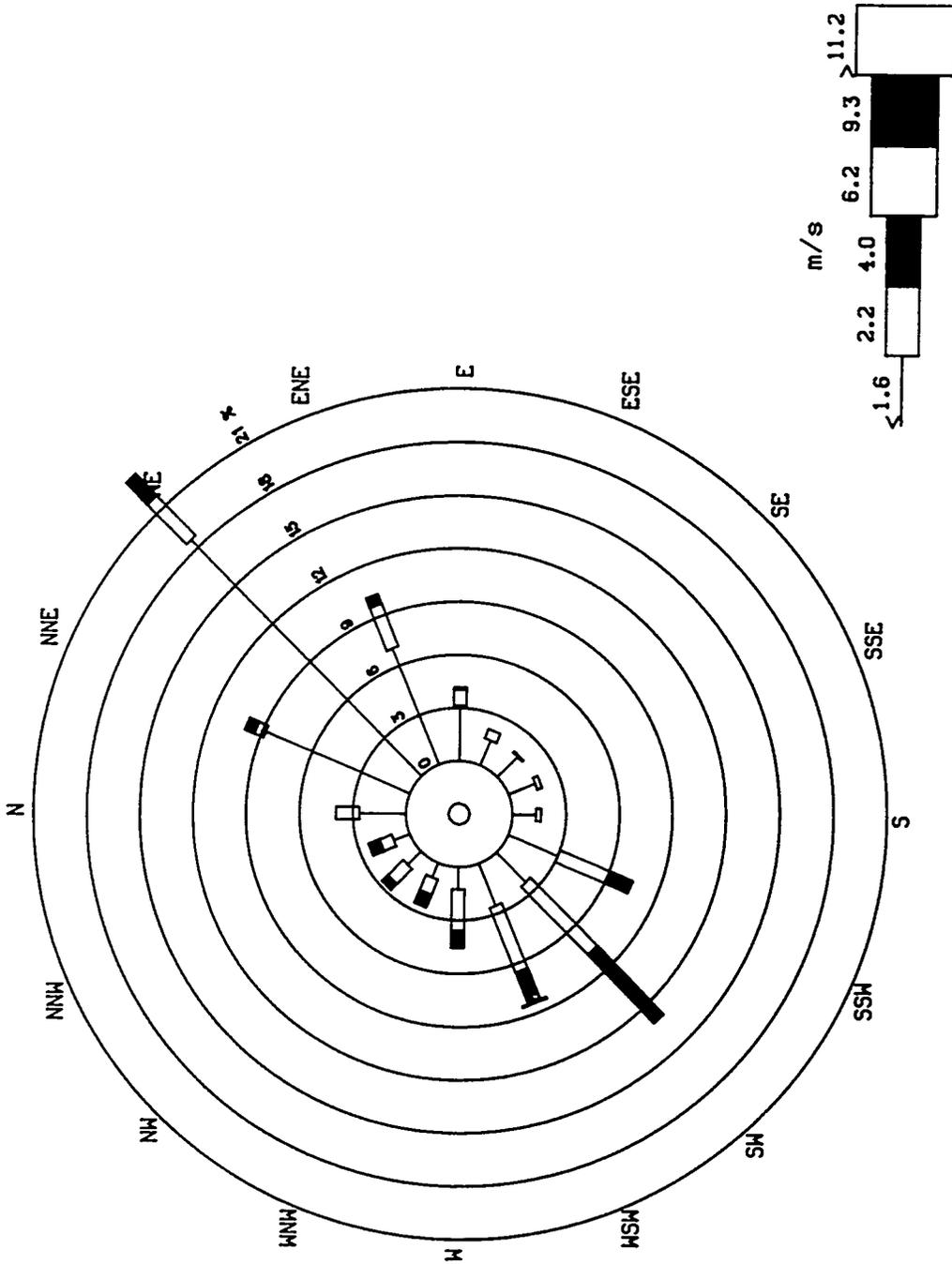
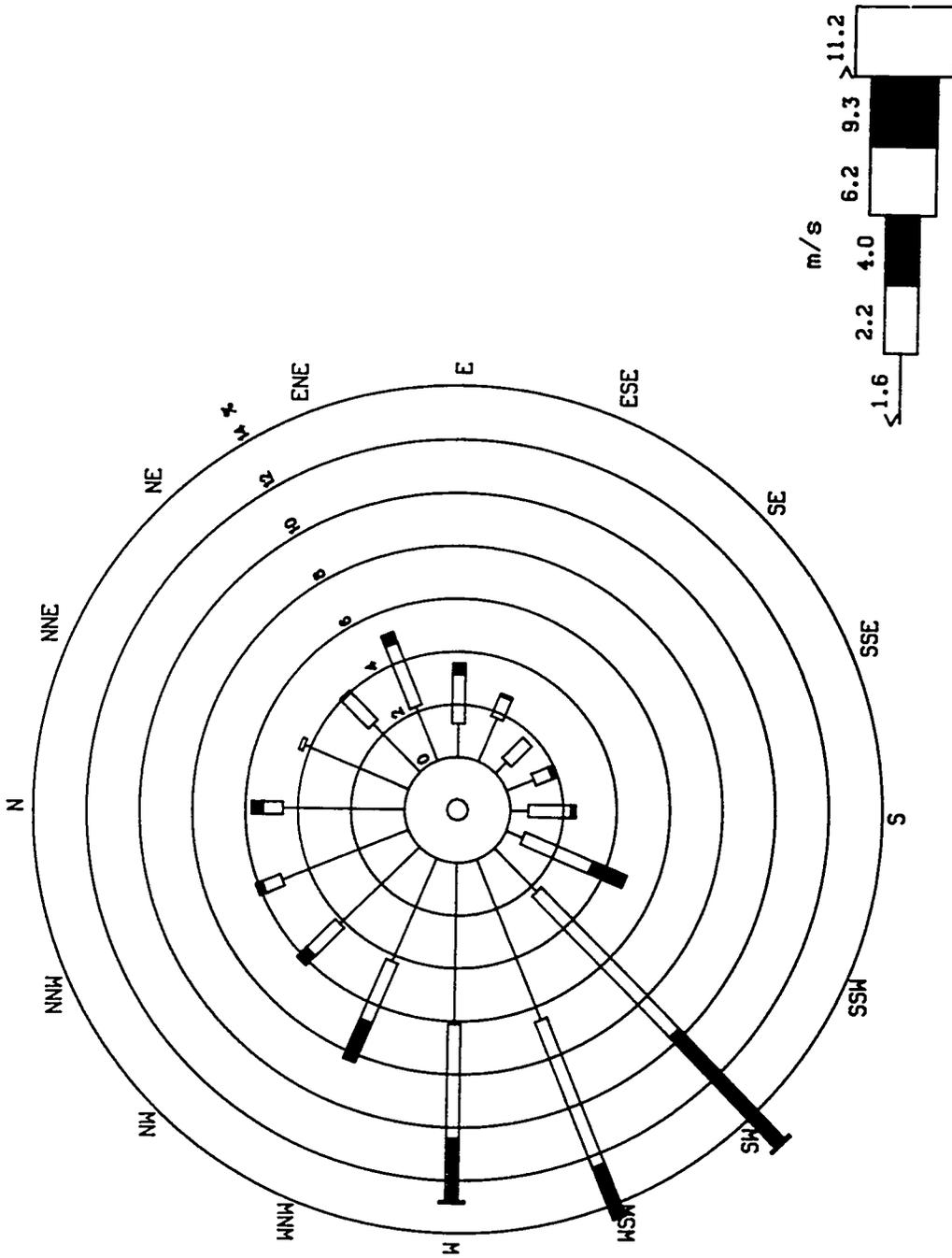


Fig. 14 Wind rose at 10-m level of meteorological tower B, April-June 1986



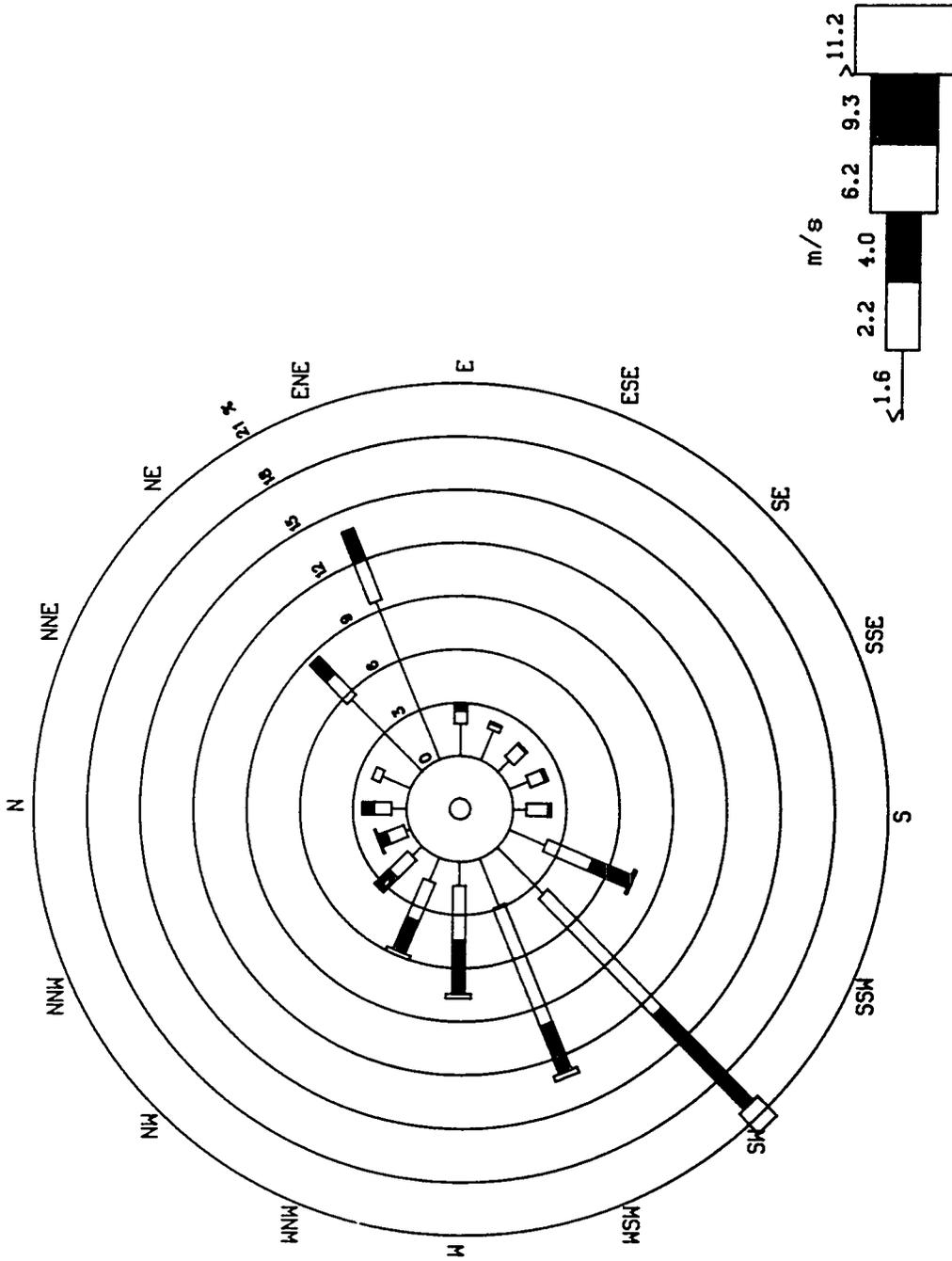


Fig. 17 Wind rose at 30-m level of meteorological tower C, April-June 1986

Biological Monitoring: Milk

Raw milk is monitored for ^{131}I and ^{90}Sr by collection and analysis of samples from seven locations and one dairy within a radius of 80 km of Oak Ridge. Samples are collected every two weeks for five stations located near the Oak Ridge area (Figure 19). Three other stations are more remote with respect to the Oak Ridge facilities and are sampled at the rate of about one to two stations every quarter (Figure 20). For the second quarter there were four stations sampled for the immediate environs and three stations sampled for the remote environs. Samples are analyzed by ion exchange and gamma spectrometry, and the results are compared with intake guidelines (Tables 25 and 26) specified by the Federal Radiation Council (FRC).

Concentrations of ^{90}Sr are shown in Table 25. The average concentration of ^{90}Sr of all stations in the immediate Oak Ridge area was 0.053 Bq/L, which is within Range I of the FRC guidelines, and the average concentrations for each individual immediate station was also within the Range I category. The average concentration of ^{90}Sr of all stations in the remote Oak Ridge area was 0.047 Bq/L, which is within Range I of the FRC guidelines, and the average concentration for each individual remote station was also within the Range I category.

Concentrations of ^{131}I are shown in Table 26. The average concentration of ^{131}I for all stations in the immediate Oak Ridge area was 0.066 Bq/L, which is within Range I of the FRC guidelines. The average concentration of ^{131}I for all remote stations was 0.006 Bq/L, which is within Range I of the FRC guidelines.

During mid May (1986), the ^{131}I concentration in milk for the immediate environs increased due to the ^{131}I fallout from the Chernobyl incident that began on April 26, 1986 (Figure 21). All ^{131}I concentrations in milk during 1983, 1984, 1985, and to May 1986 from these stations have been below 0.03Bq/L. The highest concentration of ^{131}I detected at the four stations after the incident was 0.41 Bq/L, which fell within the Range II category of the FRC guidelines requiring active surveillance (Figure 21). The concentrations for the other stations, while increased, still fell within the Range I category of the FRC guidelines requiring adequate surveillance.

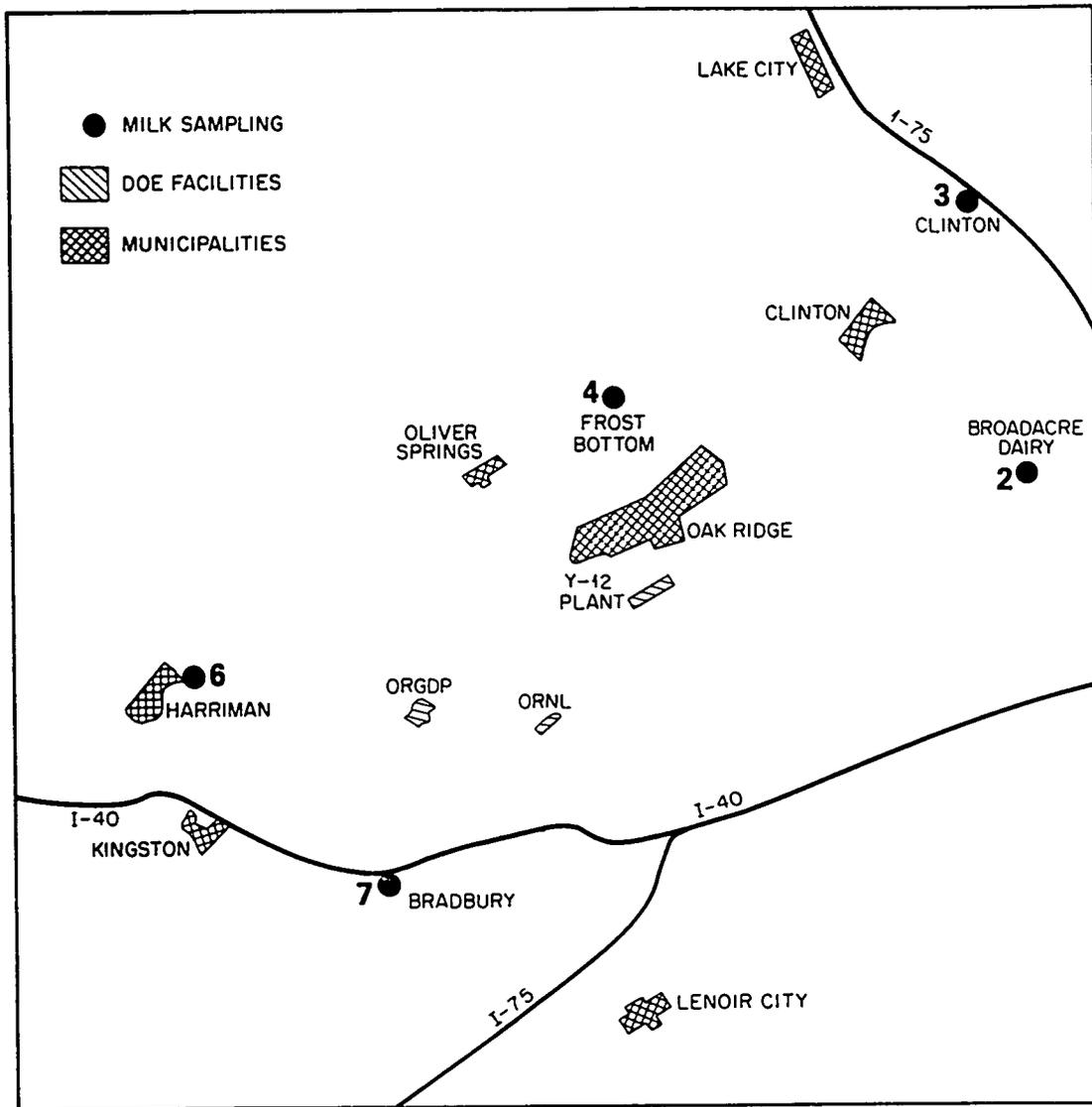


Fig. 19 Locations of milk sampling stations near the Oak Ridge facilities

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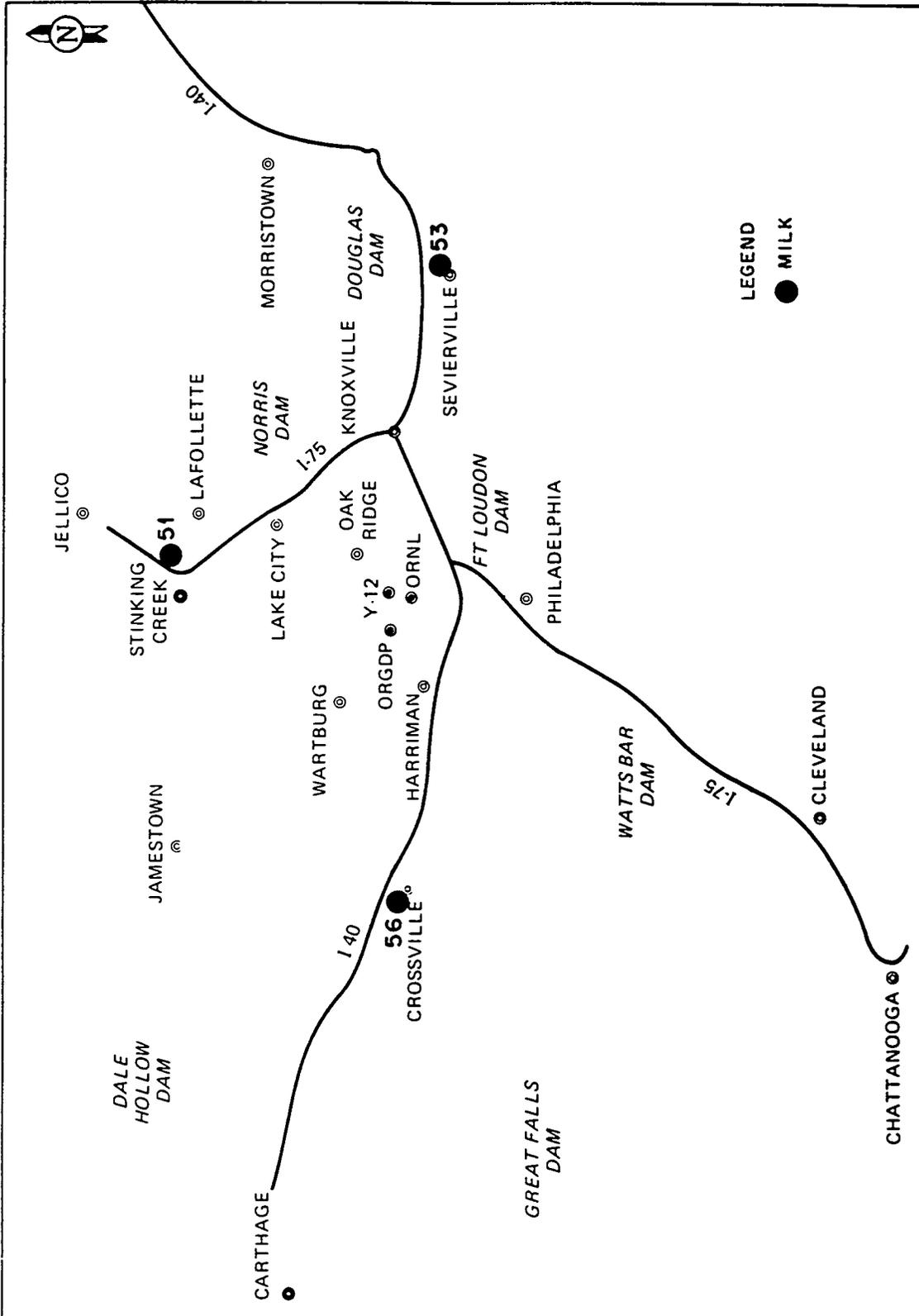


Fig. 20 Locations of milk sampling stations remote from the Oak Ridge facilities

Table 25. Concentrations of ^{90}Sr in milk^a

April - June 1986

Station	No. of samples	Concentration (Bq/L)				Comparison with standard ^c
		Max	Min	Av	95%cc ^b	
Immediate Environs ^d						
2	7	0.06	0.02	0.041	0.0092	Range I
3	6	0.07	0.01	0.042	0.017	Range I
4	7	0.10	0.03	0.064	0.017	Range I
7	7	0.07	0.05	0.066	0.0059	Range I
Network summary	27	0.10	0.01	0.053	0.008	Range I
Remote environs ^e						
51	1			0.05		Range I
53	1			0.05		Range I
56	1			0.04		Range I
Network summary	3	0.5	0.4	0.047		Range I

^a Raw milk samples, except for Station 2, which is a dairy.

^b 95% confidence coefficient about the average.

^c Applicable FRC standard, assuming 1 L/d intake: Range I, 0 - 0.74 Bq/L, adequate surveillance required to confirm calculated intakes; Range II, 0.74 - 7.4 Bq/L, active surveillance required; and Range III, > 7.4 Bq/L positive control required.

^d See Figure 19.

^e See Figure 20.

Table 26. Concentrations of ^{131}I in milk^a
 April - June 1986

Station	No. of samples	Concentration (Bq/L)				Comparison with standard ^c
		Max	Min	Av	95%cc ^b	
Immediate Environs ^d						
2	8	0.27	0.004	0.058	0.064	Range I
3	6	0.27	0.003	0.066	0.083	Range I
4	8	0.41	0.001	0.11	0.10	Range I
7	7	0.09	0.001	0.029	0.026	Range I
Network summary	29	0.41	0.001	0.066	0.038	Range I
Remote environs ^e						
51	1			0.010		Range I
53	1			0.005		Range I
56	1			0.002		Range I
Network summary	3	0.10	0.02	0.006		Range I

^a Raw milk samples, except for Station 2, which is a dairy.

^b 95% confidence coefficient about the average.

^c Applicable FRC standard, assuming 1 L/d intake: Range I, 0 - 0.37 Bq/L, adequate surveillance required to confirm calculated intakes; Range II, 0.37 - 3.7 Bq/L, active surveillance required; and Range III, > 3.7 Bq/L positive control required.

^d See Figure 19.

^e See Figure 20.

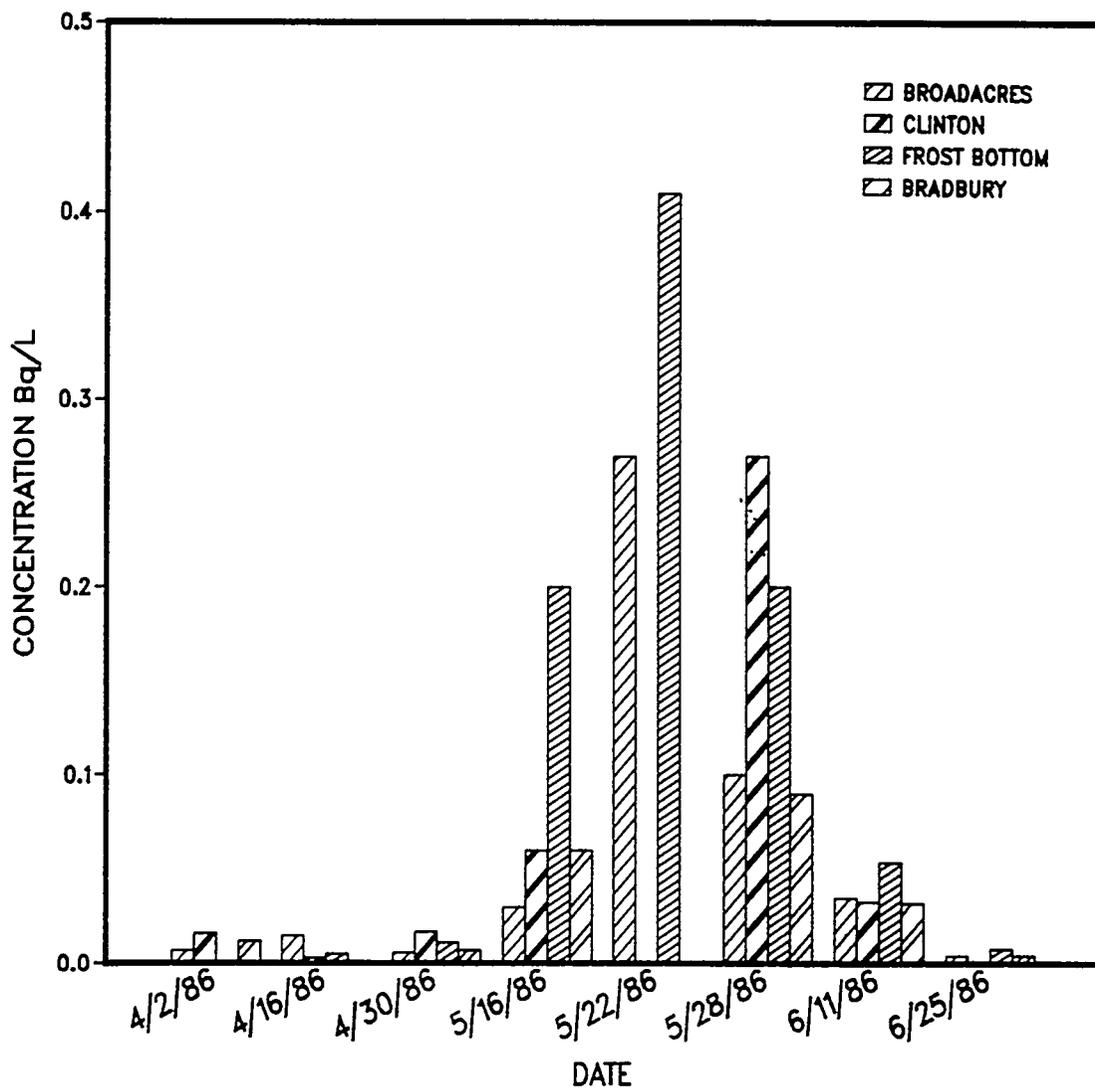


Fig. 21 ^{131}I concentrations in milk

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**OAK RIDGE
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MARTIN MARIETTA

**Environmental Surveillance
Data Report for the
Third Quarter of 1986**

**MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY**

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ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR
THE THIRD QUARTER OF 1986

Date Published: November 1986

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EXECUTIVE SUMMARY

During the third quarter of 1986, over 1900 samples which represent over 6700 analyses and measurements were collected by the Department of Environmental Management. Eleven real-time air monitoring stations which telemeter 10-minute averaged readings on radiation levels and total rainfall around ORNL also reported data. Three real-time water monitoring stations that transmit flow and water quality data were put into operation.

The ^{131}I concentrations in air and milk which were significantly elevated during the second quarter by the Chernobyl nuclear incident have returned to normal. When compared to the second quarter, no significant differences were observed in the average concentrations of ^{90}Sr in milk and air in the immediate Oak Ridge and remote areas.

Greater than 80% of the tritium discharges over White Oak Dam could be attributed to the releases into Melton Branch. Tritium discharges in this area are believed to be due primarily to releases from Solid Waste Storage Area 5 (SWSA 5). Characterization of SWSA 5, particularly the tritium problem, will be one of the highest priorities of the Remedial Investigation Feasibility Study subcontract scheduled to be awarded in early 1987.

A new National Pollutant Discharge Elimination System (NPDES) permit was issued to ORNL by the state of Tennessee and the EPA in April. Under the requirements of this permit, for the period July 1 through September 30, 1986, approximately 800 samples were collected from 183 physical locations and approximately 2600 analyses were performed. During this period, permit limits were exceeded on twenty-six occasions.

Groundwater samples from four deep wells around the ORNL surface impoundment areas 3524, 3539-40, and 7900 were also collected during this quarter. The sampling is required by the Tennessee Department of Health and Environment under interim status provisions for RCRA facilities. Further sampling of these sites will be determined based on an evaluation of the first year data. The groundwater wells in SWSAs 4, 5, and 6, and the pits and trenches areas were also analyzed for radionuclides.

Bluegill were collected from Clinch River Miles (CRMs) 5.0, 20.8, and 25 and analyzed for radionuclides. In addition, fish from CRM 20.8 and 25.0 were analyzed for mercury and PCBs. The highest concentrations of constituents were in fish collected from CRM 20.8 which is at ORNL's discharge point. The concentrations of mercury and PCBs in fish were lower than the limits set by the Food and Drug Administration.

INTRODUCTION

The Department of Environmental Management (DEM) within the Environmental and Occupational Safety Division (E&OS) at the Oak Ridge National Laboratory (ORNL) is responsible for environmental surveillance to: (1) assure compliance with all Federal, State, and DOE requirements for the prevention, control, and abatement of environmental pollution, (2) monitor the adequacy of containment and effluent controls, and (3) assess impacts of releases from ORNL facilities on the environment.

To meet these objectives, the DEM has implemented a surveillance program that consists of both monitoring and sampling of environmental constituents. Monitoring provides continuous data for rapid screening of parameters. Sampling followed by laboratory analyses are usually recommended for routine surveillance rather than continuous monitoring. In general, monitoring systems are less sensitive and as a result have much higher detection levels than laboratory analysis. Laboratory analysis provides a quantitative estimate of concentrations or activities at environmental levels.

The surveillance program for 1986 includes sampling and monitoring of air, water from surface streams and point sources groundwater, fish, grass, soil, and milk for radioactive and nonradioactive materials. Surveillance points are located on-site to quantify discharges from ORNL facilities, and off-site to determine public exposures and to establish background reference levels.

The purpose of this report is to provide Laboratory and Central Management personnel with the most recent information on environmental conditions. It is intended strictly as a data report. Each quarter a report that summarizes all environmental monitoring data from the various media will be prepared. Results for quarterly composited air and water samples have been reported only for the previous quarter because of the time required to process, analyze, and verify the data. At the end of the calendar year, the data will be consolidated in an annual report to DOE containing information on all three Oak Ridge facilities.

Summaries of data will be presented for each month and quarter where there are multiple observations. The summary tables give the number of samples collected at each station or location and the maximum, minimum, and average values of parameters for which analyses were done. The 95% confidence coefficients (CCs) were calculated and where possible, average values were compared with applicable guidelines, criteria, or standards as a means of evaluating the impact of effluent releases on environmental concentrations. Some averages have been rounded and reported to only two significant digits.

During 1986, the Low-Level Counting Facility at ORNL began reporting radionuclide measurements in a manner different from that of previous years. Prior to 1986, data below the minimum detectable limit were reported as "less than" (<) the detection limit. This year, the measured results which may be negative (values less than instrument background) are

reported. Under this system, apparent decreases may be attributed to the reporting of negative values and the subsequent inclusion of these data into the averaging.

Nonradionuclide results that are below the analytical detection limit are expressed as "less than" (<). In computing average values, less than results are assigned the detection limit. The average value is expressed as less than the computed value when all samples for the period are less than the detection limit.

The Four-Plant Analytical Committee is reviewing the standardization of reporting of less than detectable values and their recommendations will be incorporated in these reports as they become policy.

AIR

Most gaseous wastes from ORNL are released to the atmosphere through stacks. Radioactivity may be present in gaseous waste streams as a solid (particulates), as an absorbable gas (iodine), or as a nonabsorbable species (noble gas). Gaseous wastes that may contain radioactivity are processed to reduce the radioactivity to acceptable levels before they are discharged. In addition to monitoring stack effluents, atmospheric concentrations of materials occurring in the general environment around ORNL, the Oak Ridge Reservation, and the vicinity are monitored continuously by an air monitoring network of 24 stations. Relative locations of these stations are shown in Figures 1-2. These air monitoring stations are categorized into three groups according to their geographical locations:

- (1) The ORNL perimeter air monitoring network (ORNL PAMs) consists of stations 3, 7, 9, 21, and 22. These stations are located at or near the ORNL boundary (shown in Figure 1). Stations 21 and 22 are used only for external gamma radiation measurements; there is no sampling equipment. These stations are currently being upgraded to provide sampling capability.
- (2) The DOE Oak Ridge reservation network (Reservation PAMs) consists of stations 8, 23, 31, 33, 34, 36, 40-46 (Figure 1). During the latter part of 1985 and early 1986, ten of the Reservation PAMs were upgraded. Each air station has the capability to perform both sampling and continuous monitoring. Station 46 is a new real-time monitoring location installed this quarter in the Scarboro community in Oak Ridge. It currently has no sampling capability.
- (3) The remote air monitoring network (RAMs) consists of stations 51-53 and 55-57. These stations are located within a 120 km radius of ORNL outside of the DOE Oak Ridge Reservation (Figure 2).

At each station, there are monitors for five radiation parameters (gross alpha, gross beta, iodine, gross gamma, and noble gas), a rain gauge, and three process sensors that are used to calculate the volume of the sample collected. A central processor collects 10-minute average readings and transmits the data to a VAX computer for further analysis and reporting. The central processor checks the values against alarm limits. All alarms are reported to a printer as they occur. The primary purpose of the monitoring system is to determine if radiation levels on the Reservation are above background levels. If radiation levels appear to be higher than normal, additional sampling can be initiated to provide quantitative measures of concentrations in the atmosphere. In addition, sampling is done at each station to quantify levels of iodine, tritium, gross alpha, and gross beta. The real-time monitoring system is the only measure of noble gases in the area.

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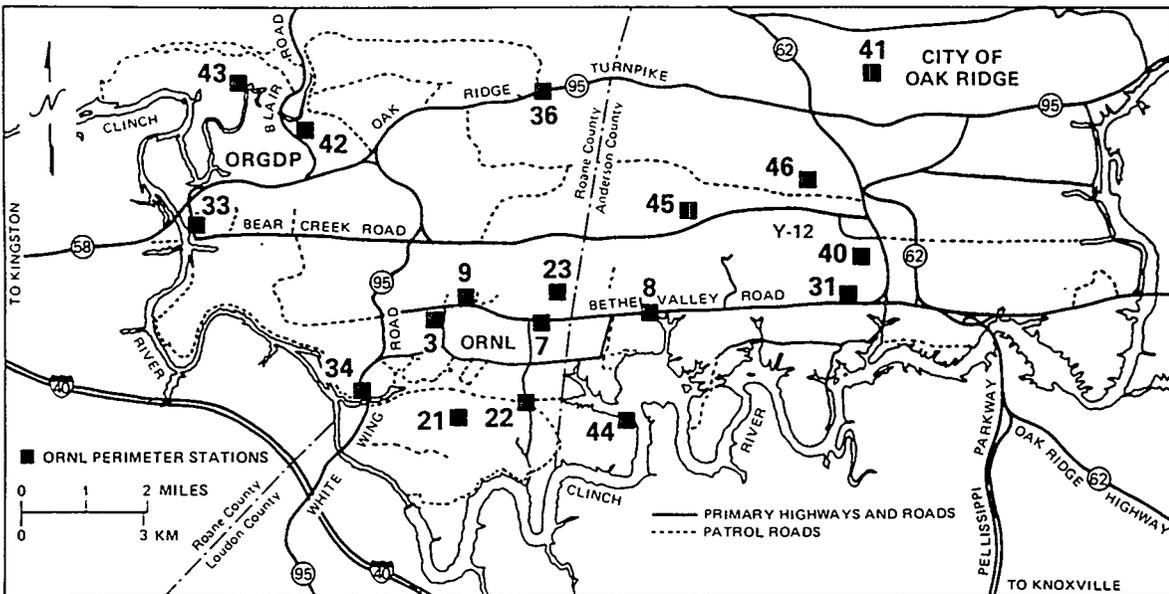


Fig. 1 Location map of the ORNL perimeter and Oak Ridge Reservation air monitoring stations

ORNL-DWG 86-9187R3

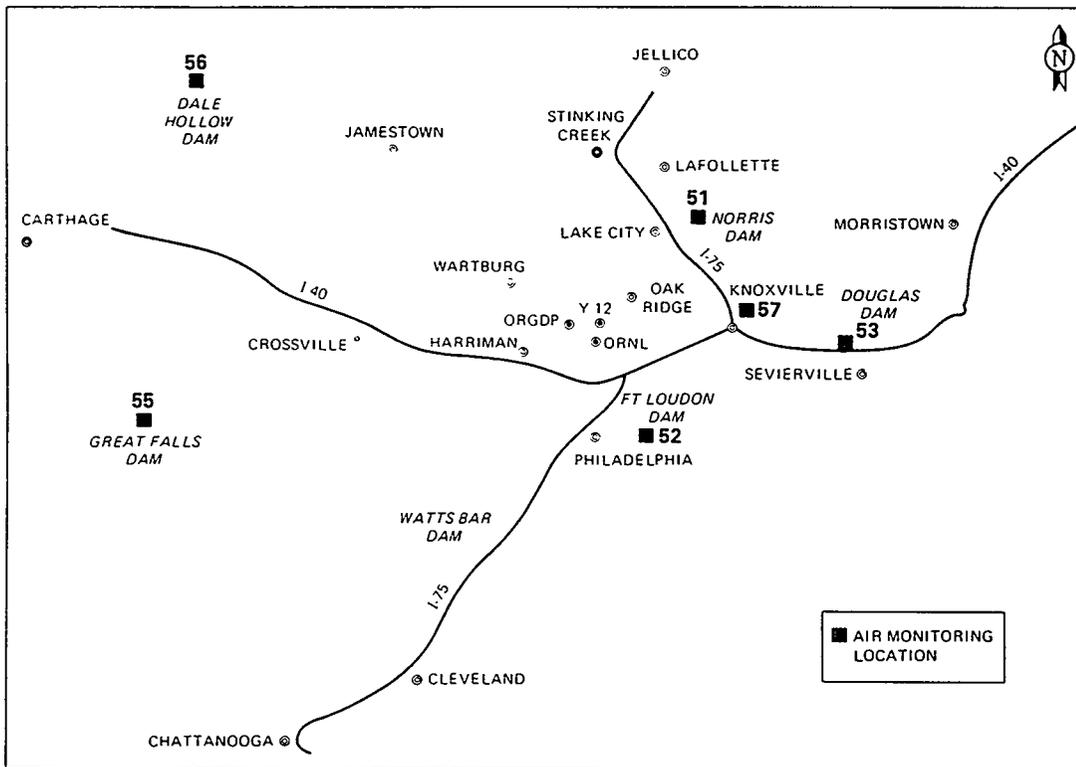


Fig. 2 Location map of the remote air monitoring stations

Airborne radioactive particulates are collected weekly by pumping a continuous flow of air through a paper filter and then through a charcoal cartridge. Between February and April, the air particulate sampling apparatus at all sampling stations was upgraded. The new apparatus is easier to handle and gives a higher counting efficiency. The filter papers are collected and analyzed weekly for gross alpha and gross beta activities. To minimize artifacts from short-lived radionuclides, the filter papers are analyzed 3-4 days after collection. The airborne ^{131}I is collected weekly using a cartridge that is packed with activated charcoal. The charcoal cartridges are analyzed within 24 hours after collection. The initial and final dates, time on and off, and flow rates are recorded when a sampler is mounted or removed. The total volume of air which flowed through the sampler at each station is calculated using this information. The flowrates at stations 3-45 are set between 1.5 and 3.0 CFM to minimize artifacts from extremely high or low flowrates. Flowrates at stations 50-57 are set between 3 and 7 CFM and flowrates outside of these ranges are removed from data analysis. The concentration of radionuclides in air is calculated by dividing the total activity per sample by the total volume of air.

Monthly (July-September) concentrations of gross alpha, gross beta, and atmospheric ^{131}I are summarized in Tables 1-6. Instrument background concentrations of ^{131}I , gross alpha, and gross beta have been subtracted from the measured concentrations in Tables 1-6. Negative values represent concentrations below the instrument background level. Beginning this quarter, a new counter has been used for analyzing weekly gross alpha and gross beta activities on filter papers. This new instrument gives a higher efficiency and is more sensitive. This improvement in sensitivity has significantly lowered the maximum and minimum values for gross alpha and minimum values for gross beta (Tables 1-3).

The charcoal samples collected weekly at the air monitoring stations showed a significant decrease in ^{131}I concentrations, indicating that the higher radioactivity levels observed in the Oak Ridge area during the second quarter as a result of the cloud from the Chernobyl incident are not continuing. The elevated ^{131}I concentration at station 43 (see Table 4) is caused by a high reading during week 31. This is presumed to be an artifact because there were no similar increases at other stations. Unfortunately, due to the short half-life of ^{131}I , verification is not possible. Station 9 is missing from the tables containing July and August data because the flow rate for the sampling apparatus is either above (> 3.0 CFM) or below (< 1.5 CFM) the sampling volume required to produce accurate results. By setting these upper and lower limits on flow rate, the bias is eliminated from the calculation of the concentration.

Monthly samples for atmospheric tritium are collected from two ORNL PAM stations (3 and 7) and one Reservation PAM station (8). Atmospheric tritium in the form of water vapor is removed from the air by silica gel. The silica gel is heated in a distillation flask to remove the moisture and the distillate is counted in a liquid scintillation counter. The concentration of tritium in the air is calculated by dividing total activity accumulated per month by total volume of air sampled. A quarterly summary of the atmospheric tritium concentration is presented in Table 7.

Table 1. (Continued)

July 1986

Concentration (10^{-8} Bq/L)

Location	Gross alpha			AV	95%cc ^a	No. of samples	Gross beta			AV	95%cc ^a
	Max	Min	No. of samples				Max	Min			
RAM Stations ^c											
51	8.0	0	2.9	3.0	14	5	4.0	7.2	3.6		
52	8.8	0	3.0	4.2	2.9	5	-13	-8.2	7.5		
53	5.6	0	1.4	2.8	25	5	-2.9	11	12		
55	7.9	0	4.0	4.6	11	4	-0.26	5.4	5.8		
56	11	5.4	8.6	2.5	38	4	7.9	19	14		
57	17	0	7.8	6.5	19	5	0.22	15	7.5		
Network summary	17	0	4.7	1.9	38	28	-13	8.5	4.6		
Overall summary	24	-1.8	4.4	1.4	170	86	-13	55	9.4		

a 95% confidence coefficient about the average of more than two samples.

b See Figure 1.

c See Figure 2.

Table 2. Long-lived gross alpha and gross beta activities in air

August 1986

Concentration (10^{-8} Bq/L)

Location	Gross alpha				Av	95%cc ^a	No. of samples	Gross beta				Av	95%cc ^a
	Max	Min	Av	No. of samples				Max	Min	Av	No. of samples		
3	15	-11	3.5	4	3.5	12	4	190	15	71	82		
7	0	-13	-6.4	4	-6.4	6.7	4	97	39	62	26		
Network summary	15	-13	-1.5	8	-1.5	7.3	8	190	15	66	40		
ORNL PAM Stations ^b													
8	15	-10	3.3	4	3.3	11	4	100	67	84	15		
23	22	-10	0.7	4	0.7	15	4	140	52	98	38		
31	5.9	0	2.9	2	2.9		2	100	71	87			
33	26	0	6.5	4	6.5	13	4	86	15	51	37		
34	12	-10	-0.29	4	-0.29	11	4	84	16	39	31		
36	16	-1.0	5.9	4	5.9	7.9	4	78	59	70	8.0		
40	0	-9.6	-4.5	4	-4.5	4.8	4	77	29	58	20		
41	8.6	-17	-8.6	3	-8.6	17	3	52	26	43	17		
42	0	-10	-6.9	3	-6.9	6.9	3	62	47	52	10		
43	39	-13	6.9	4	6.9	24	4	97	32	55	31		
44	0	-15	-7.6	2	-7.6		2	82	23	53			
45			-1.7	1	-1.7		1		43				
Network summary	39	-17	0.42	39	0.42	3.9	39	140	15	62	9.3		

Table 2. (Continued)

August 1986

Location	Concentration (10^{-8} Bq/L)									
	Gross alpha					Gross beta				
	No. of samples	Max	Min	Av	95%cc ^a	No. of samples	Max	Min	Av	95%cc ^a
	RAM Stations ^c									
51	4	9.1	0	3.9	4.6	4	32	0.17	11	14
52	4	2.8	0	0.69	1.4	4	-6.2	-14	-9.5	3.1
53	3	4.9	0	2.6	2.9	3	8.5	-5.6	-0.70	9.2
55	4	8.1	0	3.8	3.4	4	2.6	-5.3	-0.32	3.5
56	3	5.4	2.4	3.5	1.9	3	19	-1.2	6.0	13
57	4	6.5	0	3.6	2.7	4	11	-0.38	5.3	5.3
Network summary	22	9.1	0	3.0	1.2	22	32	-14	2.0	4.3
Overall summary	69	39	-17	1.0	2.4	69	190	-14	43	9.8

95% confidence coefficient about the average of more than two samples.

See Figure 1.

See Figure 2.

Table 3. Long-lived gross alpha and gross beta activities in air
September 1986

Location	Gross alpha						Gross beta					
	No. of samples	Max	Min	AV	95%cc ^a	No. of samples	Max	Min	AV	95%cc ^a		
Concentration (10 ⁻⁸ Bq/L)												
3	4	-9.7	-15	-11	2.7	4	65	13	30	24		
7	4	0	-9.7	-7.3	4.9	4	140	52	83	38		
9	4	0	-15	-7.7	6.2	4	120	45	99	37		
Network summary	12	0	-15	-8.7	2.7	12	140	13	71	25		
ORNL PAM Stations ^b												
8	4	0	-12	-5.0	6.0	4	160	36	110	51		
23	4	0	-7.8	-1.9	3.9	4	130	54	95	33		
31	3	0	-9.7	-3.2	6.5	3	140	69	110	43		
33	4	0	-13	-9.7	6.5	4	130	43	88	37		
34	2	-7.8	-12	-9.9		2	48	26	37			
36	4	0	-12	-6.9	5.0	4	97	73	80	11		
40	3	8.6	0	5.8	5.8	3	130	40	75	51		
41	3	0	-7.8	-2.6	5.2	3	190	54	110	82		
42	4	10	-7.5	0.72	7.3	4	110	65	83	19		
43	4	-9.7	-15	-11	2.7	4	100	7.6	72	44		
44	4	14	-12	1.1	12	4	86	35	61	23		
Network summary	39	14	-15	-3.9	2.4	39	190	7.6	85	12		
Reservation PAM Stations ^b												

Table 3. (Continued)

September 1986

Location	Gross alpha				Gross beta				No. of samples	95%cca ^a	RAM Stations ^c	95%cca
	Max	Min	AV	No. of samples	Max	Min	AV	95%cca				
51	3.2	0	2.3	4	6.5	-6.5	1.9	4	1.5		3.4	
52	7.4	3.2	4.4	4	3.4	-11	-6.2	4	2.0		6.6	
53	3.0	0	1.0	3	5.4	-2.7	1.9	3	2.0		4.8	
55	10	0	4.3	3	-2.1	-2.9	-2.5	3	6.2		0.49	
56	9.0	0	3.9	4	13	1.5	8.3	4	3.8		5.3	
57	6.5	0	3.2	4	6.5	2.2	4.0	4	2.8		2.2	
Network summary	10	0	3.2	22	13	-11	1.4	22	1.2		2.6	
Overall summary	14	-15	-2.5	73	190	-11	57	73	1.7		12	

95% confidence coefficient about the average of more than two samples.

See Figure 1.

See Figure 2.

Table 4. Iodine - 131 in Air

July 1986

Location	No. of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95%cc ^a
ORNL Perimeter Stations ^b					
3	2	0	-2.5	-1.2	
7	5	12	-2.2	5.9	4.7
Network summary	7	12	-2.5	3.8	4.2
Reservation Perimeter Stations ^b					
8	5	5.8	-5.6	0.034	3.6
23	3	12	-2.5	2.5	9.8
31	5	15	-2.3	3.1	6.5
33	4	0	-6.1	-3.3	2.7
34	5	7.2	0	1.9	2.8
36	5	13	-2.0	5.9	5.5
40	5	7.4	0	2.3	2.7
41	2	3.3	-11	-3.9	
42	5	7.7	-4.2	2.5	4.8
43	5	60	-2.3	17	22
44	4	12	-1.3	4.1	6.2
45	3	4.1	-3.5	0.20	4.4
Network summary	51	60	-11	3.2	2.7
Overall summary	58	60	-11	3.3	2.4

^a 95% confidence coefficient about the average of more than two samples.

^b See Figure 1.

Table 5. Iodine - 131 in Air

August 1986

Location	No. of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95%cc ^a
ORNL Perimeter Stations ^b					
3	4	8.2	-3.1	0.47	5.2
7	4	16	-1.5	6.2	7.1
Network summary	8	16	-3.1	3.3	4.6
Reservation Perimeter Stations ^b					
8	4	7.4	-4.2	0.088	5.0
23	4	6.3	-3.7	0.31	4.3
31	2	9.6	0	4.8	9.6
33	4	2.0	-8.2	-4.1	4.9
34	4	2.6	-4.8	-1.9	3.4
36	4	9.8	0	2.8	4.7
40	4	3.9	0	1.9	2.1
41	3	9.3	-7.0	1.6	9.5
42	3	7.0	1.4	3.3	3.7
43	4	1.8	-5.3	-0.49	3.3
44	2	4.2	2.1	3.1	
45	1			-7.0	
Network summary	39	9.8	-8.2	0.45	1.5
Overall summary	47	16	-8.2	0.94	1.5

^a 95% confidence coefficient about the average of more than two samples.

^b See Figure 1.

Table 6. Iodine - 131 in Air
September 1986

Location	No. of samples	Concentration (10^{-8} Bq/L)			
		Max	Min	Av	95%cc ^a
ORNL Perimeter Stations ^b					
3	4	14	0	4.5	6.4
7	4	5.3	0	1.8	2.5
9	4	6.1	-5.6	2.9	5.7
Network summary	12	14	-5.6	3.1	2.8
Reservation Perimeter Stations ^b					
8	4	5.6	-4.2	0.70	4.1
23	4	1.6	-6.5	-1.3	3.8
31	3	6.6	2.3	4.7	2.5
33	4	9.3	-8.2	-1.5	8.1
34	2	-1.4	-1.6	-1.5	
36	4	7.0	-4.2	2.1	5.2
40	3	8.2	-4.1	0.97	7.4
41	3	4.9	-1.4	1.9	3.7
42	4	8.0	-1.4	4.9	4.2
43	4	2.0	-8.8	-1.7	4.8
44	4	1.3	-4.9	-0.9	2.9
45					
Network summary	39	9.3	-8.8	0.74	1.5
Overall summary	51	14	-8.8	1.3	1.3

^a 95% confidence coefficient about the average of more than two samples.

^b See Figure 1.

Table 7. Tritium activity in air
July - September 1986

Location ^a	No. of samples	Concentration (10^{-4} Bq/L)			
		Max	Min	Av	95%cc ^b
3	3	4.4	2.4	3.6	1.2
7	3	22	7.7	13	9.4
8	3	2.6	0.7	1.8	1.1
Overall summary	9	22	0.7	6.0	4.4

^a See Figure 1.

^b 95% confidence coefficient about the average of more than two samples.

For the first quarter of 1986, composite air filters were analyzed from ORNL PAMs (stations 3, 7, and 9), Reservation PAMs (excluding stations 36, 40, and 41), RAMs (stations 51-53 and 55-57), and from individual stations (36, 40, and 41). Filters from both the old and new sampling apparatus were combined for subsequent analysis. Due to the importance and visibility of the White Oak Dam station (or station 34), starting with the second quarter, filters were analyzed separately. All other samples were composited the same way as in the first quarter. The results of specific radionuclide analyses of composited air filters for the second quarter are given in Table 8. As expected, due to the Chernobyl incident, radioactivities for all locations in the second quarter were generally higher than the previous quarter. Three relatively short lived radionuclides (^{134}Cs , ^{103}Ru , and ^{106}Ru) were also found in the second quarter. The concentration of ^{90}Sr at ORNL PAMs is 240×10^{-10} Bq/L which is approximately a 10-fold increase from last year's quarterly averages (23×10^{-10} Bq/L). During the same period, the ^{90}Sr concentration in milk showed no significant difference from 1985.

Table 8. Long-lived radioactivity in composited air filters
for the second quarter

April - June 1986

Radionuclide	Concentration (10^{-10} Bq/L)									
	ORNL		Reservation		Location ^a					
	PAMS	PAMS	PAMS	RAMS	Station 34	Station 35	Station 36	Station 40	Station 41	Station
¹³⁴ Cs	7600	500	190	ND ^b	ND ^b	590	930	1100		
¹³⁷ Cs	15000	1100	420	980	860	1900	2800			
²³⁸ Pu	< 0.28	0.01	< 0.06	< 0.67	0.27	< 0.54	0.98			
²³⁹ Pu	0.69	< 0.80	0.01	0.62	0.81	1.2	< 0.16			
¹⁰³ Ru	12000	770	260	ND ^b	590	1900	1800			
¹⁰⁶ Ru	6000	450	190	ND ^b	ND ^b	780	1200			
⁹⁰ Sr	240	27	68	< 150	120	97	390			
²²⁸ Th	48	11	8.8	5.7	17	17	29			
²³⁰ Th	48	10	9.2	6.7	15	16	21			
²³² Th	53	13	10	5.7	17	14	23			
²³⁴ U	140	160	12	34	81	840	230			
²³⁵ U	19	15	0.99	3.5	6.5	51	29			
²³⁸ U	76	47	10	22	32	110	88			

^a See Figures 1 and 2.

^b ND = Not detected in gamma scan.

EXTERNAL GAMMA RADIATION

External gamma radiation measurements are made to confirm that routine radioactive effluents from ORNL are not increasing external radiation levels significantly above normal background.

Currently, external gamma radiation measurements are made monthly at the ORNL PAM stations (Figure 1) and at Reservation PAM stations 8 and 23 (Figure 1), quarterly at sites along the bank of the Clinch River (Figure 3), and semiannually at the RAM stations (Figure 2). Measurements along the bank of the Clinch River, from the mouth of White Oak Creek for several hundred yards downstream, are made to evaluate gamma radiation levels resulting from ORNL effluent releases and "sky shine" from an experimental radioactive cesium plot located near the river bank. Measurements at these sites are made using thermoluminescent dosimeters (TLDs). Three dosimeters are placed in each container at the remote air monitoring stations and two are placed in containers at the other locations. The containers are suspended one meter above the ground. Measurements from each dosimeter are averaged for the month, quarter, or semiannual period. Since April, real-time readings of external gamma radiation have been collected at 10-minute intervals for all Reservation PAM stations (except stations 8 and 23) and monthly averages are calculated based on the real-time readings. The external gamma radiation at stations 8 and 23 are measured monthly using TLDs. Summaries of external gamma radiation are in Tables 9-11.

External gamma radiation levels measured at the ORNL and Reservation perimeter stations were similar to the respective second quarter levels. The average value for stations along the Clinch River was less than the two previous quarters. The second quarter value, which was higher than previous years, may have been elevated by the Chernobyl incident.

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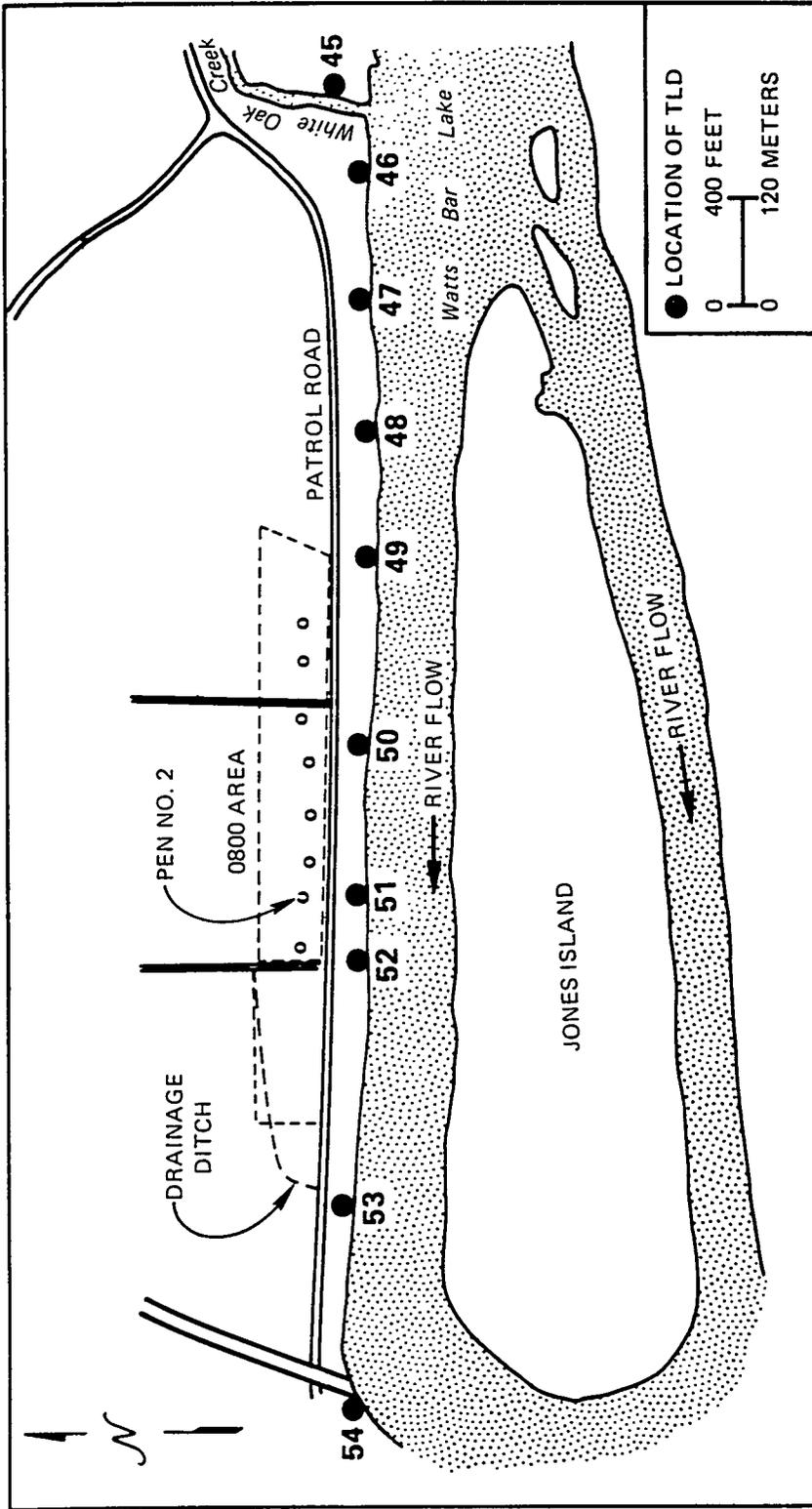


Fig. 3 Location map of TLDs along the Clinch River

Table 9. External gamma radiation measurements at ORNL and reservation perimeter air monitoring stations

July - September 1986

Location	No. of samples ^a	Concentration ($\mu\text{R/h}$)			
		Max	Min	Av	95%cc ^b
ORNL PAM Stations					
3	2	13	7.3	10	
7	2	9.7	8.3	9.0	
9	2	11	7.7	9.2	
21	2	11	9.3	10	
22	2	11	10	11	
Network summary	10	13	7.3	9.8	1.1
Reservation PAM Stations					
8	2	7.7	5.7	6.7	
23	2	8.0	6.3	7.2	
31	45	11	7.3	7.9	0.2
33	41	8	7.3	7.6	0.06
34	60	10	7.7	8.8	0.15
36	75	8.0	7.1	7.4	0.04
40	84	8.6	7.5	8.1	0.05
41	77	8.8	7.9	8.1	0.03
42	76	7.9	7.0	7.4	0.05
43	65	7.7	6.3	7.1	0.05
44	87	8.2	6.9	7.2	0.04
45	52	7.7	6.9	7.2	0.04
46	6	9.3	9.0	9.2	0.07
Network summary	672	13	5.7	7.7	0.05

^a Individual dosimeters at locations 3,7,8,9,21,22, and 23 are averaged for each station. The number of samples indicates the number of months of data. No data available for the month of July.

Real-time readings were collected at stations 31,33,34,36,40-46, at 10-minute intervals. The number of samples indicates the total number of days.

^b 95% confidence coefficient about the average of more than two samples.

Table 10. External gamma radiation measurements at remote stations

January - August 1986

Location ^a	No. of Samples ^b	Concentration ($\mu\text{R/h}$)
51	1	5.3
52	1	7.1
53	1	6.7
55	1	4.5
56	1	5.4
57	1	5.8
58	1	11
Network Average		6.5

^a See Figure 2.

^b Individual dosimeters are averaged for each station. The number of samples indicate the number of semi-annual periods of data.

Table 11. External gamma radiation measurements
along the Clinch River

July - September 1986

Location ^a	No. of Samples ^b	Concentration (μ R/h)
45	1	7.3
46	1	10
47	1	5.3
48	1	6.7
49	1	14
50	1	25
51	1	25
52	1	1.9
53	1	9.7
54	1	5.7
Quarterly average		13

^a See Figure 3.

^b Individual dosimeters are averaged for each station. The number of samples indicates the number of quarters of data.

WATER

Most of the drainage or liquid effluent from ORNL flows into the Clinch River by way of White Oak Creek (WOC). The Clinch River flows southwest from Virginia to its mouth near Kingston, Tennessee, where it joins with the Tennessee River.

Runoff from the majority of the sites at ORNL, including that from the burial grounds, reaches WOC either directly or via one of its tributaries, such as Melton Branch (MB). Concentrations of contaminants in WOC are affected by White Oak Dam (WOD) which controls the stream's flow. Flow in WOC may also be augmented by discharges from the ORNL cooling towers and Sewage Treatment Plant. Below WOD, WOC is affected by water levels in the Clinch River which are controlled by Melton Hill Dam, shown in Figure 4.

Surveillance of the water environment consists of the collection of surface water samples, samples required under the National Pollutant Discharge Elimination System (NPDES) permit, and water from wells around surface impoundments, Solid Waste Storage Areas (SWSAs), and pits and trenches. Samples are analyzed for radionuclides and nonradioactive chemicals.

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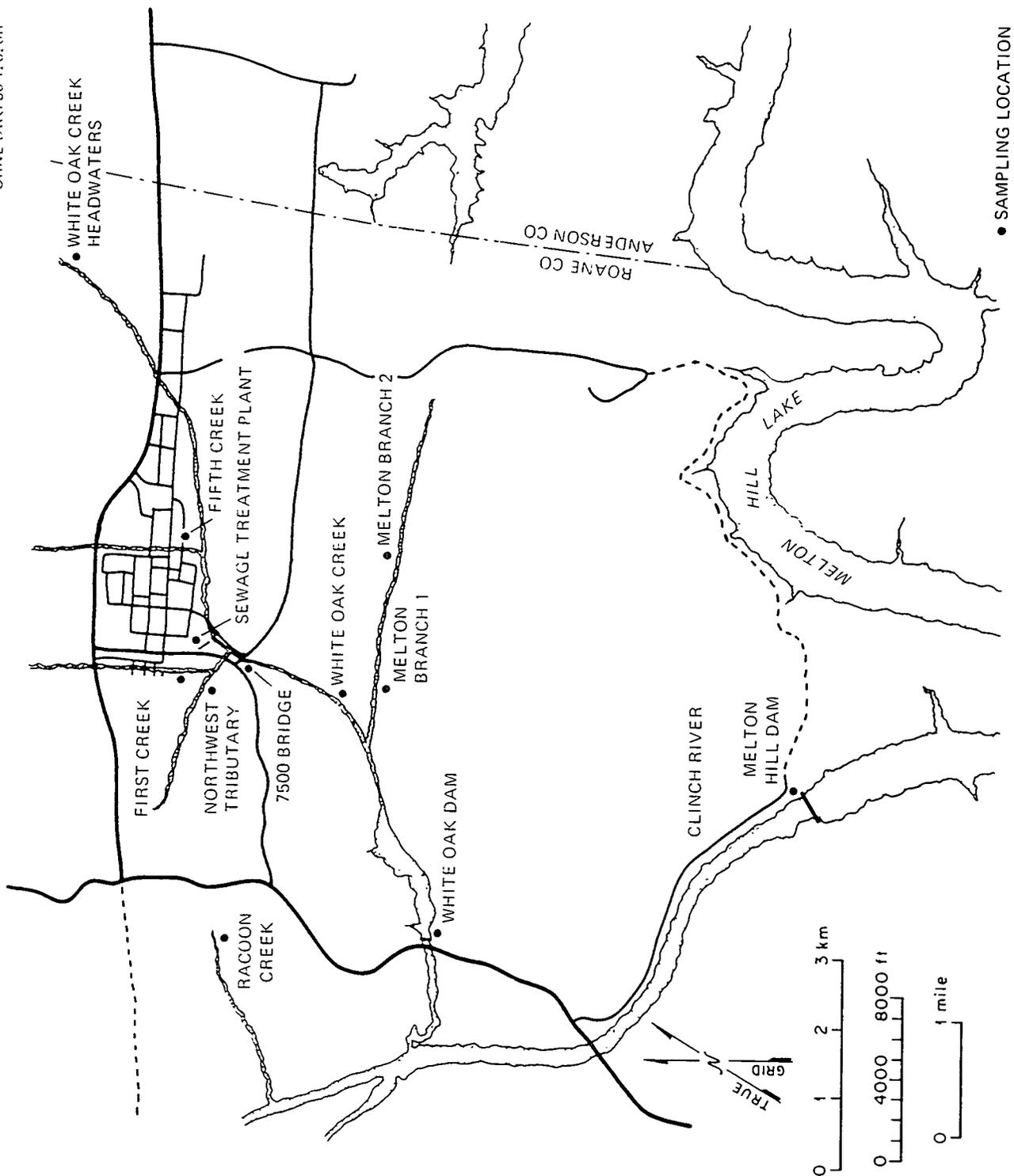


Fig. 4 Location map of ORNL streams and sampling stations

Surface Water

White Oak Creek drains an area of 17 km² in Bethel and Melton Valleys and is the largest stream flowing through ORNL. Run-off from sites at ORNL reaches WOC either directly or via one of its tributaries. After entering Melton Valley, WOC is joined by its major tributary, MB, at WOC kilometer 2.49. White Oak Dam, located one kilometer above the mouth of WOC, forms White Oak Lake and serves as a point for monitoring flow and discharges of contaminants from the ORNL site. Major discharges to WOC include (1) treated domestic (sanitary) waste from the Sewage Treatment Plant (STP); (2) cooling tower blowdown; (3) cooling water; (4) demineralizer regeneration waste; (5) surface drainage from the main Laboratory area (including drainage from several Solid Waste Storage Areas, SWSAs); (6) discharges from the low-level radioactive waste collection and ion exchange treatment system; and (7) discharges from process building areas. Major discharges to MB include discharges from Solid Waste Storage Area 5, blowdown from the recirculating cooling water system at the High Flux Isotope Reactor, and discharges from the 7900 waste pond system.

To determine discharges of radionuclides from ORNL processes, flow and concentration data from ORNL streams are recorded. Water samples are collected regularly from the following stations: First Creek, Fifth Creek, 7500 Bridge, Melton Branch 1 (MB1), Melton Branch 2 (MB2), Melton Hill Dam, Northwest Tributary (NWT), Raccoon Creek, STP, WOC, White Oak Creek Headwaters, and WOD (Figure 4). In addition, process water samples are collected from the sanitary waste treatment plants at the Oak Ridge Gaseous Diffusion Plant (ORGDP - Gallaher) and at Kingston (Figure 5). ORNL tap water is also sampled. Samples collected from Melton Hill Dam, WOC Headwaters, and ORNL tap are considered as background or reference samples.

Table 12 summarizes the sampling and analysis frequencies, the parameters analyzed, and the type of sample collected at each of these stations. Flow proportional samples at 7500 Bridge are collected and analyzed daily as an early warning of discharges of radioactivity from ORNL processes. Another sample is collected weekly and analyzed monthly for additional parameters. The flow proportional samples from WOD are collected and analyzed weekly while those from WOC, MB1, STP, and Melton Hill Dam are collected weekly, composited, and analyzed monthly. Grab samples from First Creek, Fifth Creek, MB2, NWT, Raccoon Creek, and WOC Headwaters are collected weekly, composited, and analyzed monthly. The time proportional samples from ORGDP and the grab samples from Kingston and ORNL tap water are composited and analyzed quarterly. Summaries of radionuclide concentrations are presented in Tables 13-15. The 95% confidence coefficients about the averages are not appropriate and have not been presented for stations with less than three samples. Concentrations of ⁹⁰Sr and total Sr (⁸⁹Sr and ⁹⁰Sr) are presented in Tables 13-14. Samples collected during the month of July and three weeks of August were analyzed for ⁹⁰Sr while those collected later were analyzed for total Sr. The change in the analytical method for strontium was instituted by the Analytical Chemistry Division to comply with the method recommended by EPA.

Flows in the Clinch River as measured at Melton Hill Dam and in WOC as measured at WOD and the ratio of these flows are presented in Table 16.

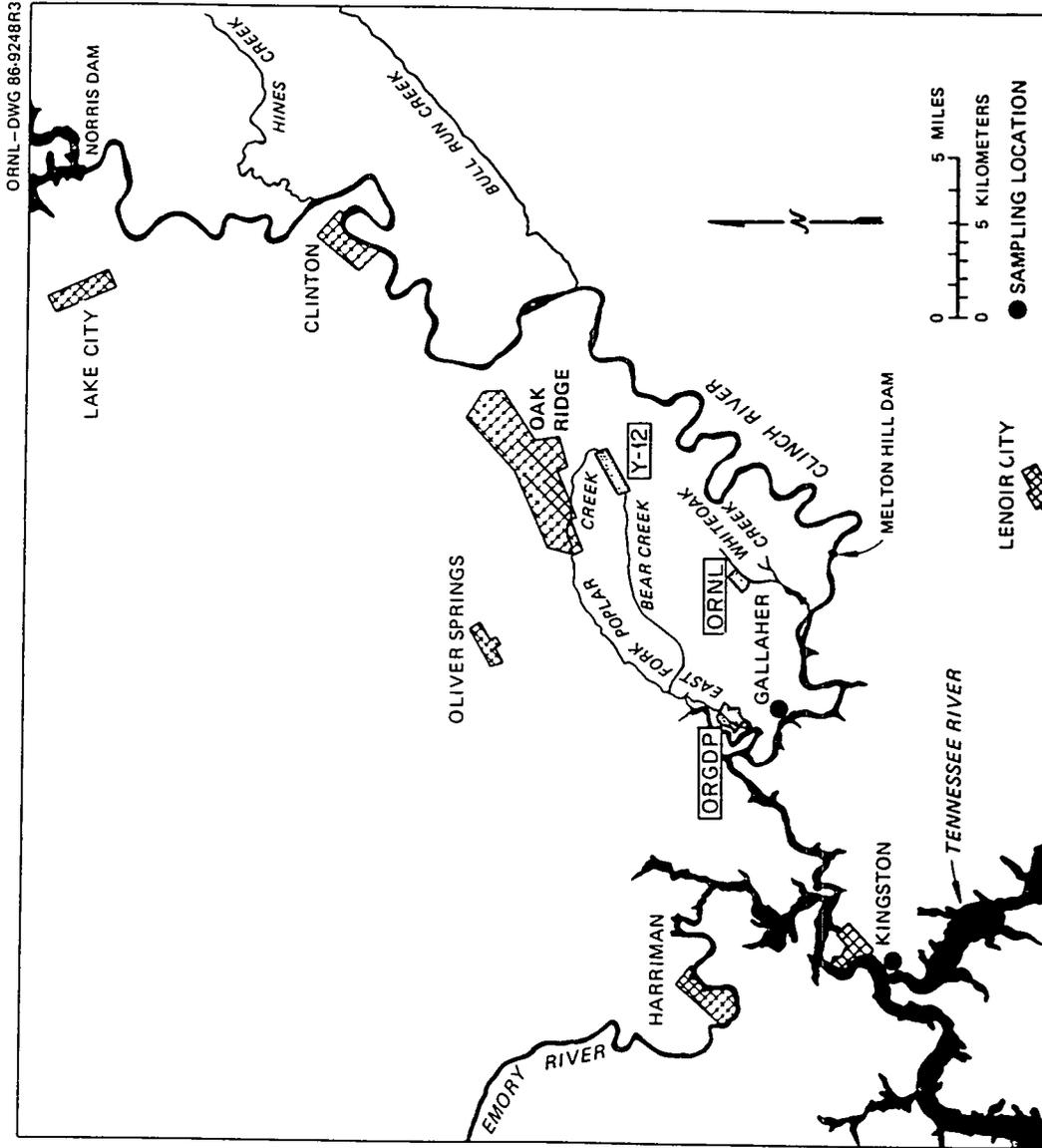


Fig. 5 Location map of Gallaher and Kingston sampling points

Table 12. Summary of collection and analysis frequencies of surface and tap water samples

Station	Parameter	Collection frequency	Type	Analysis frequency
7500 Bridge	Gross alpha, gross beta, gamma scan, ^{90}Sr	Daily	Flow Proportional	Daily
7500 Bridge, MB1,	Gamma scan, ^{90}Sr , ^3H	Weekly	Flow Proportional	Monthly
First Creek, Fifth Creek, NWT, Raccoon Creek,	Gamma scan, ^{90}Sr	Weekly	Grab	Monthly
Kingston	^3H	Weekly	Grab	Monthly
	Gamma scan, ^{90}Sr , Pu, transPu, U	Monthly	Grab	Quarterly
MB2	Gamma scan, ^{90}Sr , ^3H	Weekly	Grab	Monthly
Melton Hill Dam	Gamma scan, ^{90}Sr , Pu, transPu, ^3H , Th, U	Weekly	Flow Proportional	Monthly
ORGDP	^3H	Weekly	Time Proportional	Monthly
	Gamma scan, ^{90}Sr , Pu	Monthly	Time Proportional	Quarterly
ORNL tap	Gamma scan, ^{90}Sr , Pu, transPu, U	Daily	Grab	Quarterly
STP	Gamma scan, ^{90}Sr	Weekly	Flow Proportional	Monthly
WOC	Gamma scan, ^{90}Sr , ^3H	Weekly	Flow Proportional	Monthly
WOC Headwaters	Gamma scan, ^{90}Sr , Pu, transPu, ^3H	Weekly	Grab	Monthly
WOD	Gross alpha, gross beta, gamma scan, ^{90}Sr , Pu, transPu, ^3H	Weekly	Flow Proportional	Weekly

Table 13. Radionuclide concentrations in water

July - September 1986

Radionuclide	No. of samples	Concentration (Bq/L)			
		Max	Min	Av	95%cc ^a
First Creek ^b					
⁶⁰ Co	3	< 0.30	< 0.10	< 0.20	0.12
¹³⁷ Cs	3	< 1.0	< 0.20	< 0.53	0.48
⁹⁰ Sr	1			30	
Total Sr	2	35	26	31	
Fifth Creek ^b					
⁶⁰ Co	3	< 0.30	< 0.10	< 0.20	0.12
¹³⁷ Cs	3	< 0.30	< 0.10	< 0.23	0.13
⁹⁰ Sr	1			1.3	
Total Sr	2	1.5	1.3	1.4	
7500 Bridge ^b					
⁶⁰ Co	3	< 0.60	< 0.20	< 0.37	0.24
¹³⁷ Cs	3	8.4	4.3	6.5	2.4
³ H	3	300	130	210	97
⁹⁰ Sr	1			2.8	
Total Sr	2	5.7	3.9	4.8	
Melton Branch 1 ^b					
⁶⁰ Co	3	8.3	6.0	7.4	1.4
¹³⁷ Cs	3	< 0.40	< 0.10	< 0.32	0.20
³ H	3	55000	19000	36000	21000
⁹⁰ Sr	1			5.4	
Total Sr	2	6.6	2.3	4.5	
Melton Branch 2 ^b					
⁶⁰ Co	3	13	4.2	8.7	5.1
¹³⁷ Cs	3	< 0.40	< 0.10	< 0.27	0.18
³ H	3	6300	4500	5500	1000
⁹⁰ Sr	1			0.10	
Total Sr	2	0.72	0.12	0.42	

Table 13. (Continued)

July - September 1986

Radionuclide	No. of samples	Concentration (Bq/L)			
		Max	Min	Av	95%cc ^a
Melton Hill Dam ^b					
⁶⁰ Co	3	< 0.30	< 0.10	< 0.17	0.13
¹³⁷ Cs	3	< 0.30	< 0.10	< 0.17	0.13
³ H	3	120	120	120	0
Pu	3	0.0010	0.0010	0.0010	0.00033
⁹⁰ Sr	1			< 0.10	
Total Sr	2	0.26	0.040	0.13	
²²⁸ Th	3	0.0020	< 0.00020	0.0010	0.00093
²³⁰ Th	3	0.0020	< 0.00020	0.0010	0.00095
²³² Th	3	0.0010	< 0.00020	0.0010	0.00047
Trans Pu	3	0.0020	0.0010	0.0015	0.00060
²³⁴ U	3	0.018	0.014	0.016	0.0023
²³⁵ U	3	0.0031	0.00060	0.0016	0.0015
²³⁸ U	3	0.12	0.022	0.077	0.058
Northwest Tributary ^b					
⁶⁰ Co	3	< 0.20	< 0.10	< 0.17	0.067
¹³⁷ Cs	3	0.30	< 0.10	0.20	0.12
⁹⁰ Sr	1			0.11	
Total Sr	2	0.33	0.10	0.22	
Raccoon Creek ^b					
⁶⁰ Co	3	< 0.20	< 0.10	< 0.17	0.067
¹³⁷ Cs	3	< 0.20	< 0.10	< 0.17	0.067
⁹⁰ Sr	1			6.6	
Total Sr	2	6.2	5.8	6.0	
Sewage Treatment Plant ^b					
⁶⁰ Co	3	< 0.30	< 0.20	< 0.26	0.061
¹³⁷ Cs	3	< 0.31	< 0.30	< 0.30	0.067
⁹⁰ Sr	1			3.7	
Total Sr	2	3.9	3.8	3.9	
White Oak Creek ^b					
⁶⁰ Co	3	< 0.30	< 0.20	< 0.27	0.067
¹³⁷ Cs	3	7.2	4.5	6.2	1.7
³ H	3	220	130	180	51
⁹⁰ Sr	1			3.6	
Total Sr	2	5.8	5.3	5.6	

Table 13. (Continued)

July - September 1986

Radionuclide	No. of samples	Concentration (Bq/L)			
		Max	Min	Av	95%cc ^a
White Oak Creek Headwaters ^b					
⁶⁰ Co	3	< 0.20	< 0.10	< 0.13	0.067
¹³⁷ Cs	3	< 0.30	< 0.10	< 0.17	0.13
³ H	3	120	120	120	0
Pu	3	0.0010	0.0010	0.0010	0.00013
⁹⁰ Sr	1			0.17	
Total Sr	2	0.10	0.080	0.090	
²²⁸ Th	3	0.0010	< 0.00020	0.00040	0.00037
²³⁰ Th	3	0.0013	0.00050	0.0010	0.00048
²³² Th	3	0.00040	< 0.00020	0.00030	0.00012
Trans Pu	3	0.0020	0.0010	0.0016	0.00053
²³⁴ U	3	0.021	0.012	0.016	0.0052
²³⁵ U	3	0.0050	0.0010	0.0024	0.0026
²³⁸ U	3	0.10	0.023	0.070	0.049
White Oak Dam ^b					
⁶⁰ Co	13	1.3	< 0.30	0.65	0.19
¹³⁷ Cs	13	12	0.63	4.3	1.9
Gross alpha	13	4.0	0.60	2.2	0.62
Gross beta	13	24	10	18	2.4
³ H	13	4000	1500	2800	460
Pu	13	0.062	0.0030	0.020	0.010
⁹⁰ Sr	8	5.4	3.1	4.6	0.53
Total Sr	5	8.0	4.2	5.9	1.5
Trans Pu	13	0.10	0.0020	0.040	0.017

^a 95% confidence coefficient about the average of more than two samples.

^b See Figure 4.

Table 14. Radionuclide concentrations in water at 7500 Bridge^a
July - September 1986

Radionuclide	No. of samples	Concentration (Bq/L)			
		Max	Min	Av	95% cc ^b
July					
⁶⁰ Co	18	0.49	< 0.10	0.27	0.043
¹³⁷ Cs	18	17	2.6	8.5	1.9
²⁴ Na	2	1.0	0.48	0.74	
⁹⁰ Sr	20	7.1	1.9	2.8	0.49
August					
⁶⁰ Co	18	< 0.90	< 0.20	< 0.37	0.076
¹³⁷ Cs	18	24	6.6	13	2.4
⁹⁰ Sr	21	31	1.6	5.6	2.7
September					
⁶⁰ Co	21	5.3	< 0.20	0.62	0.47
¹³⁷ Cs	21	23	1.4	10	2.8
¹³¹ I	3	0.53	< 0.20	0.39	0.20
⁹⁰ Sr	1			6.0	
Total Sr	20	16	2.3	6.1	1.7

^a See Figure 4.

^b 95% confidence coefficient about the average of more than two samples.

Table 15. Quarterly concentrations of radionuclides in surface streams and tap water

April - June 1986

Radionuclide	Concentration (Bq/L)
Gallaher ^a	
⁶⁰ Co	< 0.0060
¹³⁷ Cs	< 0.0050
Gross alpha	0.18
Gross beta	0.57
³ H	53
Pu ^b	< 0.00011
⁹⁰ Sr	0.14
²³⁴ U	0.0053
²³⁵ U	0.00016
²³⁶ U	< 0.0000062
²³⁸ U	0.0032
Kingston ^a	
⁶⁰ Co	< 0.0030
¹³⁷ Cs	< 0.0030
Gross alpha	0.038
Gross beta	0.15
³ H	14
Pu ^b	< 0.00011
⁹⁰ Sr	0.0070
²³⁴ U	0.0047
²³⁵ U	0.00016
²³⁶ U	0.000066
²³⁸ U	0.0031
ORNL Tap Water	
⁶⁰ Co	< 0.0050
¹³⁷ Cs	< 0.0040
Gross alpha	0.038
Gross beta	0.14
Pu ^b	< 0.00011
⁹⁰ Sr	0.042
²³⁴ U	0.0059
²³⁵ U	0.00016
²³⁶ U	< 0.0000064
²³⁸ U	0.0033

^a See Figure 5.^b Total Pu (²³⁹Pu + ²⁴⁰Pu)

Table 16. Flows for Clinch River and White Oak Creek
July - September 1986

Month	Flow (10^9 Liters)		Average Ratio ^b
	Clinch River ^a	White Oak Creek ^a	
July	250	0.72	360
August	170	0.56	300
September	240	0.57	450

^a See Figure 4.

^b Ratio of Clinch River to White Oak Creek flow is calculated weekly and averaged for the month.

Total flows per day at MBI, WOC, and WOD, are calculated by subtracting consecutive daily flow recorder readings and multiplying by a factor for conversion to liters. Clinch River flow is recorded daily by personnel of the Tennessee Valley Authority and forwarded monthly to the Department of Environmental Management. Low flow and high flow readings are recorded for WOC and MBI and are summed to estimate total flow. Three flows: low, medium, and high are recorded at WOD and summed to give total flow. The weekly total flow is determined by averaging the total flow for the week and multiplying by the number of days in the week.

The discharge of radionuclides at WOD, WOC, MBI, and the STP is calculated by multiplying the concentration (in Bq/L) by the flow (in liters). At WOC, MBI, and the STP, a single flow proportional sample is analyzed monthly to estimate radionuclide concentrations. At WOD, weekly flow proportional samples are analyzed. Radionuclide discharges at WOC, MBI, and the STP are calculated by dividing the concentration in the monthly composite sample by the total flow for the month at each station (Tables 17-19). However, at WOD, weekly radionuclide discharges are calculated by dividing the weekly composite sample concentration by the total weekly flow. Monthly discharges of radionuclides at WOD are then calculated by averaging the weekly discharges and multiplying by the number of weeks per month (Tables 17-19). A flow weighted concentration at WOD for the month is calculated by dividing the total radionuclide discharge for the month by the total monthly flow (Tables 17-19).

The concentrations of ^{60}Co appear to be highest at Melton Branch stations 1 and 2 (Table 13) while ^{137}Cs concentrations are highest in WOC (Table 13). Most of the ^3H is derived from SWSA 5 near the MBI station and the highest concentrations of that radionuclide are observed there (Table 13). The highest concentrations of ^{90}Sr are found at the First Creek station due to probable leakage from burst pipes. The suspected pipe breaks in this area are being addressed in the short-term by placing a liner inside the pipes. There is a long-term project to replace selected piping in the ORNL complex.

Tritium and ^{90}Sr are the radionuclides of greatest concern in terms of radiation doses to the public from drinking water. In the third quarter of 1986, greater than 80% of the ^3H discharges over WOD could be accounted for by the discharges of ^3H over the MBI weir (Tables 17-19). The ^3H values measured at MBI are thought to be due primarily to releases from SWSA 5. Tritium values measured at MBI weir, which is below the area where SWSA 5 discharges to Melton Branch, are generally more than an order of magnitude higher than values measured at the MB2 weir above the SWSA 5 area.

Characterization of SWSA 5 and particularly the ^3H problem in SWSA 5 will be one of the highest priorities of the Remedial Investigation Feasibility Study (RI/FS) subcontract. This characterization which is scheduled to begin in April, 1987, is necessary in order to comply with Resource Conservation and Recovery Act (RCRA) requirements and to determine the measures necessary to most effectively reduce the flow of ^3H and/or other contaminants from SWSA 5.

Table 17. Discharges of radionuclides in water

July 1986

Radionuclide	Flow (10 ⁶ Liters)	Concentration (Bq/L)	Discharge (10 ⁴ mega Bq)
Melton Branch 1 ^a			
⁶⁰ Co	57	8.0	0.046
¹³⁷ Cs	57	< 0.10	0.00060
³ H	57	33000	190
⁹⁰ Sr	57	5.4	0.031
Sewage Treatment Plant ^a			
⁶⁰ Co	22	0.28	0.00062
¹³⁷ Cs	22	0.31	0.00069
⁹⁰ Sr	22	3.7	0.0081
White Oak Creek ^a			
⁶⁰ Co	680	0.20	0.014
¹³⁷ Cs	680	7.2	0.49
³ H	680	220	15
⁹⁰ Sr	680	3.6	0.24
White Oak Dam ^{a, b}			
⁶⁰ Co	720	0.74	0.053
¹³⁷ Cs	720	3.5	0.25
Gross alpha	720	2.2	0.16
Gross beta	720	18	1.3
³ H	720	2900	210
⁹⁰ Sr	720	4.5	0.32
Transuranics	720	0.040	0.0030

^a See Figure 4.

^b Concentration is a flow weighted average of the weekly samples.
Discharge is the total for the month.

Table 18. Discharges of radionuclides in water

August 1986

Radionuclide	Flow (10 ⁶ Liters)	Concentration (Bq/L)	Discharge (10 ⁴ mega Bq)
Melton Branch 1 ^a			
⁶⁰ Co	38	6.0	0.023
¹³⁷ Cs	38	< 0.40	< 0.0015
³ H	38	19000	73
Total Sr	38	2.3	0.0087
Sewage Treatment Plant ^a			
⁶⁰ Co	22	< 0.30	< 0.00060
¹³⁷ Cs	22	0.30	0.00060
Total Sr	22	3.8	0.0085
White Oak Creek ^a			
⁶⁰ Co	530	< 0.30	0.016
¹³⁷ Cs	530	6.8	0.36
³ H	530	130	6.9
Total Sr	530	5.3	0.28
White Oak Dam ^{a, b}			
⁶⁰ Co	560	< 0.79	< 0.044
¹³⁷ Cs	560	5.8	0.32
Gross alpha	560	2.0	0.11
Gross beta	560	19	1.1
³ H	560	2200	130
Total Sr ^c	560	6.0	0.34
Transuranics	560	0.10	0.0055

^a See Figure 4.

^b Concentration is a flow weighted average of the weekly samples.
Discharge is the total for the month.

^c Concentration is an average of three samples analyzed for ⁹⁰Sr
and one sample analyzed for total Sr.

Table 19. Discharges of radionuclides in water
September 1986

Radionuclide	Flow (10 ⁶ Liters)	Concentration (Bq/L)	Discharge (10 ⁴ mega Bq)
Melton Branch 1 ^a			
⁶⁰ Co	40	8.3	0.034
¹³⁷ Cs	40	< 0.40	< 0.0016
³ H	40	55000	220
Total Sr	40	6.6	0.027
Sewage Treatment Plant ^a			
⁶⁰ Co	22	< 0.20	< 0.00040
¹³⁷ Cs	22	< 0.30	< 0.00060
Total Sr	22	3.9	0.0086
White Oak Creek ^a			
⁶⁰ Co	530	< 0.30	< 0.016
¹³⁷ Cs	530	4.5	0.24
³ H	530	180	9.6
Total Sr	530	5.8	0.31
White Oak Dam ^{a, b}			
⁶⁰ Co	570	< 0.55	< 0.032
¹³⁷ Cs	570	4.6	0.26
Gross alpha	570	2.3	0.13
Gross beta	570	17	0.99
³ H	570	3400	200
Total Sr	570	6.0	0.32
Transuranics	570	0.070	0.0040

^a See Figure 4.

^b Concentration is a flow weighted average of the weekly samples.
Discharge is the total for the month.

Tritium discharges at WOD, WOC, STP, and MBI were two to four times lower than their respective second quarter discharges Table (17-19). The decreases in the ^3H discharges were due primarily to lower measured concentrations. Strontium discharges from ORNL, unlike ^3H which comes primarily from SWSA 5, are much more diffuse. They are primarily the result of discharges from the plant area, burial grounds, and floodplains, with lesser amounts also being contributed by process discharges. Most of the strontium discharged from ORNL can be attributed to discharges into WOC occurring above the WOC monitoring station.

Strontium concentrations and discharges at White Oak Dam were similar to those observed in the second quarter. The concentrations and discharges of strontium at White Oak Dam during the second and third quarters have been below normal. This can be attributed to the lower than normal levels of precipitation, since it is believed that at ORNL a significant portion (> 50%) of the strontium discharges, during periods of normal rainfall, are the result of run-off.

New real-time monitoring systems were installed at WOD, MBI, and WOC stations. These stations transmit flow (in gallons per minute) over each of the weirs and water quality data (pH, temperature, turbidity, dissolved oxygen, and conductivity) for ten minute intervals. Monthly averages will be incorporated into this report in the future.

National Pollutant Discharge Elimination System (NPDES) Requirements

Under the requirements of the Clean Water Act, a new NPDES permit was issued to ORNL and became effective on April 1, 1986. Prior to that time, only three stations were sampled for compliance with permit limits. These points were in two major drainage areas (White Oak Creek and Melton Branch) and at the Sewage Treatment Plant. The new permit has over 183 stations and is designed to monitor point sources at their point of discharge into receiving streams (Figure 6). In addition, there are some sampling locations that are located in the streams as reference points or for additional information. The sampling locations and permit requirements are described below:

1. Point Source Outfalls - These outfalls are discernable, confined, and discrete conveyances from which a process stream is discharged to receiving waters. The effluent must be monitored before it reaches the receiving water, or mixes with any other wastewater stream. Point source outfalls include:

<u>NPDES Number</u>	<u>Location</u>	<u>M*</u>	<u>L*</u>
X01	Sewage Treatment Plant		X**
X02	Coal Yard Runoff Treatment Facility		X**
X03	1500 Area	X**	
X04	2000 Area	X**	
X06	190 Ponds (3539 and 3540)	X**	
X07	Process Waste Treatment Plant	X**	
X08	TRU Ponds	X**	
X09	HFIR Ponds	X**	
X10	ORR Resin Regeneration Facility	X**	
X11	Acid Neutralization Facility	X**	
X12	Nonradiological Wastewater Treatment Plant		X***

* M = monitoring only, L = concentration or mass limits

** pH is limited at all outfalls

*** March 1990 compliance

Composite samples are collected by either automatic samplers or as grab samples. New monitoring stations were installed at X02, X04, X06, X08, X09, X10, and X11.

2. Ambient Monitoring Stations - Because of historical data and in order to obtain information on total ORNL discharges before they enter the Clinch River, Melton Branch 1, White Oak Creek and White Oak Dam have been placed on the permit for monitoring purposes only. All three of these ambient stations have newly constructed (1984) weirs and monitoring stations. White Oak Dam has two gates which can be lowered in case of potentially hazardous releases.
3. Category I Outfalls - Storm Drains - There are 35 discharge pipes to receiving streams which have been characterized by ORNL and identified in the NPDES permit as storm drains. These outfalls are not contaminated by any known activity and do not discharge through any

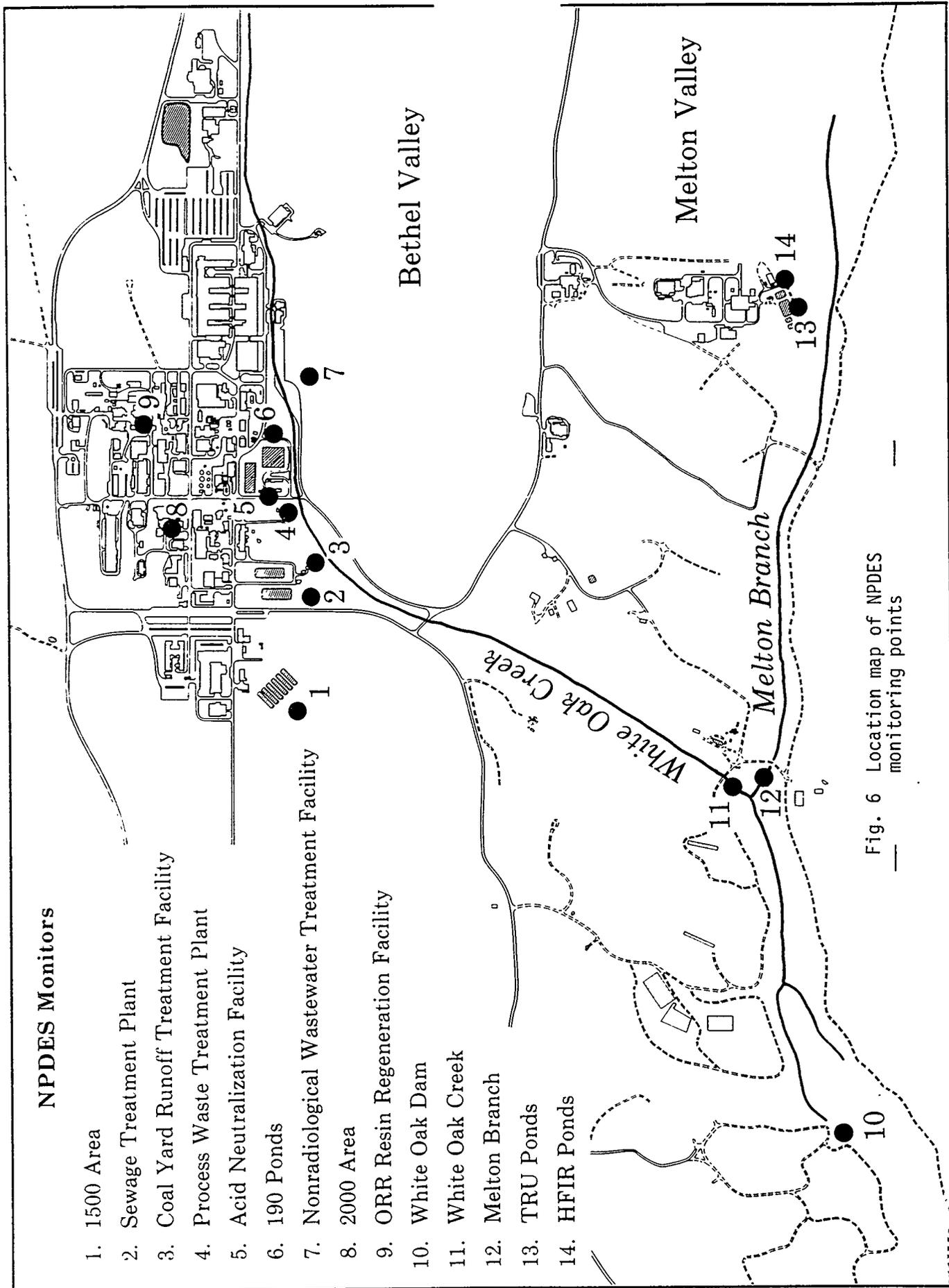


Fig. 6 Location map of NPDES monitoring points

oil/water separator or other treatment equipment or facility. Limits have been placed on the following parameters: pH, temperature, oil and grease, and total suspended solids. Samples are taken from the nearest accessible point prior to actual discharge or mixing with receiving waters.

4. Category II Outfalls - The following discharge pipes have been characterized by ORNL and identified in the NPDES permit as Category II Outfalls:

44 parking lot and roof drains
8 condensate drains
7 cooling tower drains
2 storage area drains

These outfalls are considered to be contaminated by ORNL activities, but are not discharged through any oil/water separator or other treatment equipment or facility. Limits have been placed on the following parameters: pH, temperature, oil and grease, and total suspended solids.

5. Category III Outfalls - Untreated Process Drains - There are 32 discharge pipes which have been characterized by ORNL and identified in the NPDES permit as untreated process drains. These outfalls are actually either Category I or Category II Outfalls, but because of inflow/infiltration, cross-connects, or improper disposal of chemicals have become contaminated with pollutants. Further characterization and determination of the source of the pollutants is underway with the goal of eliminating any untreated process discharge to receiving waters. The only limitation placed on these outfalls is pH.
6. Miscellaneous Source Outfalls - These outfalls have not been assigned serial numbers but are specific to special categories identified by the EPA. Facilities which have been placed in these categories are:

4 cooling towers
1 Boiler (Building 2519, Central Steam Plant)
1 Vehicle and Equipment Cleaning Facility (Building 7002)
1 Painting and Corrosion Control Facility (Building 7007)
1 Vehicle and Equipment Maintenance Facility (Building 7002)
4 Photographic Laboratories (Buildings 1500, 4500N, 7934, 7601)
1 Firefighter Training Area (outside Building 2500)

Limitations have been placed on all Miscellaneous Source Outfalls.

7. The NPDES permit contains provisions for designing and implementing a number of "special" monitoring plans. These are the Mercury Assessment Plan, Radiological Monitoring Plan, Monitoring Plan for PCBs in the Aquatic Environment, and the ORNL Biological Monitoring and Abatement Plan.

The mercury, PCB, and radiological monitoring plan have been developed. Their implementation is scheduled for January 1, 1987. The Biological Monitoring Plan is being conducted by the Environmental Sciences Division.

Data collected for the NPDES permit are summarized monthly and submitted to DOE. These data are available upon request. Values outside the specified permit limits (noncompliances) are given in Table 20.

Most total suspended solids and oil and grease noncompliances at Category II Outfalls can be attributed to the extremely dry weather experienced during the third quarter. Flows from these outfalls are usually dependent upon rainfall via parking lot drains, and samples must be collected either during or right after a rain event. All Category II Outfalls were sampled on August 11, 1986. According to the U.S. Department of Commerce data, the last significant rainfall preceding August 11 occurred on July 13 (28 days). Due to the lack of rainfall, sufficient buildup of dirt, dust, oil, etc., will occur which increases the potential for total suspended solids and oil and grease violations. A check was made by the Department of Environmental Management after the August 11 violations were reported and each of the oil and grease violations could be directly related to a parking lot grate near an area where a considerable amount of motor oil/grease had accumulated.

The fecal coliform noncompliances at the Sewage Treatment Plant are thought to be due to the lower chlorine concentrations required under the new NPDES permit. The old permit allowed concentrations up to 2 mg/L while the current permit regulates chlorine concentrations to below 0.5 mg/L. These lower concentrations of chlorine have not effectively killed the fecal coliform bacteria. The plant operators are currently adjusting the levels of chlorine in order to maintain permit limits for chlorine while controlling the fecal coliform bacteria.

The permit noncompliances resulting from the operation of the cooling systems are being studied to develop new strategies for minimizing the impact of those operations on the environment. These studies include acceptable methods of algae and bacterial control and disinfection systems. Until studies are complete and improvements are made, infrequent violations will continue to occur.

Noncompliances in suspended solids at the paint facilities may be due to ineffective filters. These are being investigated to see if maintenance or replacement is required. In addition, samples are being analyzed from the vehicle cleaning and paint facilities to further determine pollutants that might be in these effluent streams. Based on the results of this study, efforts will be made to reduce the pollutants discharged or collect the effluent for further treatment before discharge.

Table 20. Parameters whose values exceed NPDES compliance limits

July - September 1986

Station	Parameter	Concentration (mg/L)		
		Monthly average	Daily average	Daily maximum
July 1986				
Sewage Treatment Plant	Dissolved Oxygen	5.4		
Sewage Treatment Plant	Fecal Coliform			2,600
Cooling System 3025E	Temperature			38.1
Cooling System 3026	Zinc			1.2
Cooling System 7619	Zinc			1.3
Painting and Corrosion Control Facility 7007	Total Suspended Solids			65
August 1986				
TRU/TURF Process Waste Basin	pH upper limit			9.4
Category II - 202	Total Suspended Solids			221
Category II - 213	Total Suspended Solids			306
Category II - 216	Total Suspended Solids			1137
Category II - 233	Total Suspended Solids			78
Category II - 265	Oil & Grease			18
Fifth Creek	Visible Oil Sheen			

Table 20. (Continued)

July - September 1986

Station	Parameter	Concentration (mg/L)		
		Monthly average	Daily average	Daily maximum
Vehicle Cleaning (Bldg. 7002)	Total Suspended Solids			71
Painting Facilities (Bldg. 7007)	Total Suspended Solids			66
Sewage Treatment Plant	Oil & Grease			51
Sewage Treatment Plant	Oil & Grease	45		
Coal Yard Runoff	Total Suspended Solids			54
Coal Yard Runoff	Iron, total		11	45
September 1986				
Painting Facilities (Bldg. 7007)	Total Suspended Solids			148
Vehicle Cleaning (Bldg. 7002)	Fecal Coliform		231	
Sewage Treatment Plant	Fecal Coliform			540
Painting Facilities (Bldg. 7007)	Total Suspended Solids	93		
Vehicle Cleaning (Bldg. 7002)	Total Suspended Solids		29	71

Groundwater

The Environmental Protection Agency (EPA) has established regulations in 40 CFR, Part 265, Subpart F, which requires the owners/operators of hazardous waste facilities to monitor the groundwater beneath those facilities. The ORNL facility has a groundwater network consisting of 22 wells located adjacent to three impoundment areas: 3524, 7900, and 3539-40 (Figures 7-8). The 3524 area consists of wells 31-001, 31-002, 31-003, 31-004, 31-013, and 31-015. The 7900 area consists of wells 32-001, 32-002, 32-003, 32-004, 32-005, 33-001, 33-002, and 33-003. The 3539-40 area consists of wells 31-005, 31-006, 31-007, 31-008, 31-009, 31-010, 31-011, and 31-012. The wells are also classified as upgradient (reference) or downgradient depending on their location relative to the general direction of groundwater flow. The upgradient wells (31-001, 31-007, 31-009, 32-001, 33-001) were located so as to provide groundwater samples that would not be affected significantly by possible leakage from the impoundment. The downgradient wells (those not listed as upgradient) were located immediately adjacent to the waste management facility. Information on the well installation is given in Table 21. All elevations (ground surface, bottom of bore hole, bottom and top of well screen) are given in meters above sea level. The pipe and screen materials were of threaded stainless steel and the diameter of each ranged from 5 cm to 10 cm. Three volumes of water were pumped from each well before sampling. Samples collected at these wells represent the quality of groundwater at the point of compliance.

Water samples were collected twice from deep wells 31-013, 31-015, and 32-004 and once from deep well 31-011 which was dry during the second sampling period in September. The samples were analyzed for the parameters listed below. The data required by EPA and the State of Tennessee fall into one of three categories:

- (1) Drinking water parameters (As, Ba, Cd, Cr, F, Pb, Hg, NO₃, Se, Ag, endrin, lindane, methoxychlor, toxaphene, 2,4-D, 2,4,5-TP Silvex, Ra, gross alpha, gross beta, and fecal coliform);
- (2) Water quality parameters (Cl, Fe, Mn, phenols, Na, and SO₄); or
- (3) Groundwater contamination parameters (pH, specific conductance total organic carbon, and total organic halides).

In accordance with the regulations, a minimum of four measurements per well were recorded for pH, specific conductance, and temperature. Four measurements were recorded for total organic carbon and total organic halides while only one measurement was recorded on the other parameters. Summary of the total concentrations for total metals and other parameters are given in Tables 22-24. The concentrations of total metals include the concentrations of metals in the liquid as well as in any sediment in the samples. Samples collected for dissolved metals are filtered to remove particulate matter and the concentrations are determined on the liquid. Summary concentrations of dissolved metals are given in Table 25.

The analytical values were compared to the EPA Interim Primary Drinking Water Standards. The values for several of the wells exceeded the standards for Ba, gross alpha, Pb, and radium (Table 26). The values for

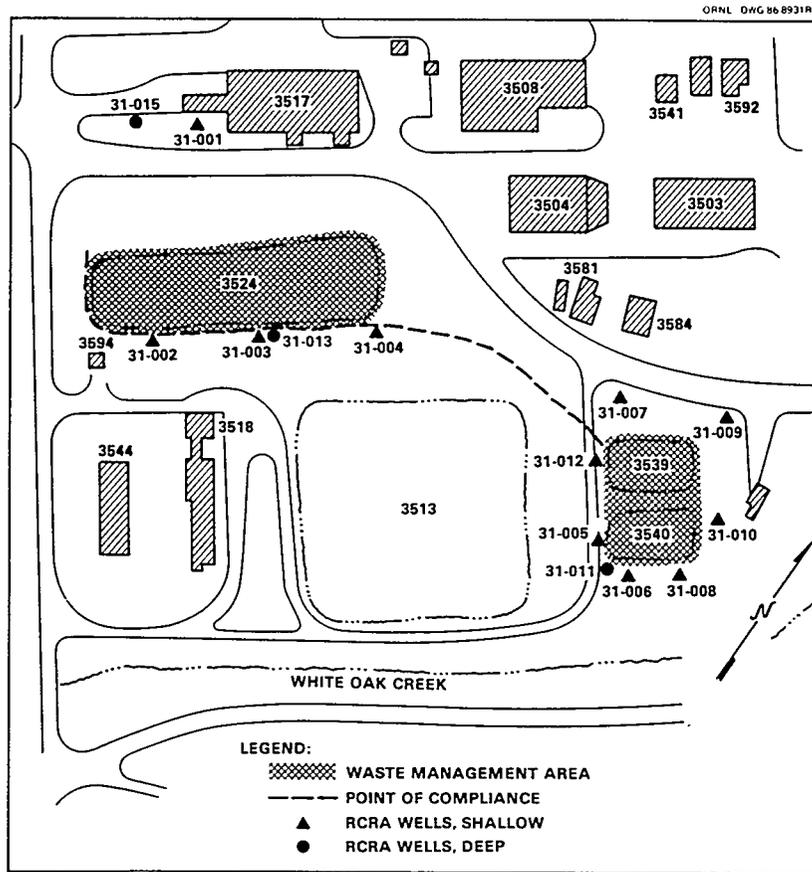


Fig. 7 Locations of sampling wells around ponds 3524, 3539, and 3540

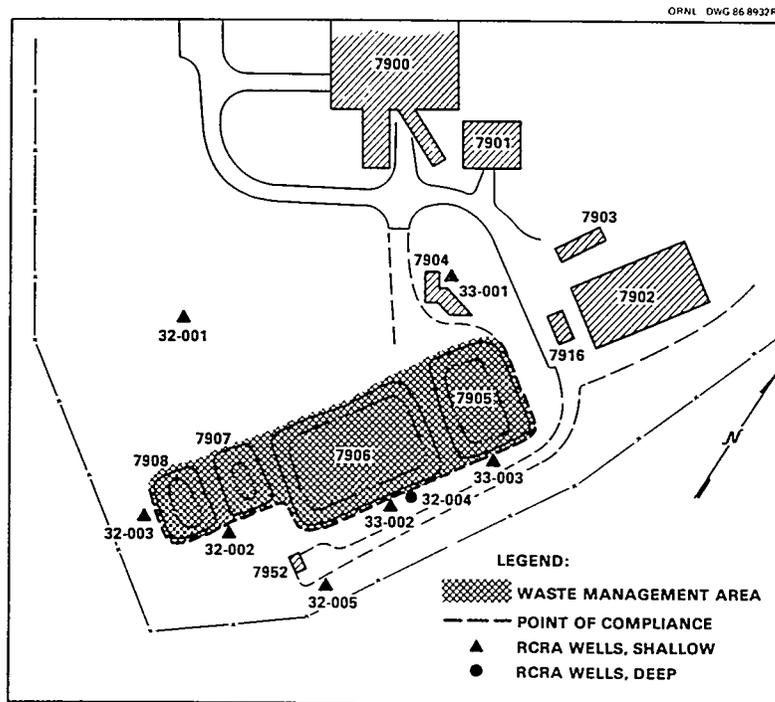


Fig. 8 Locations of sampling wells around ponds 7905, 7906, 7907, and 7908

Table 21. RCRA well specifications

Well ID	Installation date	Geological unit formation	Ground surface elevation (M)	Bottom of bore hole elevation (M)	Bottom of wells screen elevation (M)	Top of wells Screen elevation (M)
3524 Area						
31-001	08/14/85	Chickamauga	242.3	235.4	235.4	237.0
31-002	08/13/85	Chickamauga	238.6	234.8	234.8	236.4
31-003	08/18/85	Chickamauga	239.4	235.4	235.4	237.0
31-004	08/11/85	Chickamauga	238.9	235.0	235.2	236.8
31-013	11/08/85	Chickamauga	238.8	223.2	223.5	226.6
31-015	10/26/85	Chickamauga	242.3	233.3	233.3	234.8
3539-40 Area						
31-005	08/09/85	Chickamauga	240.0	235.1	235.2	236.9
31-006	08/09/85	Chickamauga	240.2	234.8	235.1	236.7
31-007	08/08/85	Chickamauga	241.7	235.3	235.5	237.2
31-008	08/08/85	Chickamauga	240.3	235.4	235.5	237.1
31-009	08/07/85	Chickamauga	241.5	235.0	235.1	236.7
31-010	08/21/85	Chickamauga	241.2	235.6	235.7	237.3
31-011	10/24/85	Chickamauga	240.2	224.7	224.7	228.2
31-012	08/20/85	Chickamauga	240.2	234.9	235.0	236.6
7900 Area						
32-001	07/19/85	Conasauga	248.2	239.4	240.1	241.8
32-002	08/05/85	Conasauga	244.2	238.1	238.1	239.7
32-003	08/23/85	Conasauga	246.0	239.5	239.6	241.3
32-004	11/06/85	Conasauga	245.1	229.6	229.9	232.9
32-005	08/22/85	Conasauga	244.5	237.2	237.2	238.9
33-001	07/29/85	Conasauga	247.3	239.8	240.4	242.0
33-002	08/05/85	Conasauga	245.2	238.8	238.8	240.4
33-003	08/01/85	Conasauga	246.0	239.6	239.6	241.3

Table 22. Concentrations of parameters in wells around 3524^a

August - September 1986

Parameter	No. of samples	Concentration (mg/L) ^b			
		Max	Min	Av	95% cc ^c
2,4,5-TP Silvex	4	< 0.010	< 0.010	< 0.010	0
2,4-D	4	< 0.010	< 0.010	< 0.010	0
Ag	4	< 0.0050	< 0.0050	< 0.0050	0
As	4	< 0.010	< 0.010	< 0.010	0
Ba	4	< 1.0	< 1.0	< 1.0	0
Cd	4	< 0.0020	< 0.0020	< 0.0020	0
Cl	4	10	5.2	7.4	2.4
Cr	4	< 0.020	< 0.020	< 0.020	0
Endrin	4	< 0.00020	< 0.00020	< 0.00020	0
F	4	< 1.0	< 1.0	< 1.0	0
Fe	4	0.38	0.26	0.33	0.051
Fecal coliform ^d	4	0	0	0	0
Gross alpha ^e	4	0.20	0.080	0.14	0.053
Gross beta ^e	4	1.4	0.52	0.97	0.50
Hg	4	< 0.00010	< 0.00010	< 0.00010	0
Lindane	4	< 0.0020	< 0.0020	< 0.0020	0
Methoxychlor	4	< 0.0080	< 0.0080	< 0.0080	0
Mn	4	0.28	0.010	0.13	0.13
Na	4	24	17	22	2.9
NO ₃	4	< 5.0	< 5.0	< 5.0	0
Pb	4	< 0.020	< 0.020	< 0.020	0
pH ^f	28	8.2	7.0	7.4	0.010
Phenols	4	0.0010	< 0.0010	< 0.0010	0
Ra (Total) ^e	4	0.030	0.0040	0.015	0.011
Se	4	< 0.0050	< 0.0050	< 0.0050	0
SO ₄	4	100	11	57	50
Specific conductance ^g	28	0.35	0.17	0.27	0.027
Temperature ^h	28	24	18	21	0.78
Total organic carbon	16	3.6	0.76	2.0	0.52
Total organic halides	16	0.022	0.010	0.014	0.0023
Toxaphene	4	< 0.0050	< 0.0050	< 0.0050	0

a. See Figure 7.

b. Values for all metals are total concentrations.

c. 95% confidence coefficient about the average of more than two samples.

d. Units are colonies per 100 mL.

e. Units are Bq/L.

f. Value in pH units.

g. Units are in mmhos/cm.

h. Units are in °C.

Table 23. Concentrations of parameters in wells around 3539-40^a
August - September 1986

Parameter	No. of samples	Concentration (mg/L) ^b			
		Max	Min	Av	95% cc ^c
2,4,5-TP Silvex	1			< 0.010	
2,4-D	1			< 0.010	
Ag	1			< 0.0050	
As	1			< 0.010	
Ba	1			1.3	
Cd	1			< 0.0020	
Cl	1			2.7	
Cr	1			< 0.050	
Endrin	1			< 0.00020	
F	1			< 1.0	
Fe	1			0.050	
Fecal coliform ^d	1			0	
Gross alpha ^e	1			0.92	
Gross beta ^e	1			13	
Hg	1			< 0.00010	
Lindane	1			< 0.0020	
Methoxychlor	1			< 0.0080	
Mn	1			0.10	
Na	1			200	
NO ₃	1			< 5.0	
Pb	1			0.26	
pH ^f	14	13	12.5	13	0.085
Phenols	1			< 0.0010	
Ra (Total) ^e	1			0.21	
Se	1			< 0.0050	
SO ₄	1			14	
Specific conductance ^g	14	10	0.52	8.5	1.8
Temperature ^h	14	22	19	20	0.70
Total organic carbon	4	16	15	16	0.45
Total organic halides	4	0.035	< 0.025	< 0.031	0.0044
Toxaphene	1			< 0.0050	

- a. See Figure 7.
b. Values for all metals are total concentrations.
c. 95% confidence coefficient about the average of more than two samples.
d. Units are colonies per 100 mL.
e. Units are Bq/L.
f. Value in pH units.
g. Units are in mmhos/cm.
h. Units are in °C.

Table 24. Concentrations of parameters in wells around 7900a

August - September 1986

Parameter	No. of samples	Concentration (mg/L) ^b			
		Max	Min	Av	95% cc ^c
2,4,5-TP Silvex	2	< 0.010	< 0.010	< 0.010	
2,4-D	2	< 0.010	< 0.010	< 0.010	
Ag	2	< 0.0050	0.0050	< 0.0050	
As	2	< 0.010	0.010	< 0.010	
Ba	2	< 1.0	< 1.0	< 1.0	
Cd	2	< 0.0020	< 0.0020	< 0.0020	
Cl	2	6.8	6.5	6.7	
Cr	2	< 0.020	< 0.020	< 0.020	
Endrin	2	< 0.00020	< 0.00020	< 0.00020	
F	2	< 1.0	< 1.0	< 1.0	
Fe	2	0.32	0.28	0.30	
Fecal coliform ^d	2	0	0	0	
Gross alpha ^e	2	0.47	0.10	0.29	
Gross beta ^e	2	0.97	0.62	0.80	
Hg	2	< 0.00010	< 0.00010	< 0.00010	
Lindane	2	< 0.0020	< 0.0020	< 0.0020	
Methoxychlor	2	< 0.0080	< 0.0080	< 0.0080	
Mn	2	0.13	0.11	0.12	
Na	2	8.5	7.7	8.1	
NO ₃	2	5.0	< 5.0	< 5.0	
Pb	2	< 0.020	0.020	< 0.020	
pH ^f	14	8.3	7.6	7.9	0.11
Phenols	2	< 0.0010	< 0.0010	< 0.0010	
Ra (Total) ^e	2	0.027	0.0090	0.018	
Se	2	< 0.0050	< 0.0050	< 0.0050	
SO ₄	2	28	23	26	
Specific conductance ^g	14	0.080	0.010	0.030	0.013
Temperature ^h	14	20	17	18	0.46
Total organic carbon	8	0.82	0.62	0.72	0.054
Total organic halides	8	< 0.010	< 0.010	< 0.010	0
Toxaphene	2	< 0.0050	< 0.0050	< 0.0050	

a. See Figure 8.

b. Values for all metals are total concentrations.

c. 95% confidence coefficient about the average of more than two samples.

d. Units are colonies per 100 mL.

e. Units are Bq/L.

f. Value in pH units.

g. Units are in mmhos/cm.

h. Units are in °C.

Table 25. Concentrations of dissolved metals in wells around 3524, 3539-40, and 7900^a

August - September 1986

Parameter	No. of samples	Concentration (mg/L)			
		Max	Min	Av	95% cc ^b
3524					
Ag	4	< 0.0050	< 0.0050	< 0.0050	0
As	4	< 0.010	< 0.010	< 0.010	0
Ba	4	< 1.0	< 1.0	< 1.0	0
Cd	4	< 0.0020	< 0.0020	< 0.0020	0
Cr	4	< 0.020	< 0.020	< 0.020	0
Fe	4	0.11	< 0.050	0.088	0.026
Hg	4	< 0.00010	< 0.00010	< 0.00010	0
Mn	4	0.25	< 0.010	0.12	0.13
Na	4	24	17	21	3.3
Pb	4	< 0.020	< 0.020	< 0.020	0
Se	4	< 0.0050	< 0.0050	< 0.0050	0
3539-40					
Ag	1				< 0.0050
As	1				< 0.010
Ba	1				1.1
Cd	1				< 0.0020
Cr	1				0.050
Fe	1				< 0.050
Hg	1				< 0.00010
Mn	1				< 0.010
Na	1				200
Pb	1				0.28
Se	1				< 0.0050
7900					
Ag	2	< 0.0050	< 0.0050	< 0.0050	
As	2	< 0.010	< 0.010	< 0.010	
Ba	2	< 1.0	< 1.0	< 1.0	
Cd	2	< 0.0020	< 0.0020	< 0.0020	
Cr	2	< 0.020	< 0.020	0.020	
Fe	2	0.070	< 0.050	0.060	
Hg	2	< 0.00010	< 0.00010	< 0.00010	
Mn	2	0.10	0.090	0.095	
Na	2	8.5	7.7	8.1	
Pb	2	< 0.020	< 0.020	< 0.020	
Se	2	< 0.0050	< 0.0050	< 0.0050	

^a See Figures 7 and 8.^b 95% confidence coefficient about the average of more than two samples.

Table 26. Concentrations of parameters whose values exceed standards in groundwater wells on the ORNL site

August - September 1986

Area	Well ^a ID	Date	Parameters				
			Gross Beta (Bq/L)	Gross Alpha (Bq/L)	Ra (Bq/L)	Pb (mg/L)	Ba (mg/L)
	Standard ^b		0.13	0.56	0.19	0.050	1.0
3524	31-013	08/21/86	1.4				
		09/26/86	1.4				
	31-015	08/21/86	0.56				
		09/25/86	0.52				
3539-40	31-011	08/20/86	13	0.92	0.21	0.26 (total) 0.28 (dissolved)	1.3 (total) 1.1 (dissolved)
7900	32-004	08/20/86	0.62				
		09/24/86	0.97				

^a See Figures 7 and 8.

^b EPA Interim Primary Drinking Water Standard.

gross beta at all wells exceeded the calculated standard. The EPA Interim Primary Drinking Water Standard for gross beta is an annual dose equivalent of four millirem. A concentration was calculated from this dose based on ingestion of 2.2L of water per day. All gross beta was assumed to be ^{90}Sr which is a worst case analysis. Its dose conversion factor of 1.438 rem per microcurie was used to calculate the concentration.

Groundwater was sampled from wells in the Solid Waste Storage Areas (SWSAs) 4, 5, 6 and the pits and trenches area at ORNL (Figs. 9-12). The reference well is hydraulically upgradient from the waste storage area (well 189, Fig. 9). It should be considered only as a reference well and not as a background well because it is located in SWSA 4 and does receive surface runoff. The groundwater samples were analyzed for ^{60}Co , ^{137}Cs , ^3H , gross alpha and beta activities and total strontium. Data on the concentrations of radionuclides measured in the monitoring and reference wells are presented in Table 27. The 95% confidence coefficient was not calculated because the distribution of the radionuclide concentrations does not appear to be normally distributed.

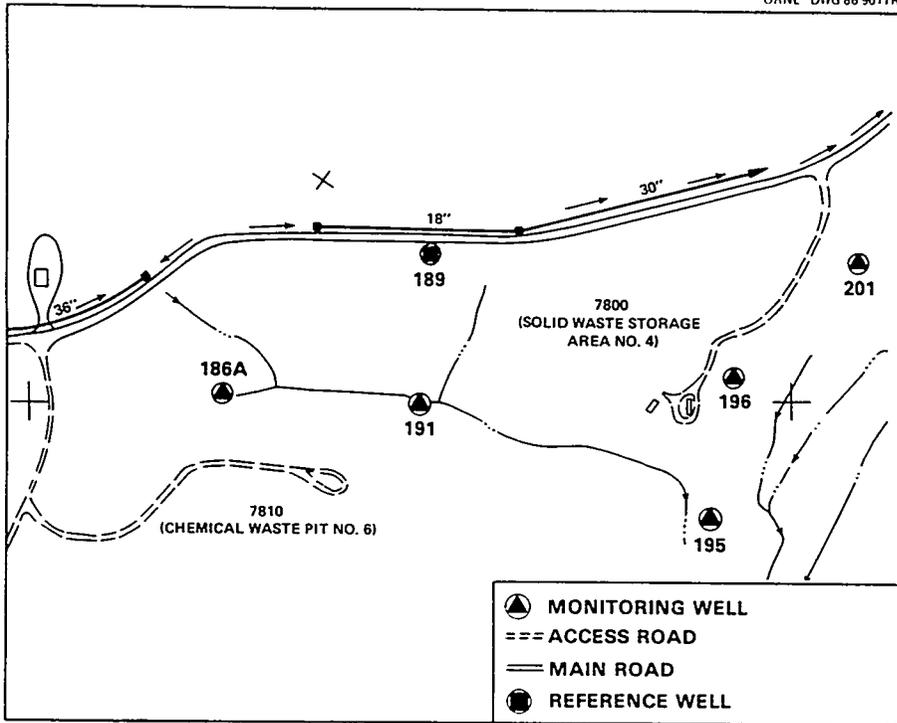


Fig. 9 Locations of sampling wells in Solid Waste Storage Area 4

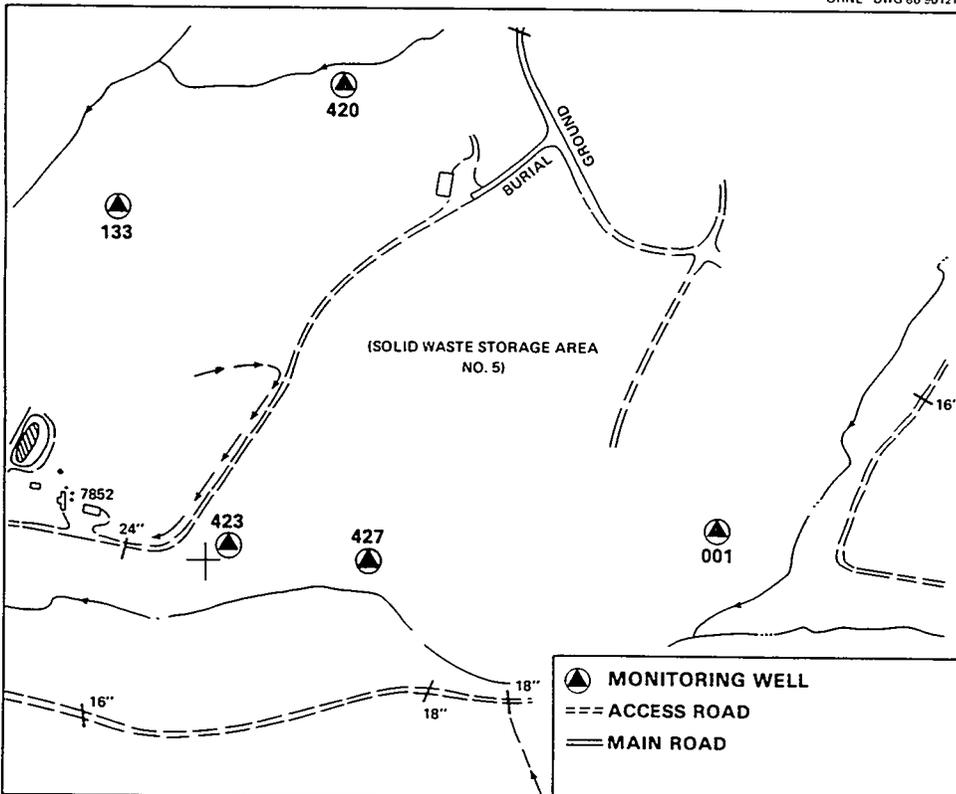


Fig. 10 Locations of sampling wells in Solid Waste Storage Area 5

ORNL DWG 86 9013R3

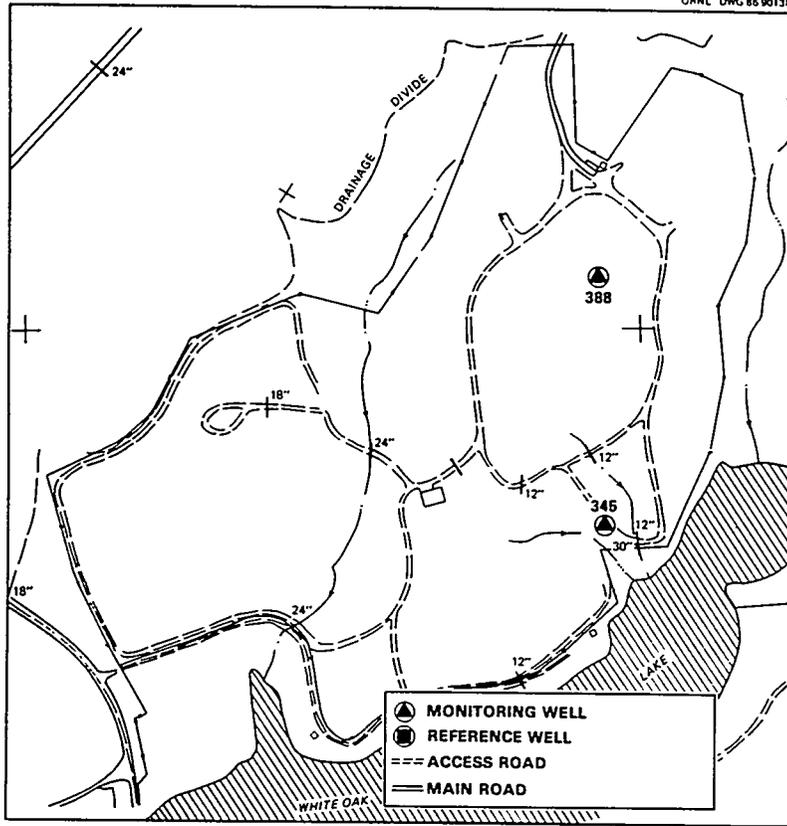


Fig. 11 Locations of sampling wells in Solid Waste Storage Area 6

ORNL DWG 86 9014R3

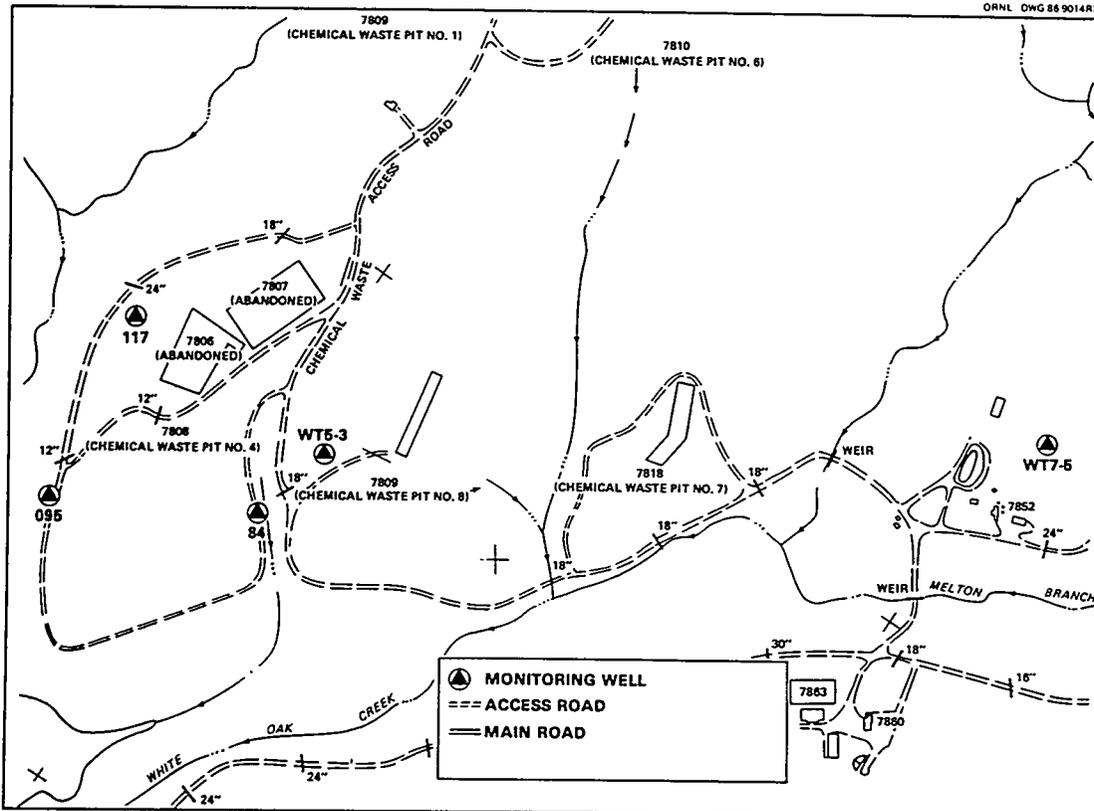


Fig. 12 Locations of sampling wells in pits and trenches

Table 27. Groundwater monitoring of radionuclides around ORNL solid waste storage areas

July 1986

Radionuclide	No. of Samples	Concentration (Bq/L)		
		Maximum	Minimum	Average
Solid Waste Storage Area 4 ^a				
⁶⁰ Co	5	< 0.30	< 0.20	< 0.26
¹³⁷ Cs	5	< 0.30	< 0.20	< 0.26
Gross alpha	5	73	1.3	28
Gross beta	5	2300	47	760
³ H	5	76000	2200	19000
Total Sr	5	1400	30	470
Solid Waste Storage Area 5 ^b				
⁶⁰ Co	5	0.20	< 0.090	0.18
¹³⁷ Cs	5	< 0.070	0.011	0.044
Gross alpha	5	1.5	0.40	0.84
Gross beta	5	1200	2.0	240
³ H	5	1800000	760	400000
Total Sr	5	630	0.11	130
Solid Waste Storage Area 6 ^c				
⁶⁰ Co	2	< 0.30	< 0.30	< 0.30
¹³⁷ Cs	2	< 0.20	< 0.20	< 0.20
Gross alpha	2	0.90	0.60	0.75
Gross beta	2	3.8	2.3	3.1
³ H	2	850	590	720
Total Sr	2	0.87	0.33	0.60
Pits and Trenches ^d				
⁶⁰ Co	5	110	< 0.20	26
¹³⁷ Cs	5	0.30	< 0.030	0.10
Gross alpha	5	40	0.40	9.0
Gross beta	5	580	1.8	170
³ H	5	3400	1200	1900
Total Sr	5	2.7	0.18	0.82

Table 27. (Continued)

Radionuclide	No. of Samples	Concentration (Bq/L)		
		Maximum	Minimum	Average
Reference Well ^e				
⁶⁰ Co	1			< 0.30
¹³⁷ Cs	1			< 0.20
Gross alpha	1			1.5
Gross beta	1			2
³ H	1			< 19
Total Sr	1			0.34

^a See Figure 9.

^b See Figure 10.

^c See Figure 11.

^d See Figure 12.

^e See Figure 9.

METEOROLOGICAL PROCESSES

The ORNL meteorological system consists of three towers (A, B, and C) with sensors mounted at two levels (10 and 30 meters) for Towers A and B and three levels (10, 30, and 100 meters) for Tower C. Locations of meteorological towers at ORNL are shown in Figure 13. Data from the sensors are acquired, stored, edited, and formatted by a data collection system consisting of a central processor and remote data logger. One-minute averages are processed into fifteen-minute averages which are kept for one day. The fifteen-minute averages are processed into hourly averages which are stored for at least one year.

Examination of quarterly wind roses (Figures 14-18) reveals that the prevailing winds are almost equally split into two directions that are 180° apart; one prevailing direction is from the SW to WSW sector, and the other prevailing direction is from the NE to ENE sector. The winds are strongly aligned along these directions because of the channeling effect induced by the ridge and valley structure of the area. Another feature observed from the wind roses is that the wind speeds increase with height (tower level) at each of the towers. On the average, the wind speeds can be expected to increase steadily from ground level to 100 meters.

Wind roses for Tower B have not been included because the instrument malfunctioned. This tower was recently recalibrated and is now functioning properly.

ORNL-DWG 86-9142R2

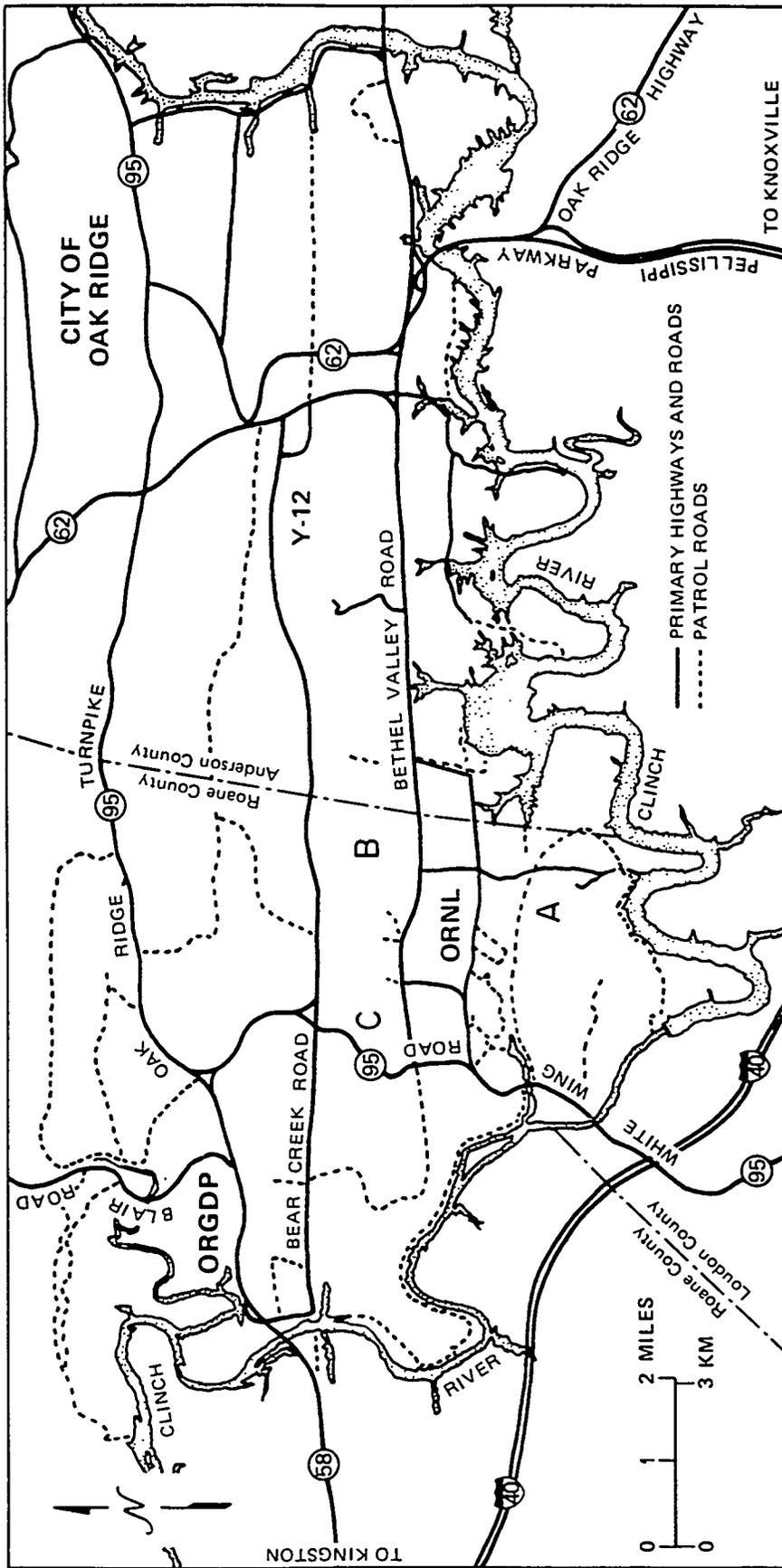


Fig. 13 Locations of meteorological towers at ORNL

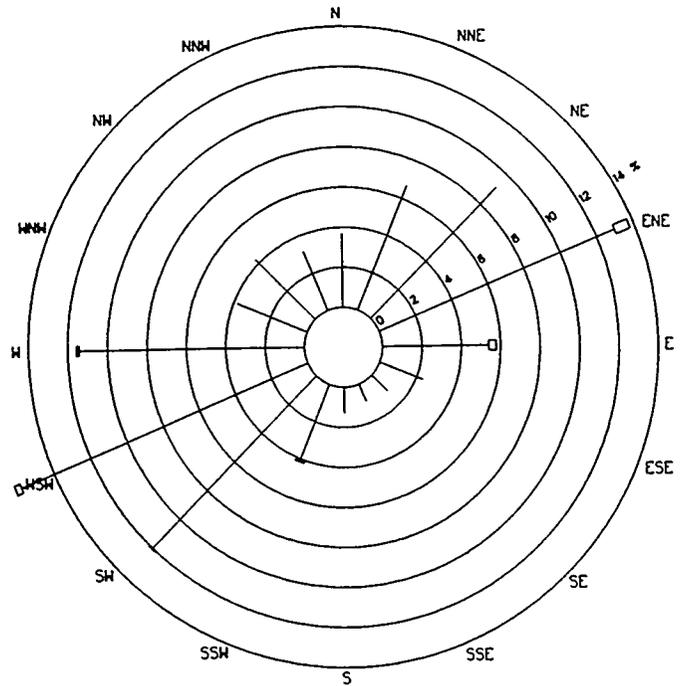


Fig. 14 Wind rose at 10-m level of meteorological tower A, July-September 1986

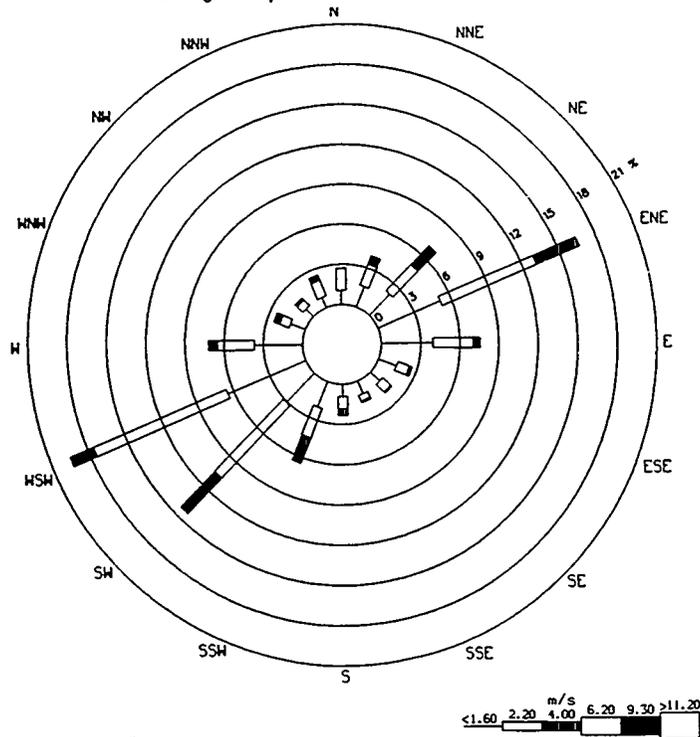


Fig. 15 Wind rose at 30-m level of meteorological tower A, July-September 1986

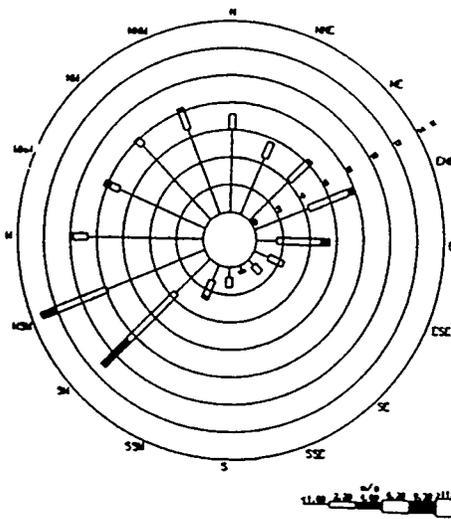


Fig. 16 Wind rose at 10-m level of meteorological tower C, July-September 1986

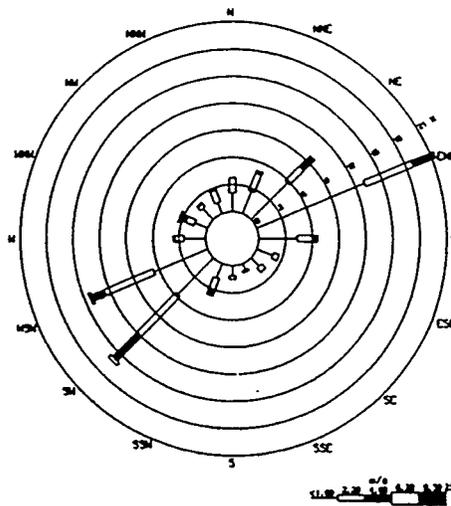


Fig. 17 Wind rose at 30-m level of meteorological tower C, July-September 1986

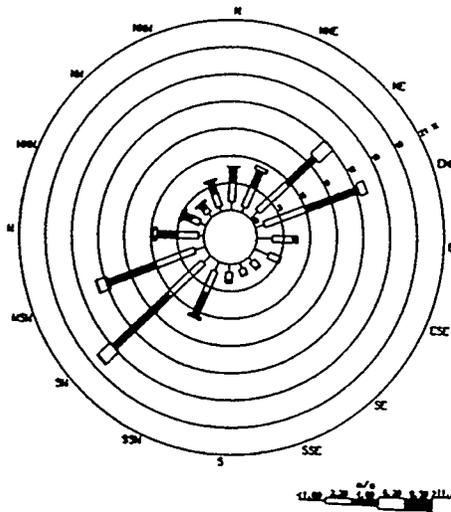


Fig.18 Wind rose at 100-m level of meteorological tower C, July-September 1986

BIOLOGICAL MONITORING

Milk

Raw milk from six locations and one dairy within a radius of 80 km of Oak Ridge is monitored for ^{131}I and ^{90}Sr . Samples are collected every two weeks from four stations located near the Oak Ridge area (Figure 19). Three other stations are more remote with respect to the Oak Ridge facilities and are sampled at the rate of about one to two stations every quarter (Figure 20). Samples are analyzed by ion exchange and low level beta counting and the results are compared with intake guidelines (Tables 28-29) specified by the Federal Radiation Council (FRC).

Concentrations of ^{90}Sr are shown in Table 28. The average concentration of ^{90}Sr at all stations in the immediate Oak Ridge area was 0.058 Bq/L which is within Range I of the FRC guidelines, as were the average concentrations for each individual station. The average concentration of ^{90}Sr for all stations in the area more remote from Oak Ridge was 0.047 Bq/L, which is within Range I of the FRC guidelines, and the average concentration for each individual remote station was also within the Range I category.

Concentrations of ^{131}I are shown in Table 29. The average concentration of ^{131}I for all stations in the immediate Oak Ridge area was 0.0088 Bq/L, which is within Range I of the FRC guidelines. The average concentration of ^{131}I for all remote stations was 0.016 Bq/L, which is within Range I of the FRC guidelines. The ^{131}I concentrations in milk, which were elevated during the second quarter by the Chernobyl nuclear incident, have returned to normal.

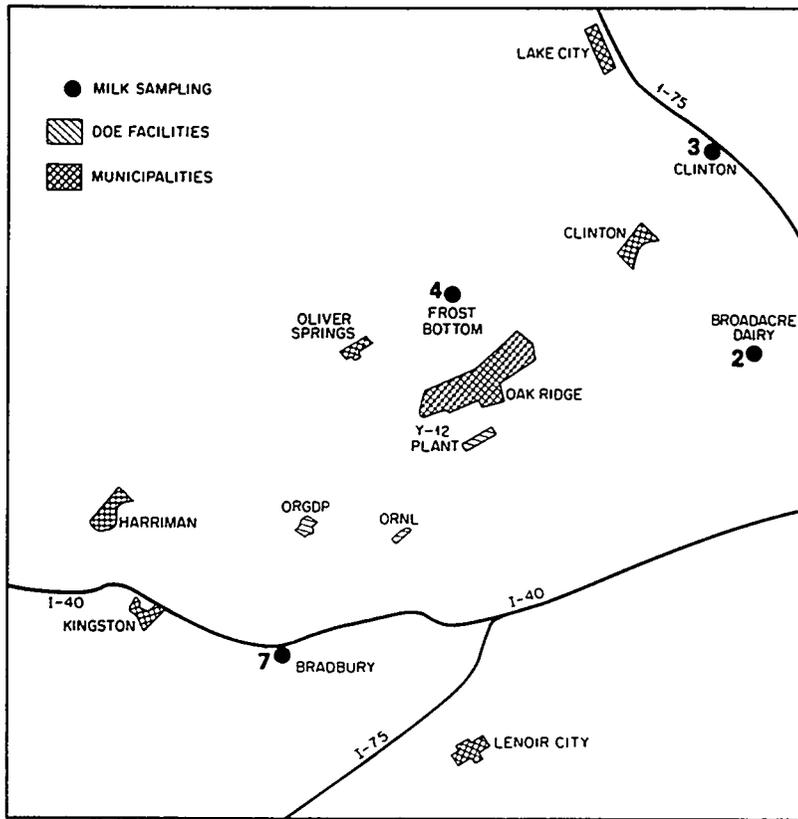


Fig. 19 Locations of milk sampling stations near the Oak Ridge facilities

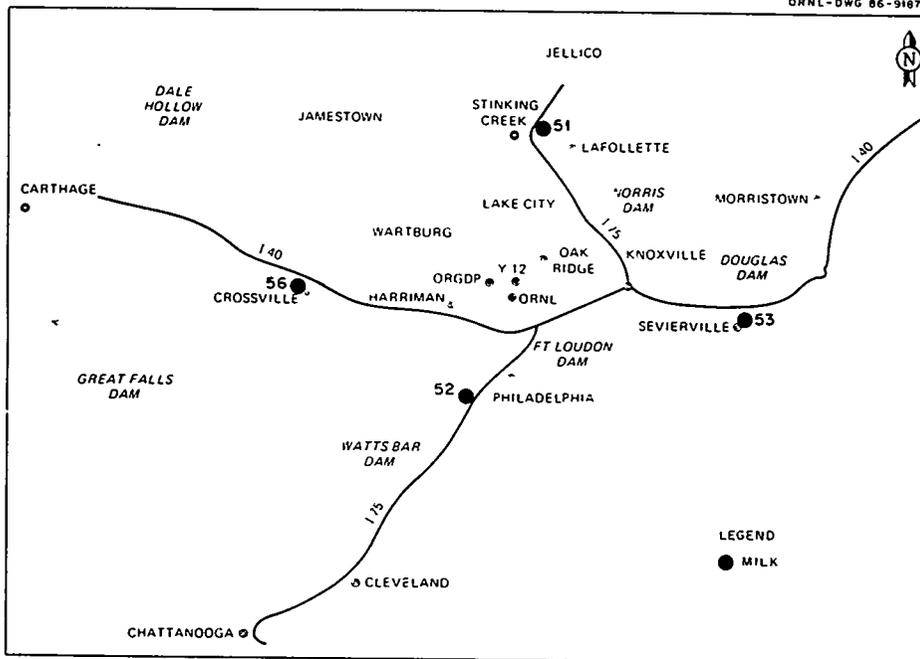


Fig. 20 Locations of milk sampling stations remote from the Oak Ridge facilities

Table 28. Concentrations of ^{90}Sr in milk^a
August - September 1986

Station	No. of samples	Concentration (Bq/L)				Comparison with standard ^c
		Max	Min	Av	95%cc ^b	
Immediate Environs ^d						
2	6	0.06	0.03	0.045	0.0086	Range I
3	6	0.06	0.03	0.047	0.0099	Range I
4	6	0.12	0.05	0.068	0.022	Range I
7	6	0.09	0.06	0.073	0.0099	Range I
Network summary	24	0.12	0.03	0.058	0.013	Range I
Remote Environs ^e						
51	1			0.06		Range I
53	1			0.03		Range I
56	1			0.05		Range I
Network summary	3	0.06	0.03	0.047	0.018	Range I

^a Raw milk samples, except for Station 2, which is a dairy.

^b 95% confidence coefficient about the average of more than two samples.

^c Applicable FRC standard, assuming 1 L/d intake: Range I, 0 - 0.74 Bq/L, adequate surveillance required to confirm calculated intakes; Range II, 0.74 - 7.4 Bq/L, active surveillance required; and Range III, > 7.4 Bq/L positive control required.

^d See Figure 19.

^e See Figure 20.

Table 29. Concentrations of ^{131}I in milka
August - September 1986

Station	No. of samples	Concentration (Bq/L)				Comparison with standard ^c
		Max	Min	Av	95%cc ^b	
Immediate Environs ^d						
2	6	0.02	0.003	0.0092	0.0049	Range I
3	6	0.017	0.004	0.0082	0.0040	Range I
4	6	0.019	0.003	0.0087	0.0048	Range I
7	6	0.02	0.001	0.0093	0.0056	Range I
Network summary	24	0.02	0.001	0.0088	0.0048	Range I
Remote Environs ^e						
51	1			0.010		Range I
53	1			0.005		Range I
56	1			0.033		Range I
Network summary	3	0.033	0.005	0.016	0.017	Range I

^a Raw milk samples, except for Station 2, which is a dairy.

^b 95% confidence coefficient about the average of more than two samples.

^c Applicable FRC standard, assuming 1 L/d intake: Range I, 0 - 0.37 Bq/L, adequate surveillance required to confirm calculated intakes; Range II, 0.37 - 3.7 Bq/L, active surveillance required; and Range III, >3.7 Bq/L positive control required.

^d See Figure 19.

^e See Figure 20.

Fish

Bluegill from the Clinch River are collected semi-annually for analyses of radionuclides (^{60}Co , ^{137}Cs , ^{90}Sr , and ^{40}K), mercury and polychlorinated biphenyls (PCBs). The three sampling locations along the Clinch River include river miles: (1) 25.0 which is above Melton Hill Dam and serves as a reference location (CRM 25.0); (2) 20.8 which is the point where discharges from White Oak Creek meet the Clinch River (CRM 20.8); and (3) 5.0 which is at Centers Ferry, downstream from ORGDP and ORNL (CRM 5.0) (Figure 21).

For the 1986 sampling period, the fish program was modified and bluegill was selected as a representative species. It has been shown to accumulate high levels of radionuclides, mercury, and PCBs. It is a sport fish which is abundant and a sufficient number of the fish can be collected.

Radionuclide concentrations are determined on a composite sample of 6-12 fish from each location. For river miles 25.0 and 5.0, two composite samples were analyzed from each location. A single composite sample was analyzed from river mile 20.8. Scales, heads, and entrails are removed from each fish before samples are obtained. A fresh flesh sample is taken for mercury and PCB determination. Composite flesh samples are ashed and analyzed by gamma spectrometry and radiochemical techniques for the radionuclides that contribute most to the potential radiation dose to humans. While the analyses are done on ashed samples, a conversion to wet weight is done for reporting. Mercury and PCBs are analyzed in samples from six randomly selected individual fish collected at CRM 20.8 and 25.0. The samples are scanned for all major PCB isomers. Those which predominate in the bluegill are PCB-1254 and PCB-1260.

The concentrations of radionuclides in Clinch River bluegill are shown in Table 30. The highest radionuclide concentrations were found in samples from CRM 20.8. In 1985, bluegill from CRM 20.8 also had the highest concentration of these radionuclides.

The highest concentrations of mercury and PCBs (Table 31) were found in fish collected from CRM 20.8. All values were below the Federal Drug Administration tolerance for both mercury (1000 ng/g) and PCBs (2 $\mu\text{g/g}$). Average values for 1986 samples were lower than 1985.

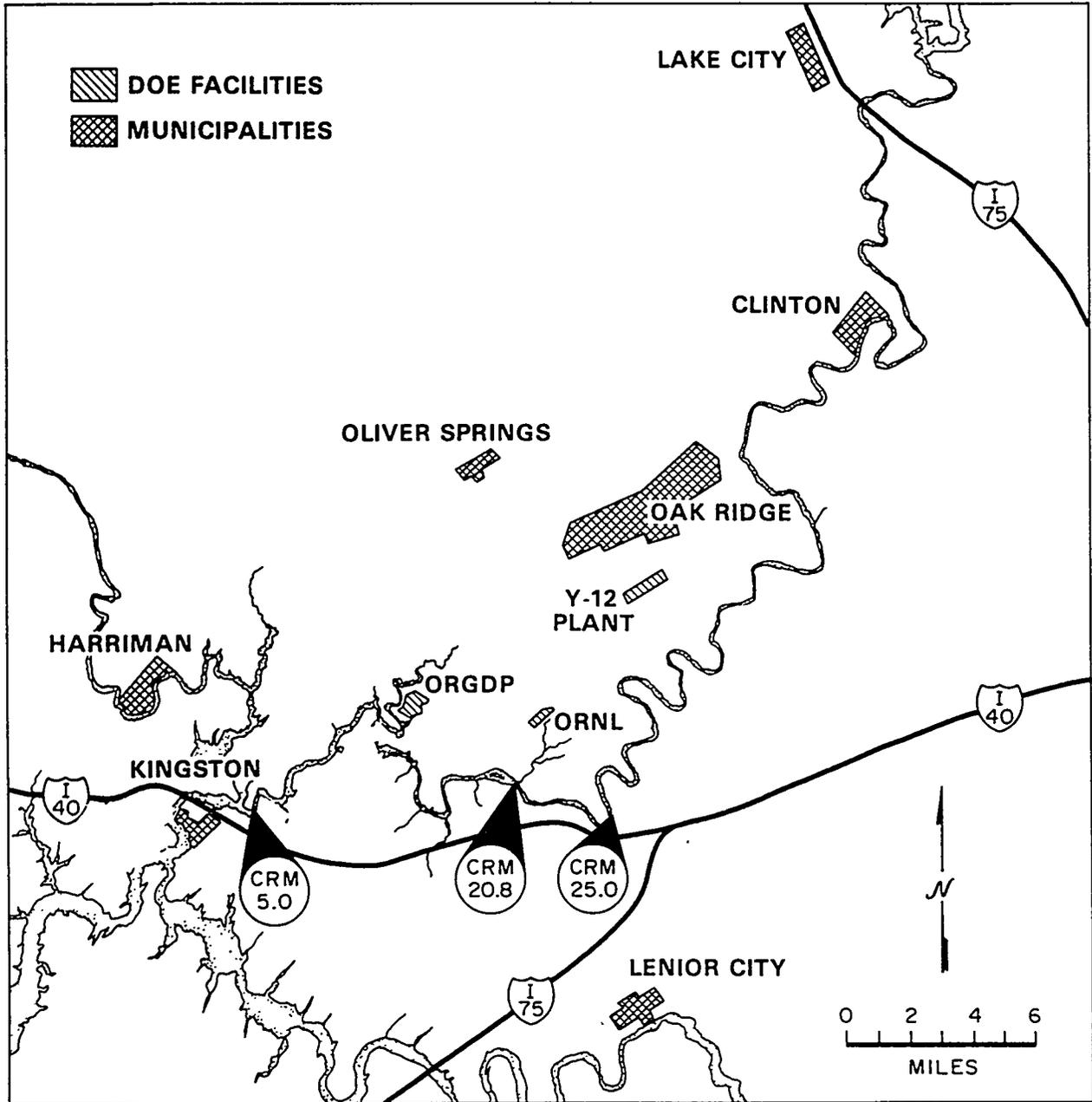


Fig. 21 Locations of fish sampling points

Table 30. Radionuclide concentrations of beta and gamma emitters in Clinch River bluegill^a

June 1986

Location ^b	Concentration (Bq/Kg wet wt.)			
	⁶⁰ Co	¹³⁷ Cs	⁹⁰ Sr	⁴⁰ K
CRM 5.0 ^c	< 0.19	2.5	0.41	111
CRM 20.8	< 0.41	15	1.2	123
CRM 25.0 ^c	< 0.08	< 0.05	0.16	68

^a Composite of 6-12 fish.

^b See Figure 21.

^c Average of two composites.

Table 31. PCB and mercury concentrations in Clinch River bluegill

June 1986

Location ^a	No. of Fish Sampled	Max	Min	Av	95% cc ^b	Percentage of A.L. ^c
Concentration ($\mu\text{g/g}$ wet wt.)						
PCB - 1254						
CRM 20.8	6	0.07	< 0.01	0.02	0.02	< 1.0
CRM 25.0	6	< 0.01	< 0.01	< 0.01	0.0	< 0.5
PCB - 1260						
CRM 20.8	6	0.50	0.02	0.12	0.15	6.0
CRM 25.0	6	< 0.02	< 0.01	< 0.01	0.003	< 0.5
Concentration (ng/g wet wt.)						
Mercury						
CRM 20.8	6	104	30	82	23	8.2
CRM 25.0	6	39	17	25	6	2.5

^a See Figure 21.

^b 95% confidence coefficient about the average.

^c Percentage of Food and Drug Administration tolerance for PCBs in fish (2 $\mu\text{g/g}$ wet wt.) or action level for mercury in fish (1000 ng/g wet wt.) for the average concentration.

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**OAK RIDGE
NATIONAL
LABORATORY**

MARTIN MARIETTA

**Environmental Surveillance Data
Report for the First Quarter of 1990**

P. Y. Goldberg
B. M. Horwedel
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C. K. Valentine
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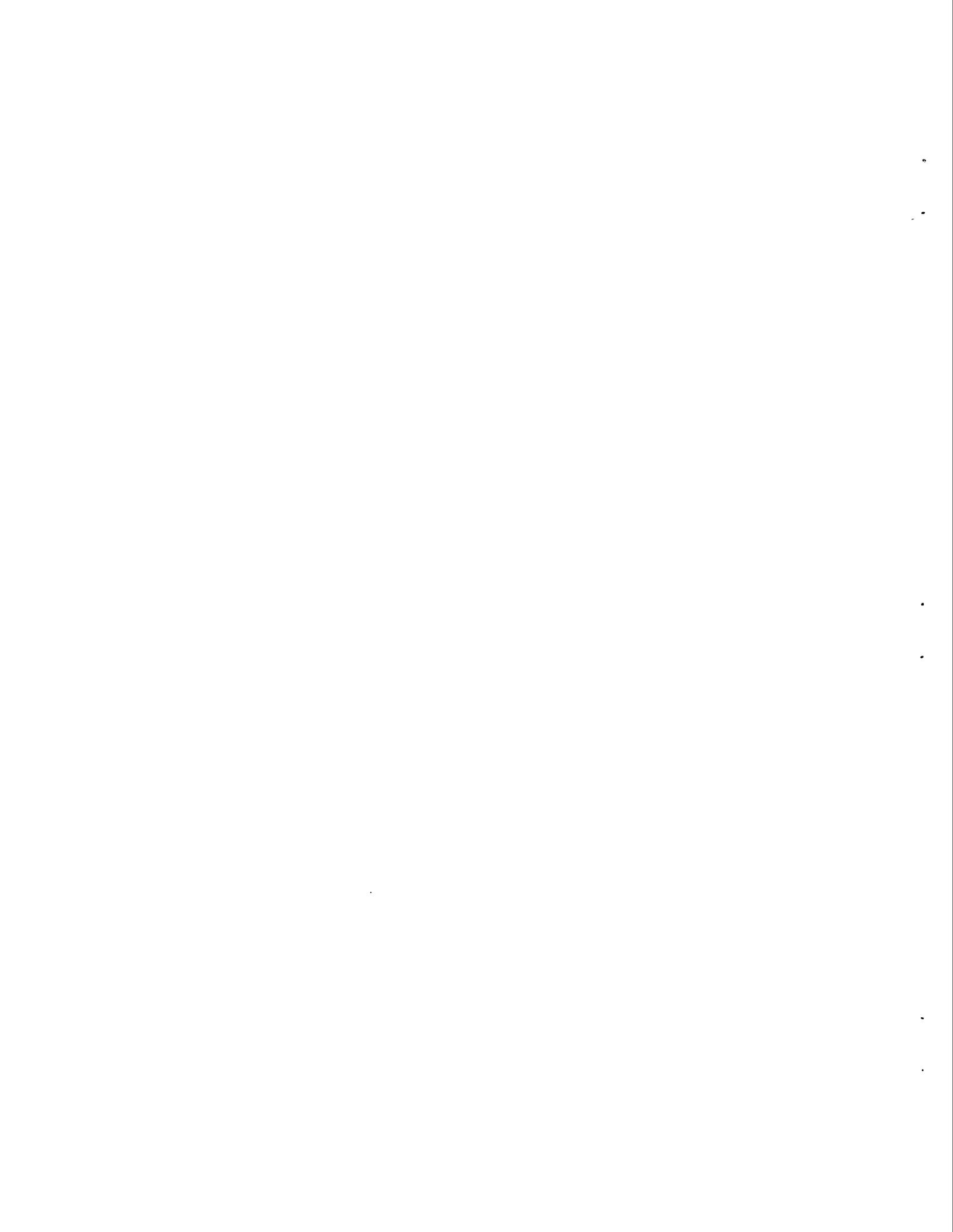
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ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR
THE FIRST QUARTER OF 1990

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LIST OF ACRONYMS

AQCA	Air Quality Control Act
ATDD	Atmospheric Turbulence and Diffusion Division
BMP	best management practice
BOD	biochemical oxygen demand
CAA	Clean Air Act
CWA	Clean Water Act
CYRTF	Coal Yard Runoff Treatment Facility
DCG	derived concentration guide
DOE	U.S. Department of Energy
DWL	drinking water limit
DWS	Drinking Water Standard
EHP	Office of Environmental and Health Protection Division (ORNL)
EPA	U. S. Environmental Protection Agency
ESP	Environmental Surveillance and Protection Section (ORNL)
FRC	Federal Radiation Council
HEPA	high-efficiency particulate air
HFIR	High Flux Isotope Reactor
ICP	inductively coupled plasma
MB	Melton Branch
NESHAP	National Emission Standards for Hazardous Air Pollutants
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRWTP	Nonradiological Wastewater Treatment Plant
NWT	Northwest Tributary
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PAM	perimeter air monitoring
PCB	polychlorinated biphenyl
PWTP	Process Waste Treatment Plant
QER	Quality Event Report
RAM	remote air monitoring
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SE	standard error of the mean
SI	Systeme Internationale
STP	Sewage Treatment Plant
SWMU	Solid Waste Management Unit
SWSA	Solid Waste Storage Area
TDHE	Tennessee Department of Health and Environment
TOC	total organic carbon
TRU	Transuranium Processing Plant
TSS	total suspended solids
TTO	total toxic organics
WAG	waste area grouping
WOC	White Oak Creek
WOD	White Oak Dam
WOL	White Oak Lake

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EXECUTIVE SUMMARY

The format of these reports has been changed commencing with this quarter. Each section of the report now consists of a program description; results for the quarter; and an analysis of trends over the previous 2 years, depending upon the availability of data. The executive summary will now only touch upon the major highlights of the report. The reader is directed to the trend subsections for more in-depth summaries of each data section.

Airborne Emissions and Ambient Air

Emissions of tritium to the atmosphere were lower by a factor of ten across the facility due to reduced emissions from the Tritium Target Facility (7025) and the Isotope Solid-State Ventilation System (3039-3). Other airborne emissions were consistent with recent monitoring results.

Ambient air sampling around ORNL and the reservation showed that I-131 and H-3 continue to be at concentrations of less than 0.01% of the derived concentration guides (DCG) for these isotopes. Gross alpha and beta results are similar to the previous quarter.

Surface Water

Tritium and strontium concentrations at White Oak Dam were at 13% and 20% of their DCGs for the quarter respectively. All of the other radionuclides that were evaluated at the Dam were at 2% or less of their DCGs.

There were 37 noncompliances associated with the NPDES permit for the quarter. Twenty four of the exceedences were due to Category I and Category II outfalls. This has been a chronic problem for ORNL. The other violations are associated with the Vehicle Cleaning Facility, cooling towers, Equipment Maintenance Facility and the Steam Plant.

Results for PCB in the surface waters around ORNL continue to show no detection. This indicates that surface water is not a transport pathway for PCB.

Biological Monitoring

Iodine 131 and total radioactive strontium is routinely monitored in milk obtained from area farmers. Iodine was undetectable in all the samples for the quarter. Total radioactive strontium was detected at two of the stations. The concentrations were less than 1% of the DCG for Sr-90.

1. INTRODUCTION

The Environmental Surveillance and Protection Section (ESP) within the Office of Environmental and Health Protection (EHP) at the Oak Ridge National Laboratory (ORNL) is responsible for the development and implementation of an environmental program to (1) ensure compliance with all federal, state, and U.S. Department of Energy (DOE) reporting requirements to quantitatively demonstrate prevention, control, and abatement of environmental pollution; (2) monitor the adequacy of containment and effluent controls; and (3) assess impacts on the environment of releases from ORNL facilities.

The current environmental program is designed primarily to meet regulatory requirements and DOE directives and to provide a continuity of data on environmental media at unregulated locations. The major legislation affecting the environmental program at the DOE facilities includes the Clean Water Act (CWA), the Clean Air Act (CAA), the Resource Conservation and Recovery Act (RCRA), and the Superfund Amendments and Reauthorization Act (SARA). In November 1988, DOE finalized Order 5400.1, "General Environmental Protection Program," which establishes the requirements, authorities, and responsibilities for DOE operations for ensuring compliance with applicable federal, state, and local environmental protection laws and regulations. This order sets forth the requirements for both radiological and nonradiological monitoring. DOE's Order 5400.5, "Radiation Protection of the Public and the Environment," specifies the guidelines for releases of radionuclides to various media. Definitive radiological monitoring requirements have been established, and additional guidance on recommended procedures and activities is provided in Draft DOE 5400.6, "Radiological Effluent Monitoring and Environmental Surveillance."

Environmental monitoring, as defined by Draft DOE Order 5400.6, consists of two major activities: effluent monitoring and environmental surveillance. Effluent monitoring is the collection and analysis of samples, or measurements of liquid and gaseous effluents. Environmental surveillance is the collection and analysis of samples, or direct measurements, of air, water, soil, foodstuff, biota, and other media from DOE sites and their environs.

Although Draft DOE Order 5400.6 has not been finalized, ORNL is evaluating the requirements and is revising the environmental program to reflect changing requirements. Generally, the effluent monitoring and environmental surveillance programs were reviewed to increase the precision of the measurements and to increase the efficiency of the program. Compliance with all of the new DOE orders that impact effluent monitoring and environmental surveillance is targeted for November 9, 1991, as required in DOE Order 5400.1.

Monthly or quarterly summaries are presented in this report for each of the media sampled. The summary tables generally give the number of samples collected during the period and the maximum, minimum, average, and standard error of the average (SE) values of parameters for which determinations were made. This value is based on multiple samples collected throughout the period. It includes the random uncertainty, over time and space, associated with

sampling, analysis, and the intrinsic variability of the media. The random uncertainty is a statement of precision (or imprecision), a measure of the reproducibility or scatter in a set of successive measurements, and an indication of the stability of the average value for the parameter. When differences in the magnitudes of the observations are small, the SE is small, and the precision is said to be high; when the differences are large, the SE is large, and the precision is low. Average values have been compared, where possible, to applicable guidelines, criteria, or standards as a means of evaluating the impact of effluent releases or environmental concentrations.

In some of the tables, radionuclide concentrations are compared with derived concentration guides (DCGs) as published in DOE Order 5400.5. These DCGs were established for drinking water and inhaled air and are guidelines for the protection of the public. DOE Order 5400.5 defines a DCG as the concentration of a radionuclide in air or water for which, under conditions of continuous exposure by one exposure pathway (i.e., drinking water, inhaling air, submersion) for 1 year, a "reference man" would receive the most restrictive of (1) an effective dose equivalent of 100 mrem or (2) a dose equivalent of 5 rem to any tissue, including skin and lens of the eye. A "reference man" is a hypothetical human who is assumed to inhale 8400 m³ of air in a year and to drink 730 L of water in a year. When there are multiple DCGs for a given isotope, the most restrictive value is used for comparisons. When the percent of the DCG is less than 0.01, the percent is reported as <0.01. When total radioactive strontium is measured, it is compared to the DCG for ⁹⁰Sr, which is the most restrictive value.

Radioactivity measurements are reported as the net activity, or the difference between the gross activity and instrument background activity. Because of the intrinsic uncertainties associated with making radiation measurements, it is possible to subtract an instrument background value from a sample result and get a negative number. Radiation measurements are reported in units of becquerel (Bq). A becquerel is a Systeme Internationale (SI) unit equivalent to one disintegration per second.

Radioactivity data are assessed for differences from zero in one of three ways, depending upon the use of the values. Single values are tested using their counting uncertainties with a one-tailed test of significance at 95%. Averages of measurements are tested for difference from zero using the SE of the values and a one-tailed test at 95%. According to normal theory, this approach incorporates both the counting uncertainty and the variability of the samples into the SE. Sums of measurements are tested for difference from zero by summing the variances of the individual measurements, as represented by the counting uncertainties, and using a one-tailed test for difference from zero at 95%.

Chemical (nonradionuclide) results that are below the analytical detection limit are expressed as "less than" (<) values. In computing the average values, "less than" results are assigned the detection limit. The average value is expressed as less than the computed value when at least one of the results used for the average is less than the detection limit.

2. AIR

Airborne emissions from U.S. Department of Energy (DOE) facilities are regulated under the provisions of the Clean Air Act (CAA), DOE orders, and the Tennessee Air Quality Control Act (AQCA). The U.S. Environmental Protection Agency (EPA), which has authority and responsibility for enforcing the regulations associated with the CAA, has delegated authority for nonradioactive air pollutants to the state of Tennessee. Regulatory criteria for CAA are promulgated in 40 CFR Pt. 61, the National Emission Standards for Hazardous Air Pollutants (NESHAP). The DOE orders are enforced at the local level through the Oak Ridge National Laboratory (ORNL) Directorate for Environmental, Safety, and Health Compliance. The DOE orders that address air emissions are 5400.1, 5400.5 (formerly 5400.XX), and draft 5400.6 (formerly 5400.XY).

The Laboratory has monitoring requirements for radioactive emissions only. These are NESHAP standards based on calculated dose (10 mrem committed effective dose, equivalent) to off-site individuals. In addition, the DOE orders require that the collective dose be calculated for the population within 80 km of the site.

The monitoring and surveillance of airborne emissions at ORNL is a two-tiered program. The first tier consists of source-term-emissions sampling and quantification for each of the stacks at the facility that is an emission point for processes involving radioactive materials. These data are used in calculating the annual dose associated with operations at the facility. The second tier consists of ambient-air sampling systems located within the boundary of the facility, on the reservation perimeter, and at remote locations assumed to be unaffected by facility operations. These data are used to measure directly the impact of ORNL operations on the surrounding area and to provide empirical data for assessing the inhalation and external pathways of exposure.

2.1 AIRBORNE EMISSIONS

2.1.1 Program Description

The major gaseous emission point sources at the Laboratory consist of eight stacks. They are as follows:

<u>Building</u>	<u>Description</u>
2026	High Radiation Level Analytical Laboratory
3020	Radiochemical Processing Plant
3039	Duct 1--3500 and 4500 areas cell ventilation systems Duct 2--central off-gas and scrubber system Duct 3--isotope solid-state ventilation system Duct 4--3025 and 3026 areas cell ventilation systems
7025	Tritium Target Fabrication Facility
7830	Melton Valley Storage Tank (MVST) Facility

7911	Melton Valley Complex [High Flux Isotope Reactor (HFIR) and Radiochemical Engineering Design Center]
7512	Molten Salt Reactor Facility
6010	Electron Linear Accelerator Facility

The locations of the stacks are shown in Fig. 1. Each of these point sources is provided with a variety of surveillance instrumentation, including radiation alarms, near-real-time monitors, and continuous sample collectors. Only data resulting from the analysis of the continuous samples are used in this report. The other equipment does not provide data of sufficient accuracy and precision to support the quantitation of emission source terms. Data are presented for all stacks except the Electron Linear Accelerator Facility (Building 6010), where continuous sampling equipment is not currently installed.

The sampling systems generally consist of in-stack sampling probes, sample transport piping, a 47-mm-diam particulate filter, a 47-mm-diam by 25-mm-thick activated-charcoal canister, a silica gel tritium trap, flow measurement and totalizing instruments, a sampling pump, and return piping to the stack. The sampling system for the Tritium Target Fabrication Facility (Stack 7025) is configured with a tritium trap only. The sampling systems at Stacks 2026, 3020, and 7512 do not have tritium traps.

The sampling media are collected and evaluated weekly. The particulate filters are analyzed for gross alpha and gross beta activity. Gross alpha and gross beta measurements are made 8 d after the samples are collected to reduce the contribution of short-lived natural radionuclides to the measurement. The silica gel samples are composited and analyzed biweekly for tritium. The charcoal canisters are analyzed each week by gamma spectroscopy. Because of the prevalence of iodine isotopes in the stack emissions, values are reported for ^{131}I and ^{133}I each week. Data for other gamma-emitting isotopes are opportunistically captured. If an isotope is present at a concentration above the analytical instrument background, the value is reported. Consequently, 13 data values are typically associated with gross alpha, gross beta, ^{131}I , and ^{133}I measurements. This is the usual number of samples for a quarter. In a particular quarter, some isotopes may be represented by fewer than 13 values because they were not detected in all of the sampling events. Normally there are six values for each tritium emission sampler because the weekly samples are analyzed as biweekly composites.

Data are not presented in this report for noble gas or ^{125}I and ^{129}I emissions. A program is being developed to validate the noble gas data, and analytical methods are being investigated that will address spectral interferences associated with the detection and quantitation of the iodines. Noble gas data are presented in the Oak Ridge Reservation (ORR) annual environmental report.

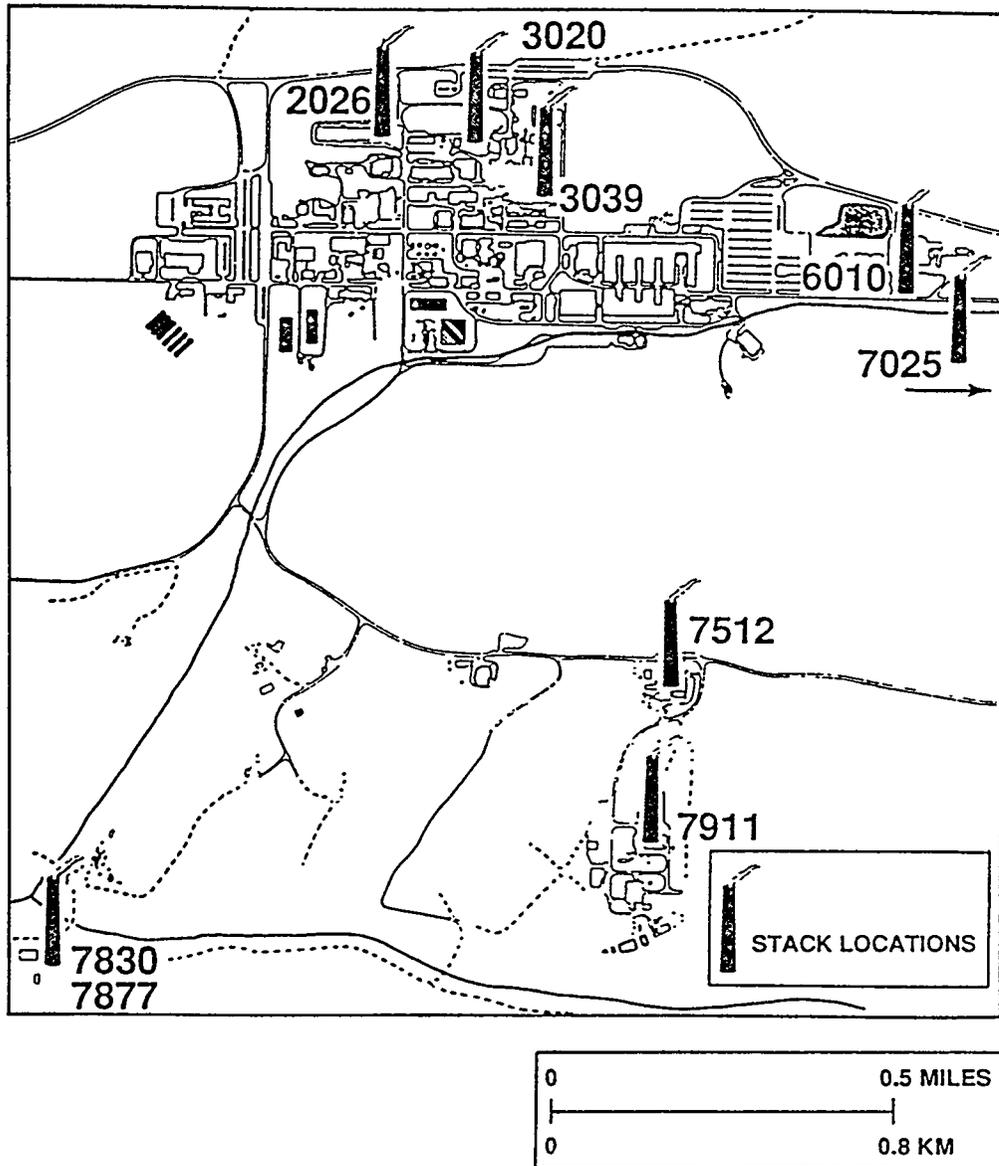


Fig. 1. Location map of major stacks (emission points) at ORNL.

2.1.2 Procedures and Results

The current convention for data at the instrument detection limit is to treat it as all other data are treated. The instrument background is subtracted from the actual instrument signal, and the result is reported. This practice can result in negative numbers. Results so reported may be reduced with summary statistics without incurring the difficulties associated with performing calculations on "less than" (<) values.

On upgraded systems in which sample flow totalizers have been installed, measured activity values are multiplied by a conversion factor that is the ratio of the total stack or duct discharge for the sampling period divided by the total sample flow during the period. For the older sampling systems at Stacks 2026, 3020, and 7512, the conversion factor consists of the average stack discharge rate divided by the average sampling rate.

All emissions data are rounded to two significant digits and presented in units of 10^6 becquerel (Bq). Negative activity values are converted into negative emissions. These values represent the random uncertainty associated with quantifying emissions. Although negative emissions values can be used to infer the total measurement system uncertainty for a given isotope, the inference must be isotope-specific. The uncertainty for each isotope is unique; therefore, extrapolating across isotopes is not valid.

Summed emission values for particular isotopes are tested for statistical significance using the laboratory counting uncertainty associated with each measured activity. If the 95% lower bound calculated from the variance of the sum is greater than zero, then the sum is determined to be significantly different from zero. The variance used in the test is based only on the counting uncertainty; it does not include uncertainty due to the sampling process.

Previous quarterly data reports have included separate tables of results for each stack. One set presented summaries of weekly emissions and listed the maximum, minimum, and average activity for each radionuclide detected at the stack. A second set presented monthly and quarterly totals for each radionuclide at the stack. Beginning with this quarter, results for all stacks are reported in a single table.

Table 1 presents the airborne radionuclide emissions for the quarter, listing total activity for each isotope and the percent contribution to the total from each stack. The percent values are based on summed emissions for the quarter from each stack. In the table, percents derived from sums that were determined to be significantly different from zero are marked with an asterisk.

During this quarter, the radioactive airborne emissions from the Laboratory consisted primarily of ^3H , ^{191}Os , ^{212}Pb , ^{131}I , ^{133}I , and ^{135}I . Most of the ^3H originated at Stack 7025 at the Tritium Target Fabrication Facility (80%, 3.3×10^{12} Bq). Smaller amounts came from Stack 3039-3, the Isotope Solid State Ventilation System (12%, 4.8×10^{11} Bq), Stack 3039-4 (7%, 2.8×10^{11} Bq), and Stack 3039-1 (1%, 3.9×10^{10} Bq).

Table 1. ORNL airborne radionuclide emissions, January-March 1990

Isotope	Percent contribution by stack ^{a,b}						Total emission (10 ⁶ Bq)
	2026	3020	3039	7025	7830	7911	
¹⁹⁴ Au			100*				0.23
⁸² Br			100*				0.19
⁶⁰ Co	0.15	<0.0001	100*				0.87
¹³⁷ Cs	89*	3.9*	6.6*				0.15
³ H			20*	80*			4,100,000
¹³¹ I	<0.0001	<0.0001	19*		0.00022	0.10*	200
¹³² I						81*	<0.0001
¹³³ I	0.012	<0.0001	0.19*		0.00050	100*	8.0
¹³⁵ I	0.14*	0.0028	0.051		0.0010	100*	200
¹⁴⁰ La						100*	140
¹⁹¹ Os			100*				0.0080
²¹² Pb	24*	39*	25*		0.98*	12*	2,200
¹⁰⁶ Ru			100*				720
⁷⁵ Se			100*				0.052
¹³² Te							0.028
Gross alpha	47*	6.1*	47*		0.033*	100*	0.042
Gross beta	0.42*	0.056*	99*		0.0060*	0.28*	0.43
						0.11*	79

^aTotal percentages that exceed 100 are due to rounding.

^bAn asterisk (*) indicates that the emission is statistically determined to be significantly different from zero. Note that the variance used in the significance test is based only on the counting uncertainty and does not include uncertainty due to the sampling process.

Virtually all of the total ^{133}I (2.0×10^8 Bq) and ^{135}I (1.4×10^8 Bq) was emitted from Stack 7911 in the Melton Valley Complex. Most of the total ^{131}I emission also came from Stack 7911 (81%, 1.6×10^8 Bq), with a smaller amount from Stack 3039-3 (19%, 3.8×10^7 Bq).

Four locations accounted for 93% of the ^{212}Pb reported for the quarter: Stack 3020 at the Radiochemical Processing Plant (39%, 2.8×10^8 Bq), Stack 2026 at the High Radiation Level Analytical Laboratory (24%, 1.7×10^8 Bq), Stack 3039-2 from the Central Off-gas and Scrubber System (18%, 1.2×10^8 Bq), and Stack 7911 in the Melton Valley Complex (12%, 8.4×10^7 Bq).

Virtually all of the reported ^{191}Os (2.2×10^9 Bq) was released at Stack 3039-4, the 3025 and 3026 Areas Cell Ventilation Systems.

2.1.3 Trends

During the first quarter, tritium emissions were significantly lower than levels reported for preceding quarters. The total ^3H for this quarter was 4.1×10^{12} Bq, compared with 39×10^{12} Bq for the fourth quarter of 1989. Emissions from the largest source, Stack 7025 at the Tritium Target Fabrication Facility, were lower by almost a factor of 10, down from 31×10^{12} Bq in the last quarter of 1989 to 3.3×10^{12} Bq in this quarter. Reduced emissions from Stack 7025 are expected as production work is discontinued at the facility. Stack 3039-3, another usually large source, was down by more than a factor of 10, from 5.8×10^{12} to 0.48×10^{12} Bq. Emissions from the other tritium sources were also down, except for Stack 3039-1, which showed some increase from 13×10^9 Bq to 39×10^9 Bq.

Iodine levels were slightly lower than those reported for last quarter. The major source, Stack 7911 in the Melton Valley complex, showed no change for ^{131}I (160×10^6 Bq) and slight decreases for ^{133}I and ^{135}I from 220×10^6 to 200×10^6 Bq for ^{133}I , and from 170×10^6 to 140×10^6 Bq for ^{135}I . The usual small sources of iodine showed only minor fluctuations in iodine levels as compared with those last quarter.

Total emissions of ^{212}Pb show a small increase this quarter, up from 620×10^6 Bq in the fourth quarter 1989 to 720×10^6 Bq in first quarter 1990. The increase is due to emissions from Stack 3020 at the Radiochemical Processing Plant. Emissions there were up from 11×10^6 Bq in the fourth quarter of 1989 to 280×10^6 Bq in this quarter, primarily because of a reported emission of 230×10^6 Bq in March. The increase was partially offset by a decrease in the emission from Stack 3039-2, the Central Off-gas and Scrubber System, from 230×10^6 to 120×10^6 Bq.

Total ^{191}Os emissions for this quarter were 2.2×10^9 Bq, down from 4.3×10^9 Bq in the last quarter of 1989. Virtually all of the ^{191}Os was detected at Stack 3039-4 from the Cell Ventilation Systems in areas 3025 and 3026. This quarter a small amount (3.3×10^6 Bq) was detected at Stack 3039-3, the Isotope Solid-State Ventilation System.

2.2 AMBIENT AIR

2.2.1 Program Description

Most gaseous wastes from ORNL are released to the atmosphere from stacks. Radioactivity may be present in gaseous waste streams as a solid (particulates), an adsorbable gas (e.g., iodine), or a nonadsorbable species (noble gas). At ORNL, gaseous wastes that may contain radioactivity are processed to reduce the radioactivity to acceptable levels before the wastes are discharged to the atmosphere. As described in Sect. 2.1, airborne emissions are monitored as they leave the stacks. In addition, radioactivity in the atmosphere is continuously monitored at 18 stations placed around ORNL, the ORR, and the surrounding area. The ambient air monitoring stations are categorized into three groups according to their geographical locations:

1. The ORNL perimeter air monitoring (PAM) network consists of stations 3, 7, 9, 20, 21, and 22. These six stations, located at or near the ORNL boundary, as shown in Fig. 2, provide data on the impact on ambient air from operations at ORNL.
2. The ORR PAM network consists of stations 23, 33, 34, and 40-46, also shown in Fig. 2. The ORR PAM stations, located at or near the ORR boundary, provide data on effects from operations on the ORR.
3. The remote air monitoring (RAM) network consists of stations 52 and 58. These stations, located within a 120-km radius of ORNL outside the ORR boundary, as shown in Fig. 3, provide reference data from areas not expected to be affected by operations on the ORR.

All ORNL and most ORR PAM stations have real-time monitors for five radiation parameters, including gross alpha, gross beta, iodine, gross gamma, and noble gas. The primary purpose of the monitoring system is to determine whether radiation levels on the ORR are above background levels. If radiation levels appear to be higher than normal, additional sampling can be initiated to provide quantitative measures of concentrations in the atmosphere. ORR PAM stations 33, 34, and 40 through 45 perform real-time monitoring, and station 46 is currently being equipped for real-time monitoring.

Sampling of ambient air occurs at all 18 stations. Airborne radioactive particulates are collected by pumping a continuous flow of air through a paper filter. Then, at most stations, the air flows through a cartridge packed with activated charcoal to collect adsorbable gases. The filter papers are collected and analyzed biweekly for gross alpha and gross beta activity. The filter papers are analyzed 4 d after collection to minimize artifacts from short-lived radionuclides, and again after 8 d for comparability with similar data in the airborne emissions program. The charcoal cartridge filters are collected biweekly and analyzed within 24 h for ^{131}I . The beginning and ending dates, total time on and off, and flow values are recorded when a sample medium is mounted or removed. The total volume of air that flowed through the sampler during the sampling period is obtained from a flow totalizer installed at each station. The concentration of radionuclides in the sampled air is

ORNL-DWG 88M 7874R3

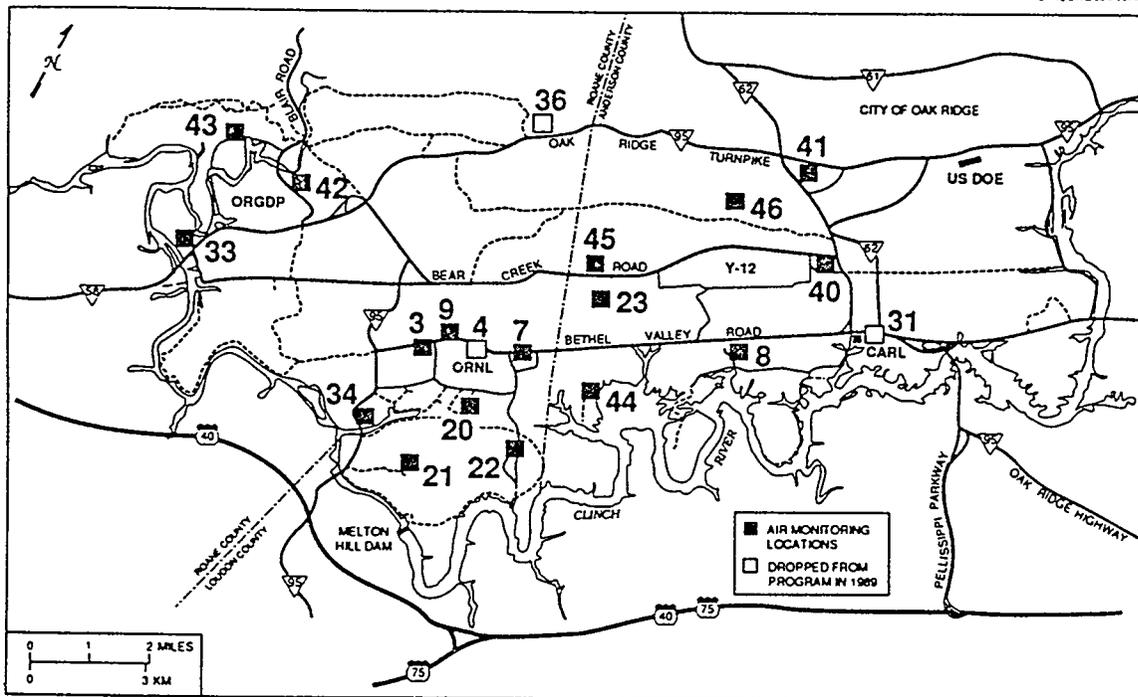


Fig. 2. Location map of ORR and ORNL PAM stations.

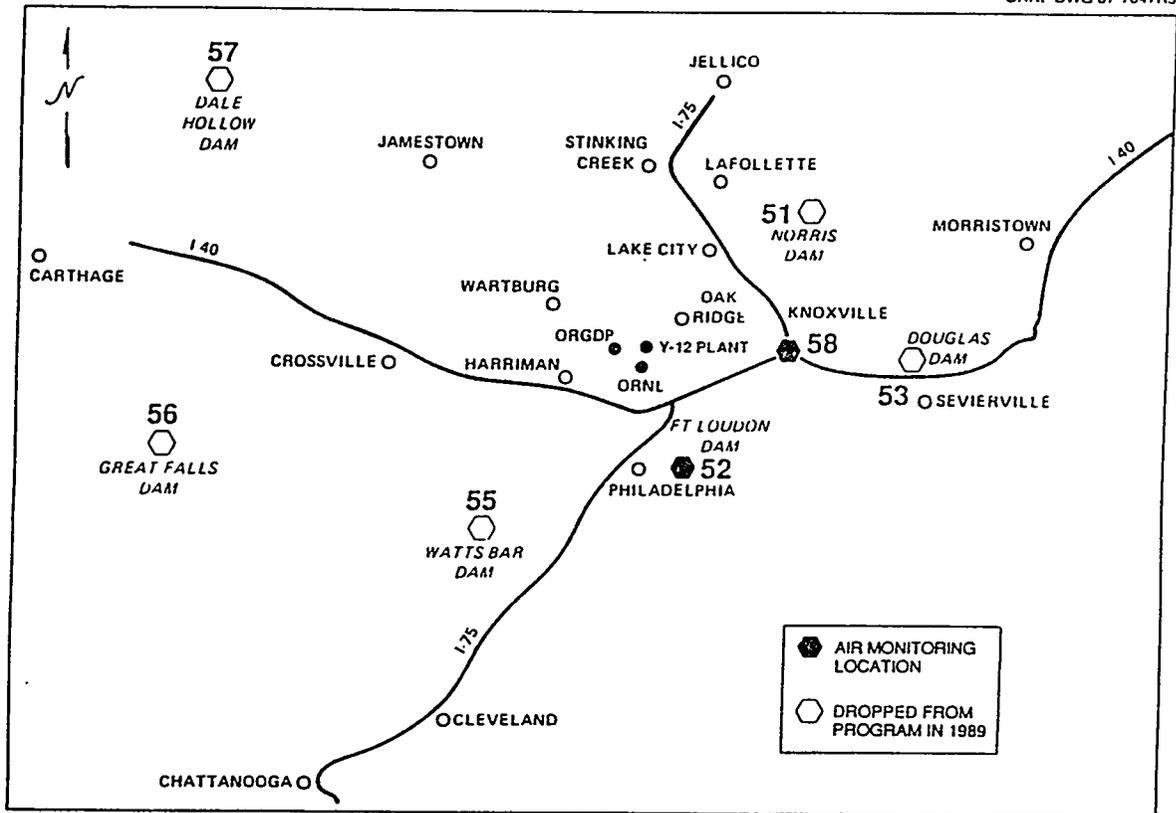


Fig. 3. Location map of RAM stations.

calculated by dividing the total activity in the sample by the total volume of air sampled.

In addition, the particulate filters are composited annually and analyzed for specific radionuclides of uranium, thorium, and plutonium and for total strontium. Annual analysis is performed because the isotopes of interest are all long-lived and because the composite provides a larger sample volume and allows more precise measurement. Results from analyses of composites prepared at the end of the fourth quarter of 1989 were summarized in the report for that quarter. The next summary of specific isotopes will appear in the report for the fourth quarter, 1990.

Monthly samples for atmospheric tritium are routinely collected from air monitoring station 3, at the west end of ORNL, and from station 8, located east of ORNL. At these stations, atmospheric tritium in the form of water vapor is removed from the air in silica gel. In the analytical laboratory, the silica gel is heated in a distillation flask to remove the moisture, and the distillate is counted in a liquid scintillation counter. The concentration of tritium in the air is calculated by dividing the total activity in the sample by the total volume of air sampled.

2.2.2 Results

Concentrations of gross alpha, gross beta, atmospheric ^{131}I , and atmospheric tritium for first quarter of 1990 are summarized in Tables 2-5. In the laboratory, instrument background levels are subtracted from the measured value, sometimes resulting in a negative number. Negative concentration values in the tables represent activities below the instrument background level.

Average concentration values for gross alpha, gross beta, ^{131}I , and ^3H are tested for statistical significance using a calculated variance that includes variation from the sampling process and from the laboratory counting process. If the 95% lower bound calculated from the variance of the mean is greater than zero, then the mean is determined to be significantly different from zero. In the tables, averages that were determined to be significantly different from zero are marked with an asterisk.

The report for this quarter includes data from the 2-week period, December 18, 1989, through January 2, 1990, which were not included in the report for the fourth quarter of 1989.

Summary data for gross alpha activity detected at stations in the three air monitoring networks are presented in Table 2. Average concentration values from all stations were determined to be statistically significantly different from zero, except for station 41, which is represented by only two samples. In the ORNL network, the maximum concentration (7.0×10^{-8} Bq/L) occurred at station 7, at the west end of the 1 plant. The maximum concentration reported in the ORR network (9.9×10^{-8} Bq/L) occurred at station 46, north of the Y-12 Plant. The highest average concentrations over all three networks were reported from two ORR PAM stations: station 40, near the Y-12 Plant, with an average of 4.8×10^{-8} Bq/L, and station 46, with an average of

Table 2. Long-lived gross alpha activity in air, January-March 1990

Location	No. of samples	Concentration (10^{-8} Bq/L)			Standard error ^b
		Max	Min	Av ^a	
ORNL PAM stations ^c					
3	7	5.6	2.2	4.1*	0.48
7	5	7.0	2.3	3.9*	0.86
9	7	5.7	1.5	3.0*	0.66
20	7	5.2	2.0	4.0*	0.40
21	4	4.3	2.5	3.4*	0.37
22	5	3.7	2.2	3.1*	0.32
Network summary	35	7.0	1.5	3.6*	0.22
ORR PAM stations ^c					
23	6	5.2	2.2	4.3*	0.51
33	7	4.5	3.1	3.8*	0.19
34	6	5.7	2.0	3.9*	0.51
40	6	6.5	2.8	4.8*	0.57
41	2	4.4	2.8	3.6	0.84
42	7	5.3	2.2	3.3*	0.41
43	5	5.4	2.8	3.7*	0.45
44	7	5.7	2.1	3.3*	0.43
45	7	6.9	2.1	4.3*	0.66
46	7	9.9	1.5	4.7*	1.1
Network summary	60	9.9	1.5	4.0*	0.19
RAM stations ^d					
52	2	4.0	3.1	3.6*	0.41
Network summary	2	4.0	3.1	3.6*	0.41
Overall summary	97	9.9	1.5	3.8*	0.14

^aAverages marked with an asterisk (*) are statistically significantly different from zero.

^bStandard error of the mean.

^cSee Fig. 2.

^dSee Fig. 3.

Table 3. Long-lived gross beta activity in air, January-March 1990

Location	No. of samples	Concentration (10^{-8} Bq/L)			Standard error ^b
		Max	Min	Av ^a	
ORNL PAM stations ^c					
3	7	110	69	95*	7.0
7	5	480	75	170*	78
9	7	110	41	72*	9.1
20	7	120	75	97*	6.3
21	4	120	71	99*	12
22	5	110	71	89*	7.5
Network summary	35	480	41	100*	12
ORR PAM stations ^c					
23	6	120	78	97*	7.0
33	7	120	73	99*	7.0
34	6	110	56	80*	7.6
40	6	87	65	79*	3.6
41	2	92	64	78	14
42	7	120	65	86*	6.7
43	5	120	74	96*	7.4
44	7	140	54	87*	11
45	7	130	74	93*	7.7
46	7	120	61	85*	8.2
Network summary	60	140	54	89*	2.5
RAM station ^d					
52	2	86	74	80*	5.9
Network summary	2	86	74	80*	5.9
Overall summary	97	480	41	93*	4.5

^aAverages marked with an asterisk (*) are statistically significantly different from zero.

^bStandard error of the mean.

^cSee Fig. 2.

^dSee Fig. 3.

Table 4. ^{131}I concentrations in air, January-March 1990

Location	No. of samples	Concentration (10^{-8} Bq/L)				
		Max	Min	Av ^a	Standard error ^b	Percentage DCG ^c
ORNL PAM stations ^d						
3	7	16	-29	-3.6	5.6	<0.01
7	5	15	-3.4	2.5	3.5	<0.01
9	7	17	-6.1	0.49	3.0	<0.01
20	7	25	-26	1.3	5.7	<0.01
21	4	7.0	-3.4	1.8	2.2	<0.01
22	5	3.2	-7.7	-0.79	2.2	<0.01
Network summary	35	25	-29	0.10	1.7	<0.01
ORR PAM stations ^d						
23	6	28	-8.7	4.6	5.1	<0.01
34	6	30	-2.6	9.4	5.7	<0.01
40	6	2.3	-11	-3.1	1.9	<0.01
41	2	8.3	-2.6	2.8	5.4	<0.01
44	7	6.3	-5.8	-0.24	1.8	<0.01
45	7	3.8	-3.5	0.97	0.93	<0.01
46	7	20	-21	0.60	5.8	<0.01
Network summary	41	30	-21	2.0	1.6	<0.01
Overall summary	76	30	-29	1.1	1.2	<0.01

^aAverages marked with an asterisk (*) are statistically significantly different from zero.

^bStandard error of the mean.

^cPercentage DCG = average value \times 100 divided by DCG. The DCG for ^{131}I is 1.5×10^{-2} Bq/L.

^dSee Fig. 2.

Table 5. Tritium activity in air, January-March 1990

Location ^a	No. of samples	Concentration (10^{-4} Bq/L)				
		Max	Min	Av ^b	Standard error ^c	Percentage DCG ^d
3	3	5.1	1.9	3.9*	1.0	0.011
8	1	7.6	7.6	7.6		0.021
Overall summary	4	7.6	1.9	4.8*	1.2	0.013

^aSee Fig. 2.

^bAverages marked with an asterisk (*) are statistically significantly different from zero.

^cStandard error of the mean.

^dPercentage DCG = average \times 100 divided by the DCG.

The DCG for tritium is 3.7 Bq/L. This assumes that 50% of the tritium is absorbed through the skin.

4.7×10^{-8} Bq/L. There is little difference in average alpha activity among the ORNL, ORR, and remote networks. The average gross alpha concentration for the whole ORNL network is 3.6×10^{-8} Bq/L, and for the Reservation network, it is 4.0×10^{-8} Bq/L. The only remote station reported this quarter, station 52 at Fort Loudon Dam, had an average concentration of 3.6×10^{-8} Bq/L.

Gross beta activity summary data are given in Table 3. All average concentration values are marked as significantly different from zero, except for the average computed for station 41 from only two samples. The relatively high maximum value (480×10^{-8} Bq/L) reported for ORNL station 7 has been confirmed, but the reason for the occurrence has not been determined. The maximum gross beta concentration reported in the ORR network (140×10^{-8} Bq/L) occurred at station 44, southwest of ORNL. The highest average concentrations over all three networks were reported from station 7, with 170×10^{-8} Bq/L, and from ORR station 33, with 99×10^{-8} Bq/L. For the ORNL network, the average gross beta concentration was 100×10^{-8} Bq/L; for the ORR network, 89×10^{-8} Bq/L; and for the remote network, 80×10^{-8} Bq/L.

A summary of atmospheric ^{131}I concentrations in the first quarter is presented in Table 4. No average concentration values for ^{131}I were determined to be significantly different from zero, and all values are reported as less than 0.01% of the derived concentration guide. The maximum value over all three networks, 30×10^{-8} Bq/L, reported for ORR station 34 near White Oak Dam, is only 0.002% of the DCG for ^{131}I . The highest average concentration, 9.4×10^{-8} Bq/L, also occurred at station 34. The average concentration of atmospheric ^{131}I from the ORNL network was 0.10×10^{-8} Bq/L, and for the ORR network, 2×10^{-8} Bq/L.

Concentrations of atmospheric tritium for the period are summarized in Table 5. The average concentration value for station 3 (3.9×10^{-4} Bq/L) computed from three monthly samples is marked as significantly different from zero. Station 8 had only one sample analyzed during the quarter; the sample showed a concentration of 7.6×10^{-4} Bq/L.

2.2.3 Trends

The revised sampling schedule is proving beneficial. Fewer negative concentration values occur now that filter papers are collected and analyzed biweekly, rather than weekly. The two-week sampling period doubles the sample volume and increases the activity sufficiently to discriminate it from analytical background.

A review of individual concentration values at all stations over the last 14 months shows that concentrations of atmospheric ^{131}I are consistently below 35×10^{-8} Bq/L, with one exception, 49×10^{-8} Bq/L, reported for ORNL station 3 in April 1989. That highest reported value is 0.003% of the DCG for ^{131}I . Individual concentrations of long-lived gross alpha are all below 10×10^{-8} Bq/L, except for one excursion to 17×10^{-8} Bq/L, which was reported for remote station 52 in February 1989. Long-lived gross beta concentrations for the 14-month period fall in the range 15×10^{-8} to 170×10^{-8} Bq/L. Two

exceptions are a value of 480×10^{-8} Bq/L, which occurred at ORNL station 7 during this quarter, and a value of 210×10^{-8} Bq/L, which was reported for remote station 52 in November 1989.

Compared with summary results from the previous quarter, concentrations in air during the first quarter of 1990 were similar or slightly lower for gross alpha, gross beta, and tritium. At ORNL PAM stations, the average concentration of gross alpha activity for this quarter (3.6×10^{-8} Bq/L) is similar to that for the fourth quarter of 1989 (4.2×10^{-8} Bq/L). Also, at the ORR PAM stations, average gross alpha for this quarter (4×10^{-8} Bq/L) is similar to that for the fourth quarter of 1989 (4.3×10^{-8} Bq/L). Over the last year, gross alpha activity reported for the three networks has shown little variation.

Concentrations of long-lived gross beta activity in the first quarter of 1990 are slightly lower than those for the fourth quarter of 1989. At the ORNL stations, average concentrations for this quarter and the previous quarter are 100×10^{-8} and 110×10^{-8} Bq/L, respectively; at the ORR stations, values are 89×10^{-8} and 100×10^{-8} Bq/L. The trend over the last year, however, shows a small increase in gross beta activity. Average concentration values reported at ORNL stations for the last four quarters are 77×10^{-8} , 78×10^{-8} , 110×10^{-8} , and 100×10^{-8} Bq/L. Average concentrations at the ORR stations have been 66×10^{-8} , 70×10^{-8} , 100×10^{-8} , and 89×10^{-8} Bq/L. The remote stations have shown average concentrations of 68×10^{-8} , 92×10^{-8} , 95×10^{-8} , and 80×10^{-8} Bq/L.

Atmospheric ^{131}I concentrations in the first quarter are slightly higher than those from the previous quarter when more negative values were reported. Comparison of network average concentrations over the last five quarters, however, shows a decrease. Values at ORNL stations, beginning with the first quarter of 1989, have been 2.1×10^{-8} , 3.7×10^{-8} , 0.39×10^{-8} , -0.91×10^{-8} , and 0.1×10^{-8} Bq/L. Average concentrations of atmospheric ^{131}I have been reported as less than 0.01% of the DCG for all stations for all five quarters.

The average tritium concentration for the first quarter of 1990 (4.8×10^{-4} Bq/L) is lower than that reported for the fourth quarter of 1989 (11×10^{-4} Bq/L). The average for this quarter is based on only four samples rather than the normal six. Longer-range comparisons cannot be made because of problems in determining the volume of air sampled at stations 3 and 8 during the first three quarters of 1989. Data for comparison are not available.

2.3 EXTERNAL GAMMA RADIATION

2.3.1 Program Description

External gamma radiation measurements (exposure rates) are recorded on a near real-time data acquisition system at ORNL and ORR PAM stations. The location of these PAMs are shown in Fig. 2. The readings are averaged at 10-min intervals and stored in a data base on the host computer. From these data, hourly averages are computed and also stored in a data base. Readings are

marked as invalid by the system if less than 75% of data are available for the computation for the average as well as if the data are out of a predefined range. If a station has been marked "off-poll," there will be no readings returned to the data acquisition system for inclusion in the data bases.

2.3.2 Procedures and Results

The valid hourly readings for the quarter are queried from the data acquisition system data base and processed by a statistical program to produce a table of valid hourly measurements. Table 6 summarizes these measurements for the first quarter of 1990. The equivalent dose rate is calculated using the average reading for each station during the quarter.

2.3.3 Trends

Typical external gamma exposure rates for cities in the United States are usually between 1.5 and 4.2 nanocoulombs per kilogram per hour (nC/kg/h) according to the recent issues of EPA Environmental Radiation Data. The median value for cities in the contiguous United States for the first three quarters of 1989 was 2.4 nC/kg/h. The last value given for Knoxville (July-September 1989) was 2.4 nC/kg/h. All of the values given in Table 6 are close to the range of background values as given above. Readings at station 4 have been historically higher than the norm. These are believed to be due to its location near the Process Waste Treatment Plant (PWTP).

Table 6. External gamma radiation measurements at ORNL and ORR PAMs, January-March 1990

Location	No. of samples ^b	Exposure rate (nC/kg/h) ^a				Equivalent dose (μ Sv/h)
		Max	Min	Av	Standard error ^c	
ORNL PAM stations ^d						
04	2072	36	22	28	0.047	1.1
07	1350	2.4	1.4	1.8	0.0068	0.069
20	346	2.6	2.0	2.2	0.0045	0.084
Network summary	3768	36	1.4	16	0.22	0.64
ORR PAM stations ^e						
08	687	2.3	1.7	1.9	0.0031	0.072
31	862	2.4	1.9	2.0	0.0023	0.079
33	1329	3.7	1.7	2.0	0.0044	0.077
34	1435	2.6	1.9	2.1	0.0034	0.083
36	58	1.9	1.8	1.8	0.0037	0.071
40	648	2.4	1.9	2.0	0.0027	0.076
41	1474	1.6	1.4	1.5	0.00078	0.057
43	1326	7.4	1.5	1.7	0.0082	0.067
44	2135	2.1	1.5	1.6	0.0016	0.064
45	2159	2.5	1.6	1.8	0.0021	0.070
Network summary	12113	7.4	1.4	1.8	0.0022	0.071

^aNanocoulomb per kilogram per hour.

^bReal-time readings were collected at all stations at 10-min intervals. The number of samples indicate the total number of valid hourly averages during the quarter.

^cStandard deviation of the mean.

^dSee Fig. 2.

^eSee Fig. 3.

3. WATER

The Oak Ridge National Laboratory (ORNL) site is drained by two main streams, White Oak Creek (WOC) and Melton Branch (MB). With the exception of two small discharges from the 7600 area into Melton Hill Lake, all ORNL effluents discharge to these two streams or their tributaries. WOC flows through Bethel Valley where Fifth Creek, First Creek, and the Northwest Tributary (NWT) join it (Fig. 4). WOC continues through a gap in Chestnut Ridge into Melton Valley, where it is joined by MB, which drains Melton Valley. Water quality in these streams is affected primarily by wastewater discharges and by groundwater transport of contaminants from land disposal of wastes. WOC empties into White Oak Lake (WOL), which is controlled by White Oak Dam (WOD) and is the last sampling point before effluents leave the ORNL site. The majority of the drainage or liquid effluent from ORNL flows into the Clinch River by way of WOC. The Clinch River flows southwest from Virginia to its mouth near Kingston, Tennessee, where it joins with the Tennessee River. Process effluents discharged to these streams are handled in a number of ways which include treatment at the Process Waste Treatment Plant (PWTP) and Coal Yard Runoff, storage in holding basins [190 ponds, High Flux Isotope Reactor/Transuranium Processing Plant (HFIR/TRU) ponds], and direct discharge to the stream. Sanitary effluent is discharged to WOC after treatment at the Sewage Treatment Plant (STP). Below WOD, WOC is affected by water levels in the Clinch River which are controlled by operators at Melton Hill Dam.

Surveillance of the water environment consists of the collection of surface water, effluent, and sediment samples required under the National Pollutant Discharge Elimination System (NPDES) permit, and groundwater from waste area grouping (WAG) 1 and WAG 6. Samples are analyzed for radionuclides and nonradioactive chemicals.

3.1 SURFACE WATER

3.1.1 Program Description

WOC drains an area of 17 km² in Bethel and Melton valleys and is the largest stream flowing through ORNL. After entering Melton Valley, WOC is joined by its major tributary, MB. WOD, located above the mouth of WOC, forms WOL and serves as a point for monitoring flow and discharges of contaminants from the ORNL site.

Samples are collected for radiological analyses at off-site and on-site locations, at background or reference locations, in streams on the ORNL site, and from all process discharge point sources. A summary of locations, parameters analyzed, and frequencies of sample collection and analysis for all radiological samples is provided in Table 7.

Changes in the sampling procedures were implemented during this quarter. Effective in March, X09A (HFIR ponds and TRU ponds), X06A (190 ponds, 1500 area and 2000 area), 3518, and 3544 effluents were redirected to the Nonradiological Wastewater Treatment Plant (NRWTP). The results section

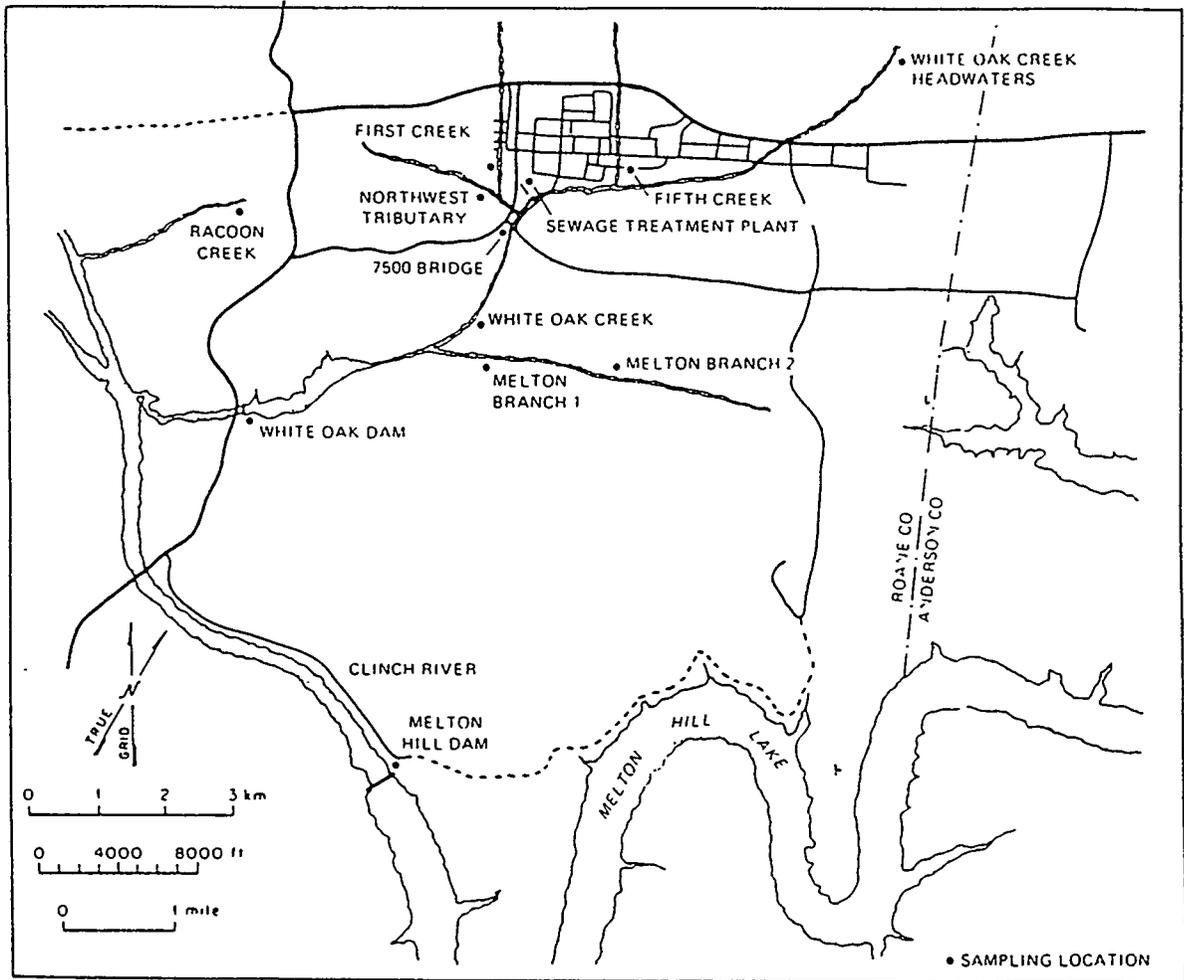


Fig. 4. Location map of ORNL streams and sampling stations.

Table 7. Summary of collection and analysis frequencies of surface, pond, and effluent water samples

Station	Parameter	Collection frequency	Analysis type	Frequency
3518	Gross alpha, gross beta	Weekly	Flow proportional	Monthly
STP	Gamma scan, gross beta, total Sr ^a	Weekly	Flow proportional	Monthly
3544	Gross alpha, gross beta, gamma scan, total Sr ^a	Weekly	Flow proportional	Monthly
7500 Bridge, MB1, WOC, MB2	Gamma scan, total Sr, ^a ³ H	Weekly	Flow proportional	Monthly
First Creek, Fifth Creek, Raccoon Creek	Gamma scan, total Sr ^a	Weekly	Grab	Monthly
Gallaher	³ H, gamma scan, gross alpha, gross beta, total Sr, ^a ²³⁸ Pu, ²³⁹ Pu	Weekly	Time proportional	Quarterly
Kingston	³ H, gamma scan, gross alpha, gross beta, total uranium, total Sr, ^a ²³⁸ Pu, ²³⁹ Pu	Weekly	Grab	Quarterly
TRU/TURF and HFIR ponds	Gamma scan, gross alpha, gross beta	After discharge	Flow proportional	Monthly
Melton Hill Dam	Gamma scan, gross alpha, ^b gross beta ^c	Weekly	Flow proportional	Monthly
NRWTP	³ H, gamma scan, gross alpha, gross beta, total Sr ^a	Weekly	Flow	Monthly proportional
NWT	Gamma scan, total Sr ^a	Weekly	Flow proportional	Monthly

Table 7 (continued)

Station	Parameter	Collection frequency	Analysis type	Frequency
WOC headwaters	Gamma scan, gross alpha, ^b gross beta ^c	Weekly	Flow proportional	Monthly
WOD	Gamma scan, gross alpha, gross beta	Weekly	Flow proportional	Weekly
WOD	³ H, total Sr ^a	Weekly	Flow proportional	Weekly

^aTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

^bIf gross alpha >1 Bq/L, then analyze for ²⁴¹Am, ²⁴⁴Cm, ²³⁸Pu, ²³⁹Pu, ²²⁸Th, ²³⁰Th, ²³³Th, ²³⁴U, ²³⁵U, and ²³⁸U.

^cIf gross beta >30 Bq/L, then analyze for total radioactive Sr.

contains data summaries of samples collected from each location and reflects the schedule changes made during this quarter.

A one-tailed test of significance is used to determine whether a radionuclide concentration is significantly greater than zero. If the concentration is statistically significant, the concentration is followed by an asterisk in the tables. Whenever a concentration is not significantly greater than zero, no further summaries derived from that concentration are presented, for example, percentage of the derived concentration guide (DCG) or discharge. All tests are performed at the 5% significance level.

When there is a single observation, the normal approximation is used to approximate the distribution of net activity concentration. The estimated counting uncertainty, which is based upon Poisson statistics and treated as known for the purpose of this test, is used to derive an estimate of the variance. When there are multiple observations, a one-sided t-test is used to test whether an average concentration is greater than zero. The mean is compared to its standard error using the t-distribution with $n - 1$ degrees of freedom, where n is the number of observations used to calculate the mean. Note that two different types of tests are performed. In the first case the test is whether a particular observed concentration exceeds zero, whereas in the second case the test is whether the assumed constant population mean (not an individual concentration) exceeds zero. In the first case the variance estimate pertains only to the counting process, whereas in the second case the variance estimate pertains to the combined sampling and counting processes.

3.1.2 Results

Treated water samples are collected weekly at the Kingston and Oak Ridge Gaseous Diffusion Plant (ORGDP, Gallaher) potable water treatment plants (Fig. 5) and are analyzed quarterly. Table 8 contains the concentrations measured at these stations during the first quarter of 1990. At Gallaher, gross beta, total radioactive strontium and ^3H were significantly greater than zero, but all were less than 11% of the respective U.S. Environmental Protection Agency (EPA) drinking water standards. At Kingston, gross beta, ^{238}Pu and ^3H were significantly greater than zero. Gross beta and ^3H concentrations were less than 4% of the drinking water standards, and the ^{238}Pu concentration is less than 0.02% of the gross alpha drinking water standard. No test of significance was possible for the single total uranium measurement (concentration was not determined from a counting process) at each site, but the concentrations at Kingston and Gallaher are less than 0.05% of the gross alpha standard.

Melton Hill Dam and WOC headwater, two locations above ORNL discharge points, serve as references for other water sampling locations at the ORNL site. Water samples are collected there and from six streams: WOC, MB, First Creek, Fifth Creek, NWT, and Raccoon Creek (Fig. 4). Summary statistics for each radionuclide at each surface water sampling location are given in Table 9.

DOE Order 5400.5, Chap. III, requires comparison of annual average radionuclide concentrations with the DCG values. According to the DOE order, a

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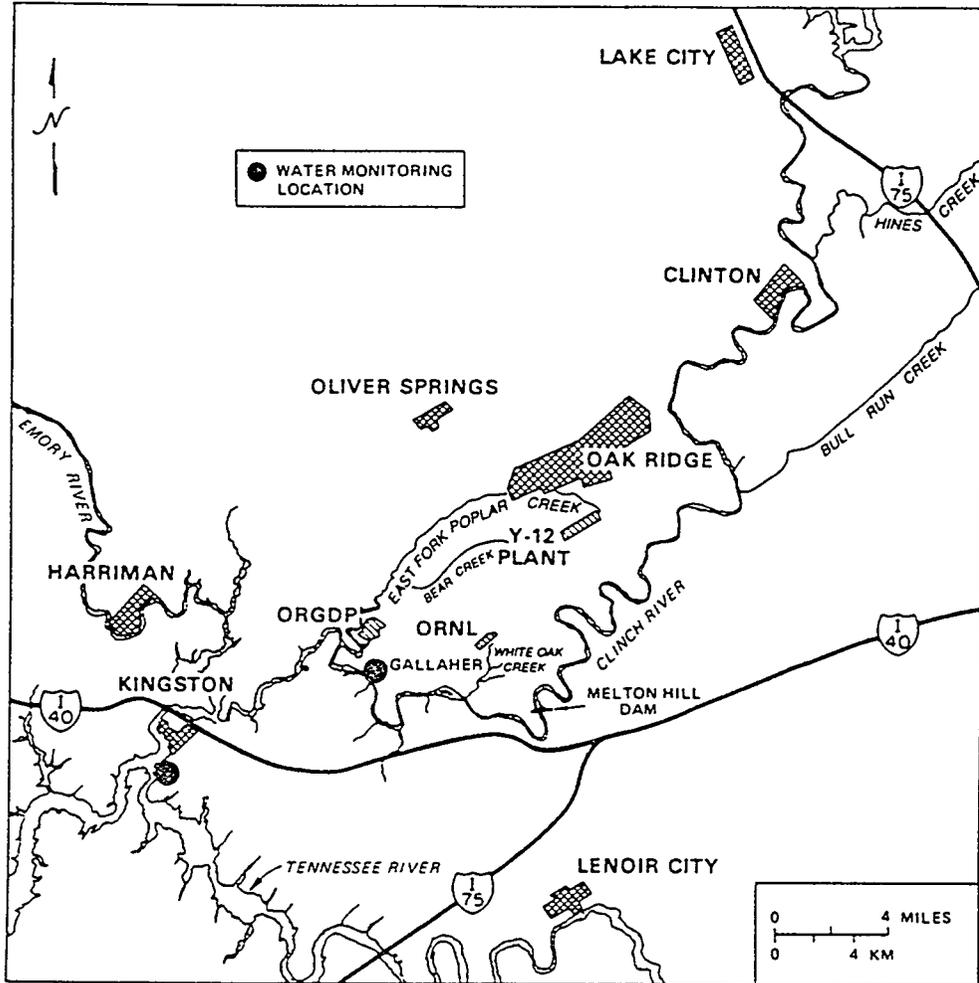


Fig. 5. Location map of Kingston and Gallaher sampling points.

Table 8. Summary of radionuclide concentrations in water off-site of ORNL, January-March 1990

Radionuclide	Concentration ^a (Bq/L)	Drinking water standard ^b (DWS) (Bq/L)	Percentage of DWS ^c
Gallahe ^d			
⁶⁰ Co	0.010	e	e
¹³⁷ Cs	0.0080	e	e
Gross alpha	0.0040	0.56	e
Gross beta	0.14*	1.5	9.3
²³⁸ Pu	0.00011	e	e
²³⁹ Pu	-0.00032	e	e
Total Sr ^f	0.030*	0.30	10
Total U ^g	0.00026	e	e
³ H	52*	740	7.0
Kingston ^d			
⁶⁰ Co	-0.0050	e	e
¹³⁷ Cs	0.0010	e	e
Gross alpha	0.00050	0.56	e
Gross beta	0.049*	1.5	3.3
²³⁸ Pu	0.00013*	e	e
²³⁹ Pu	-0.0000080	e	e
Total Sr ^f	0.0047	0.30	e
Total U ^g	0.00015	e	e
³ H	11*	740	1.5

^aConcentrations significantly greater than zero are identified by an asterisk (*).

^bNational Primary Drinking Water Standard. From 40 CFR Pt. 141, as amended. Values for gross beta and total strontium are based upon the ⁹⁰Sr limit.

^cConcentration as a percentage of the DWS.

^dSee Fig. 5.

^eNot applicable.

^fTotal radioactive strontium (⁸⁹Sr + ⁹⁰Sr).

^gNo test for significance is possible.

Table 9. Radionuclide concentrations in surface waters around ORNL,^a
January-March 1990

Radionuclide	No. of samples	Concentration (Bq/L)					(DCG) ^d	Percentage of DCG ^e
		Max	Min	Av ^b	Standard error ^c			
Melton Hill Dam								
⁶⁰ Co	3	1.5	-0.10	0.70	0.46	190	<i>f</i>	
¹³⁷ Cs	3	0.70	-0.10	0.33	0.23	110	<i>f</i>	
Gross alpha	3	0.93	0.040	0.36	0.28	<i>f</i>	<i>f</i>	
Gross beta	3	0.90	-0.30	0.13	0.38	<i>f</i>	<i>f</i>	
White Oak Creek Headwaters								
⁶⁰ Co	3	1.9	0.40	1.3	0.45	190	<i>f</i>	
¹³⁷ Cs	3	0.60	-0.90	-0.13	0.43	110	<i>f</i>	
Gross alpha	3	0.69	-0.080	0.18	0.26	<i>f</i>	<i>f</i>	
Gross beta	3	1.1	-0.50	0.50	0.50	<i>f</i>	<i>f</i>	
7500 Bridge								
⁶⁰ Co	3	1.4	-0.10	0.60	0.44	190	<i>f</i>	
¹³⁷ Cs	3	1.1	0.90	1.0*	0.067	110	0.94	
Total Sr ^g	3	3.1	2.5	2.8*	0.18	37	7.5	
³ H	3	100	95	97*	1.5	74,000	0.13	
First Creek								
⁶⁰ Co	3	1.0	0.30	0.73*	0.22	190	0.39	
¹³⁷ Cs	3	1.2	0.10	0.47	0.37	110	<i>f</i>	
Total Sr ^g	3	6.6	5.9	6.2*	0.22	37	17	
Fifth Creek								
⁶⁰ Co	3	1.0	-2.2	-0.37	0.95	190	<i>f</i>	
¹³⁷ Cs	3	0.90	-1.3	-0.33	0.65	110	<i>f</i>	
Total Sr ^g	3	0.98	0.75	0.87*	0.066	37	2.3	

Table 9 (continued)

Radionuclide	No. of samples	Concentration (Bq/L)				Standard error ^c	(DCG) ^d	Percentage of DCG ^e
		Max	Min	Av ^b				
Melton Branch 2								
⁶⁰ Co	3	0.90	0.40	0.63*	0.15	190	0.33	
¹³⁷ Cs	3	-0.30	-0.80	-0.47	0.17	110	f	
Total Sr ^g	3	0.51	0.040	0.21	0.15	37	f	
³ H	3	3,600	32	1,200	1,200	74,000	f	
Northwest Tributary								
⁶⁰ Co	3	0.50	-0.50	0.13	0.32	190	f	
¹³⁷ Cs	3	1.5	-0.40	0.57	0.55	110	f	
Total Sr ^g	3	2.3	1.9	2.2*	0.13	37	5.9	
Raccoon Creek								
⁶⁰ Co	3	1.3	-0.20	0.60	0.44	190	f	
¹³⁷ Cs	3	-0.10	-1.0	-0.40	0.30	110	f	
Total Sr ^g	3	0.42	0.11	0.27*	0.090	37	0.73	

^aLocations are shown in Fig. 4.

^bMean concentrations significantly greater than zero are identified by an asterisk (*).

^cStandard error of the mean.

^dDCG for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG, calculated only when a DCG exists and mean concentration is significantly greater than zero.

^fNot applicable.

^gTotal radioactive strontium (⁸⁹Sr + ⁹⁰Sr).

DCG for water is the concentration of a particular radionuclide for which a "reference man" under continuous exposure (ingestion) for 1 year would receive the most restrictive of (1) an effective dose equivalent of 1 mSv (1 mSv = 100 mrem) or (2) a dose equivalent of 50 mSv to any particular tissue. Although the DCGs apply at the point of discharge to a receiving stream prior to dilution in the stream, average quarterly stream concentrations were compared with the DCGs as a guideline. Average concentrations of each parameter are expressed as a percentage of the DCG in Table 9.

No average concentration at the two reference sites were significantly greater than zero. At all sites where there was an average concentration significantly greater than zero, the concentration was less than 10% of the DCG. The exception to this was at First Creek, where the average concentration of total strontium (average of 6.2 Bq/L) was 17% of the DCG for ^{90}Sr .

Locations that are sampled for nonradioactive chemicals under the requirements of the National Pollutant Discharge Elimination System (NPDES) permit (see Sect. 3.3) are also sampled for radionuclides (Fig. 6). Parameters analyzed and the frequency of analysis are given in Table 7. Table 10 contains a summary of the concentrations for each of these locations during this quarter. The average concentration is expressed as a percentage of the DCG (when one exists) in the last column of this table.

No parameter average concentration exceeded 57% of its DCG. Average ^{137}Cs concentration at the Process Waste Treatment Plant (PWTP) (63 Bq/L) was at 57% of the DCG. The gross beta concentration (66 Bq/L) is likely the result of the ^{137}Cs . At MB1 the average concentrations for total strontium (15 Bq/L) and ^3H (28,000 Bq/L) were 41% and 38%, respectively, of the DCGs. All other radionuclide average concentrations at all sites were less than 30% of the DCGs. Os-191 was detected in a WOD sample for the first time.

The discharge of radioactive contaminants from ORNL is affected by the stream flows. Flows in MB (as measured at station MB1), WOC (as measured at the confluence of MB and at WOD), and the Clinch River (as measured at Melton Hill Dam) are given in Table 11. Clinch River flows are regulated by a series of TVA dams, one of which is Melton Hill Dam. The flow in Melton Branch is usually about one-third that of WOC. The ratio of WOC flow to Clinch River flow is also reported in Table 11. The average ratios given were calculated daily and averaged for the month. This ratio gives an indication of the dilution factor that is expected for potential contaminants entering the Clinch River from WOC. The ratio for the quarter ranged from 310 to 570.

Discharges of radioactivity into WOC at the STP; at the confluence of WOC and MB, at WOD, and into MB were calculated from concentration and flow. A single flow-proportional sample was obtained weekly at each of WOD, WOC, MB1, and STP stations and analyzed at monthly intervals. (WOD monthly analyses were done for ^3H and total strontium only.) The discharge during that period was calculated as the product of the flow-weighted concentration and the total flow for the sampling period (Tables 12-14). In addition, weekly flow-proportional samples were obtained at WOD and analyzed (for radionuclides other than ^3H and total strontium) at weekly intervals. The average concentration during the calendar month was calculated as a weighted sum of

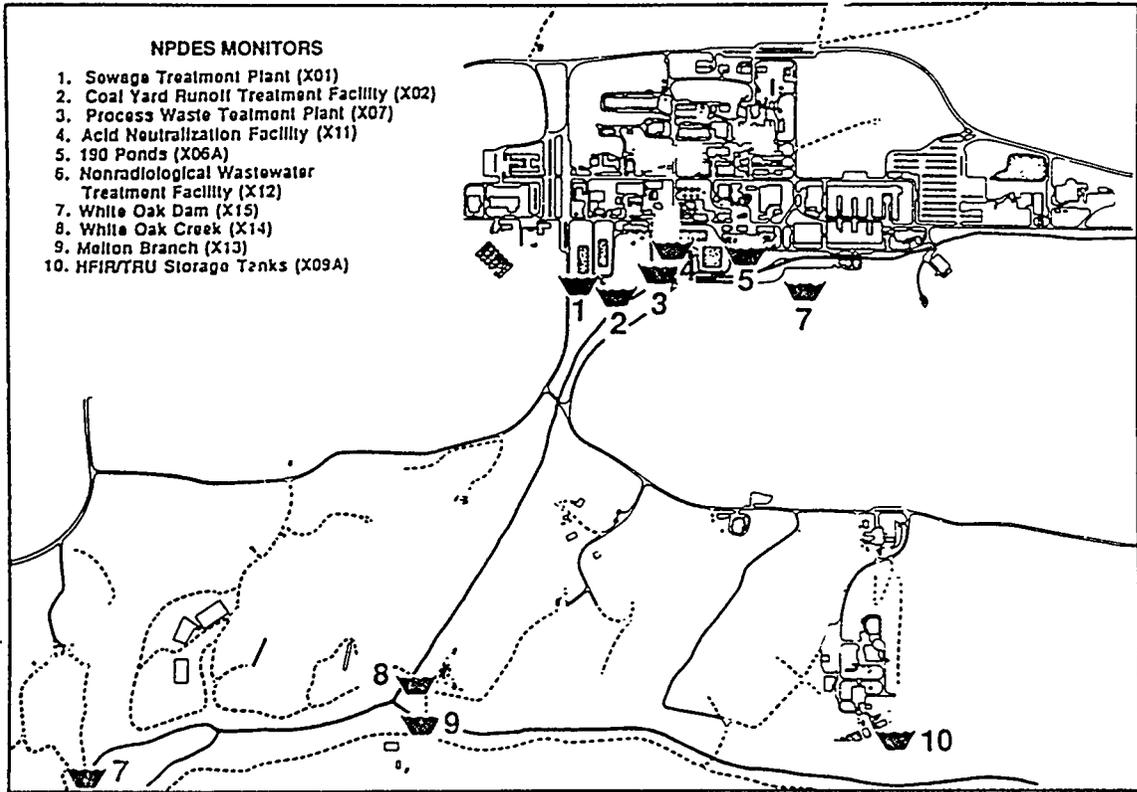


Fig. 6. Location map of ORNL NPDES and radioactivity sampling locations.

Table 10. Radionuclide concentrations at ORNL NPDES locations,^a
January-March 1990

Radionuclide	No. of samples	Concentration (Bq/L)					DCG ^d	Percentage of DCG ^e
		Max	Min	Av ^b	Standard error ^c			
Sewage Treatment Plant (X01)								
⁶⁰ Co	3	0.80	0.40	0.57*	0.12	190	0.30	
¹³⁷ Cs	3	0.40	-0.10	0.20	0.15	110	f	
Gross beta	3	17	11	14*	1.8	f	f	
Total Sr ^g	3	10	4.3	7.1*	1.6	37	19	
190 Ponds, 1500 Area and 2000 Area (X06A)								
⁶⁰ Co	2	0.90	0.70	0.80*	0.10	190	0.42	
¹³⁷ Cs	2	1.8	0.60	1.2	0.60	110	f	
Gross alpha	2	1.1	-0.080	0.51	0.59	f	f	
Gross beta	2	6.9	0.90	3.9	3.0	f	f	
Total Sr ^g	2	2.9	0.56	1.7	1.2	37	f	
Process Waste Treatment Plant (X07)								
⁶⁰ Co	3	6.5	0.90	3.2	1.7	190	f	
¹³⁷ Cs	3	76	47	63*	8.5	110	57	
Gross alpha	3	7.6	1.6	4.3	1.8	f	f	
Gross beta	3	73	56	66*	5.2	f	f	
Total Sr ^g	3	20	0.040	9.5	5.8	37	f	
TRU/TURF and HFIR Ponds (X09A)								
⁶⁰ Co	2	8.0	5.6	6.8	1.2	190	f	
¹³⁷ Cs	2	0.40	0.40	0.40*	0	110	0.36	
Gross alpha	2	0.90	0.010	0.46	0.45	f	f	
Gross beta	2	20	19	20*	0.50	f	f	
Total Sr ^g	2	0.56	0.14	0.35	0.21	37	f	

Table 10 (continued)

Radionuclide	No. of samples	Concentration (Bq/L)				Standard error ^c	DCG ^d	Percentage of DCG ^e
		Max	Min	Av ^b				
Acid Neutralization Facility (X11)								
Gross alpha	2	2.8	0.27	1.5	1.3	<i>f</i>	<i>f</i>	
Gross beta	2	2.9	0.70	1.8	1.1	<i>f</i>	<i>f</i>	
Nonradiological Waste Treatment Facility (X12)								
⁶⁰ Co	2	-0.30	-0.40	-0.35	0.050	190	<i>f</i>	
¹³⁷ Cs	2	42	24	33	9.0	110	<i>f</i>	
Gross alpha	2	0.32	0.26	0.29*	0.030	<i>f</i>	<i>f</i>	
Gross beta	2	26	22	24*	2.0	<i>f</i>	<i>f</i>	
Total Sr ^g	2	0.60	0.31	0.46	0.15	37	<i>f</i>	
³ H	2	990	710	850	140	74,000	<i>f</i>	
Melton Branch 1 (X13)								
⁶⁰ Co	3	1.8	-0.40	0.97	0.69	190	<i>f</i>	
¹³⁷ Cs	3	1.0	-0.90	-0.17	0.59	110	<i>f</i>	
Total Sr ^g	3	22	11	15*	3.5	37	41	
³ H	3	35,000	25,000	28,000*	3,300	74,000	38	
White Oak Creek (X14)								
⁶⁰ Co	3	1.0	-1.9	-0.17	0.88	190	<i>f</i>	
¹³⁷ Cs	3	2.3	0.80	1.5*	0.43	110	1.4	
Total Sr ^g	3	6.0	5.1	5.5*	0.26	37	15	
³ H	3	6,500	3,400	4,800*	910	74,000	6.5	

Table 10 (continued)

Radionuclide	No. of samples	Concentration (Bq/L)				Standard error ^c	DCG ^d	Percentage of DCG ^e
		Max	Min	Av ^b				
White Oak Dam (X15)								
⁶⁰ Co	13	0.58	0.050	0.26*	0.036	190	0.14	
¹³⁷ Cs	13	2.7	0.93	1.8*	0.15	110	1.6	
Gross alpha	13	0.69	-1.0	0.053	0.14	f	f	
Gross beta	13	24	9.2	17*	1.4	f	f	
¹⁹¹ Os	1	3.3	3.3	3.3*	f	f	f	
Total Sr ^g	3	9.3	5.2	7.7*	1.3	37	21	
³ H	3	10,000	9,200	9,700*	270	74,000	13	

^aLocations are shown in Fig. 6.

^bMean concentrations significantly greater than zero are identified by an asterisk (*).

^cStandard error of the mean.

^dDCG for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG, calculated only when a DCG exists and mean concentration is significantly greater than zero.

^fNot applicable.

^gTotal radioactive strontium (⁸⁹Sr + ⁹⁰Sr).

Table 11. Stream^a flows, January-March 1990

Flow (10 ⁹ L)					
Month	Melton Branch 1	White Oak Creek ^b	White Oak Dam ^c	Clinch River	Average ratio ^d
January	0.49	1.5	2.2	550	340
February	0.61	1.6	2.2	980	570
March	0.36	1.2	1.6	360	310

^aSee Fig. 4.

^bWhite Oak Creek at confluence of Melton Branch.

^cWhite Oak Creek at White Oak Dam.

^dFlow ratios Clinch River to White Oak Creek at White Oak Dam are calculated daily and averaged for the month.

Table 12. Radionuclide concentrations and releases at ORNL,^a January 1990

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percentage of DCG ^e
Melton Branch 1 (12/27-01/31)					
⁶⁰ Co	520	0.079	1.5*	190	0.79
¹³⁷ Cs	520	g	-0.60	110	g
Total Sr ^f	520	0.58	11*	37	30
³ H	520	1,300	25,000*	74,000	34
Sewage Treatment Plant (12/27-01/31)					
⁶⁰ Co	26	g	0.50	190	g
¹³⁷ Cs	26	g	-0.10	110	g
Gross beta	26	0.028	11*	g	g
Total Sr ^f	26	0.011	4.3*	37	12
White Oak Creek (12/27-01/31)					
⁶⁰ Co	1,500	g	1.0	190	g
¹³⁷ Cs	1,500	g	0.80	110	g
Total Sr ^f	1,500	0.85	5.5*	37	15
³ H	1,500	1,000	6,500*	74,000	8.8
White Oak Dam ^h (01/01-02/01)					
⁶⁰ Co	2,200	0.047	0.22*	190	0.12
¹³⁷ Cs	2,200	0.39	1.8*	110	1.6
Gross alpha	2,200	g	0.065	g	g
Gross beta	2,200	4.0	19*	g	g
¹⁹¹ Os	2,200	0.054	3.3*	g	g
White Oak Dam (12/27-01/31)					
Total Sr ^f	2,200	1.2	5.2*	37	14
³ H	2,200	2,200	10,000*	74,000	14

^aLocations are shown in Fig. 4.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an asterisk (*).

^dDCG for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG.

^fTotal radioactive strontium (⁸⁹Sr + ⁹⁰Sr).

^gNot applicable.

^hConcentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

Table 13. Radionuclide concentrations and releases at ORNL,^a February 1990

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percentage of DCG ^e
Melton Branch 1 (01/31-02/28)					
⁶⁰ Co	620	g	-0.40	190	g
¹³⁷ Cs	620	g	-0.90	110	g
Total Sr ^f	620	0.74	12*	37	32
³ H	620	1,500	25,000*	74,000	34
Sewage Treatment Plant (01/31-02/28)					
⁶⁰ Co	25	g	0.40	190	g
¹³⁷ Cs	25	g	0.30	110	g
Gross beta	25	0.043	17*	g	g
Total Sr ^f	25	0.025	10*	37	27
White Oak Creek (01/31-02/28)					
⁶⁰ Co	1,700	g	0.40	190	g
¹³⁷ Cs	1,700	g	1.5	110	g
Total Sr ^f	1,700	1.0	6.0*	37	16
³ H	1,700	750	4,500*	74,000	6.1
White Oak Dam ^h (02/01-03/01)					
⁶⁰ Co	2,200	0.048	0.22*	190	0.12
¹³⁷ Cs	2,200	0.48	2.2*	110	2.0
Gross alpha	2,200	g	0.12	g	g
Gross beta	2,200	4.5	20*	g	g
White Oak Dam (01/31-02/28)					
Total Sr ^f	2,300	1.9	8.5*	37	23
³ H	2,300	2,100	9,200*	74,000	12

^aLocations are shown in Fig. 4.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an asterisk (*).

^dDCG for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG.

^fTotal radioactive strontium (⁸⁹Sr + ⁹⁰Sr).

^gNot applicable.

^hConcentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

Table 14. Radionuclide concentrations and releases at ORNL,^a March 1990

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percentage of DCG ^e
Melton Branch 1 (02/28-03/28)					
⁶⁰ Co	350	0.063	1.8*	190	0.95
¹³⁷ Cs	350	g	1.0	110	g
Total Sr ^f	350	0.77	22*	37	59
³ H	350	1,200	35,000*	74,000	47
Sewage Treatment Plant (02/28-03/28)					
⁶⁰ Co	24	g	0.80	190	g
¹³⁷ Cs	24	g	0.40	110	g
Gross beta	24	0.032	13*	g	g
Total Sr ^f	24	0.017	6.9*	37	19
White Oak Creek (02/28-03/28)					
⁶⁰ Co	1,100	g	-1.9	190	g
¹³⁷ Cs	1,100	0.26	2.3*	110	2.1
Total Sr ^f	1,100	0.59	5.1*	37	14
³ H	1,100	390	3,400*	74,000	4.6
White Oak Dam ^h (03/01-04/01)					
⁶⁰ Co	1,600	0.047	0.30*	190	0.16
¹³⁷ Cs	1,600	0.23	1.5*	110	1.3
Gross alpha	1,600	g	-0.12	g	g
Gross beta	1,600	2.2	14*	g	g
White Oak Dam (02/28-03/28)					
Total Sr ^f	1,500	1.4	9.3*	37	25
³ H	1,500	1,500	10,000*	74,000	14

^aLocations are shown in Fig. 4.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an asterisk (*).

^dDCG for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG.

^fTotal radioactive strontium (⁸⁹Sr + ⁹⁰Sr).

^gNot applicable.

^hConcentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

all concentrations obtained for sampling periods overlapping the calendar month. The weights were proportional to the calendar period total flow attributable to the sampling periods. This average concentration was multiplied by the calendar month total flow to arrive at the discharge.

Each average flow-weighted concentration was compared with a corresponding DCG. Cobalt-60 and ^{137}Cs concentrations were less than 3% of the DCG. Percentages for total radioactive strontium and ^3H at MB1 are higher but less than 60% of the DCG. During this quarter, concentrations at MB1 ranged from 30 to 59% of the DCG for total radioactive strontium and from 34% to 47% of the DCG for ^3H . Total radioactive strontium and ^3H concentrations ranged respectively from 12 to 23% and 4.6 to 15% of the DCG at the other locations.

3.1.3 Trends

Radionuclide concentrations obtained during this quarter were compared with historical concentrations to assess trends. For the off-site stations Gallaher and Kingston, the concentrations have been fairly stable historically. The significant concentrations observed during this quarter are all lower than the 2-year maxima.

All radionuclide concentrations reported this quarter for MB1, WOC, and WOD are lower than past 2-year maxima. There is however evidence of seasonality in total radioactive strontium, a tendency for higher values in the winter and spring and lower values in the summer and fall. Total strontium concentrations at MB1 appear to have been increasing slightly over the past 2 years.

The concentration of ^3H at MB1 appears to be decreasing with time, whereas the levels at WOC and WOD have been fairly constant since the fall of 1989. Prior to then there was a clear seasonal trend at WOD, with higher values in the winter and spring and lower values in the summer and fall.

Cobalt-60 and ^{137}Cs concentrations appear to be stable, over time, at MB1, WOC, and WOD.

Total radioactive strontium concentrations in First Creek have decreased since 1988 (27 Bq/L average concentration in 1988 to 11 Bq/L in 1989) and exhibit a seasonal pattern with higher concentrations in the fall relative to the spring.

3.2 REFERENCE SURFACE WATERS

3.2.1 Program Description

Monthly surface water samples are collected at two sampling locations for the purpose of determining background contamination levels before the influence of ORNL. One sampling location is the Melton Hill Dam above ORNL's discharge point into the Clinch River (Fig. 4). The other sample location is WOC headwaters, above the point where ORNL discharges to WOC (Fig. 4). Analyses were performed to detect classical, inorganic, and organic pollutants in the

water. Classical pollutants are those indicated by conductivity, temperature, turbidity, pH, total dissolved solids, suspended solids, and oil and grease. Inorganic parameters are those indicated by metal and anion analysis. The presence of organic pollutants is based on the total organic carbon (TOC) analysis. If significant amounts of TOC are detected, a more complete organic analysis is performed.

The inorganics, oil and grease, and dissolved solids were collected flow-proportionally by a sampling station at each location. All other samples are grab samples taken once per month.

3.2.2 Results

The results for the classical, inorganic, and organic pollutants are found in Table 15. The column "percentage DWL" is included to show the average concentration as a percentage of the National Primary or Secondary Drinking Water Regulation level, where available. There were no high levels of organic compounds detected by the TOC analysis at either location, as indicated by the average value of 1.9 mg/L. Most inorganic compounds were also below the National Primary and Secondary Drinking Water regulation levels. Arsenic, cadmium, iron, magnesium, and selenium all show a high-percentage DWL. This is the result of high analytical detection limits for these analytes. The average concentration of manganese at Melton Hill Dam was found to be 232% of the National Secondary Drinking Water Limit, which is 0.05 mg/L. The average concentration of manganese at WOC was <649% of the DWL. The average concentration of iron at Melton Hill Dam was 185% of the National Secondary Drinking Water Limit, and at WOC this figure was <603%. Similarly, arsenic, selenium, and cadmium all show high values for DWL. Because the standard error of these averages are all high, the drinking water limits fall within 95% confidence intervals about the averages of the analytes. More samples would be required to determine if the DWLs for these elements have actually been exceeded.

Many of the inorganic analytical results show a wide range of detection limits. This results from a dilution that must be made to some of the water samples. When a given sample contains an element in a concentration that is higher than the inductively coupled plasma (ICP) equipment can accurately measure, this compound can cause a spectral interference with other elements. The sample must then be diluted to bring the interfering element into a range that the equipment can accurately measure. The resulting analytical values from the ICP process must be adjusted by the dilutions factor. This dilution factor must also be applied to the detection limit value for each element.

3.2.3 Trends

Current trends in the concentration of pollutants found at these reference locations are assessed by comparing the maximum and average values for the quarter, to the historic concentrations of these pollutants at the same locations for the last 2 years. In the current quarter barium and oil and grease values have exceeded the 2-year maximum at Melton Hill Dam. The barium

Table 15. Surface water analyses at reference locations, February-April 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error	Percent ^a DWL
		Max	Min	Av		
Melton Hill Dam						
Aluminum--total	3	1.5	<0.030	<0.63	0.44	
Antimony--total	3	<0.050	<0.050	<0.050	0	
Arsenic--total	3	<0.050	<0.050	<0.050	0	<100
Barium--total	3	0.071	0.029	0.045	0.013	4.4
Beryllium--total	3	<0.010	<0.00030	<0.0035	0.0032	
Boron--total	3	<0.080	<0.080	<0.080	0	
Cadmium--total	3	<0.020	<0.0040	<0.010	0.0049	<103
Calcium--total	3	39	35	36	1.3	
Chromium--total	3	<0.050	<0.0040	<0.019	0.015	<38
Cobalt--total	3	<0.0040	<0.0040	<0.0040	0	
Copper--total	3	<0.050	<0.0060	<0.021	0.015	<2.0
Dissolved solids--total	3	190	160	180	9.7	
Fluoride--total	3	<1.0	<1.0	<1.0	0	
Iron--total	3	1.3	0.098	0.56	0.38	185
Lead--total	3	<0.050	<0.030	<0.037	0.0067	<73
Lithium--total	3	<15	<15	<15	0	
Magnesium--total	3	10	8.7	9.4	0.38	
Manganese--total	3	0.27	0.011	0.12	0.079	232
Molybdenum--total	3	<0.040	<0.040	<0.040	0	
Nickel--total	3	<0.050	<0.0090	<0.026	0.012	
Nitrate	3	<5.0	<5.0	<5.0	0	<50
Oil and grease	3	11	<2.0	<5.0	3.0	
Organic carbon--total	3	3.3	1.9	2.5	0.41	
Oxygen--dissolved	3	12	9.0	9.9	0.85	
Phosphorus--total	3	<0.30	<0.30	<0.30	0	
Selenium--total	3	<0.050	<0.040	<0.043	0.0033	<433
Silicon--total	3	3.9	1.5	2.5	0.73	
Silver--total	3	<0.020	<0.0050	<0.010	0.0050	<20
Sodium--total	3	<5.0	4.2	<4.7	0.27	
Strontium--total	3	0.10	0.086	0.092	0.0041	
Sulfate (as SO ₄)	3	29	22	25	2.2	9.8
Suspended solids--total	3	22	<5.0	<11	5.7	
Tin--total	3	<0.050	<0.050	<0.050	0	
Titanium--total	3	0.022	<0.020	<0.021	0.00067	
Vanadium--total	3	<0.0040	<0.0040	<0.0040	0	

Table 15 (continued)

Parameter	No. of samples	Concentration (mg/L)			Standard error	Percent ^a DWL
		Max	Min	Av		
Zinc--total	3	<0.050	<0.0050	<0.024	0.014	<0.47
Zirconium--total	3	<0.020	<0.020	<0.020	0	
Conductivity, mS/cm	3	0.80	0.30	0.50	0.15	
Temperature, °C	3	10	8.0	9.4	0.70	
Turbidity, JTU	3	70	10	40	17	
pH, standard units	3	7.5	7.2	7.4	0.088	
White Oak Creek						
Aluminum--total	3	4.8	<0.030	<1.6	1.6	
Antimony--total	3	<0.050	<0.050	<0.050	0	
Arsenic--total	3	<0.050	<0.050	<0.050	0	<100
Barium--total	3	0.13	0.028	0.063	0.033	6.3
Beryllium--total	3	<0.010	<0.00030	<0.0035	0.0032	
Boron--total	3	<0.080	<0.080	<0.080	0	
Cadmium--total	3	<0.020	<0.0040	<0.010	0.0049	<103
Calcium--total	3	23	13	17	3.1	
Chromium--total	3	<0.050	<0.0040	<0.019	0.015	<38
Cobalt--total	3	0.0061	<0.0040	<0.0047	0.00070	
Copper--total	3	<0.050	<0.0050	<0.020	0.015	<2.0
Dissolved solids--total	3	78	67	71	3.4	
Fluoride--total	3	<1.0	<1.0	<1.0	0	
Iron--total	3	5.3	<0.010	<1.8	1.7	<603
Lead--total	3	<0.050	<0.030	<0.037	0.0067	<73
Lithium--total	3	<15	<15	<15	0	
Magnesium--total	3	9.9	6.3	7.7	1.1	
Manganese--total	3	0.97	<0.0020	<0.32	0.32	<649
Molybdenum--total	3	<0.040	<0.040	<0.040	0	
Nickel--total	3	<0.050	<0.0090	<0.026	0.012	
Nitrate	3	10	<5.0	<6.7	1.7	<66
Oil and grease	3	2.0	<2.0	<2.0	0	
Organic carbon--total	3	2.0	0.90	1.3	0.34	
Oxygen--dissolved	3	11	8.0	9.5	0.78	
Phosphorus--total	3	<0.30	<0.30	<0.30	0	
Selenium--total	3	<0.050	<0.040	<0.043	0.0033	<433
Silicon--total	3	8.4	3.2	5.0	1.7	
Silver--total	3	<0.020	<0.0050	<0.010	0.0050	<20

Table 15 (continued)

Parameter	No. of samples	Concentration (mg/L)			Standard error	Percent ^a DWL
		Max	Min	Av		
Sodium--total	3	<5.0	<2.0	<4.0	1.0	
Strontium--total	3	0.025	0.017	0.020	0.0025	
Sulfate (as SO ₄)	3	<5.0	<5.0	<5.0	0	<2.0
Suspended solids--total	3	340	<5.0	<120	110	
Tin--total	3	<0.050	<0.050	<0.050	0	
Titanium--total	3	0.045	<0.020	<0.028	0.0083	
Vanadium--total	3	0.0085	<0.0040	<0.0055	0.0015	
Zinc--total	3	<0.050	<0.0050	<0.031	0.014	<0.62
Zirconium--total	3	<0.020	<0.020	<0.020	0	
Conductivity, mS/cm	3	0.20	0.20	0.20	0	
Temperature, °C	3	12	10	11	0.44	
Turbidity, JTU	3	98	20	64	23	
pH, standard units	3	7.9	7.3	7.6	0.18	

^aAverage concentration as a percentage of National Primary or Secondary Drinking Water Regulation level.

^bSee Fig. 4.

concentration is within the standard error of the 2-year high and is not significantly different from that value. The oil and grease maximum value for Melton Hill Dam is higher than previous recorded values. The average values for these two parameters are greater than past average values. Aluminum, barium, and nitrate have exceeded the 2-year maximum value at the WOC reference location. However, all of these values are within the standard error of the 2-year maximum and do not represent a significant increase in concentration. Average values for these parameters remain at or below the 2-year average.

3.3 NPDES REQUIREMENTS

ORNL's current NPDES permit requires that point-source outfalls be sampled prior to their discharge into receiving waters or before mixing with any other wastewater stream. The NRWTP began operating in March 1990. The 190 ponds (X06A), PWTP (X07), HFIR ponds (X09A), and Acid Neutralization Facility (X11) discharges were rerouted to the NRWTP in February 1990. In addition, there are ambient sampling points that are located in the streams as reference points or for additional information. The Vehicle Cleaning Facility (VC7002) has been under investigation for some time. Effluent discharge from that facility was discontinued on March 8, 1990, pending resolution of the problem.

Quarterly summary statistics for the first quarter of 1990 are given for each sampling location in Tables 16 through 31. Monitoring of the 190 ponds (X06A), PWTP (X07), HFIR ponds (X09A), and Acid Neutralization Facility (X11) is no longer required because those discharges are now treated at the NRWTP. At the PWTP (X07), the maximum value reflected a prefix of B (Table 19), which represents the fact that TTO (total toxic organics) was found in the blank. Gross beta values greater than 30 Bq/L are not included in the summary tables and are listed individually in Table 32.

Data collected for the NPDES permit are also summarized monthly for reporting to DOE and the state of Tennessee. These summaries are submitted to DOE in the Monthly Discharge Monitoring Reports and are available upon request. Noncompliances are provided in Tables 33 through 35. A brief summary of the noncompliances follows.

3.3.1 January 1990

The exceedences at VC7002 and EF7002 are attributed to normal cleaning of vehicles and equipment conducted in that facility. The exceedences have been recognized as a compliance issue, and funding is being obtained to procure and install a more effective grease trap for that facility. This has been identified as a potential corrective measure. A letter has been submitted to the Tennessee Department of Health and Environment (TDHE) requesting that EF7002 be removed from ORNL's NPDES permit because it has been realized that EF7002 and VC7002 are in essence the same effluent.

Table 16. NPDES discharge point X01,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Ammonia (as N)	39	1.6	0.030	0.16	0.042
Biochemical oxygen demand	39	<5.0	<5.0	<5.0	0
Bromodichloromethane	3	<0.0050	<0.0050	<0.0050	0
Chlorine--total residual	39	0.48	<0.010	<0.25	0.017
Copper--total	3	0.0092	<0.0050	<0.0067	0.0013
Cyanide--total	3	<0.0020	<0.0020	<0.0020	0
Downstream pH, standard units	13	8.3	6.8	NA ^c	NA
Fecal coliform, col/100 mL ^d	39	65	<1.0	<1.5	1.1
Flow, Mgd	64	0.33	0.15	0.22	0.0049
Mercury--total	3	<0.00005	<0.00005	<0.00005	0
Oil and grease	39	3.0	<2.0	<2.1	0.036
Oxygen--dissolved	63	15	6.7	9.7	0.24
pH, standard units	13	8.1	6.6	NA	NA
Recoverable phenolics-total	3	<0.0010	<0.0010	<0.0010	0
Silver--total	3	<0.0050	<0.0050	<0.0050	0
Suspended solids-total	39	5.0	<5.0	<5.0	0
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Zinc--total	3	0.066	0.063	0.064	0.00088

^aSee Fig. 6.

^bStandard error of the mean.

^cNA = not applicable.

^dGeometric mean.

Table 17. NPDES discharge point X02,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic--total	13	0.62	<0.050	<0.24	0.053
Cadmium--total	13	<0.0070	<0.0040	<0.0063	0.00036
Chromium--total	13	0.029	<0.0040	<0.012	0.0026
Copper--total	13	<0.050	<0.0050	<0.013	0.0034
Downstream pH, standard units	63	8.3	6.6	NA ^c	NA
Flow, Mgd	63	0.31	0	0.044	0.0071
Iron--total	13	0.38	0.062	0.22	0.023
Lead--total	13	<0.050	<0.030	<0.033	0.0021
Manganese--total	13	0.066	<0.0020	<0.030	0.0051
Nickel--total	13	<0.020	<0.0090	<0.012	0.0014
Oil and grease	13	12	<2.0	<2.8	0.77
pH, standard units	63	8.5	6.1	NA	NA
Selenium--total	13	<0.040	<0.040	<0.040	0
Silver--total	13	0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	870	350	610	150
Suspended solids-total	13	9.0	<5.0	<5.9	0.38
Temperature, °C	63	20	6.4	11	0.40
Zinc--total	13	0.035	<0.0050	<0.018	0.0027

^aSee Fig. 6.

^bStandard error of the mean.

^cNA = not applicable.

Table 18. NPDES discharge point X06A,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic--total	3	<0.050	<0.050	<0.050	0
Cadmium--total	3	<0.0070	<0.0040	<0.0050	0.0010
Chromium--total	3	0.016	<0.0040	<0.0087	0.0037
Copper--total	3	0.046	0.011	0.024	0.011
Downstream pH, standard units	6	7.8	7.0	NA ^c	NA
Flow, Mgd	6	0.21	0.10	0.17	0.015
Iron--total	3	0.049	0.025	0.033	0.0078
Lead--total	3	<0.030	<0.030	<0.030	0
Mercury--total	3	0.00077	0.00063	0.00069	0.000042
Nickel--total	3	<0.020	<0.0090	<0.016	0.0037
Oil and grease	3	<2.0	<2.0	<2.0	0
Organic carbon--total	3	5.2	3.6	4.3	0.47
pH, standard units	6	8.3	6.2	NA	NA
Phosphorus--total	3	0.30	0.30	0.30	0
Selenium--total	3	<0.040	<0.040	<0.040	0
Silver--total	3	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	27	26	26	0.33
Suspended solids--total	3	<5.0	<5.0	<5.0	0
Temperature, °C	6	14	9.4	13	0.72
Zinc--total	3	0.17	0.10	0.13	0.022

^aSee Fig. 6.^bStandard error of the mean.^cNA = not applicable.

Table 19. NPDES discharge point X07,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic--total	3	<0.050	<0.050	<0.050	0
Cadmium--total	3	<0.0070	<0.0040	<0.0050	0.0010
Chromium--total	3	<0.0040	<0.0040	<0.0040	0
Copper--total	3	0.027	<0.0060	<0.018	0.0062
Downstream pH, standard units	6	7.7	7.1	NA ^c	NA
Flow, Mgd	27	0.25	0.022	0.11	0.012
Lead--total	3	<0.030	<0.030	<0.030	0
Nickel--total	3	<0.020	<0.0090	<0.016	0.0037
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	3	<2.0	<2.0	<2.0	0
Organic carbon--total	3	6.0	1.8	3.4	1.3
pH, standard units	6	7.9	7.0	NA	NA
Silver--total	3	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	240	160	200	23
Suspended solids--total	3	<5.0	<5.0	<5.0	0
Temperature, °C	6	18	12	14	0.82
Total toxic organics	3	B0.014 ^d	<0.010	<0.011	0.0013
Zinc--total	3	0.091	0.013	0.043	0.024

^aSee Fig. 6.

^bStandard error of the mean.

^cNA = not applicable.

^dB = TTO (Total toxic organics) found in blank.

Table 20. NPDES discharge point X09A,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic--total	8	<0.050	<0.050	<0.050	0
Cadmium--total	8	<0.0070	<0.0040	<0.0055	0.00057
Chromium--total	8	0.014	<0.0040	<0.0059	0.0013
Copper--total	8	0.064	0.041	0.053	0.0027
Downstream pH, standard units	8	8.1	7.4	NA ^c	NA
Flow, Mgd	8	0.0032	0.0017	0.0022	0.00018
Lead--total	8	<0.030	<0.030	<0.030	0
Nickel--total	8	<0.020	<0.0090	<0.015	0.0021
Nitrate	8	5.9	<5.0	<5.1	0.11
Oil and grease	8	2.0	<2.0	<2.0	0
Organic carbon--total	8	9.1	2.1	4.6	0.91
pH, standard units	8	8.2	6.9	NA	NA
Sulfate (as SO ₄)	8	34	24	30	1.2
Suspended solids--total	8	8.0	<5.0	<5.4	0.38
Temperature, °C	8	20	12	16	0.85
Zinc--total	8	0.16	0.065	0.11	0.010

^aSee Fig. 6.

^bStandard error of the mean.

^cNA = not applicable.

Table 21. NPDES discharge point X11,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic--total	4	0.19	0.067	0.13	0.027
Cadmium--total	4	<0.0070	<0.0040	<0.0055	0.00087
Chromium--total	4	0.029	<0.0040	<0.022	0.0059
Copper--total	4	0.024	0.012	0.017	0.0026
Downstream pH, standard units	9	8.0	7.2	NA ^c	NA
Flow, Mgd	2	0.032	0.019	0.026	0.0067
Lead--total	4	<0.030	<0.030	<0.030	0
Nickel--total	4	<0.020	<0.0090	<0.016	0.0026
Nitrate	9	<5.0	<5.0	<5.0	0
Oil and grease	4	<2.0	<2.0	<2.0	0
Organic carbon--total	9	9.3	0.70	3.6	0.95
pH, standard units	9	7.4	6.2	NA	NA
Phosphorus--total	4	3.1	0.70	1.6	0.54
Sulfate (as SO ₄)	9	2600	330	1800	240
Suspended solids--total	4	460	<5.0	<130	110
Temperature, °C	9	13	9.9	12	0.39
Zinc--total	4	1.3	0.24	0.76	0.23

^aSee Fig. 6.

^bStandard error of the mean.

^cNA = not applicable.

Table 22. NPDES discharge point X12,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
1,1-Dichloroethane	14	<0.0050	<0.0050	<0.0050	0
Arsenic--total	13	0.083	<0.050	<0.053	0.0025
Benzene	14	<0.0050	<0.0050	<0.0050	0
Biochemical oxygen demand	13	<5.0	<5.0	<5.0	0
Bromodichloromethane	14	<0.0050	<0.0050	<0.0050	0
Cadmium--total	13	<0.0070	<0.0040	<0.0063	0.00036
Chlorobenzene	14	<0.0050	<0.0050	<0.0050	0
Chloroform	14	<0.0050	<0.0050	<0.0050	0
Chromium--total	13	0.0096	<0.0040	<0.0048	0.00051
Copper--total	13	<0.050	<0.0050	<0.010	0.0034
Cyanide--total	13	<0.020	<0.0020	<0.0034	0.0014
Downstream pH, standard units	62	8.4	6.7	NA ^c	NA
Flow, Mgd	61	0.63	0.00050	0.37	0.019
Fluoride--total	13	2.1	1.0	1.1	0.084
Iron--total	13	3.2	<0.010	<0.30	0.24
Lead--total	13	<0.050	<0.030	<0.033	0.0021
Mercury--total	13	0.00010	<0.00005	<0.000064	0.0000057
Methylene chloride	14	-0.0020	-0.00050	-0.00096	0.000093
Nickel--total	13	0.020	<0.0090	<0.013	0.0014
Nitrate	13	12	<5.0	<6.5	0.70
Oil and grease	13	<2.0	<2.0	<2.0	0
pH, standard units	63	9.0	6.6	NA	NA
Phosphorus--total	13	4.3	<0.30	<0.88	0.31
Recoverable phenolics--total	13	<0.0010	<0.0010	<0.0010	0
Selenium--total	13	0.053	<0.040	<0.042	0.0012
Silver--total	13	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	13	1300	72	310	95
Suspended solids--total	13	38	<5.0	<7.5	2.5
Temperature, °C	63	20	8.1	14	0.40
Tetrachloroethene	14	<0.0050	<0.0050	<0.0050	0
Total toxic organics	13	0.25	<0.010	<0.038	0.019
Trichloroethene	14	<0.0050	<0.0050	<0.0050	0
Zinc--total	13	0.26	<0.0050	<0.031	0.019

^aSee Fig. 6.^bStandard error of the mean.^cNA = not applicable.

Table 23. NPDES discharge point X13,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Aluminum--total	3	4.8	0.70	2.1	1.4
Ammonia (as N)	3	0.044	0.030	0.035	0.0047
Arsenic--total	3	0.066	<0.050	<0.055	0.0053
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium--total	3	<0.0020	<0.0020	<0.0020	0
Chlorine--total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.0050	-0.0030	-0.0043	0.00067
Chromium--total	3	0.014	0.0043	0.0078	0.0031
Conductivity, mS/cm	3	0.90	0.26	0.69	0.21
Copper--total	3	0.0075	<0.0050	<0.0058	0.00083
Dissolved solids--total	3	170	130	150	14
Flow, Mgd	63	24	0.82	3.9	0.62
Fluoride--total	3	<1.0	<1.0	<1.0	0
Iron--total	3	3.9	0.45	1.7	1.1
Lead--total	3	<0.0040	<0.0040	<0.0040	0
Manganese--total	3	0.28	0.050	0.14	0.071
Mercury--total	3	<0.00005	<0.00005	<0.00005	0
Nickel--total	3	0.014	<0.0090	<0.011	0.0017
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	24	<2.0	<4.6	1.8
Organic carbon--total	3	5.6	2.0	3.6	1.1
Oxygen--dissolved	13	14	7.2	9.9	0.57
PCB--total	3	<0.00050	<0.00050	<0.00050	0
pH, standard units	3	8.2	7.3	NA ^c	NA
Phosphorus--total	3	<0.30	<0.10	<0.23	0.067
Recoverable phenolics--total	3	<0.0010	<0.0010	<0.0010	0
Silver--total	3	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	16	13	15	0.88
Suspended solids--total	3	120	<5.0	<43	38
Temperature, °C	16	15	5.7	9.2	0.57
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU ^d	3	110	80	97	8.8
Zinc--total	3	0.026	<0.0050	<0.012	0.0070

^aSee Fig. 6.

^bStandard error of the mean.

^cNA = not applicable.

^dMeasured in Jackson Turbidity Units.

Table 24. NPDES discharge point X14,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Aluminum--total	3	4.1	0.12	1.6	1.3
Ammonia (as N)	3	0.035	0.030	0.032	0.0017
Arsenic--total	3	<0.050	<0.050	<0.050	0
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium--total	3	<0.0020	<0.0020	<0.0020	0
Chlorine--total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.0050	<0.0050	<0.0050	0
Chromium--total	3	0.012	<0.0040	<0.0077	0.0023
Conductivity, mS/cm	3	1.0	0.27	0.69	0.22
Copper--total	3	0.013	<0.0050	<0.0077	0.0027
Dissolved solids--total	3	190	140	170	14
Flow, Mgd	63	44	5.0	12	0.88
Fluoride--total	3	1.0	<1.0	<1.0	0
Iron--total	3	3.3	0.15	1.3	1.0
Lead--total	3	<0.0040	<0.0040	<0.0040	0
Manganese--total	3	0.12	0.020	0.060	0.031
Mercury--total	3	<0.00005	<0.00005	<0.00005	0
Nickel--total	3	0.015	<0.0090	<0.011	0.0019
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	15	<2.0	<3.9	1.3
Organic carbon--total	3	4.4	1.6	3.1	0.81
Oxygen--dissolved	13	14	7.5	10	0.53
PCB--total	3	0.00060	<0.00050	<0.00053	0.000033
pH, standard units	3	8.1	7.6	NA ^c	NA
Phosphorus--total	3	<0.30	<0.10	<0.23	0.067
Recoverable phenolics--total	3	<0.0010	<0.0010	<0.0010	0
Silver--total	3	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	29	21	24	2.5
Suspended solids--total	3	140	<5.0	<51	43
Temperature, °C	16	16	8.3	12	0.54
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU ^d	3	40	30	37	3.3
Zinc--total	3	0.062	0.013	0.030	0.016

^aSee Fig. 6.^bStandard error of the mean.^cNA = not applicable.^dMeasured in Jackson Turbidity Units.

Table 25. NPDES discharge point X15,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Aluminum--total	3	1.4	0.61	0.90	0.25
Ammonia (as N)	3	0.074	0.030	0.051	0.013
Arsenic--total	3	<0.050	<0.050	<0.050	0
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium--total	3	<0.0020	<0.0020	<0.0020	0
Chlorine--total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.0050	<0.0050	<0.0050	0
Chromium--total	3	0.020	0.011	0.016	0.0027
Conductivity, mS/cm	3	1.4	0.26	0.82	0.33
Copper--total	3	0.012	0.0063	0.0089	0.0017
Dissolved solids--total	3	190	160	170	11
Flow, Mgd	63	100	6.4	16	1.9
Fluoride--total	3	<1.0	<1.0	<1.0	0
Iron--total	3	1.2	0.69	0.86	0.17
Lead--total	3	0.0070	<0.0040	<0.0057	0.00088
Manganese--total	3	0.12	0.065	0.090	0.016
Mercury--total	3	0.00008	<0.00005	<0.00006	0.00001
Nickel--total	3	<0.0090	<0.0090	<0.0090	0
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	18	<2.0	<4.6	1.4
Organic carbon--total	3	6.8	2.0	3.8	1.5
Oxygen--dissolved	13	15	6.2	9.9	0.77
PCB--total	3	<0.00050	<0.00050	<0.00050	0
pH, standard units	3	8.0	7.5	NA ^c	NA
Phosphorus--total	3	<0.30	0.20	0.27	0.033
Silver--total	3	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	45	21	30	7.7
Suspended solids--total	3	27	9.0	18	5.2
Temperature, °C	16	17	7.2	11	0.67
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU ^d	3	90	40	63	15
Zinc--total	3	0.027	0.015	0.023	0.0038

^aSee Fig. 6.^bStandard error of the mean.^cNA = not applicable.^dMeasured in Jackson Turbidity Units.

Table 26. NPDES miscellaneous source VC7002,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Biochemical oxygen demand	2	1200	73	620	550
Fecal coliform, col/100 mL	2	>6000	>600	>3300	2700
Flow, Mgd	47	0.00056	0	0.000086	0.000015
Oil and grease	2	210	160	180	22
Recoverable phenolics--total	2	0.24	0.21	0.23	0.015
Suspended solids--total	2	3300	2400	2800	440
pH, standard units	2	7.0	6.7	NA ^c	NA

^aVehicle and Equipment Cleaning Facility, Building 7002.

^bStandard error of the mean.

^cNA = not applicable.

Table 27. NPDES cooling towers,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Chlorine--total residual	8	1.7	<0.010	<0.23	0.21
Chromium--total	8	0.072	0.0088	0.023	0.0074
Copper--total	8	0.18	<0.0060	<0.064	0.020
Downstream pH, standard units	7	8.3	7.5	NA ^c	NA
Flow, Mgd	8	0.18	0.0033	0.030	0.022
pH, standard units	8	8.6	7.0	NA	NA
Temperature, °C	8	25	14	19	1.2
Zinc--total	8	1.9	0.16	0.55	0.20

^aORNL.^bStandard error of the mean.^cNA = not applicable.

Table 28. NPDES miscellaneous outfalls,
January-March 1990

Parameter	Concentration (mg/L)	
	EF7002 ^a	SP2519 ^b
Flow, Mgd		0.0042
Oil and grease	590	
pH, standard units	11	10
Temperature, °C		24

^aVehicle and Equipment Maintenance Facility,
Building 7002.

^bCentral Steam Plant, Building 2519.

Table 29. NPDES discharge point category I outfalls,^a January-March 1990

Parameter	No. samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Downstream pH, standard units	17	8.1	7.3	NA ^c	NA
Flow, Mgd	17	0.14	0.00029	0.026	0.0098
Gross beta, Bq/L	19	2.8	-1.4	0.27	0.23
Oil and grease	15	53	<2.0	<16	4.0
Suspended solids-total	15	1100	<5.0	<110	73
Temperature, °C	17	17	11	14	0.43
pH, standard units	17	8.1	6.8	NA	NA

^aORNL.^bStandard error of the mean.^cNA = not applicable.

Table 30. NPDES discharge point category II outfalls,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Downstream pH, standard units	47	8.5	7.2	NA ^c	NA
Flow, Mgd	51	1.0	0.000086	0.078	0.022
Gross beta, Bq/L	57/60	6.5	-1.0	0.58 ^d	0.17
Oil and grease	42	44	<2.0	<8.4	1.5
Suspended solids-total	42	290	<5.0	<29	8.0
Temperature, °C	51	61	11	17	1.0
pH, standard units	51	8.3	6.8	NA	NA

^aORNL.^bStandard error of the mean.^cNA = not applicable.^dAverage is statistically significantly different than zero.

Table 31. NPDES discharge point category III outfalls,^a January-March 1990

Parameter	No. of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Flow, Mgd	19	1.2	0.00055	0.096	0.064
pH, standard units	19	8.2	7.6	NA ^c	NA

^aORNL.^bStandard error of the mean.^cNA = not applicable.

Table 32. Gross beta exceeding 30 Bq/L

Station	Value	Units	Date
204	540	Bq/L	20FEB90
	71	Bq/L	08MAR90
	68	Bq/L	08MAR90

Table 33. NPDES noncompliances, January 1990

Station	Parameter	Permit limit (mg/L)	Daily maximum concentration (mg/L)
Cooling Systems (CS2535)	Chlorine	0.2	1.7
Cooling Systems (CS3517-3)	Zinc	1.0	1.9
Equipment Maintenance Facility (EF7002)	pH, standard units	9.0	11
	Oil and grease	15	588
Steam Plant (SP2519)	pH, standard units	9.0	10
Vehicle Cleaning Facility (VC7002)	Biological oxygen demand	45	73
	Fecal coliform (col/100 mL)	200	>6000
	Oil and grease	15	163
	Total suspended solids	40	3270

Table 34. NPDES noncompliances, February 1990

Station	Parameter	Permit limit (mg/L)	Daily maximum concentration (mg/L)
Category I	Oil and grease	15	53
Outfall 109	Total suspended solids	50	1087
Category I	Oil and grease	15	21
Outfall 110	Total suspended solids	50	59
Category I	Oil and grease	15	21
Outfall 112			
Category I	Oil and grease	15	45
Outfall 114	Total suspended solids	50	350
Category I	Total suspended solids	50	79
Outfall 115			
Category I	Oil and grease	15	19
Outfall 170			
Category I	Oil and grease	15	26
Outfall 173			
Category II	Total suspended solids	50	182
Outfall 203			
Category II	Oil and grease	15	21
Outfall 216			
Category II	Oil and grease	15	16
Outfall 233			
Category II	Oil and grease	15	16
Outfall 234			
Category II	Oil and grease	15	17
Outfall 247			
Category II	Oil and grease	15	44
Outfall 250			
Category II	Total suspended solids	50	58
Outfall 268			

Table 34 (continued)

Station	Parameter	Permit limit (mg/L)	Daily maximum concentration (mg/L)
Category II Outfall 283	Total suspended solids	50	76
Vehicle Cleaning Facility (VC7002)	Biological oxygen demand	45	1170
	Fecal coliform (col/100 mL)	200	>600
	Oil and grease	15	206
	Total suspended solids	40	2400

Table 35. NPDES noncompliances, March 1990

Station	Parameter	Permit limit (mg/L)	Daily maximum concentration (mg/L)
Category II Outfall 214	Oil and grease	15	17
Category II Outfall 223	Oil and grease	15	20
Category II Outfall 224	Oil and grease	15	39
	Total suspended solids	50	290
Category II Outfall 244	Oil and grease	15	18
	Total suspended solids	50	79

The metals exceedences at the cooling towers are attributed to corrosion of tower piping and other components. An Energy Systems Quality Event Report (QER) is in progress to investigate the situation in greater detail.

The chlorine exceedence was due to a cooling tower blowdown valve having been left open during disinfectant addition due to construction in the area of the tower. The result was a temporary excessive level of chlorine in the tower's blowdown effluent. A QER was filed to address this issue.

The pH exceedence at SP2519 is a recurring situation that has been addressed in a letter to the TDHE requesting permit modification. Because the discharge is not found to violate water quality standards in the receiving stream, a permit condition for that outfall, it has been requested that the permit limits be waived. No TDHE response has been received.

3.3.2 February 1990

Several exceedences of ORNL NPDES Permit limits for total suspended solids and oil and grease were monitored at category I and category II outfalls. These exceedences are experienced during most precipitation events. A request for a permit modification was submitted to DOE for concurrence and subsequent transmittal to the TDHE. This request is based upon no significant observed impact on water quality of surface streams as a result of total suspended solids or oil and grease influent during precipitation events. The request also reflects ORNL's active approach toward best management practices (BMPs) to minimize pollution of surface streams via precipitation runoff, and the fact that some limit exceedences may occur even under the best of conditions.

The NPDES limit exceedences at the ORNL Vehicle and Equipment Cleaning Facility (VC7002) have been under investigation for some time. Effluent discharge from that facility was discontinued on March 8, 1990, pending resolution of the problem. Alternatives currently being evaluated include installing a more effective grease trap and/or oil separator, possibly as a pretreatment mechanism for subsequent feed to the ORNL Sewage Treatment Plant.

3.3.2 March 1990

The permit limit exceedences that were noted in March 1990 occurred at four outfalls, which discharge primarily stormwater runoff from streets, steam condensate, and roof drainage to receiving streams. Most of the exceedences were slightly above permit limits and are attributed to the routine conveyance of accumulated dust, debris, and oil residue via stormwater.

Two of the subject outfalls, 214 and 223, are being evaluated as to appropriate cleanout or stabilization measures that may result in decreased concentrations of total suspended solids or oil and grease from these outfalls. The other two outfalls, 224 and 244, will be improved as part of an ORNL engineering project that is being developed to upgrade some ORNL drain pipes and outfalls. As part of normal practice, BMPs are developed and

implemented at ORNL to protect storm drain outfalls from pollutants during ORNL operations.

3.4 PCBs IN THE AQUATIC ENVIRONMENT

3.4.1 Program Description

Water samples were collected from various locations along WOC, MB, Northwest tributary (NWT) and the Clinch River (CR) to determine PCB concentrations in these areas (Fig. 7). A total of 12 sites were sampled; 8 on WOC (including 1 at WOD), 1 on MB, 1 on the NWT and 2 on the Clinch River. Two samples per site were taken for water during January through March 1990. This was done to comply with the Clean Water Act (CWA) and is an integral part of ORNL's NPDES activities. Water samples are being analyzed quarterly for aroclors 1016, 1221, 1232, 1242, 1248, 1254 and 1260. Sediment samples are being analyzed for the same aroclors semiannually. The EPA acute criteria for the protection of fish and aquatic life are 2 $\mu\text{g/L}$ for PCBs.

Water samples were taken by the manual grab method and placed in amber glass containers. The samples were cooled to 4°C; the water samples can be held for a maximum of 7 d before extraction. The samples were analyzed by a gas chromatographic procedure and measured by an electron capture detector. This provides a method to determine individual aroclors and total PCB content. The results from these samples will be used to help detect sources of PCB contamination and provide a history of PCB concentrations in the ORNL area.

3.4.2 Results

The concentrations of PCB in water during January through March 1990 were below the analytical quantitation limit at all sampling sites (Table 36), except for a few positive results at stations 1, 4, 5, 8, 9, and 14. Analyses were performed for seven aroclors of PCB; all except a few were below the quantitation limit. The quantitation limit for PCB aroclors 1016, 1221, 1232, 1242, and 1248 is 0.6 $\mu\text{g/L}$. The quantitation limit for PCB aroclors 1254 and 1260 is 1.1 $\mu\text{g/L}$. Some samples (1, 4, 5, 8, 9, and 14) showed indications of higher values due to contamination of the sample. Blanks that were processed with these samples showed the same quantity of the same aroclor. Samples associated with these contaminated blanks show indication of higher PCB values because of similar contamination of the sample. This contamination was traced to the glass-cleaning procedure in the organic preparations laboratory and has been corrected. These data are reported at face value, but should be regarded as suspect.

3.4.3 Trends

Current trends in the concentration of PCB found at these sites are assessed by comparing the maximum and average values for the quarter to the concentration of PCB at the same locations for the last 2 years. In the current quarter aroclors 1016, 1242, and 1248 showed increases at stations 1, 4, 5, 8, 9, and 14 in the maximum concentrations. These have been linked to

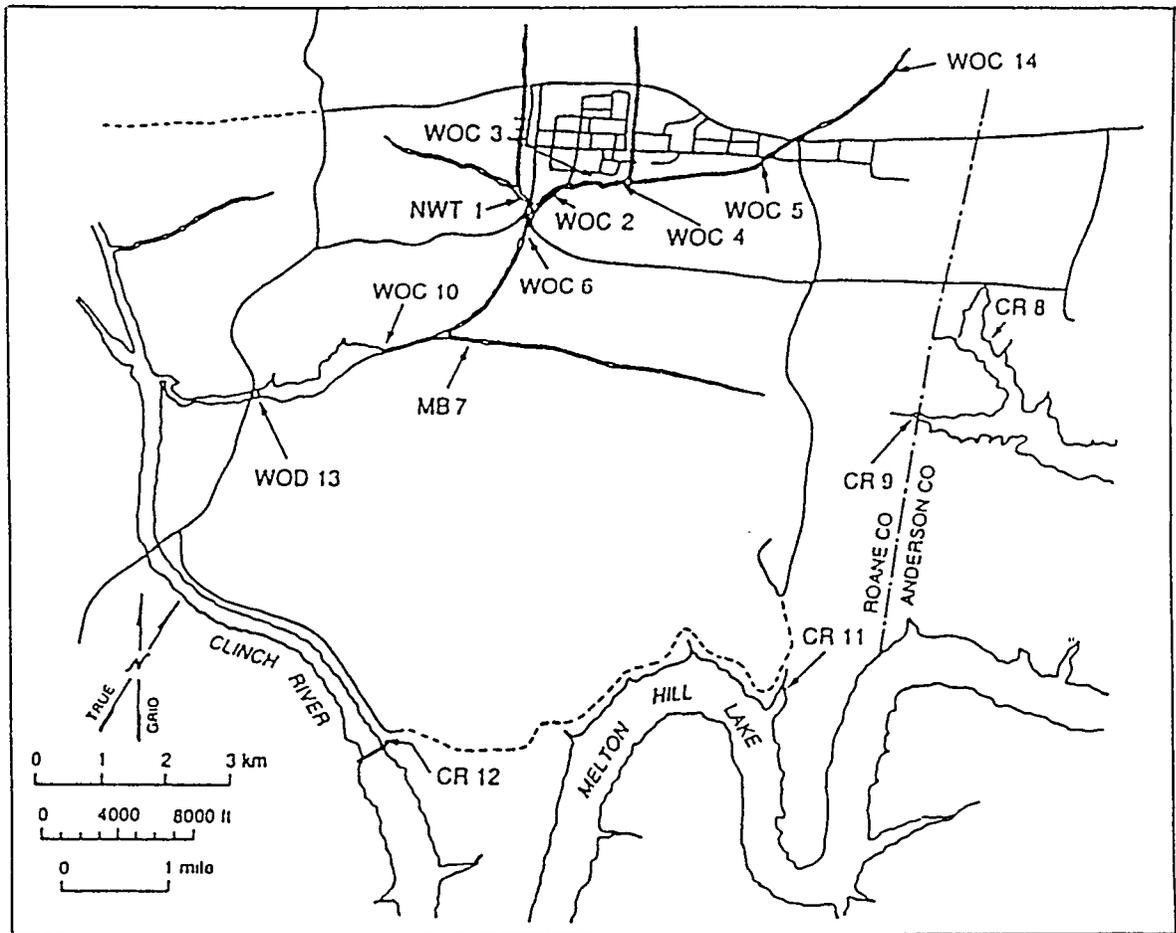


Fig. 7. Location map of PCB sampling points.

Table 36. Concentration of PCB in water, January-March 1990

Location ^a	Analysis	No. of samples	Concentration ($\mu\text{g/L}$)			Standard error ^b
			Max	Min	Av	
01	AROCLOR-1016	2	<0.60	<0.60	<0.60	0
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242 ^c	2	2.1	<0.60	<1.4	0.75
	AROCLOR-1248	2	<0.60	<0.60	<0.60	0
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0
02	AROCLOR-1016	2	<0.60	<0.60	<0.60	0
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242	2	<0.60	<0.60	<0.60	0
	AROCLOR-1248	2	<0.60	<0.60	<0.60	0
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0
03	AROCLOR-1016	2	<0.60	<0.60	<0.60	0
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242	2	<0.60	<0.60	<0.60	0
	AROCLOR-1248	2	<0.60	<0.60	<0.60	0
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0
04	AROCLOR-1016	2	<0.60	<0.60	<0.60	0
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242	2	<0.60	<0.60	<0.60	0
	AROCLOR-1248 ^c	2	2.6	2.0	2.3	0.32
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0
05	AROCLOR-1016	2	<0.60	<0.60	<0.60	0
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242	2	<0.60	<0.60	<0.60	0
	AROCLOR-1248 ^c	2	2.9	1.3	2.1	0.77
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0

Table 36 (continued)

Location ^a	Analysis	No. of samples	Concentration ($\mu\text{g/L}$)			Standard error ^b
			Max	Min	Av	
06	AROCLOR-1016	2	<0.60	<0.60	<0.60	0
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242	2	<0.60	<0.60	<0.60	0
	AROCLOR-1248	2	<0.60	<0.60	<0.60	0
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0
07	AROCLOR-1016	2	<0.60	<0.60	<0.60	0
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242	2	<0.60	<0.60	<0.60	0
	AROCLOR-1248	2	<0.60	<0.60	<0.60	0
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0
08	AROCLOR-1016 ^c	2	0.98	<0.60	<0.79	0.19
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242	2	<0.60	<0.60	<0.60	0
	AROCLOR-1248	2	<0.60	<0.60	<0.60	0
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0
09	AROCLOR-1016 ^c	2	-0.59	-0.13	-0.36	0.23
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242	2	<0.60	<0.60	<0.60	0
	AROCLOR-1248	2	<0.60	<0.60	<0.60	0
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0
10	AROCLOR-1016	2	<0.60	<0.60	<0.60	0
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242	2	<0.60	<0.60	<0.60	0
	AROCLOR-1248	2	<0.60	<0.60	<0.60	0
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0

Table 36 (continued)

Location ^a	Analysis	No. of samples	Concentration ($\mu\text{g/L}$)			Standard error ^b
			Max	Min	Av	
13	AROCLOR-1016	2	<0.60	<0.60	<0.60	0
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242	2	<0.60	<0.60	<0.60	0
	AROCLOR-1248	2	<0.60	<0.60	<0.60	0
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0
14	AROCLOR-1016 ^c	2	0.80	<0.60	<0.70	0.10
	AROCLOR-1221	2	<0.60	<0.60	<0.60	0
	AROCLOR-1232	2	<0.60	<0.60	<0.60	0
	AROCLOR-1242	2	<0.60	<0.60	<0.60	0
	AROCLOR-1248	2	<0.60	<0.60	<0.60	0
	AROCLOR-1254	2	<1.1	<1.1	<1.1	0
	AROCLOR-1260	2	<1.1	<1.1	<1.1	0

^aSee Fig. 7.

^bStandard deviation of the mean.

^cBlanks associated with these samples were contaminated.

blank contamination and do not appear to be a trend toward higher PCB values. All other values remain within the distribution of maximum and average values for the last 2 years.

4. METEOROLOGICAL PROCESSES

Meteorological processes are continuously monitored at ORNL so that current weather conditions may be taken into account, as needed, in response to emergencies that may arise. Weather records are also kept for climatological studies and for supportive information in hydrologic modeling and monitoring, facility design, scheduling of construction activities, and interpretation of nonmeteorological data (e.g., total suspended solids in surface water) that may depend on recent weather conditions.

4.1 WIND

4.1.1 Program Description

The ORNL wind tower network consists of towers A and B, each with sensors mounted at 10 and 30 m, and tower C with sensors mounted at 10, 30, and 100 m. Locations of these towers are shown in Fig. 8. Data from the sensors are acquired, stored, edited, and formatted by a data collection system consisting of a central processor and remote data logger. One-minute vector averages of wind velocity are calculated in the conventional way and retained 24 h. These velocities are processed into 15-min averages using a procedure that avoids the unrealistically low windspeed values obtained when appreciable winds of nearly opposite direction are vector-averaged in the conventional way. This alternative averaging procedure involves calculating a unit vector to represent the direction of each 1-min wind velocity, finding the vector average of those unit vectors, scaling that average to a unit vector, and multiplying the result by the mean (scalar) windspeed. A similar calculation is used to convert the 15-min averages into hourly averages. The 15-min averages are retained for 1 d, and the hourly averages are stored for at least 1 year and eventually archived.

4.1.2 Results

The hourly averages are used to generate wind roses (Figs. 9-14) for the quarter. Examination of these quarterly wind roses reveals that the prevailing winds are almost equally split into two general directions that are 180° apart: one prevailing direction is from the southwest to west-southwest sector, and the other prevailing direction is from the northeast to east-northeast sector. The winds are strongly aligned along these directions because of the channeling effect induced by the ridge and valley structure of the area. This channeling effect is least evident at 100-m elevation, where the winds are more south-southwesterly. Another feature observed from the wind roses is that the wind speeds increase with height (tower level) at each of the towers. On the average, the wind speeds can be expected to increase steadily from ground level to 30 m. The wind rose for the 100-m level of tower C could not be generated due to failure of a sensor during the quarter. The problem was corrected during the second quarter of 1990.

ORNL-DWG 86-9142R4

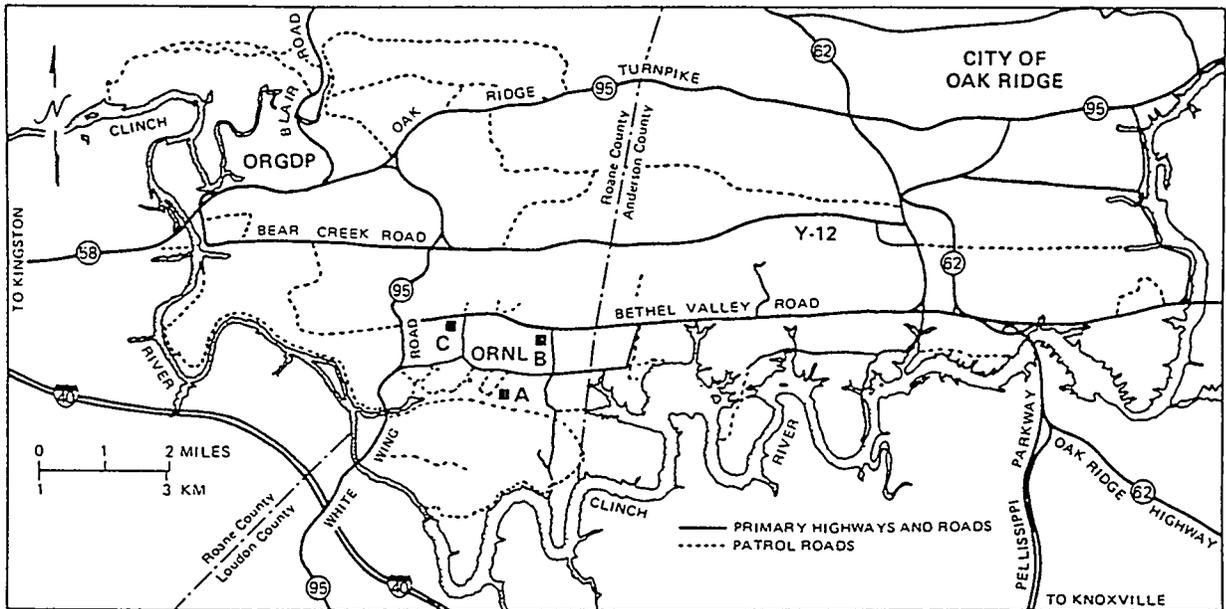


Fig. 8. Location map of meteorological towers at ORNL.

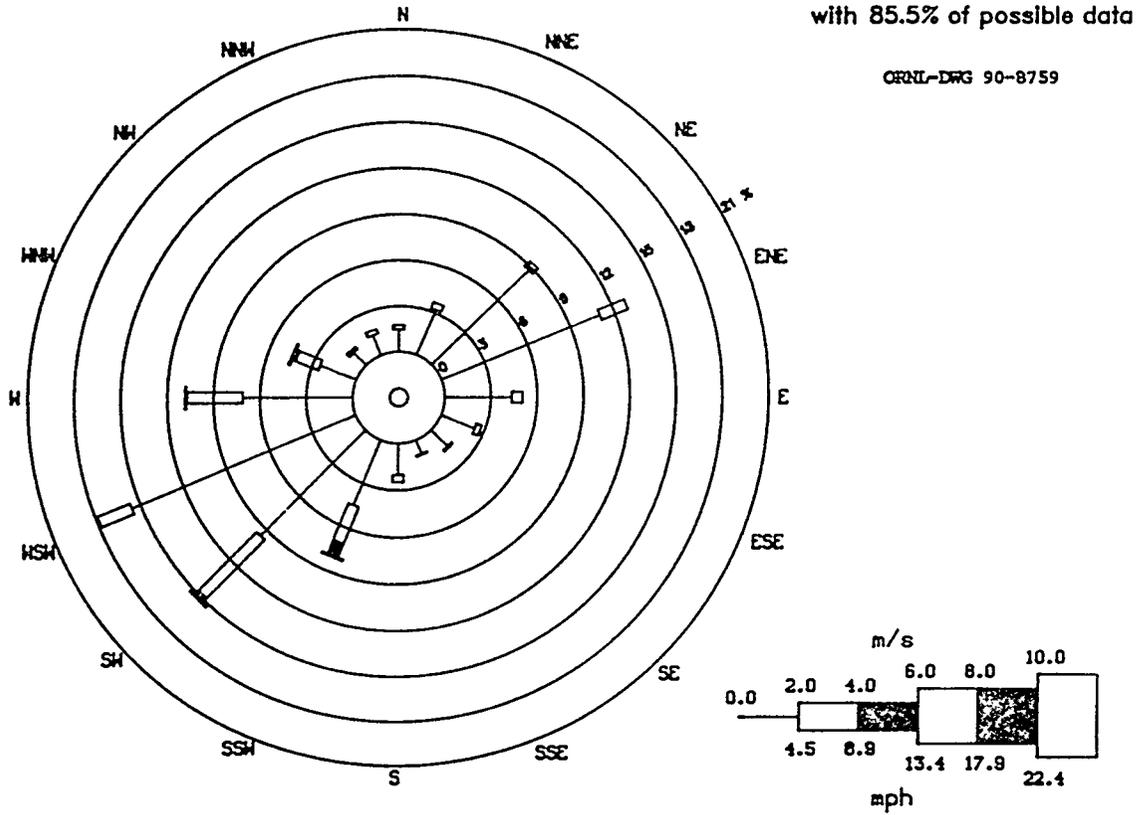


Fig. 9. Wind rose at 10-m level of meteorological tower A, January-March 1990.

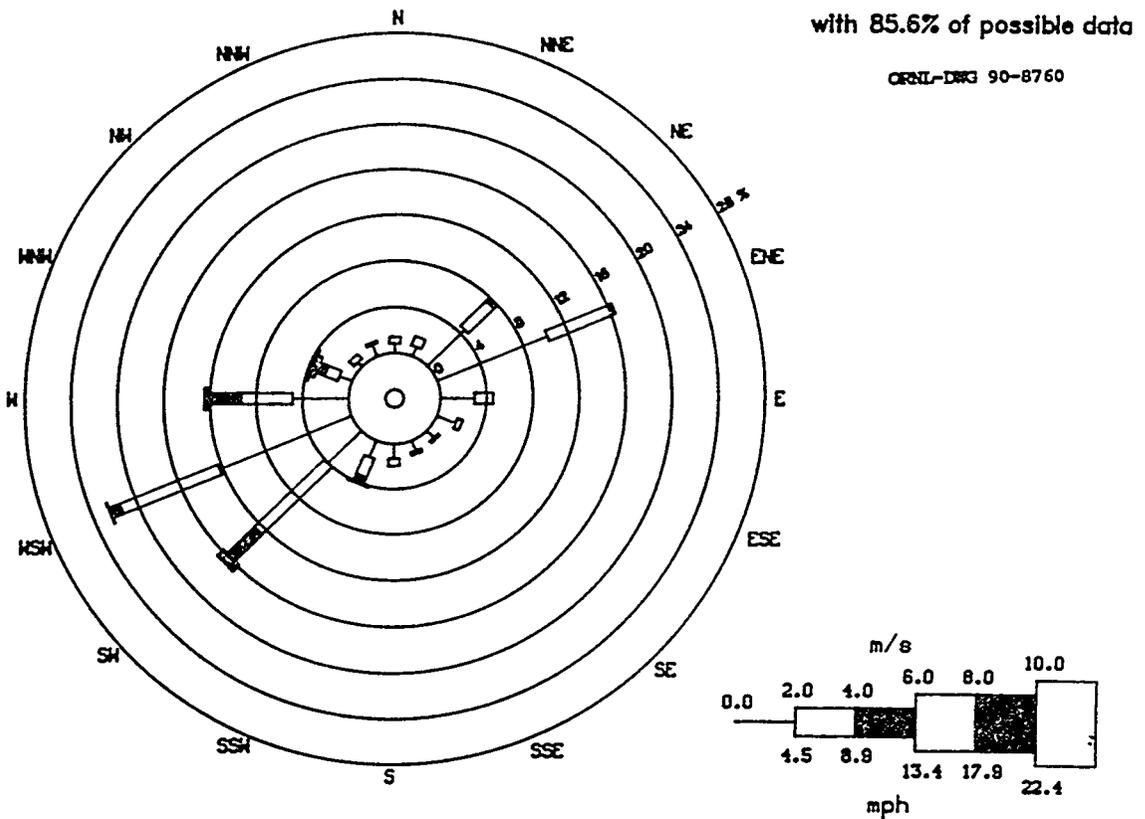


Fig. 10. Wind rose at 30-m level of meteorological tower A, January-March 1990.

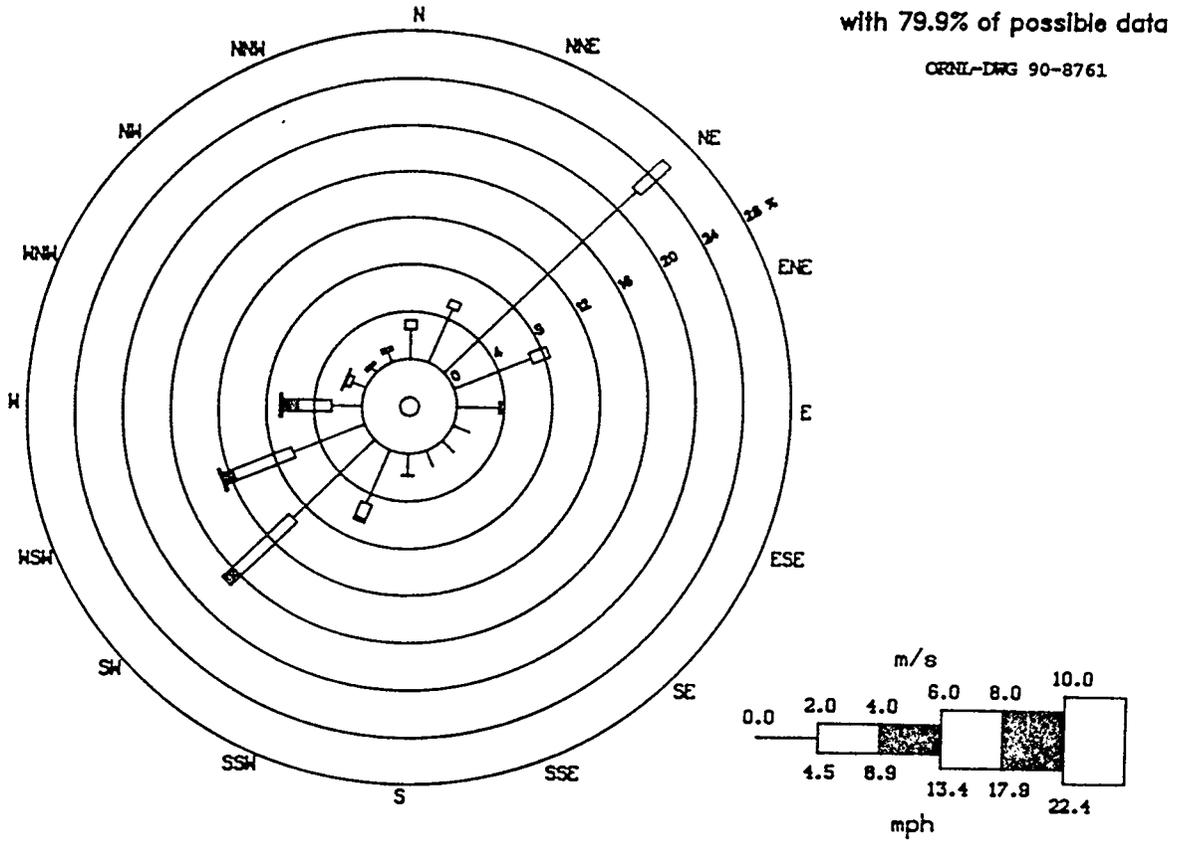


Fig. 11. Wind rose at 10-m level of meteorological tower B, January-March 1990.

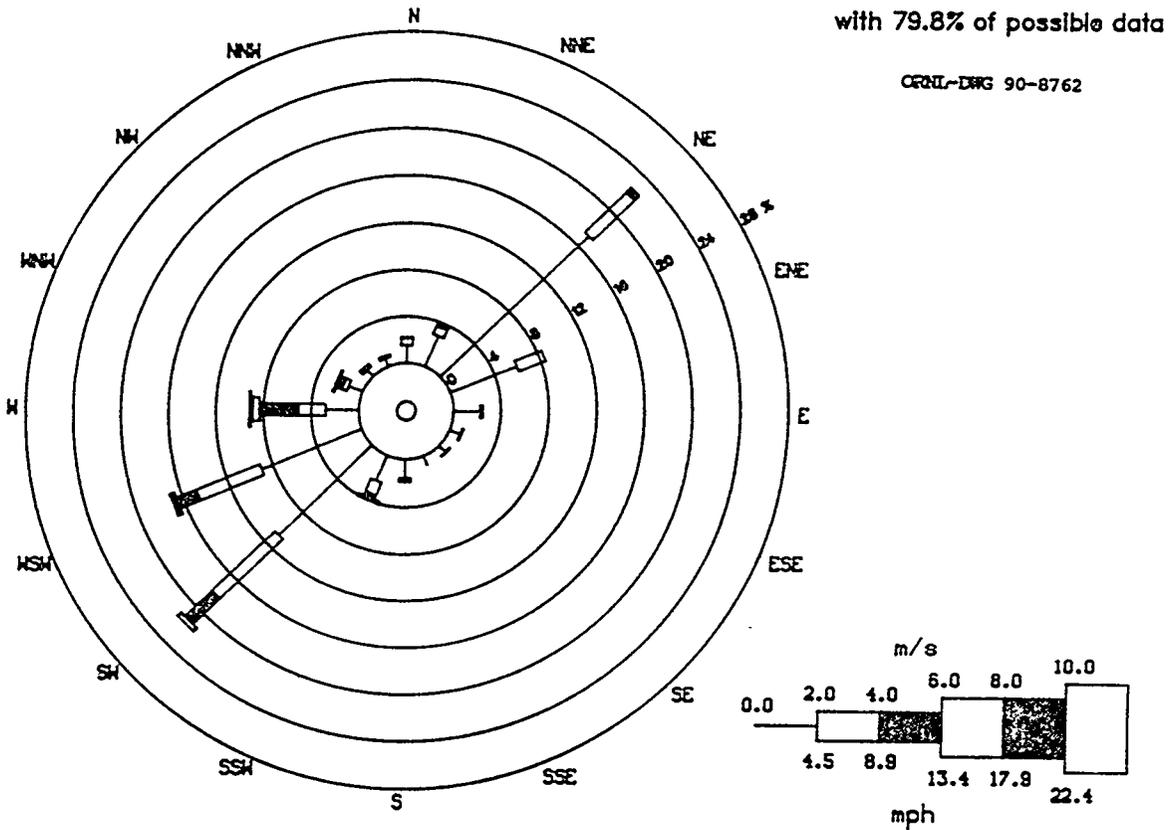


Fig. 12. Wind rose at 30-m level of meteorological tower B, January-March 1990.

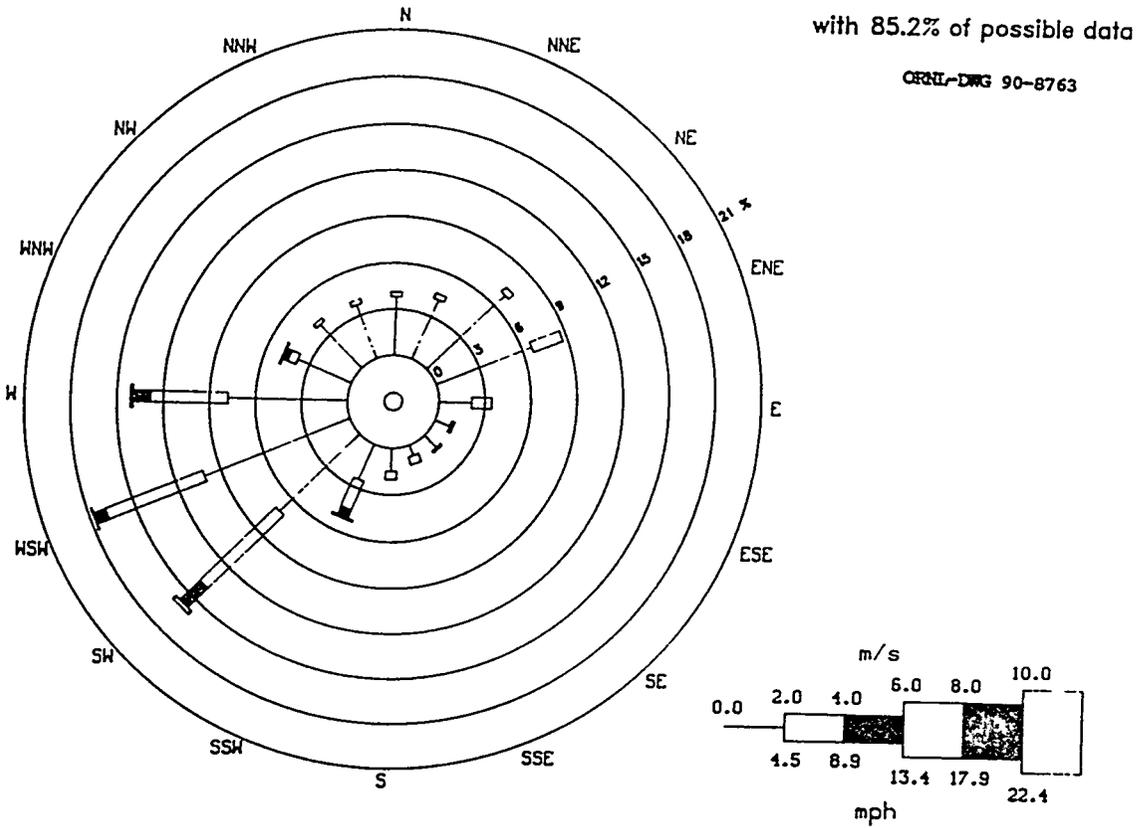


Fig. 13. Wind rose at 10-m level of meteorological tower C, January-March 1990.

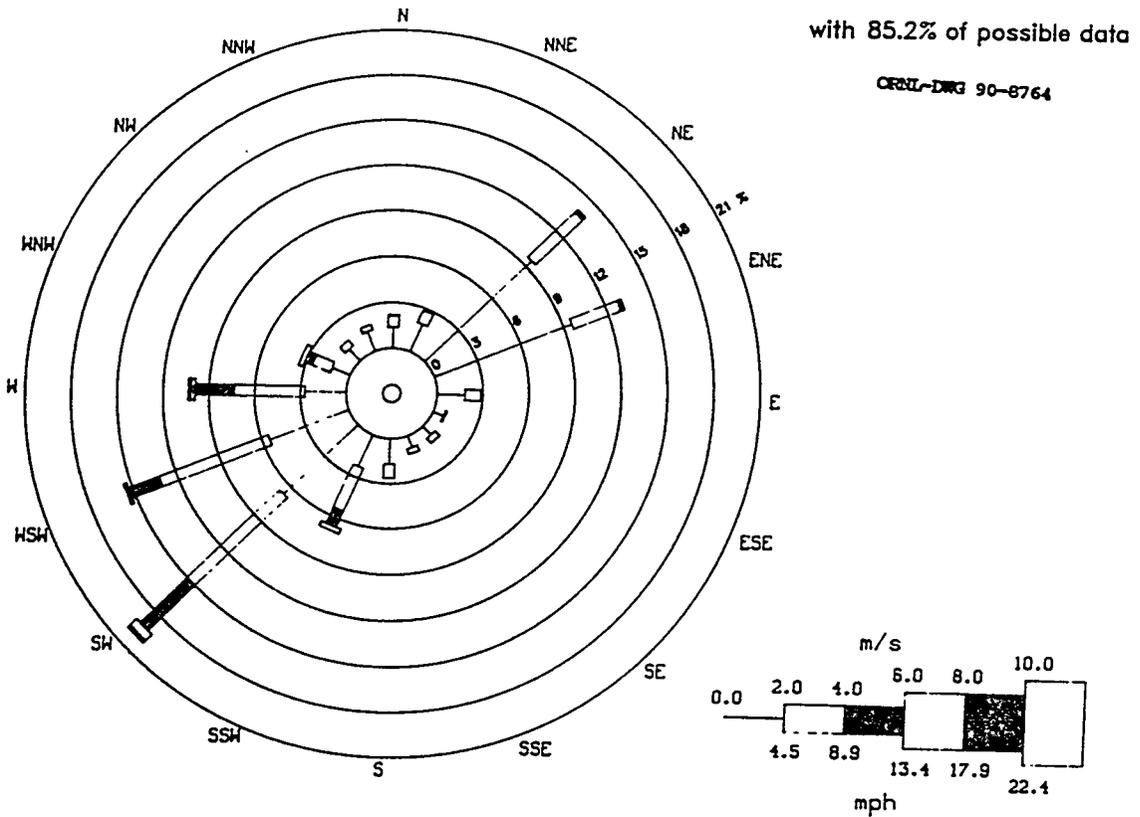


Fig. 14. Wind rose at 30-m level of meteorological tower C, January-March 1990.

4.1.3 Trends

An examination of the wind roses generated for the previous quarters have shown a consistency in results. This is due primarily to the static locations of the meteorological towers and the virtually unchanging topology of the land. These findings are consistent with expectations.

5. BIOLOGICAL MONITORING

The environmental surveillance programs include biotic and abiotic environments that may be affected by the releases from the Oak Ridge DOE facilities or may provide pathways of exposure to people. Biological monitoring consists of milk samples that are analyzed for radionuclides and nonradioactive chemicals.

Milk is a potentially significant pathway for the transfer of radionuclides from their point of release to humans because of the relatively large surface area that can be grazed daily by the cow, the rapid transfer of milk from producer to consumer, and the importance of milk in the diet. Strontium-90 and ^{131}I are radionuclides that are especially important in this atmosphere-to-pasture-to-cow-to-milk food chain. The milk samples are collected biweekly, except for May through September, during which the samples are collected monthly.

5.1 MILK

5.1.1 Program Description

Raw milk from five locations, including one dairy, within a radius of 80 km of Oak Ridge, is monitored for ^{131}I and total radioactive strontium. Samples are collected each month from the stations located near the Oak Ridge area (Fig. 15). Samples are analyzed for ^{131}I by gamma spectroscopy and for total radioactive strontium by chemical separation and low-level beta counting. Instrument background values are subtracted from the measured values of ^{131}I and strontium in milk samples, and net activity concentrations are summarized. One sample was not obtained this quarter from station 1 because the milk was picked up by the dairy's buyer immediately before sampling personnel arrived.

5.1.2 Results

Concentrations of total radioactive strontium are shown in Table 37. The estimated overall average concentration of total radioactive strontium at the stations in the immediate Oak Ridge area was 0.17 Bq/L, which is significantly greater than zero. Values of ^{131}I for the first quarter were often less than instrument background, as is indicated by negative values in Table 38. The estimated overall average concentration of ^{131}I at the stations in the immediate Oak Ridge area was -0.024 Bq/L, which is not significantly greater than zero.

Dose was calculated for a station when the average value obtained was statistically greater than zero. The measured average concentrations of total radioactive strontium (assuming 100% ^{90}Sr) and ^{131}I in milk were used to calculate the potential 50-year committed effective dose equivalents given in

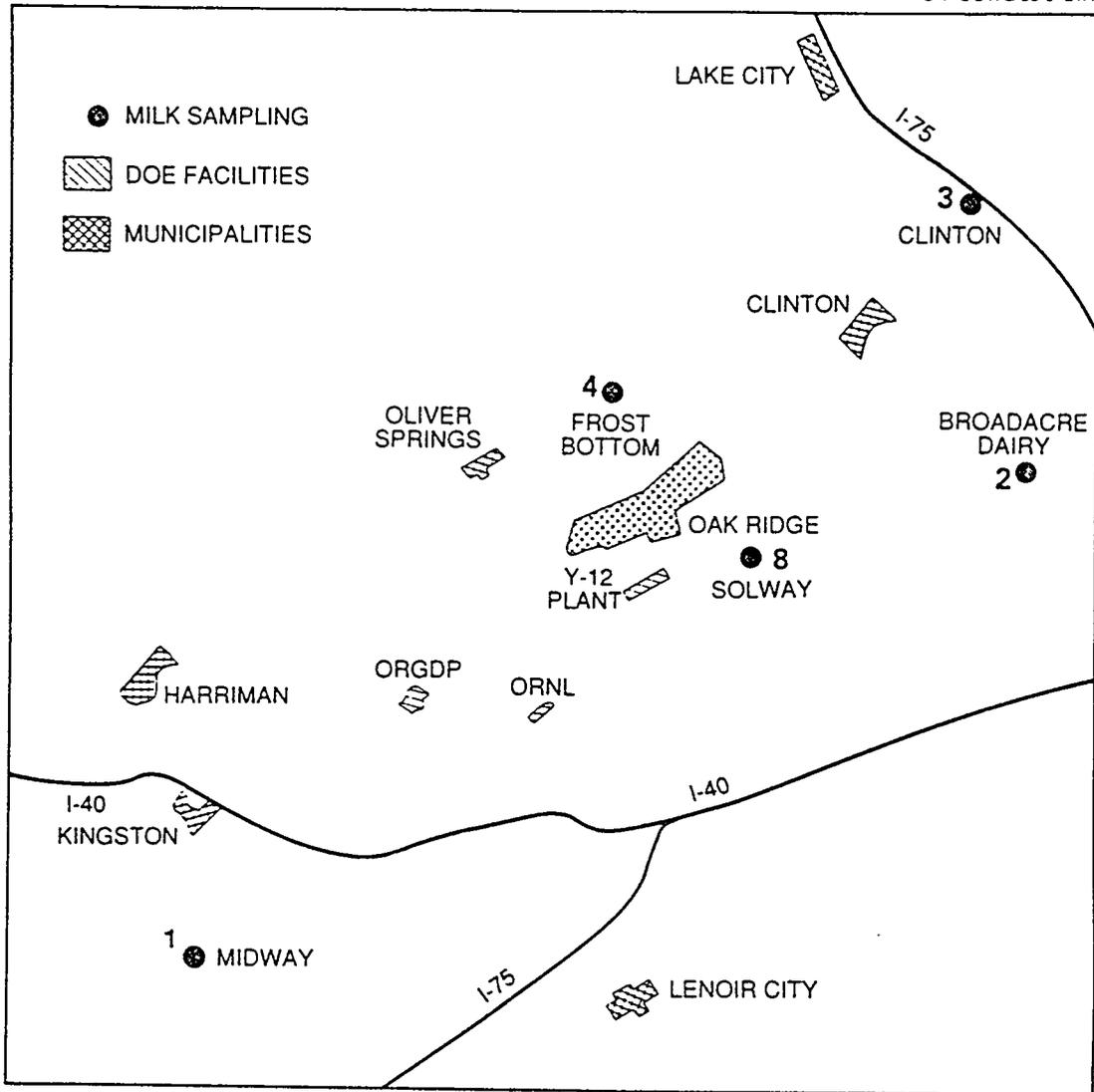


Fig. 15. Location map of milk-sampling stations near the Oak Ridge facilities.

Tables 37 and 38. This calculation is based on the assumption that 1 L/d of milk is ingested at these concentrations for 365 days. Doses resulting from ingestion of milk were less than 1% of DOE's guideline of 1000 μ Sv.

5.1.3 Trends

Current trends in the ^{131}I and strontium concentration are assessed by comparing the maximum and average values for the quarter, to the concentrations of these isotopes in milk for the last 2 years. In the current quarter ^{131}I concentrations are below the average values for the last 2 years and are not significantly greater than zero. Strontium values at stations 1, 2 and 4 are also not significantly greater than zero. These stations' maxima and average values are below the respective maxima and average values for the last 2 years. Estimated strontium activities are significantly greater than zero at stations 3 and 8. The maximum and the average values for strontium at these stations are below the 2-year maximum.

Table 37. Concentrations of strontium in milk and calculated doses,^a January-March 1990

Station	No. of samples	Concentration (Bq/L)			Standard error ^c	Dose (μ Sv) ^d
		Max	Min	Av ^b		
Immediate environs ^e						
1	2	0.63	0.16	0.40	0.24	.
2	3	0.15	0.020	0.077	0.038	.
3	3	0.17	0.050	0.12*	0.035	1.5
4	3	0.26	0.050	0.15	0.061	.
8	3	0.24	0.10	0.18*	0.042	2.3
Network summary	14	0.63	0.020	0.17*	0.040	2.2

^aRaw milk samples; station 2 is a dairy.

^bAn asterisk (*) indicates that the emission is statistically determined to be significantly different from zero.

^cStandard error of mean.

^dPotential 50-year committed effective dose equivalents from drinking 365 L of milk per year using average radionuclide concentrations at each location. Dose is estimated for stations whose average value is statistically greater than zero.

^eSee Fig. 15.

Table 38. Concentrations of ^{131}I in milk and calculated doses,^a
January-March 1990

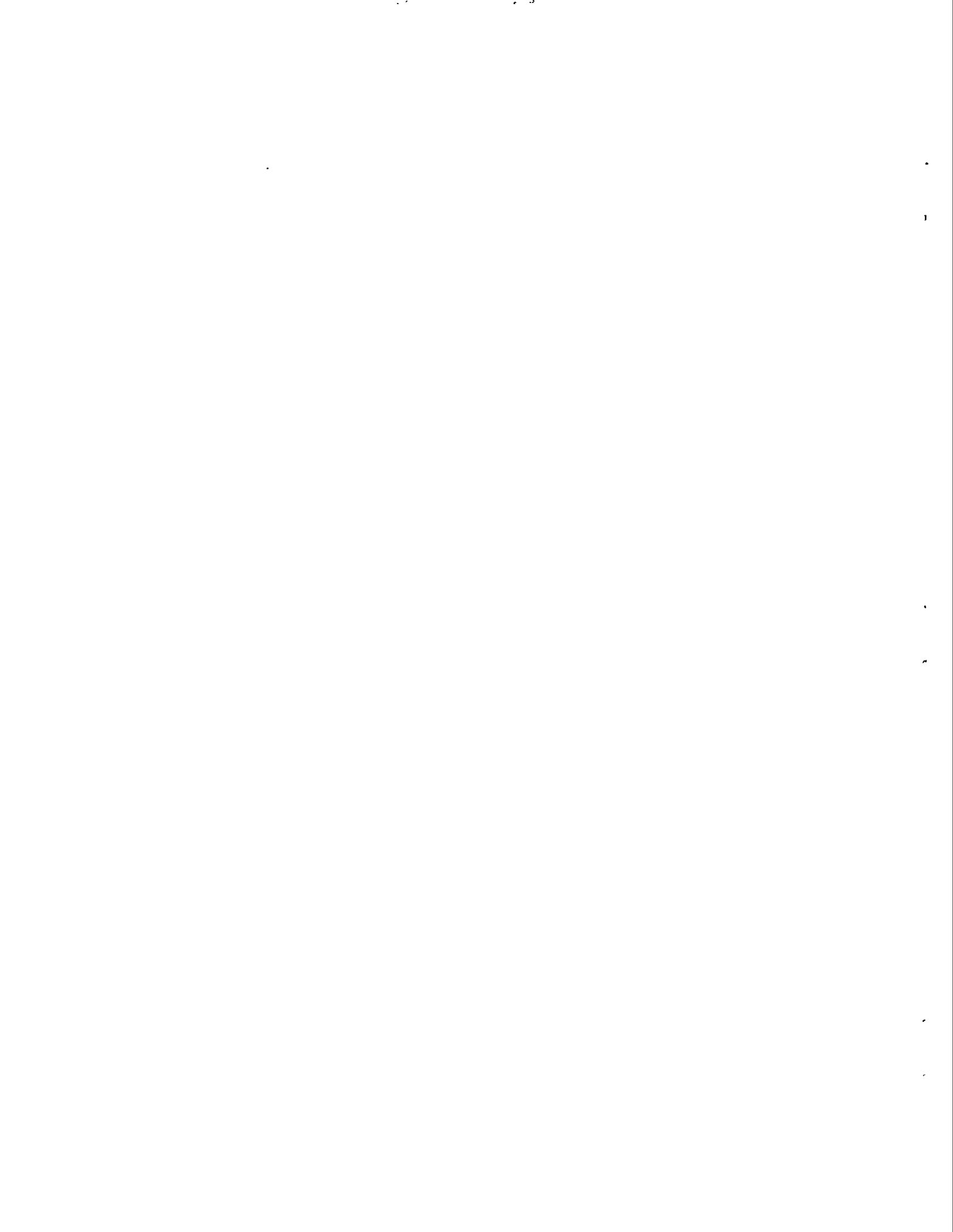
Station	No. of samples	Concentration (Bq/L)			Standard error ^b	Dose (μSv) ^c
		Max	Min	Av		
Immediate environs ^d						
1	2	-0.020	-0.080	-0.050	0.030	.
2	3	0.020	-0.050	-0.017	0.020	.
3	3	0.0040	-0.060	-0.022	0.019	.
4	3	-0.020	-0.070	-0.043	0.015	.
8	3	0.050	-0.030	0.0033	0.024	.
Network summary	14	0.050	-0.080	-0.024	0.0094	.

^aRaw milk samples; station 2 is a dairy.

^bStandard error of mean.

^cPotential 50-year committed effective dose equivalents from drinking 365 L of milk per year using average radionuclide concentrations at each location. Dose is estimated for stations whose average value is statistically greater than zero.

^dSee Fig. 15.



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