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Environmental Surveillance Data Report for the First Quarter of 1989

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I. L. McCollough
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ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR THE FIRST QUARTER OF 1989

K. L. Daniels
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D. A. Wolf

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Prepared by the
Environmental Monitoring and Compliance Section
Environmental and Health Protection Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831
operated by
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LIST OF ACRONYMS

AQCA	Air Quality Control Act
CAA	Clean Air Act
CWA	Clean Water Act
DOE	Department of Energy
DCG	derived concentration guide
EMC	Environmental Monitoring and Compliance Section (ORNL)
EHP	Environmental and Health Protection Division (ORNL)
EPA	Environmental Protection Agency
FRC	Federal Radiation Council
HEPA	high-efficiency particulate air
HFIR	High Flux Isotope Reactor
MB	Melton Branch
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
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 Facility
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
SWSA	Solid Waste Storage Area
SWMU	Solid Waste Management Unit
TRU	Transuranium Processing Plant
WAG	waste area grouping
WOC	White Oak Creek
WOD	White Oak Dam
WOL	White Oak Lake

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EXECUTIVE SUMMARY

During the first quarter of 1989, over 4100 samples, which represent more than 9100 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.

The environmental monitoring program at ORNL was reviewed during this quarter and revisions are currently being implemented to reflect changing requirements and historical results.

Six isotopes, ^{3}H, ^{131}I, ^{133}I, ^{135}I, ^{212}Pb, and ^{191}Os, were the primary isotopes emitted through ORNL stacks during this quarter. Approximately 68% of the ^{3}H released came from the Tritium Target Facility. Measured emissions of ^{3}H from this facility were about half of that measured during the fourth quarter of 1988. The Melton Valley Complex emitted virtually all of the radioactive iodine at levels that were about the same as that for the previous quarter. The highest percentage (50%) of the ^{212}Pb emitted came from the central off-gas and scrubber system (Duct 2, 3039 stack) and represents an increase of two to three times over that for last quarter. Almost all of the ^{191}Os emitted was from the 3025 and 3026 cell ventilation systems. Osmium-191 emissions were reduced during this quarter by a factor of more than 300 because fewer targets are being processed. Data are not reported for noble gas or ^{125}I and ^{129}I emissions because of problems in data validation and analytical interferences.

Alpha and beta activity, ^{131}I concentrations, and ^{3}H were all near zero at the ambient air monitoring stations. There were no changes from the previous quarter.

The highest average concentrations of total radioactive strontium are found in First Creek and Melton Branch 1 (7.8 and 9 Bq/L, respectively). In all of the stream locations, the ratio of the average total radioactive strontium concentration to the derived concentration guide (DCG) for ^{90}Sr is less than 24%. Solid Waste Storage Area (SWSA) 5 appears to be the primary contributor to total radioactive strontium in Melton Branch because there is no radioactive strontium found at the Melton Branch station located above SWSA 5. Radioactive strontium in First Creek may be the result of old waste line leaks or previously contaminated soils.

The highest average ^{3}H concentrations in water (49,000 Bq/L) are found at the Melton Branch 1 station. Average concentrations of ^{3}H at this location were less than 70% of the DCG. Tritium contamination also appears to be coming from SWSA 5.

Effluents from the processes at ORNL are sampled for radioactivity. The highest total radioactive strontium concentrations (13 Bq/L) are found in the discharge from the Process Waste Treatment Plant (PWTP). This level of radioactivity is believed to result from the presence of old waste line leaks or contaminated soils from around Building 3019. The concentration of ^{60}Co was highest (100 Bq/L) in a single discharge from the High Flux Isotope Reactor (HFIR) ponds. This concentration is similar to that in other samples collected the previous quarter from the pond and represents 54% of the DCG. Average ^{137}Cs concentrations were highest (71 Bq/L) in the discharge from the PWTP.

There were a total of 21 noncompliances associated with the National Pollutant Discharge Elimination System (NPDES) permit. Most of these occurred in February and were caused by high concentrations of oil and grease and suspended solids from parking lot runoff during heavy rains.

Polychlorinated biphenyls (PCBs) were detected in sediments at two of the nine sampling locations. Concentrations at these locations were consistent with 1988 data. The average mercury concentration in surface water was about the same as that for the fourth quarter of 1988 (0.26 μg/L vs 0.21 μg/L). During this quarter, the average concentration at station 367th on Fifth Creek exceeded the Environmental Protection Agency (EPA) Primary Drinking Water Standard. Higher concentrations than last quarter were also observed at station 202WOC, 206WOC, 304WOC, and X06WOC on White Oak Creek. The average mercury concentration in the sediments was highest (560 μg/g) in Fifth Creek; this finding is consistent with surface water results.

Groundwater concentrations of fecal coliform, fluoride, gross alpha, tritium, and total radioactive strontium exceeded drinking water standards in wells sampled in Waste Area Group (WAG) 1. In WAG 6, barium, tritium, benzene, trichloroethene, vinyl chloride, 1,2-dichloroethane, and carbon tetrachloride concentrations exceeded drinking water standards in some of the wells.

There were no significant differences in either the ^{131}I or total radioactive Sr concentrations in milk from the local or remote locations. Doses calculated from drinking milk from these locations were all less than 3 μSv, which represents 0.3% of the DOE guideline of 1000 μSv.

1. INTRODUCTION

The Environmental Monitoring and Compliance Section (EMC) within the Environmental and Health Protection Division (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 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.

The current environmental program is designed primarily to meet regulatory requirements and the 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 of 1988, DOE finalized Order 5400.1, "General Environmental Protection Program," that 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 Draft Order 5400.XX, "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 DOE 5400.XY, "Radiological Effluent Monitoring and Environmental Surveillance."

Environmental monitoring, as defined by DOE's Draft Order 5400.XY, consists of two major activities: effluent monitoring and environmental surveillance. Effluent monitoring is the collection and analysis of samples or measurement of liquid and gaseous effluents. Environmental surveillance is the collection and analysis of samples or direct measurement of air, water, soil, foodstuff, biota, and other media from DOE sites and their environs.

Although DOE's Draft Order 5400.XX and 5400.XY have not been finalized, ORNL is evaluating the requirements and is revising the environmental program to reflect changing requirements. During this quarter, the effluent monitoring and environmental surveillance programs were reviewed to increase (1) the precision of the measurements and (2) the efficiency of the program. Several changes were recommended that will be reflected in subsequent quarters. Changes that occurred during this quarter will be described in the appropriate section.

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. The average value is based on multiple samples collected throughout the period. The standard error 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 Draft DOE Order 5400.XX. These concentration guides were established for drinking water and inhaled air and are guidelines for the protection of the public. Draft DOE Order 5400.XX 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, or submersion) for 1 year, a "reference man" would receive the most restrictive of (1) an effective dose equivalent of 1000 μSv or (2) a dose equivalent of 50 mSv to any tissue, including skin and lens of the eye. A "reference man" is a hypothetical human who is assumed to inhale 8400 m^3 of air in a year and to drink 730 L of water in a year. When there are multiple DCGs for a given isotope and the chemical state of the radiation is unknown, then, the most restrictive value is used for comparisons. When the percentage of the DCG is less than 0.01, the percentage is reported as <0.01. When total radioactive strontium is measured, it is compared with the ^{90}Sr DCG, which is the most restrictive value.

Radioactivity measurements are reported as the net activity, or the difference between the gross activity and background activity. Because of the intrinsic uncertainties associated with making radiation measurements, it is possible to subtract a background value from a sample result and get a negative number. Radiation measurements are reported in becquerel units (Bq), a Systeme Internationale (SI) unit equivalent to 1 disintegration per second.

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 then the detection limit.

2. AIR

Airborne emissions from 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) has the authority and responsibility for enforcing the regulations associated with the CAA and has delegated this authority to the state of Tennessee for nonradioactive air pollutants. Regulatory criteria for CAA are promulgated in 40 CFR 61, the National Emission Standards for Hazardous Air Pollutants (NESHAPS). The DOE Orders are enforced at the local level by the Environmental and Health Protection (EHP) Division. The Orders that address air emissions are 5400.1, 5400.XX (draft), and 5400.XY (draft).

The Oak Ridge National Laboratory (ORNL) has monitoring requirements for radioactive emissions only. These are NESHAPS standards based on calculated dose (25 mrem whole-body, 75 mrem critical-organ) to off-site individuals. Additionally, 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 for 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 on the surrounding area and provide empirical data for assessing the inhalation pathways of exposure.

2.1 AIRBORNE EMISSIONS

Airborne emissions are monitored at ORNL for the purpose of complying with the CAA of 1970 and the Tennessee AQCA. The major 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 and the Radiochemical Development Engineering 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 for the Electron Linear Accelerator Facility (Building 6010) and the Hydrofracture Facility (Building 7830). Continuous sampling equipment is not currently installed at Building 6010. A stack improvement project is scheduled for 1989 that will provide continuous samplers at this stack. The sampling system at Building 7830 is currently being upgraded in preparation for the In-Tank Evaporation Project.

The sampling systems generally consist of in-stack sampling probes, sample transport piping, a 47-mm-diameter particulate filter, a 47-mm-diameter 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. Gross alpha and gross beta measurements are made 8 days after the samples are collected to reduce the contribution of short-lived natural radionuclides to the measurement. 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 value is reported. Consequently, 13 data values are typically associated with gross alpha, gross beta, tritium, ^{131}I, and ^{133}I 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 four exceptions to the 13-sample "quota" for the first quarter are:

1. The Radioactive Materials Analytical Laboratory has a total of 12 samples because a set was not collected during the week of 1/2/89.

2. The Radioactive Processing Plant has 11 particulate samples and 12 charcoal samples because samples were not collected during the week of 12/26/88, and the particulate sample collected on 1/28/89 was not delivered to the analytical laboratory within the 8-day hold time.

3. The Molten Salt Reactor Facility also has 12 particulate samples because samples were delivered after the hold time had expired.

4. The Melton Valley Complex has 14 samples because an additional set

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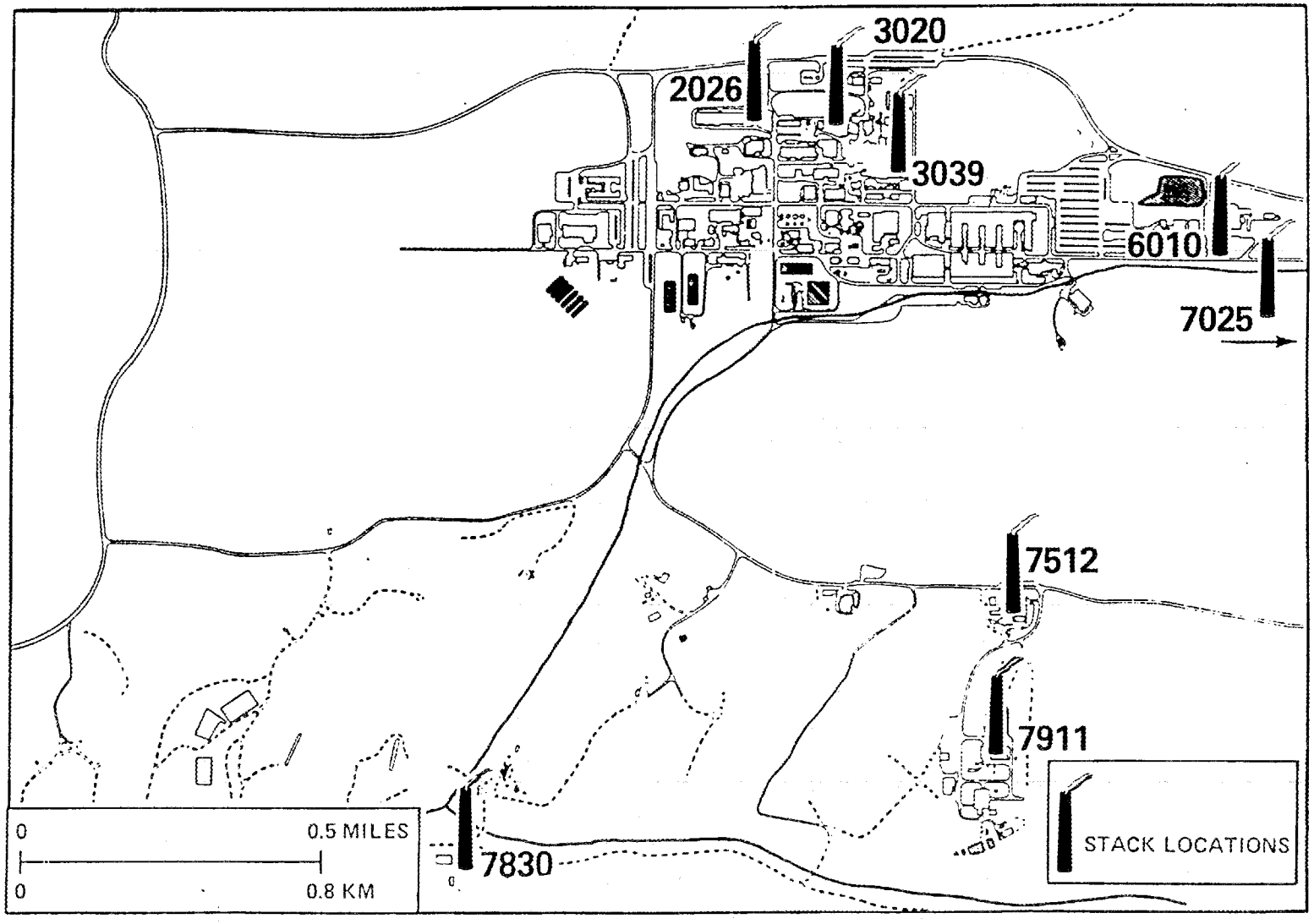

Fig. 1. Location map of major stacks (emission points) at ORNL.

was collected during the week of 2/20/88 in response to high readings on the real-time monitoring system.

The current convention for data at the instrument detection limit is to treat it the same 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.

Tables 1 through 9 present summaries of the weekly emissions data. Included are the number of samples in which a particular analyte was measured, the maximum and minimum values for the quarter, and the average. If an analyte has two or more values, then the standard error is also provided. Tables 10 through 18 present the emission totals by month and for the quarter by stack and analyte.

All data are rounded to two significant digits and are presented as 1E6 Bq. Negative sample values are treated as zeros for the purpose of computing emissions. On upgraded systems where sample flow totalizers have been installed, weekly sample data are 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 sampling systems, the conversion factor consists of the average stack discharge rate divided by the average sampling rate.

The airborne emissions for the Laboratory consist primarily of ^{3}H, ^{131}I, ^{133}I, ^{135}I, ^{212}Pb, and ^{191}Os. Tritium came mostly from the Tritium Target Fabrication Facility (56%, 1.3E12 Bq) and the Isotope Solid State Ventilation System (40%, 9.3E11 Bq). 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 of this error are being investigated.

The Melton Valley Complex emitted virtually all of the total ^{131}I (2.0E8 Bq), ^{133}I (2.5E8 Bq), and ^{135}I (1.7E8 Bq). Ninety six percent of the ^{212}Pb came from five locations: Central Off-gas and Scrubber System (50%, 4.4E8 Bq); Radioactive Materials Analytical Laboratory (18%, 1.6E8 Bq); Melton Valley Complex (15%, 1.3E8 Bq); Radioactive Processing Plant (8%, 6.8E7 Bq); and 3500 and 4500 area cell ventilation systems (5%, 4.6E7 Bq). The 3025 and 3026 cell ventilation systems released over 99.9% of the ^{191}Os (3.0E8 Bq).

Iodine-131 may be present as a fission product and as an artifact of the method used for testing high-efficiency particulate air (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.

Table 1. Summary of weekly emissions at the Radioactive Materials Analytical Laboratory, Building 2026[a], January-March 1989

Analysis	Number of samples	Total (10^6 Bq/week)			
		Max	Min	Av	Standard error[b]
^{137}Cs	4	0.084	0.020	0.051	0.015
Gross alpha	12	0.20	0.0067	0.047	0.015
Gross beta	12	0.42	0.018	0.12	0.038
^{131}I	12	0.062	0	0.0057	0.0051
^{133}I	10	0.0095	0	0.0013	0.00092
^{135}I	10	0.037	0	0.0077	0.0038
^{212}Pb	10	25	5.5	16	2.8

[a]See Fig. 1.
[b]Standard error of the average of more than two samples.

Table 2. Summary of weekly emissions at the Radioactive Processing Plant ventilation stack, Building 3020[a], January-March 1989

Analysis	Number of samples	Total (10^6 Bq/week)			
		Max	Min	Av	Standard error[b]
^{137}Cs	1	0.012	0.012	0.012	
Gross alpha	11	0.0043	0.0000	0.0018	0.00051
Gross beta	11	0.027	0.0013	0.0075	0.0022
^{131}I	12	0.048	0	0.0055	0.0039
^{133}I	10	0.0089	0	0.0019	0.00085
^{135}I	1	0.014	0.014	0.014	
^{212}Pb	3	57	2.1	23	17

[a]See Fig. 1.
[b]Standard error of the average of more than two samples.

Table 3. Summary of weekly emissions at the 3500 and 4500 area cell ventilation systems, Building 3039, Duct 1[a], January-March 1989

Analysis	Number of samples	Total (10^6 Bq/week) Max	Min	Av	Standard error[b]
^{60}Co	6	1.4	0.022	0.30	0.22
Gross alpha	13	0.10	0	0.011	0.0075
Gross beta	13	12	0.0096	1.3	0.93
^{3}H	13	2300	2.0	380	190
^{131}I	13	0.011	0	0.0017	0.00089
^{133}I	13	0.0044	0	0.0011	0.00037
^{135}I	13	0.017	0	0.0036	0.0015
^{212}Pb	13	5.2	2.3	3.5	0.21

[a]See Fig. 1.
[b]Standard error of the average of more than two samples.

Table 4. Summary of weekly emissions at the central off-gas and scrubber system Building 3039, Duct 2[a], January-March 1989

Analysis	Number of samples	Total (10^6 Bq/week) Max	Min	Av	Standard error[b]
^{60}Co	1	0.012	0.012	0.012	
^{137}Cs	2	0.11	0.066	0.086	0.020
Gross alpha	13	0.0022	0.0000	0.0004	0.00018
Gross beta	13	0.17	0.0041	0.038	0.015
^{3}H	13	1700	0.67	430	150
^{131}I	13	0.0046	0	0.0013	0.00045
^{133}I	13	0.0042	0	0.0013	0.00039
^{135}I	13	0.022	0	0.0044	0.0016
^{191}Os	2	0.32	0.18	0.25	0.069
^{212}Pb	13	57	6.3	34	3.8

[a]See Fig. 1.
[b]Standard error of the average of more than two samples.

Table 5. Summary of weekly emissions at the Isotope-Solid State ventilation system, Building 3039, Duct 3[a], January-March 1989

Analysis	Number of samples	Total (10^6 Bq/week) Max	Min	Av	Standard error[b]
^{82}Br	10	0.77	0.033	0.16	0.069
^{60}Co	10	0.13	0.017	0.046	0.011
Gross alpha	13	0.0034	0.0000	0.0015	0.00028
Gross beta	13	0.018	0.0034	0.012	0.00097
^{3}H	13	320,000	48	72,000	32,000
^{131}I	13	0.21	0	0.063	0.020
^{133}I	13	0.0039	0	0.0013	0.00039
^{135}I	13	0.043	0	0.0039	0.0033
^{191}Os	1	0.036	0.036	0.036	
^{212}Pb	13	3.9	1.5	2.3	0.20
^{75}Se	13	0.16	0.042	0.081	0.011

[a]See Fig. 1.
[b]Standard error of the average of more than two samples.

Table 6. Summary of weekly emissions at the 3025 and 3026 area cell ventilation system, Building 3039, Duct 4[a], January-March 1989

Analysis	Number of samples	Total (10^6 Bq/week) Max	Min	Av	Standard error[b]
Gross alpha	13	0.0029	0	0.0009	0.00026
Gross beta	13	3.0	0.052	0.69	0.24
^{3}H	13	35,000	260	7,900	3,000
^{131}I	13	0.0061	0	0.0012	0.00058
^{133}I	13	0.0077	0	0.0010	0.00060
^{135}I	13	0.019	0	0.0053	0.0020
^{191}Os	13	120	0.15	23	11
^{212}Pb	9	0.098	0.033	0.065	0.0069

[a]See Fig. 1.
[b]Standard error of the average of more than two samples.

Table 7. Summary of weekly emisions at the Tritium Target Fabrication Facility, Building 7025[a], January-March 1989

Analysis	Number of samples	Total (10^6 Bq/week) Max	Min	Av	Standard error[b]
^3H	13	420,000	33,000	100,000	31,000

[a]See Fig. 1.
[b]Standard error of the average of more than two samples.

Table 8. Summary of weekly emissions at the Melton Valley Complex, Building 7911[a], January-March 1989

Analysis	Number of samples	Total (10^6 Bq/week) Max	Min	Av	Standard error[b]
Gross alpha	14	0.0016	0.0000	0.0007	0.00011
Gross beta	14	0.22	0.0083	0.043	0.014
^{3}H	13	270	0	25	21
^{131}I	14	65	0.66	14	4.4
^{132}I	5	5.6	0.98	2.8	0.89
^{133}I	14	100	2.7	18	6.7
^{134}I	4	1.7	0.24	0.94	0.37
^{135}I	14	47	0.027	12	3.2
^{212}Pb	13	15	5.7	9.6	0.82
^{228}Th	1	8.3	8.3	8.3	

[a]See Fig. 1.
[b]Standard error of the average of more than two samples.

Table 9. Summary of weekly emissions at the Molten Salt Reactor Facility, Building 7512[a], January-March 1989

Analysis	Number of samples	Total (10^6 Bq/week) Max	Min	Av	Standard error[b]
Gross alpha	12	0.010	0	0.0011	0.00081
Gross beta	12	0.0083	0.0001	0.0015	0.00064
^{131}I	13	0.0020	0	0.0006	0.00022
^{133}I	11	0.0022	0	0.0007	0.00022
^{135}I	2	0.018	0.0026	0.010	0.0078
^{212}Pb	1	0.18	0.18	0.18	

[a]See Fig. 1.
[b]Standard error of the average of more than two samples.

Table 10. Monthly airborne emissions at the Radioactive Materials Analytical Laboratory, Building 2026[a], January-March 1989

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	January	February	March	
^{137}Cs	0	0.10	0.10	0.20
Gross alpha	0.33	0.14	0.10	0.57
Gross beta	0.75	0.29	0.43	1.5
^{131}I	0.0017	0.064	0.0024	0.068
^{133}I	0	0.012	0.0016	0.013
^{135}I	0.057	0.0011	0.020	0.077
^{212}Pb	49	59	51	160

[a]See Fig. 1.

Table 11. Monthly airborne emissions at the Radiochemical Process Plant ventilation stack, Building 3020[a], January-March 1989

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	January	February	March	
^{137}Cs	0	0	0.012	0.012
Gross alpha	0.0052	0.0091	0.0050	0.019
Gross beta	0.041	0.032	0.0093	0.082
^{131}I	0.057	0.0061	0.0025	0.066
^{133}I	0.0011	0.012	0.0059	0.019
^{135}I	0	0.014	0	0.014
^{212}Pb	8.9	2.1	57	68

[a]See Fig. 1.

Table 12. Monthly airborne emissions at the 3500 and 4500 area cell ventilation systems, Building 3039, Duct 1[a], January-March 1989

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	January	February	March	
^{60}Co	0.13	1.7	0.022	1.8
Gross alpha	0.11	0.0053	0.030	0.15
Gross beta	14	0.28	2.8	17
^{3}H	41	2700	2100	4900
^{131}I	0.0038	0.013	0.0049	0.022
^{133}I	0.0053	0.0051	0.0038	0.014
^{135}I	0.019	0.0053	0.023	0.047
^{212}Pb	19	14	12	46

[a]See Fig. 1.

Table 13. Monthly airborne emissions at the central off-gas and scrubber system, Building 3039, Duct 2[a], January-March 1989

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	January	February	March	
^{60}Co	0.012	0	0	0.012
^{137}Cs	0.066	0.11	0	0.17
Gross alpha	0.00068	0.0024	0.0031	0.0062
Gross beta	0.28	0.17	0.046	0.49
^{3}H	16	1500	4000	5500
^{131}I	0.012	0.0035	0.0012	0.016
^{133}I	0.0072	0.0042	0.0058	0.017
^{135}I	0.016	0.032	0.0098	0.058
^{191}Os	0	0	0.50	0.50
^{212}Pb	190	150	100	440

[a]See Fig. 1.

Table 14. Monthly airborne emissions at the Isotope-Solid State ventilation system, Building 3039, Duct 3[a], January-March 1989

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	January	February	March	
^{82}Br	0.34	0.26	0.99	1.6
^{60}Co	0.14	0.049	0.27	0.46
Gross alpha	0.0075	0.0039	0.0085	0.020
Gross beta	0.053	0.048	0.057	0.16
^{3}H	10,000	380,000	540,000	930,000
^{131}I	0.52	0.30	0.0064	0.82
^{133}I	0.0078	0.0028	0.0067	0.017
^{135}I	0.0038	0.046	0	0.050
^{191}Os	0.036	0	0	0.036
^{212}Pb	12	10	8.2	30
^{75}Se	0.44	0.35	0.26	1.1

[a]See Fig. 1.

Table 15. Monthly airborne emissions at the 3025 and 3026 area cell ventilation systems, Building 3039, Duct 4[a], January-March 1989

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	January	February	March	
Gross alpha	0.0071	0.0011	0.0044	0.013
Gross beta	2.8	1.9	4.3	8.9
^{3}H	2,100	34,000	67,000	100,000
^{131}I	0.012	0.0030	0.00028	0.015
^{133}I	0.012	0.00057	0.00056	0.013
^{135}I	0.045	0.018	0.0055	0.069
^{191}Os	290	8.2	0.87	300
^{212}Pb	0.24	0.20	0.15	0.59

[a]See Fig. 1.

Table 16. Monthly airborne emissions at the Tritium Target Fabrication Facility, Building 7025[a], January-March 1989

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	January	February	March	
^3H	860,000	190,000	290,000	1,300,000

[a]See Fig. 1.

Table 17. Monthly airborne emissions at the Melton Valley Complex, Building 7911[a], January-March 1989

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	January	February	March	
Gross alpha	0.0025	0.0041	0.0031	0.0097
Gross beta	0.32	0.15	0.13	0.60
^{3}H	13	6.1	300	320
^{131}I	46	26	130	200
^{132}I	0	3.0	11	14
^{133}I	49	38	160	250
^{134}I	0	0.39	3.4	3.8
^{135}I	33	42	99	170
^{212}Pb	46	46	33	130
^{228}Th	0	8.3	0	8.3

[a]See Fig. 1.

Table 18. Monthly airborne emissions at the Molten Salt Reactor Facility, Building 7512[a], January-March 1989

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	January	February	March	
Gross alpha	0.0014	0.010	0.0011	0.013
Gross beta	0.0040	0.010	0.0035	0.018
^{131}I	0.0019	0.0040	0.0020	0.0079
^{133}I	0.0041	0.0019	0.0019	0.0079
^{135}I	0	0.018	0.0026	0.021
^{212}Pb	0	0	0.18	0.18

[a]See Fig. 1.

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. It is hoped that this data will be available for the next quarterly report (second quarter, 1989).

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 passed through two sets of HEPA filters and an activated charcoal filter 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 through 4. These 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, 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 (reservation PAMs) network consists of stations 8, 23, 31, 33, 34, 36, and 40-46 (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 (RAM) network consists of stations 51-53 and 55-58. 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 PAM stations 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 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

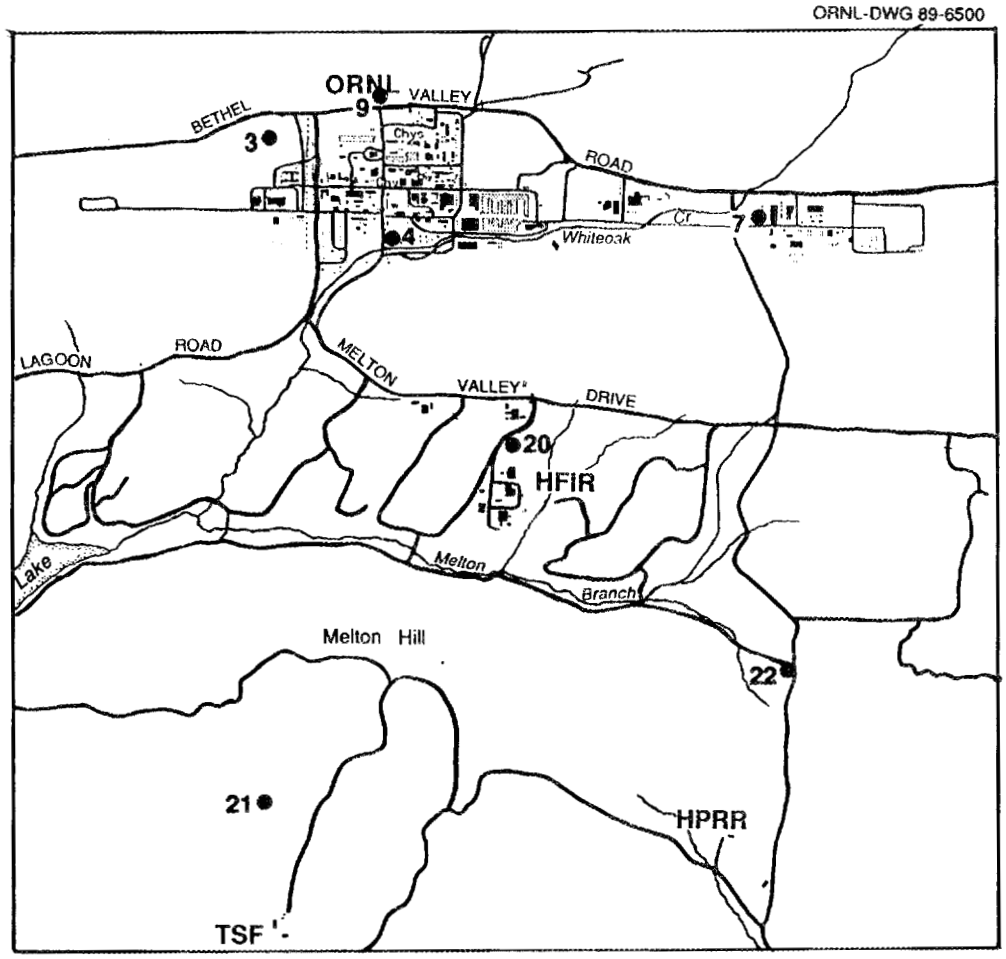

Fig. 2. Location map of ORNL perimeter air monitoring stations.

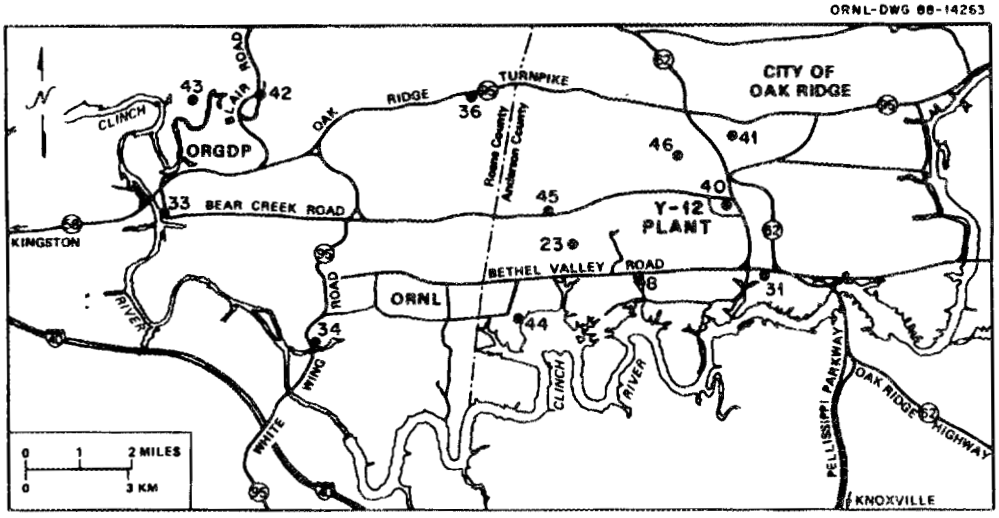

Fig. 3. Location map of Oak Ridge Reservation air monitoring stations.

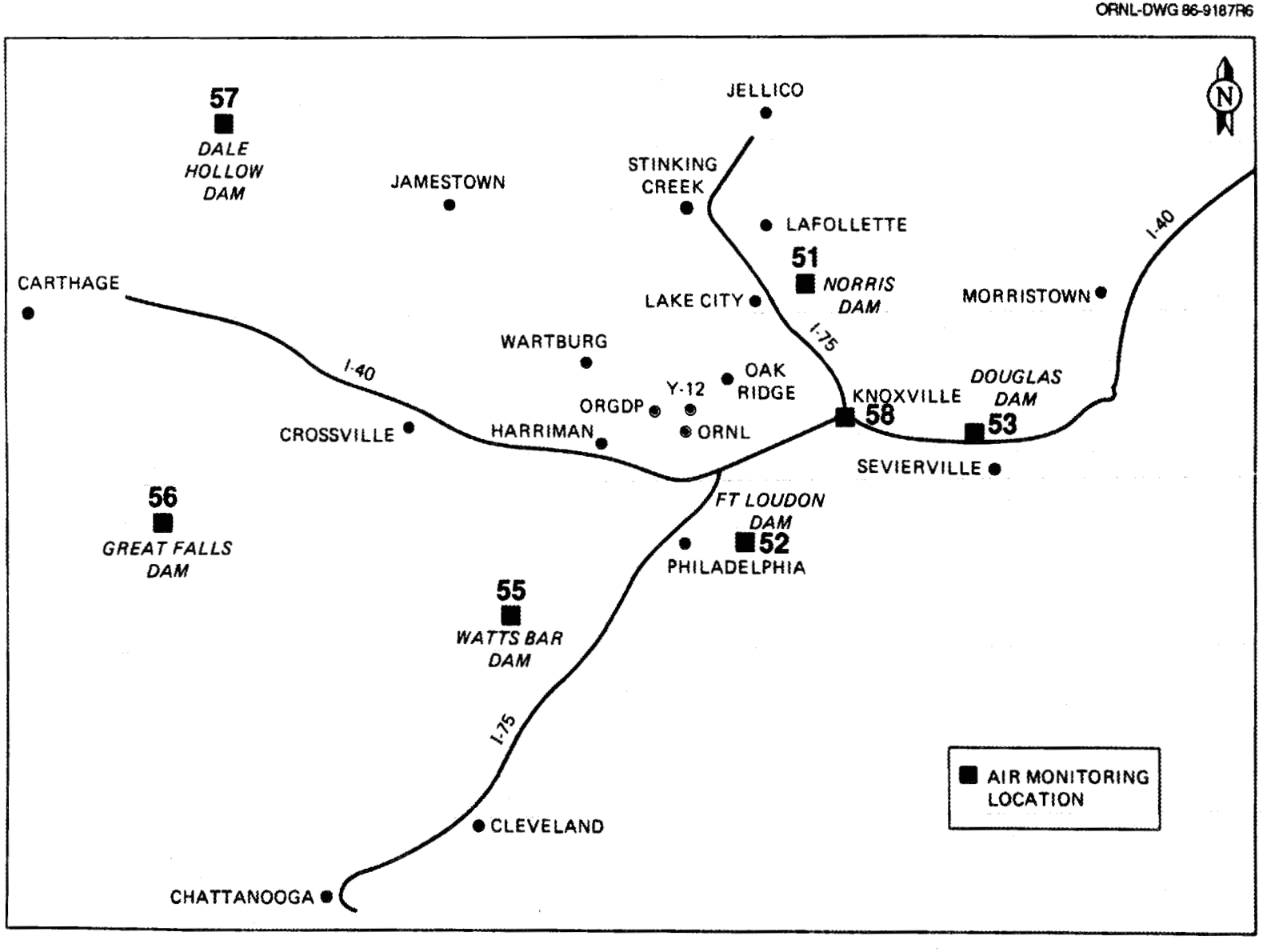

Fig. 4. Location map of the remote air monitoring stations.

beta activities. To minimize artifacts from short-lived radionuclides, the filter papers are analyzed 3 to 4 d 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 sample 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 are set between 2.0 and 3.0 ft^3/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. After a review of program needs and historical data, filter papers and charcoal cartridges were collected biweekly (rather than weekly) at stations 3 through 46 as of February 1989. To increase the precision of the measurements and because the isotopes are all long-lived, composite air filters will be prepared annually, rather than quarterly, for analysis of specific isotopes.

Concentrations of gross alpha, gross beta, and atmospheric ^{131}I are summarized in Tables 19-21. Instrument background concentrations of ^{131}I, gross alpha, and gross beta have been subtracted from the measured concentrations. Negative values represent concentrations below the instrument background level. Flow data at the remote stations have been unrealiable and highly variable this quarter. Stations 52 and 55 had only 3 valid flow values. Stations 51 and 58 were completely dropped from the gross alpha and gross beta tables because they had no valid flow values.

Alpha activity this quarter was indistinguishable from background. Average beta activity was unchanged from the preceding quarter. Values for the ORNL stations and for reservation stations were similar to values for the remote stations.

Iodine-131 concentrations (Table 21) were unchanged from the previous quarter, all values reported being less than 0.01% of the derived concentration guideline for that isotope.

Monthly samples for atmospheric tritium are routinely collected from ORNL PAM station 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 22. Station 3 has the higher values, as usual.

2.3 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.

Table 19. Long-lived gross alpha activity in air, January-March 1989

Location	Number of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	Standard error
		ORNL PAM Stations[a]			
3	7	6.3	-2.7	1.4	1.1
4	9	4.3	-4.1	0.17	1.1
7	8	5.1	-5.6	-0.83	1.6
9	5	4.1	-5.9	-3.0	1.8
20	6	4.0	-5.1	-1.2	1.5
21	8	7.9	-5.1	-0.18	1.6
22	9	7.9	-6.0	-0.94	1.6
Network summary	52	7.9	-6.0	-0.53	0.56
		Reservation PAM Stations[b]			
8	6	9.2	-7.3	-2.1	2.4
23	7	8.6	-6.2	-0.36	1.9
31	9	7.8	-5.1	-0.94	1.5
33	9	7.6	-4.0	-0.11	1.3
34	9	4.9	-5.5	-0.72	1.3
36	9	4.2	-6.1	-1.7	1.4
40	9	5.1	-5.6	0.013	1.2
41	9	6.7	-4.1	-0.55	1.3
42	9	3.5	-5.7	-1.9	1.3
43	9	6.2	-5.6	-0.68	1.3
44	9	6.6	-4.7	-0.95	1.3
45	9	8.2	-3.6	0.58	1.3
46	6	6.6	-4.2	-0.51	1.9
Network summary	109	9.2	-7.3	-0.74	0.38
		RAM Stations[c]			
52	3	8.7	1.9	5.3	2.0
53	8	11	-5.3	3.0	1.6

Table 19. (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	Standard error
55	3	1.7	-5.7	-2.3	2.2
56	12	8.0	-5.9	-1.0	1.4
57	13	10	-3.3	3.1	1.1
Network summary	39	11	-5.9	1.5	0.76
Overall summary	200	11	-7.3	-0.24	0.30

[a]See Fig. 2.
[b]See Fig. 3.
[c]See Fig. 4.

Table 20. Long-lived gross beta activity in air, January-March 1989

Location	Number of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	Standard error
		ORNL PAM Stations[a]			
3	7	140	72	99	10
4	9	130	54	92	8.7
7	8	120	63	88	6.6
9	5	110	49	71	11
20	6	170	67	110	14
21	8	130	71	98	7.5
22	9	130	68	96	8.0
Network summary	52	170	49	94	3.5
		Reservation PAM Stations[b]			
8	6	160	82	130	11
23	7	110	63	91	7.3
31	9	120	69	94	6.6
33	9	110	50	80	7.5
34	9	130	39	83	9.9
36	9	140	36	87	11
40	9	110	34	70	8.9
41	9	110	44	79	6.8
42	9	110	45	76	7.4
43	9	120	56	81	7.6
44	9	100	35	71	7.1
45	9	120	33	87	9.5
46	6	110	68	89	6.9
Network summary	109	160	33	85	2.5
		RAM Stations[c]			
52	3	130	110	120	5.1
53	8	160	78	120	10

Table 20 (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	Standard error
55	3	61	34	50	8.0
56	12	130	9.9	86	9.4
57	13	160	70	120	8.9
Network summary	39	160	9.9	100	5.7
Overall summary	200	170	9.9	91	2.1

[a]See Fig. 2.
[b]See Fig. 3.
[c]See Fig. 4.

Table 21. ^{131}I concentrations in air, January-March 1989

Location	Number of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	Standard error	Percentage DCG[a]
		ORNL PAM Stations[b]				
3	7	7.3	-27	-0.65	4.6	<0.01
4	9	11	-2.2	2.1	1.4	<0.01
7	8	5.0	-2.2	0.85	0.96	<0.01
9	5	10	-8.8	-0.083	3.1	<0.01
20	6	22	-4.1	4.5	4.2	<0.01
21	8	24	-2.1	6.8	3.2	<0.01
22	9	4.6	-5.4	0.48	1.2	<0.01
Network summary	52	24	-27	2.1	1.0	<0.01
		Reservation PAM Stations[c]				
8	6	8.5	2.4	5.1	0.98	<0.01
23	7	12	0	6.1	1.6	<0.01
31	9	5.0	-5.0	0.77	1.1	<0.01
33	9	4.8	-4.0	1.0	1.0	<0.01
34	9	4.8	-3.8	1.2	0.93	<0.01
36	9	7.5	-2.0	2.6	0.98	<0.01
40	9	5.7	-2.1	2.6	0.84	<0.01
41	9	4.8	-6.0	-0.50	1.0	<0.01
42	9	7.8	-4.0	1.4	1.2	<0.01
43	9	7.7	-5.3	1.2	1.4	<0.01
44	9	3.9	-2.9	0.23	0.83	<0.01
45	9	16	-2.1	3.3	1.9	<0.01
46	6	7.5	-2.1	1.6	1.4	<0.01
Network summary	109	16	-6.0	1.9	0.35	<0.01
Overall summary	161	24	-27	1.9	0.41	<0.01

[a]Percentage DCG = average value x 100/derived concentration guide (DCG). The DCG for ^{131}I is 1.5×10^{-2} Bq/L.
[b]See Fig. 2.
[c]See Fig. 3.

Table 22. Tritium activity in air, January-March 1989

Location[a]	Number of samples	Concentration (10^{-4} Bq/L) Max	Min	Av	Standard error	Percentage DCG[b]
3	3	8.3	1.6	4.2	2.1	0.011
8	3	0.61	0.44	0.50	0.055	0.0013
Overall summary	6	8.3	0.44	2.4	1.3	0.0064

[a]See Figs. 2 and 3.
[b]Percentage DCG = average 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.

Average gamma radiation measurements are recorded at 10-minute intervals at ORNL and PAM stations, except stations 9, 21 through 23, and 46 (Figs. 2 and 3). PAM 20, which is ordinarily monitored, was not operating for the first portion of 1989, therefore no data were reported from the station. From these data, hourly averages are computed. Table 23 summarizes the valid hourly measurements for the first quarter of 1989. Typical values for cities in the United States are usually between 1.3 and 5.2 nC/kg/h (10 nGy/h and 200 nGy/h, respectively), according to the recent issues of *EPA Environmental Radiation Data*. The median value for cities in the contiguous United States for all four quarters of 1987 was 2.4 nC/kg/h (93 nGy/h), 75% of the values being between 1.9 and 3.9 nC/kg/h (the distribution is positively skewed). All of the values given in Table 23 are close to the range of background values as given above, except for PAM 4 (30 nC/kg/h), which is located very close to the Process Waste Treatment Plant and treatment ponds. Values for station 4 are more than ten times the typical background values, which is to be expected considering the location of that particular monitor.

Table 23. External gamma radiation measurements at ORNL and reservation perimeter air monitoring stations, January-March 1989

Location	Number of samples[a]	Concentration (nC/kg/h) Max	Min	Av	Standard error[b]
		ORNL PAM Stations[c]			
03	2,154	2.2	1.6	1.8	0.0019
04	482	30	20	26	0.078
07	2,002	2.9	1.4	2.2	0.0056
Network summary	4,638	30	1.4	4.4	0.11
		Reservation PAM Stations[d]			
08	105	2.2	1.7	1.8	0.0095
31	1,695	2.7	1.9	2.0	0.0020
33	896	3.0	1.7	2.0	0.0045
34	831	2.8	1.9	2.2	0.0050
36	2,158	2.3	1.7	1.8	0.0018
40	1,081	2.5	1.7	2.0	0.0035
41	2,158	1.8	1.5	1.6	0.0010
42	1,217	2.3	1.5	1.8	0.0030
43	1,932	2.4	1.6	1.7	0.0023
44	1,907	2.3	1.4	1.7	0.0029
45	151	2.2	1.7	1.8	0.0058
Network summary	14,131	3.0	1.4	1.8	0.0017

[a]Real-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.

[b]Standard deviation of the mean.

[c]See Fig. 2.

[d]See Fig. 3.

3. WATER

Surface drainage from the Oak Ridge National Laboratory (ORNL) site flows into two main streams, White Oak Creek (WOC) and Melton Branch. With the exception of two small discharges from the 7600 area into Melton Hill Lake, all ORNL effluents also discharge to these two streams or their tributaries. WOC flows through Bethel Valley, where it is joined by Fifth Creek, First Creek, and the Northwest Tributary (Fig. 5). WOC continues through a gap in Chestnut Ridge into Melton Valley, where it is joined by Melton Branch, 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 are handled in a number of ways, including treatment [Process Waste Treatment Plant (PWTP), Coal Yard Runoff] and holding basins [190 ponds, High Flux Isotope Reactor/Transuranium Processing Plant (HFIR/TRU) ponds], before being discharged to these streams. Some direct discharges of process effluents through permitted outfalls also occur. Sanitary effluent is discharged to WOC after treatment at the Sewage Treatment Plant. Below WOD, WOC is affected by water levels in the Clinch River that are controlled by 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. Waste sites at ORNL have been combined into WAGs that are geographically contiguous and/or hydrologically defined areas. Samples are analyzed for radionuclides and nonradioactive chemicals.

3.1 SURFACE WATER

White Oak Creek receives drainage from an area of 17 km^2 in Bethel and Melton Valleys and is the largest stream flowing through ORNL. After entering Melton Valley, WOC is joined by its major tributary, Melton Branch (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.

ORNL collects samples 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. Table 24 provides a summary of locations, parameters analyzed, and frequencies of sample collection and analysis for all radiological samples. This section will summarize results of samples collected from each of these types of locations. Treated water samples are collected weekly at the Kingston and Oak Ridge Gaseous Diffusion Plant (ORGDP, Gallaher) potable water treatments plants (Fig. 6) and are analyzed quarterly. In the past, samples were collected from an ORNL tap and from Melton Hill Dam and were analyzed quarterly. The tap water sampling was dropped because they are not environmental samples. Because Melton Hill Dam water is also analyzed monthly, the quarterly sampling was dropped. Table 25

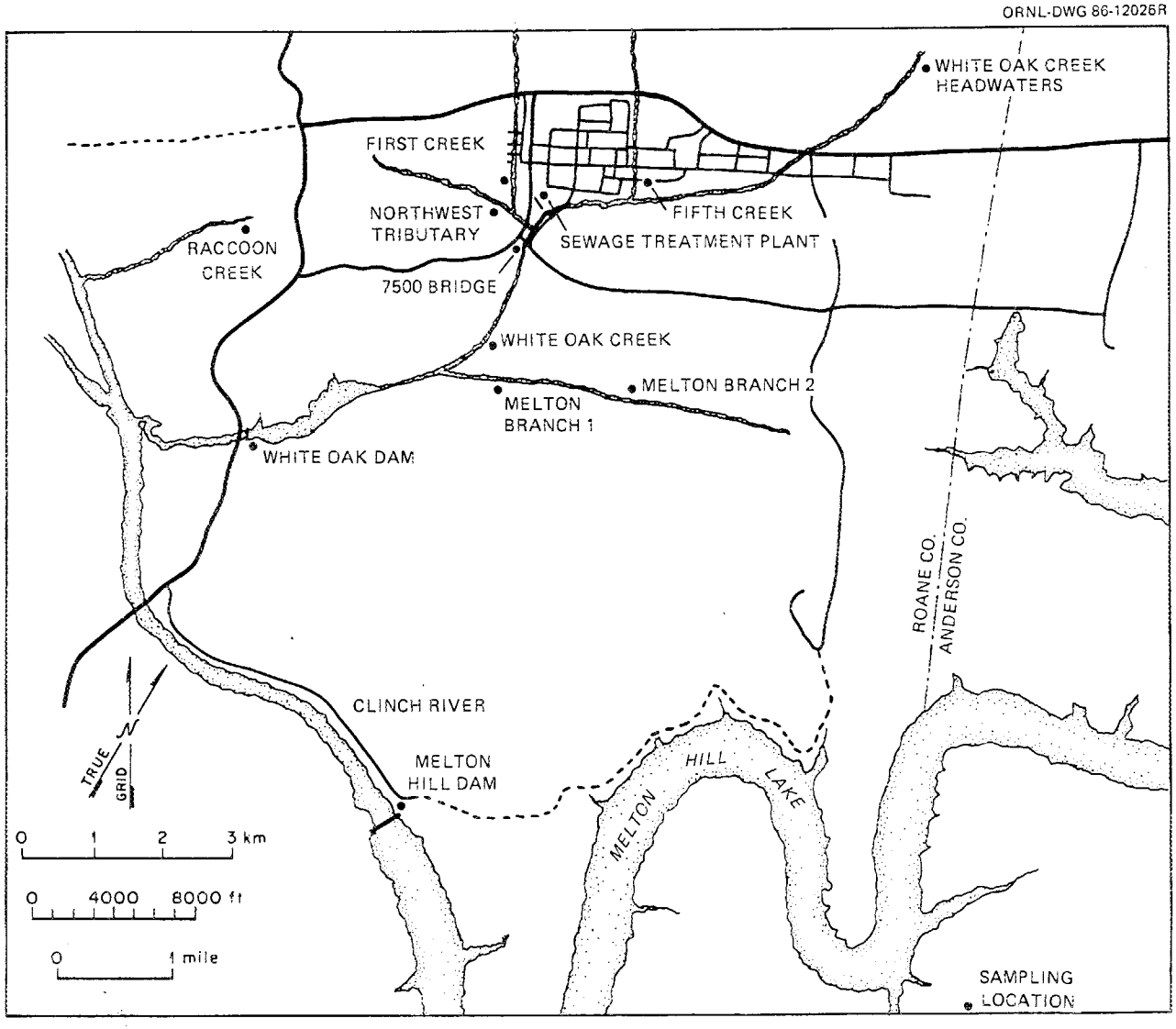

Fig. 5. Location map of ORNL streams and sampling stations.

Table 24. Summary of collection and analysis frequencies of surface, pond, and effluent 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[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 Pu, total Sr[a], U isotopes	Weekly	Time proportional	Quarterly
Kingston	^{3}H, gamma scan, gross alpha, gross beta, total Pu, total Sr[a], U isotopes	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, total Pu, total Sr[a], ^{3}H, U isotopes	Weekly	Flow proportional	Monthly
NWT	Gamma scan, total Sr[a]	Weekly	Flow proportional	Monthly
WOC headwaters	^{241}Am, ^{244}Cm, gamma scan, gross alpha, total Sr[a], ^{3}H, ^{238}Pu, ^{239}Pu	Weekly	Flow proportional	Monthly
WOD	^{241}Am, ^{244}Cm, gamma scan, gross beta, total Sr[a], ^{238}Pu, ^{239}Pu, ^{3}H	Weekly	Flow proportional	Weekly
TRU ponds	Gross beta	After discharge	Flow proportional	Monthly

[a]Total radioactive Sr (^{89}Sr + ^{90}Sr).

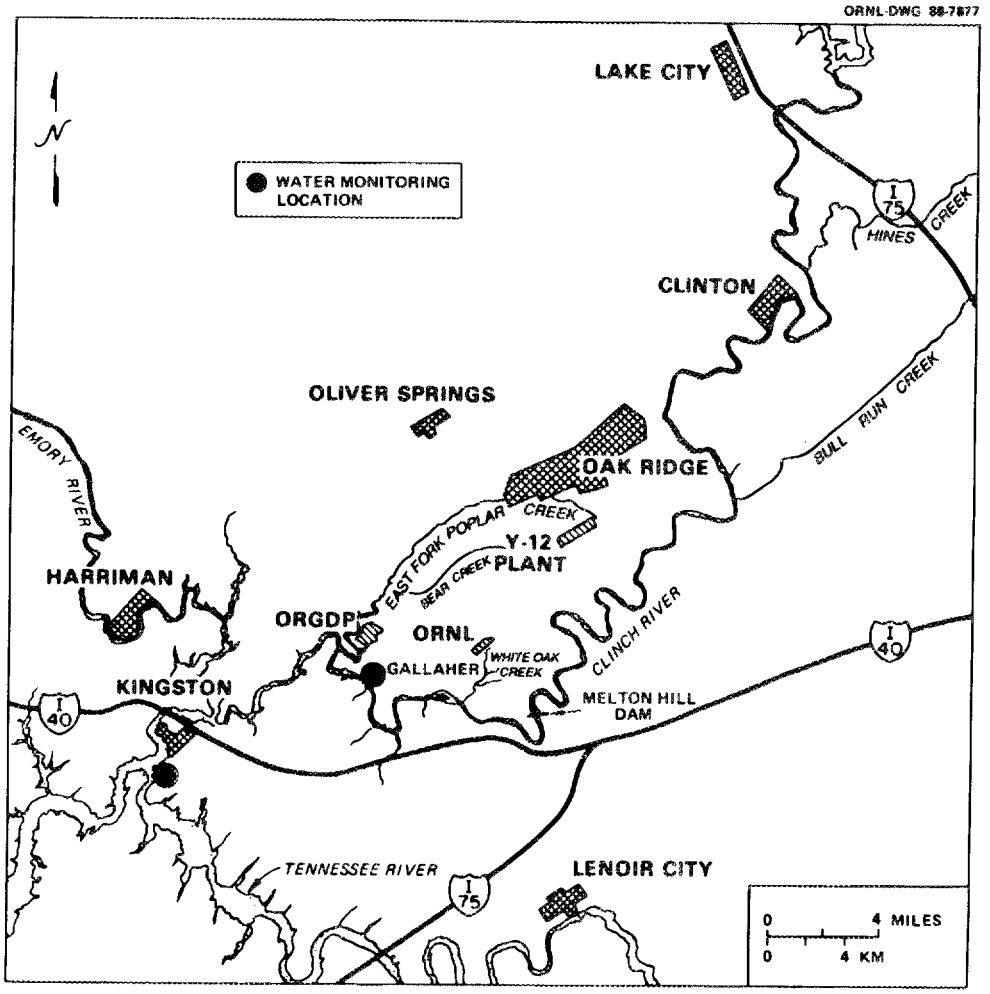

Fig. 6. Location map of Gallaher and Kingston sampling points.

Table 25. Summary of radionuclide concentrations in water off-site ORNL, January-March 1989

Radionuclide	Concentration (Bq/L)	Drinking Water Standard[a] (DWS) (Bq/L)	Percentage[b] of DWS
		Gallaher[c]	
^{60}Co	0.044	NA[d]	NA
^{137}Cs	0.020	NA	NA
Gross alpha	0.010	0.056	18
Gross beta	-0.030	1.9	<0.001
Total Pu[e]	<0.00011	NA	NA
Total Sr[f]	0.12	0.30	40
^{234}U	0.0022	NA	NA
^{235}U	0.000069	NA	NA
^{236}U	<0.0000028	NA	NA
^{238}U	0.0014	NA	NA
		Kingston[c]	
^{60}Co	-0.0020	NA	NA
^{137}Cs	0.0056	NA	NA
Gross alpha	0.020	0.056	36
Gross beta	0.090	1.9	4.9
Total Pu[e]	<0.00011	NA	NA
Total Sr[f]	0.16	0.30	53
^{234}U	0.0023	NA	NA
^{235}U	0.000065	NA	NA
^{236}U	0.0000076	NA	NA
^{238}U	0.0013	NA	NA

[a]National Primary Drinking Water Standard. From 40 CFR 141, as amended.
[b]Concentration as a percentage of the DWS.
[c]See Fig. 6.
[d]NA = not applicable.
[e]Total Pu (^{239}Pu + ^{240}Pu).
[f]Total radioactive Sr (^{89}Sr + ^{90}Sr).

gives the concentrations of radionuclides measured at these stations. These concentrations are compared with the Environmental Protection Agency (EPA) drinking water standards that apply at the outlet of a public water distribution system. The concentration is given in Table 25 as a percentage of the EPA drinking water standard. All percentages were less than 100%. Concentrations at these two locations were similar.

Two locations that are above ORNL discharges, Melton Hill Dam and WOC headwaters, serve as reference locations for comparing with streams that receive discharges from ORNL. In addition, surface water samples are collected from six streams near ORNL: WOC, MB, First Creek, Fifth Creek, Northwest Tributary, and Raccoon Creek (Fig. 5). Summary statistics for each radionuclide at each surface water sampling location are given in Table 26.

Draft DOE Order 5400.XX, Chapter II, 2.a., requires comparison of annual average radionuclide concentrations with the derived concentration guide (DCG) values. According to the Draft DOE Order, a 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 milliSievert (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 26. All parameters, with the exception of total radioactive Sr, were less than 3% of the DCG. Concentrations of total radioactive Sr were highest in First Creek (average of 7.8 Bq/L), which was 21% of the DCG for ^{90}Sr.

Locations that are sampled for nonradioactive chemicals under the requirements of the NPDES permit (see Sect. 3.2) are also sampled for radionuclides (Fig. 7). Parameters analyzed and the frequency of analysis is given in Table 24. Table 27 gives a summary of the quarterly concentrations from each of these locations. The average concentration is expressed as a percentage of the DCG in the last column of this table. All concentrations were less than 100% of the DCG.

The discharge of radioactive contaminants from ORNL is affected by the stream flows. Flows in MB (as measured at MB1 station), WOC (as measured at the confluence of MB and at WOC), and the Clinch River (as measured at Melton Hill Dam) are given in Table 28. The flow in Melton Branch is about one-third that in WOC. The ratio of WOC flow to Clinch River flow is also given in Table 28. 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 160 to 370. Clinch River flows are regulated by a series of TVA dams, one of which is Melton Hill Dam.

The quantity of radioactivity (referred to here as the discharge) in WOC as measured at the Sewage Treatment Plant, at the confluence of WOC and MB, at WOD, and at MB1 were calculated from concentration and flow. A single flow-proportional sample was obtained at each of WOC, MB1, and STP stations and

Table 26. Radionuclide concentrations in surface waters around ORNL[a], January-March 1989

Radionuclide	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Derived Concentration Guide[c] (DCG)	Percentage of DCG[d]
				Melton Hill Dam			
^{241}Am	3	0.057	-0.0012	0.020	0.018	1.1	1.8
^{244}Cm	1	0.053	0.053	0.053	NA[e]	2.2	2.4
^{60}Co	3	0.20	0.050	0.12	0.044	190	0.063
^{137}Cs	3	0.50	-0.50	0.0033	0.29	110	0.0030
Gross alpha	3	0.21	0.090	0.17	0.038	NA	NA
Gross beta	3	1.5	0.11	0.87	0.41	NA	NA
^{238}Pu	3	0.0010	-0.0024	-0.00020	0.0011	1.5	<0.0010
^{239}Pu	3	0.0020	-0.0047	-0.0011	0.0020	1.1	<0.0010
Total Sr[f]	3	0.11	-0.035	0.055	0.045	37	0.15
^{3}H	3	19	-3.0	8.0	6.4	74000	0.011
				White Oak Creek Headwaters			
^{241}Am	3	0.014	0.0017	0.0074	0.0036	1.1	0.67
^{60}Co	3	0.80	-0.20	0.17	0.32	190	0.090
^{137}Cs	3	0.40	0.10	0.28	0.093	110	0.26
Gross alpha	3	0.52	0.40	0.48	0.038	NA	NA
Gross beta	3	0.52	0.30	0.39	0.068	NA	NA
^{238}Pu	3	0.0022	-0.00080	0.00027	0.00097	1.5	0.018
^{239}Pu	3	0.00060	-0.0033	-0.0011	0.0012	1.1	<0.0010
Total Sr[f]	3	0.060	-0.060	0.013	0.037	37	0.036
^{3}H	3	16	-4.0	7.7	6.0	74000	0.010

Table 26 (continued)

Radionuclide	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Derived Concentration Guide[c] (DCG)	Percentage of DCG[d]
				7500 Bridge			
^{60}Co	3	1.0	-0.60	0.30	0.47	190	0.16
^{137}Cs	3	3.3	2.5	3.0	0.25	110	2.7
Total Sr[f]	3	3.0	2.0	2.5	0.29	37	6.8
^{3}H	3	310	230	260	25	74,000	0.35
				First Creek			
^{60}Co	3	1.1	-0.20	0.27	0.41	190	0.15
^{137}Cs	3	0.040	-0.80	-0.29	0.26	110	<0.0010
Total Sr[f]	3	8.3	7.1	7.8	0.36	37	21
				Fifth Creek			
^{60}Co	3	0.90	-0.50	0.15	0.41	190	0.083
^{137}Cs	3	0.18	-1.0	-0.37	0.34	110	<0.0010
Total Sr[f]	3	2.0	1.2	1.5	0.24	37	4.1
				Melton Branch 2			
^{60}Co	3	1.3	0.10	0.53	0.39	190	0.28
^{137}Cs	3	0.30	-0.10	0.080	0.12	110	0.072
Total Sr[f]	3	0.040	-0.090	-0.010	0.040	37	<0.0010
^{3}H	3	160	63	97	32	74,000	0.13

Table 26 (continued)

Radionuclide	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Derived Concentration Guide[c] (DCG)	Percentage of DCG[d]
				Northwest Tributary			
^{60}Co	3	0.060	-1.3	-0.81	0.44	190	<0.0010
^{137}Cs	3	0.60	0.11	0.40	0.15	110	0.36
Total Sr[f]	3	2.2	1.4	1.9	0.27	37	5.2
				Raccoon Creek			
^{60}Co	3	0.90	0.32	0.54	0.18	190	0.29
^{137}Cs	3	0.90	-0.70	0.083	0.46	110	0.075
Total Sr[f]	3	0.48	0.39	0.43	0.026	37	1.2

[a]See Fig. 5.
[b]Standard error of the mean.
[c]Derived concentration guide for ingestion of water. From DOE Order 5400.XX.
[d]Average concentration as a percentage of the DCG.
[e]NA = not applicable.
[f]Total radioactive Sr (^{89}Sr + ^{90}Sr).

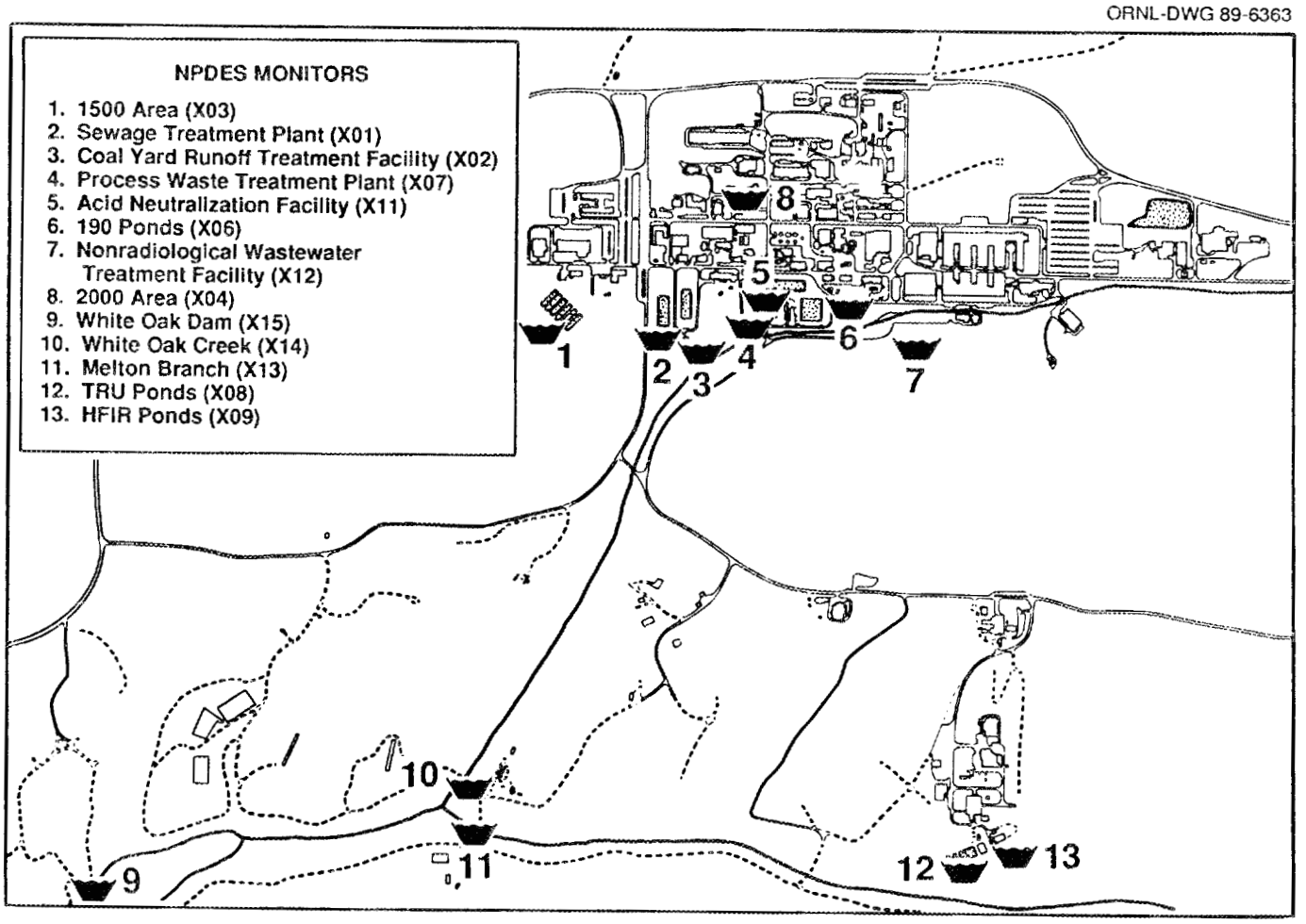

Fig. 7. Location map of ORNL NPDES and radioactivity sampling locations.

Table 27. Radionuclide concentrations at ORNL NPDES locations[a], January-March 1989

Radionuclide	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Derived Concentration Guide[c] (DCG)	Percentage of DCG[d]
Sewage Treatment Plant (X01)							
^{60}Co	3	1.3	-1.1	0.037	0.70	190	0.020
^{137}Cs	3	0.30	-0.10	0.14	0.12	110	0.13
Gross beta	3	15	12	14	0.88	NA[e]	NA
Total Sr[f]	3	5.4	4.8	5.2	0.19	37	14
1500 Area (X03)							
Gross alpha	3	0.37	0.090	0.20	0.086	NA	NA
Gross beta	3	0.80	0.0	0.51	0.26	NA	NA
2000 Area (X04)							
^{60}Co	3	0.20	-0.060	0.080	0.076	190	0.043
^{137}Cs	3	-0.090	-0.70	-0.43	0.18	110	<0.001
Gross beta	3	2.2	0.0	1.1	0.64	NA	NA
Total Sr[f]	3	0.42	-0.010	0.15	0.14	37	0.41
190 Ponds (X06)							
^{60}Co	3	0.80	-0.30	0.12	0.34	190	0.067
^{137}Cs	3	1.5	-0.10	0.52	0.50	110	0.47
Gross alpha	3	1.1	-0.10	0.47	0.35	NA	NA
Gross beta	3	1.7	1.2	1.4	0.15	NA	NA

Table 27 (continued)

Radionuclide	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Derived Concentration Guide[c] (DCG)	Percentage of DCG[d]
				Process Waste Treatment Plant (X07)			
^{60}Co	3	1.6	0.80	1.2	0.23	190	0.67
^{137}Cs	3	93	57	71	11	110	64
Gross alpha	3	2.6	0.63	1.3	0.65	NA	NA
Gross beta	3	88	60	71	8.7	NA	NA
Total Sr[f]	3	13	0.98	7.1	3.5	37	19
				TRU (X08)			
Gross beta	1	4.9	4.9	4.9	NA	NA	NA
				HFIR Ponds (X09)			
^{60}Co	1	100	100	100	NA	190	54
^{137}Cs	1	-0.40	-0.40	-0.40	NA	110	<0.001
Gross alpha	1	0.21	0.21	0.21	NA	NA	NA
Gross beta	1	88	88	88	NA	NA	NA
^{54}Mn	1	-0.10	-0.10	-0.10	NA	1900	<0.001

Table 27 (continued)

Radionuclide	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Derived Concentration Guide[c] (DCG)	Percentage of DCG[d]
Acid Neutralization Facility (X11)							
Gross alpha	3	0.63	0.20	0.43	0.12	NA	NA
Gross beta	3	3.1	0.80	1.9	0.67	NA	NA
Melton Branch 1 (X13)							
^{60}Co	3	1.3	0.20	0.69	0.32	190	0.37
^{137}Cs	3	0.60	-0.60	0.013	0.35	110	0.012
Total Sr[f]	3	13	6.9	9.0	2.0	37	24
^{3}H	3	54,000	43,000	49,000	3,200	74,000	66
White Oak Creek (X14)							
^{60}Co	3	0.10	-0.30	-0.070	0.12	190	<0.001
^{137}Cs	3	7.8	1.2	4.0	2.0	110	3.6
Total Sr[f]	3	6.2	5.3	5.7	0.27	37	15
^{3}H	3	3,000	2,600	2,800	120	74,000	3.8

Table 27 (continued)

Radionuclide	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Derived Concentration Guide[c] (DCG)	Percentage of DCG[d]
				White Oak Dam (X15)			
^{241}Am	13	0.020	-0.0085	0.010	0.0022	1.1	0.91
^{244}Cm	5	0.041	-0.061	0.011	0.018	2.2	0.51
^{60}Co	13	1.0	-0.12	0.39	0.085	190	0.21
^{137}Cs	13	6.9	0.56	2.7	0.51	110	2.4
Gross beta	5	18	12	15	1.0	NA	NA
^{238}Pu	13	0.019	-0.0010	0.0036	0.0014	1.5	0.25
^{239}Pu	13	0.028	-0.011	0.0057	0.0027	1.1	0.51
Total Sr[f]	13	9.5	3.8	6.1	0.49	37	16
^{3}H	13	16,000	7,300	12,000	830	74,000	16

[a]See Fig. 7.
[b]Standard error of the mean.
[c]Derived concentration guide for ingestion of water. From DOE Order 5400.XX.
[d]Average concentration as a percentage of the DCG.
[e]NA = not applicable.
[f]Total radioactive Sr (^{89}Sr + ^{90}Sr).

Table 28. Stream[a] flows, January-March 1989

Month	Flow (10^9 L)				
	Melton Branch 1	White Oak Creek[b]	White Oak Dam[c]	Clinch River	Average Ratio[d]
January	0.70	1.8	1.8	510	370
February	0.40	1.3	2.0	500	280
March	0.37	1.4	1.8	250	160

[a]See Fig. 5.
[b]White Oak Creek at confluence of Melton Branch.
[c]White Oak Creek at White Oak Dam.
[d]Flow ratios Clinch River : White Oak Creek at White Oak Dam are calculated daily and averaged for the month.

analyzed at (roughly) monthly intervals. The discharge during that period was calculated as the product of the flow-weighted concentration and the total flow for the sampling period (Tables 29-31). Flow proportional samples were obtained at WOD and analyzed at (roughly) weekly intervals. The average concentration during the calendar month was calculated as a weighted sum of all concentrations obtained for sampling periods intersecting (either partially or completely) the calendar month. The weights were proportional to the calendar period total flow attributable to the sample period intervals. This average concentration was multiplied by the calendar month total flow to arrive at the discharge.

Each average flow-weighted concentration is compared with a corresponding DCG. In almost all cases, the concentration is a small percentage of the corresponding DCG. However, the percentages for total radioactive Sr and tritium at MB1 are higher but less than 100% of the DCG.

Monthly surface water samples were collected at two sampling locations for the purpose of determining background contamination levels before the influence of ORNL. Because of ICP analysis problems, only one month of Sr results and two months of tin results are available. One sample was 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 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.

The organics and PCBs at both sampling locations were collected by the manual grab method. The inorganics, oil and grease, and dissolved solids were collected flow-proportionally by a sampling station at each location. All grab samples were taken one per month.

Tables 32 and 33 contain a summary of the analytical results. Table 32 displays an inorganic compound list, and Table 33 displays an organic compound list. The column entitled 'Percentage DWL' is included to show the average concentration as a percentage of the National Primary or Secondary Drinking Water Regulation level, where available. Many of the inorganic analytical results show a wide range of detection limits. This is because of a dilution that must be made to some of the water samples. When a given sample contains an element in a concentration higher than the 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 dilution factor. This dilution factor must also be applied to the detection limit value for each element.

There were no abnormally high levels of organic compounds found at either location, with most of the results below analytical reporting limits. Inorganic compounds were also below the National Primary and Secondary Drinking Water regulation levels. Arsenic, lead, and selenium all show high percentages of the regulation level; however, this is because the analytical reporting limits for these analytes are equal to or greater than the

Table 29. Radionuclide concentrations and releases at ORNL[a], January 1989

Radionuclide	Flow (10^6 L)	Discharge (10^{10} Bq)	Concentration (Bq/L)	Concentration Guide[b] (DCG) (Bq/L)	Percentage of DCG[c]
		Melton Branch 1 (12/31-01/30)			
^{60}Co	770	0.099	1.3	190	0.70
^{137}Cs	770	0.046	0.60	110	0.54
Total Sr[d]	770	0.54	7.1	37	19
^{3}H	770	3,800	50,000	74,000	68
		Sewage Treatment Plant (12/31-01/30)			
^{60}Co	27	0.0036	1.3	190	0.70
^{137}Cs	27	-0.00027	-0.10	110	<0.001
Gross beta	27	0.041	15	NA[e]	NA
Total Sr[d]	27	0.013	4.8	37	13
		White Oak Creek (12/31-01/30)			
^{60}Co	1,800	-0.055	-0.30	190	<0.001
^{137}Cs	1,800	0.55	3.0	110	2.7
Total Sr[d]	1,800	1.1	6.2	37	17
^{3}H	1,800	550	3,000	74,000	4.1
		White Oak Dam[f] (01/01-02/01)			
^{241}Am	1,800	0.0022	0.012	1.1	1.1
^{60}Co	1,800	0.071	0.39	190	0.21
^{137}Cs	1,800	0.67	3.7	110	3.3
^{238}Pu	1,800	0.0019	0.011	1.5	0.72
^{239}Pu	1,800	0.0022	0.012	1.1	1.1
Total Sr[d]	1,800	1.3	7.2	37	20
^{3}H	1,800	2,000	11,000	74,000	15

[a]See Fig. 5.

[b]Derived concentration guide for ingestion of water. From Draft DOE Order 5400.XX.

[c]Concentration as a percentage of the DCG.

[d]Total radioactive Sr (^{89}Sr + ^{90}Sr).

[e]NA = not applicable.

[f]Concentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

Table 30. Radionuclide concentrations and releases at ORNL[a], February 1989

Radionuclide	Flow (10^6 L)	Discharge (10^{10} Bq)	Concentration (Bq/L)	Concentration Guide[b] (DCG) (Bq/L)	Percentage of DCG[c]
		Melton Branch 1 (01/30-03/05)			
^{60}Co	450	0.025	0.56	190	0.30
^{137}Cs	450	0.0018	0.040	110	0.036
Total Sr[d]	450	0.31	6.9	37	19
^{3}H	450	2,000	43,000	74,000	58
		Sewage Treatment Plant (01/30-03/05)			
^{60}Co	34	-0.00031	-0.090	190	<0.001
^{137}Cs	34	0.00075	0.22	110	0.20
Gross beta	34	0.048	14	NA[e]	NA
Total Sr[d]	34	0.018	5.3	37	14
		White Oak Creek (01/30-03/05)			
^{60}Co	1,500	-0.0015	-0.010	190	<0.001
^{137}Cs	1,500	0.18	1.2	110	1.1
Total Sr[d]	1,500	0.83	5.5	37	15
^{3}H	1,500	420	2,800	74,000	3.8
		White Oak Dam[f] (02/01-03/01)			
^{241}Am	2,000	0.0019	0.0094	1.1	0.84
^{244}Cm	2,000	0.0039	0.019	2.2	0.86
^{60}Co	2,000	0.029	0.14	190	0.077
^{137}Cs	2,000	0.52	2.6	110	2.3
Gross beta	2,000	3.3	16	NA	NA
^{238}Pu	2,000	0.00061	0.0030	1.5	0.20
^{239}Pu	2,000	0.0012	0.0057	1.1	0.52
Total Sr[d]	2,000	1.1	5.5	37	15
^{3}H	2,000	2,300	11,000	74,000	15

[a]See Fig. 5.

[b]Derived concentration guide for ingestion of water. From Draft DOE Order 5400.XX.

[c]Concentration as a percentage of the DCG.

[d]Total radioactive Sr (^{89}Sr + ^{90}Sr).

[e]NA = not applicable.

[f]Concentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

Table 31. Radionuclide concentrations and releases at ORNL[a], March 1989

Radionuclide	Flow (10^6 L)	Discharge (10^{10} Bq)	Concentration (Bq/L)	Concentration Guide[b] (DCG) (Bq/L)	Percentage of DCG[c]
		Melton Branch 1 (03/05-04/04)			
^{60}Co	370	0.0074	0.20	190	0.11
^{137}Cs	370	-0.022	-0.60	110	<0.001
Total Sr[d]	370	0.48	13	37	35
^{3}H	370	2,000	54,000	74,000	73
		Sewage Treatment Plant (03/05-04/04)			
^{60}Co	24	-0.0026	-1.1	190	<0.001
^{137}Cs	24	0.00072	0.30	110	0.27
Gross beta	24	0.029	12	NA[e]	NA
Total Sr[d]	24	0.013	5.4	37	15
		White Oak Creek (03/05-04/04)			
^{60}Co	1,300	0.013	0.10	190	0.054
^{137}Cs	1,300	1.0	7.8	110	7.0
Total Sr[d]	1,300	0.70	5.3	37	14
^{3}H	1,300	340	2,600	74,000	3.5
		White Oak Dam[f] (03/01-04/01)			
^{241}Am	1,800	0.0024	0.013	1.1	1.2
^{244}Cm	1,800	0.0017	0.0093	2.2	0.42
^{60}Co	1,800	0.083	0.46	190	0.25
^{137}Cs	1,800	0.37	2.1	110	1.9
Gross beta	1,800	2.6	14	NA	NA
^{238}Pu	1,800	0.00019	0.0010	1.5	0.071
^{239}Pu	1,800	-0.0000036	-0.000020	1.1	<0.001
Total Sr[d]	1,800	1.2	6.5	37	17
^{3}H	1,800	1,900	10,000	74,000	14

[a]See Fig. 5.
[b]Derived concentration guide for ingestion of water. From Draft DOE Order 5400.XX.
[c]Concentration as a percentage of the DCG.
[d]Total radioactive Sr (^{89}Sr + ^{90}Sr).
[e]NA = not applicable.
[f]Concentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

Table 32. Inorganic surface water analyses at reference locations, January-March 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error	Percentage DWL[b]
		Melton Hill Dam[a]				
Aluminum-total	3	3.2	0.48	1.5	0.84	
Ammonia (as N)	3	0.041	0.010	0.030	0.010	
Antimony-total	3	<0.030	<0.030	<0.030	0	
Arsenic-total	3	<0.060	<0.050	<0.057	0.0033	<113
Barium-total	3	0.056	<0.0020	<0.030	0.015	3.0
Beryllium-total	3	<0.0003	<0.0003	<0.0003	0	
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0	
Boron-total	3	<0.080	0.0096	<0.057	0.023	
Cadmium-total	3	0.018	<0.0020	<0.0077	0.0051	<76
Calcium-total	3	34	33	33	0.33	
Chromium-total	3	0.021	<0.0050	<0.012	0.0047	<24
Cobalt-total	3	<0.0050	<0.0030	<0.0037	0.00066	
Copper-total	3	<0.010	<0.0040	<0.0080	0.0020	<0.80
Dissolved solids-total	3	180	160	170	6.4	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Iron-total	3	2.6	0.10	1.3	0.72	422
Lead-total	3	<0.050	<0.050	<0.050	0	<100
Lithium-total	3	<0.20	<0.0040	<0.13	0.065	
Magnesium-total	3	9.3	7.7	8.6	0.46	
Manganese-total	3	0.52	<0.0020	<0.25	0.14	<501
Molybdenum-total	3	<0.040	<0.010	<0.030	0.010	
Nickel-total	3	<0.010	<0.0050	<0.0067	0.0016	
Nitrate	3	<5.0	<5.0	<5.0	0	<50
Oil and grease	3	<2.0	<2.0	<2.0	0	
Organic carbon-total	3	2.0	1.5	1.7	0.14	
Oxygen-dissolved	3	8.9	8.2	8.6	0.20	
Recoverable phenolics-total	3	<0.0010	<0.0010	<0.0010	0	
Selenium-total	3	<0.060	<0.050	<0.057	0.0033	<566
Silicon-total	3	5.6	0.95	3.2	1.3	
Silver-total	3	<0.0060	<0.0050	<0.0053	0.00033	<10
Sodium-total	3	6.2	3.6	5.2	0.79	
Strontium-total	1	0.074	0.074	0.074		
Sulfate (as SO_4)	3	30	29	29	0.33	11
Suspended solids-total	3	48	<5.0	<32	13	
Tin-total	2	<0.050	<0.050	<0.050	0	
Titanium-total	3	0.091	0.0078	0.040	0.025	
Vanadium-total	3	0.017	<0.0050	<0.012	0.0036	
Zinc-total	3	0.037	0.0079	0.024	0.0086	0.48

Table 32 (continued)

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error	Percentage DWL[b]
Zirconium-total	3	<0.020	<0.0050	<0.015	0.0050	
Conductivity, mS/cm	3	0.90	0.70	0.77	0.066	
Temperature, °C	3	11	8.7	10	0.70	
Turbidity, NTU	3	2.4	0.80	1.7	0.48	
pH, standard units	3	8.3	7.0	7.6	0.37	
White Oak Creek Headwaters[a]						
Aluminum-total	3	0.76	0.18	0.44	0.17	
Ammonia (as N)	3	0.090	<0.010	<0.040	0.025	
Antimony-total	3	<0.030	<0.030	<0.030	0	
Arsenic-total	3	<0.060	0.058	<0.059	0.00066	<118
Barium-total	3	0.046	0.013	0.029	0.0095	2.9
Beryllium-total	3	<0.0003	<0.0003	<0.0003	0	
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0	
Boron-total	3	<0.080	<0.0040	<0.055	0.025	
Cadmium-total	3	0.017	<0.0020	<0.0073	0.0048	<73
Calcium-total	3	18	9.3	13	2.5	
Chromium-total	3	0.018	<0.0050	<0.011	0.0037	<22
Cobalt-total	3	<0.0050	<0.0030	<0.0037	0.00066	
Copper-total	3	<0.010	<0.0040	<0.0080	0.0020	<0.80
Dissolved solids-total	3	120	61	81	19	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Iron-total	3	1.0	0.067	0.42	0.29	138
Lead-total	3	<0.050	<0.050	<0.050	0	<100
Lithium-total	3	<0.20	<0.0040	<0.13	0.065	
Magnesium-total	3	7.8	4.5	6.0	0.97	
Manganese-total	3	0.010	<0.0020	<0.0047	0.0026	<9.3
Molybdenum-total	3	<0.040	<0.010	<0.030	0.010	
Nickel-total	3	<0.010	<0.0050	<0.0067	0.0016	
Nitrate	3	<5.0	<5.0	<5.0	0	<50
Oil and grease	3	<2.0	<2.0	<2.0	0	
Organic carbon-total	3	1.4	1.0	1.2	0.12	
Oxygen-dissolved	3	8.5	8.3	8.4	0.066	
Recoverable phenolics-total	3	<0.0010	<0.0010	<0.0010	0	
Selenium-total	3	<0.060	<0.050	<0.057	0.0033	<566
Silicon-total	3	4.4	3.0	3.5	0.43	
Silver-total	3	<0.0060	<0.0050	<0.0053	0.00033	<10
Sodium-total	3	1.2	0.51	0.75	0.22	
Strontium-total	1	0.0083	0.0083	0.0083		
Sulfate (as SO_4)	3	<5.0	<5.0	<5.0	0	<2.0

Table 32 (continued)

Parameter	Number of eamples	Concentration (mg/L) Max	Min	Av	Standard error	Percentage DWL[b]
Suspended solids-total	3	10	<5.0	<6.7	1.6	
Tin-total	2	<0.050	<0.050	<0.050	0	
Titanium-total	3	0.18	<0.0030	<0.069	0.055	
Vanadium-total	3	0.48	<0.0050	<0.17	0.15	
Zinc-total	3	0.030	0.0030	0.017	0.0078	0.34
Zirconium-total	3	<0.020	<0.0050	<0.015	0.0050	
Conductivity, mS/cm	3	0.50	0.40	0.47	0.033	
Temperature, °C	3	13	8.8	11	1.2	
Turbidity, NTU	3	4.1	1.0	2.4	0.90	
pH, standard units	3	7.6	7.3	7.4	0.088	

[a]See Fig. 5.
[b]Average concentration as a percentage of National Primary or Secondary Drinking Water Regulation level.

Table 33. Organic surface water analyis at reference locations, January-March 1989

Parameter	Number of samples	Concentration (μg/L) Max	Min	Av	Standard error	Percentage[a] DWL
		Melton Hill Dam[b]				
1,1,1-Trichloroethane	3	<5.0	<5.0	<5.0	0	<2.5
1,1,2,2-Tetrachloroethane	3	<5.0	<5.0	<5.0	0	
1,1,2-Trichloroethane	3	<5.0	<5.0	<5.0	0	
1,1-Dichloroethane	3	<5.0	<5.0	<5.0	0	
1,1-Dichloroethene	3	<5.0	<5.0	<5.0	0	
1,2-Dichloroethane	3	<5.0	<5.0	<5.0	0	<1.0
1,2-Dichloroethene	3	<5.0	<5.0	<5.0	0	
1,2-Dichloropropane	3	<5.0	<5.0	<5.0	0	
2-Butanone	3	<10	<10	<10	0	
2-Hexanone	3	<10	<10	<10	0	
4-Methyl-2-pentanone	3	<10	<10	<10	0	
Acetone	3	<10	<10	<10	0	
Benzene	3	<5.0	<5.0	<5.0	0	<100
Bromodichloromethane	3	<5.0	<5.0	<5.0	0	
Bromoform	3	<5.0	<5.0	<5.0	0	
Bromomethane	3	<10	<10	<10	0	
Carbon disulfide	3	<5.0	<5.0	<5.0	0	
Carbon tetrachloride	3	<5.0	<5.0	<5.0	0	<100
Chlorobenzene	3	<5.0	<5.0	<5.0	0	
Chloroethane	3	<10	<10	<10	0	
Chloroform	3	<5.0	<5.0	<5.0	0	
Chloromethane	3	<10	<10	<10	0	
Dibromochloromethane	3	<5.0	<5.0	<5.0	0	
Ethylbenzene	3	<5.0	<5.0	<5.0	0	
Methylene chloride	3	~2.0	~0.70	~1.2	0.40	
PCB-1016	3	<0.60	<0.60	<0.60	0	
PCB-1221	3	<0.60	<0.60	<0.60	0	
PCB-1232	3	<0.60	<0.60	<0.60	0	
PCB-1242	3	<0.60	<0.60	<0.60	0	
PCB-1248	3	<0.60	<0.60	<0.60	0	
PCB-1254	3	<1.1	<1.1	<1.1	0	
PCB-1260	3	<1.1	<1.1	<1.1	0	
Styrene	3	<5.0	<5.0	<5.0	0	
Tetrachloroethene	3	<5.0	<5.0	<5.0	0	
Toluene	3	<5.0	<5.0	<5.0	0	
Trichloroethene	3	<5.0	<5.0	<5.0	0	
Vinyl acetate	3	<10	<10	<10	0	
Vinyl chloride	3	<10	<10	<10	0	
Xylene-total	3	<5.0	<5.0	<5.0	0	
cis-1,3-Dichloropropene	3	<5.0	<5.0	<5.0	0	
trans-1,3-Dichloropropene	3	<5.0	<5.0	<5.0	0	

Table 33 (continued)

Parameter	Number of samples	Concentration (μg/L) Max	Min	Av	Standard error	Percentage[a] DWL
		White Oak Creek Headwaters[b]				
1,1,1-Trichloroethane	3	<5.0	<5.0	<5.0	0	<2.5
1,1,2,2-Tetrachloroethane	3	<5.0	<5.0	<5.0	0	
1,1,2-Trichloroethane	3	<5.0	<5.0	<5.0	0	
1,1-Dichloroethane	3	<5.0	<5.0	<5.0	0	
1,1-Dichloroethene	3	<5.0	<5.0	<5.0	0	
1,2-Dichloroethane	3	<5.0	<5.0	<5.0	0	<1.0
1,2-Dichloroethene	3	<5.0	<5.0	<5.0	0	
1,2-Dichloropropane	3	<5.0	<5.0	<5.0	0	
2-Butanone	3	<10	<10	<10	0	
2-Hexanone	3	<10	<10	<10	0	
4-Methyl-2-pentanone	3	<10	<10	<10	0	
Acetone	3	<10	~4.0	~8.0	2.0	
Benzene	3	<5.0	<5.0	<5.0	0	<100
Bromodichloromethane	3	<5.0	<5.0	<5.0	0	
Bromoform	3	<5.0	<5.0	<5.0	0	
Bromomethane	3	<10	<10	<10	0	
Carbon disulfide	3	<5.0	<5.0	<5.0	0	
Carbon tetrachloride	3	<5.0	<5.0	<5.0	0	<100
Chlorobenzene	3	<5.0	<5.0	<5.0	0	
Chloroethane	3	<10	<10	<10	0	
Chloroform	3	<5.0	<5.0	<5.0	0	
Chloromethane	3	<10	<10	<10	0	
Dibromochloromethane	3	<5.0	<5.0	<5.0	0	
Ethylbenzene	3	<5.0	<5.0	<5.0	0	
Methylene chloride	3	~1.0	~0.50	~0.83	0.16	
PCB-1016	3	<0.60	<0.60	<0.60	0	
PCB-1221	3	<0.60	<0.60	<0.60	0	
PCB-1232	3	<0.60	<0.60	<0.60	0	
PCB-1242	3	<0.60	<0.60	<0.60	0	
PCB-1248	3	<0.60	<0.60	<0.60	0	
PCB-1254	3	<1.1	<1.1	<1.1	0	
PCB-1260	3	<1.1	<1.1	<1.1	0	
Styrene	3	<5.0	<5.0	<5.0	0	
Tetrachloroethene	3	<5.0	<5.0	<5.0	0	
Toluene	3	<5.0	<5.0	<5.0	0	
Trichloroethene	3	<5.0	<5.0	<5.0	0	
Vinyl acetate	3	<10	<10	<10	0	
Vinyl chloride	3	<10	<10	<10	0	
Xylene-total	3	<5.0	<5.0	<5.0	0	
cis-1,3-Dichloropropene	3	<5.0	<5.0	<5.0	0	
trans-1,3-Dichloropropene	3	<5.0	<5.0	<5.0	0	

[a]See Fig. 5.

[b]Average concentration as a percentage of National Primary or Secondary Drinking Water Regulation level.

3.2 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REQUIREMENTS

ORNL's current NPDES permit requires that ten point-source outfalls be sampled before 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 [Oak Ridge Reservation (ORR) Resin Regeneration Facility] that was taken out of operation in December 1986. These thirteen sampling locations are shown in Fig. 7. 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.

Summary statistics for the first quarter of 1989 are given for each sampling location in Tables 34 through 49. 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 on request. Noncompliances are provided in Tables 50 through 52. A brief summary of the noncompliances follows.

<u>January 1989</u>

On January 17 a temporary low-pH exceedance was measured at the 1500 area sampling location (X03). The exceedance was attributed to an unintentional discharge of low-pH liquid into a laboratory drain.

Based on a daily maximum concentration of 32 mg/L and a flow of 342,970 gal, the kilograms per day limit for total suspended solids was exceeded on January 18 at the Sewage Treatment Plant (X01). Operational personnel indicated that no unusual conditions or upsets occurred.

The residual chlorine exceedances at cooling towers 2535 and 2539 on January 27 were attributed to the use of bromine biocide. A change to chlorine biocide is in progress for the two towers.

<u>February 1989</u>

The total suspended solids violation reported on February 17 at category II outfall 209 was attributed to debris in runoff from a street drain.

The February 17 total suspended solids violations at category II outfalls 243 and 281 were attributed to dirt and debris being washed from a parking lot by rainfall.

Washing of debris by rainfall from a construction area (Steam Distribution System Project) was the cause for the total suspended solids violations at category II outfalls 204, 209, 216, 225, 243, 263, and 281 on February 17.

Table 34. NPDES discharge point X01,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error
Ammonia (as N)	39	1.3	0.0060	0.12	0.039
Biochemical oxygen demand	39	<5.0	<5.0	<5.0	0
Bromodichloromethane	3	~0.0020	~0.0010	~0.0017	0.00033
Chlorine-total residual	39	0.45	<0.010	<0.27	0.018
Copper-total	3	0.060	<0.0040	<0.025	0.018
Cyanide-total	3	<0.0020	<0.0020	<0.0020	0
Downstream pH, standard units	13	7.9	6.7	NA[b]	NA
Fecal coliform, col/100 mL[c]	39	120	<1.0	1.25733	1.15656
Flow, Mgd	62	0.49	0.15	0.24	0.010
Mercury-total	3	<0.00020	<0.00020	<0.00020	0
Oil and grease	39	9.0	<2.0	<2.4	0.20
Oxygen-dissolved	62	10	6.1	8.2	0.12
pH, standard units	13	7.5	6.6	NA	NA
Recoverable phenolics-total	3	0.0020	<0.0010	<0.0013	0.00033
Silver-total	3	<0.0060	<0.0050	<0.0057	0.00033
Suspended solids-total	39	32	<2.0	<6.0	0.78
Trichloroethene	3	<0.0050	~0.00080	~0.0036	0.0014
Zinc-total	3	0.077	0.055	0.067	0.0065

[a]Sewage Treatment Plant, ORNL.
[b]NA = not applicable.
[c]Geometric mean.

Table 35. NPDES discharge point X02,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error
Arsenic-total	13	0.29	0.033	0.10	0.021
Cadmium-total	13	0.017	<0.0020	<0.0062	0.0016
Chromium-total	13	0.041	<0.0050	<0.014	0.0028
Copper-total	13	0.067	<0.0040	<0.015	0.0047
Downstream pH, standard units	62	8.9	6.4	NA[b]	NA
Flow, Mgd	62	0.24	0.000013	0.044	0.0053
Iron-total	13	0.54	0.035	0.21	0.044
Lead-total	13	<0.050	<0.030	<0.048	0.0015
Manganese-total	13	0.072	<0.0020	<0.024	0.0078
Nickel-total	13	0.021	<0.0050	<0.010	0.0016
Oil and grease	13	31	<2.0	<5.2	2.3
pH, standard units	62	11	3.1	NA	NA
Selenium-total	13	<0.060	<0.030	<0.055	0.0031
Silver-total	13	0.021	<0.0050	<0.0065	0.0012
Sulfate, as (SO_4)	3	1000	580	760	120
Suspended solids-total	13	23	<2.0	<7.4	1.4
Temperature, °C	62	21	4.7	11	0.49
Zinc-total	13	0.056	<0.0080	<0.021	0.0046

[a]Coal Yard Runoff Facility, ORNL.
[b]NA = not applicable.

Table 36. NPDES discharge point X03,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error
Arsenic-total	6	<0.060	<0.050	<0.055	0.0022
Cadmium-total	6	0.016	<0.0020	<0.0047	0.0023
Chromium-total	6	0.050	<0.0050	<0.023	0.0081
Copper-total	6	0.020	0.0050	0.011	0.0020
Downstream pH, standard units	13	7.9	5.8	NA[b]	NA
Flow, Mgd	3	0.041	0.010	0.024	0.0089
Iron-total	6	0.19	<0.0040	<0.072	0.028
Lead-total	6	<0.055	<0.050	<0.051	0.00083
Nickel-total	6	0.033	<0.0050	<0.012	0.0045
Oil and grease	6	5.0	<2.0	<2.8	0.54
Organic carbon-total	6	4.4	3.3	3.8	0.15
pH, standard units	13	7.9	3.4	NA	NA
Phosophorus-total	6	0.68	0.30	0.47	0.063
Suspended solids-total	6	<5.0	<5.0	<5.0	0
Temperature, °C	13	19	11	15	0.51
Zinc-total	6	0.18	0.040	0.12	0.019

[a]1500 area, ORNL.
[b]NA = not applicable.

Table 37. NPDES discharge point X04,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L)			
		Max	Min	Av	Standard error
Arsenic-total	6	0.060	<0.050	<0.058	0.0017
Cadmium-total	6	0.018	<0.0020	<0.0050	0.0026
Chromium-total	6	0.020	<0.0050	<0.0096	0.0023
Copper-total	6	0.016	<0.0040	<0.011	0.0017
Downstream pH, standard units	13	7.8	6.9	NA[b]	NA
Flow, Mgd	1	0.0095	0.0095	0.0095	
Lead-total	6	0.23	<0.050	<0.080	0.030
Nickel-total	6	<0.010	<0.0050	<0.0067	0.0011
Oil and grease	6	10	<2.0	<5.3	1.5
Organic carbon-total	6	2.2	1.2	1.6	0.14
pH, standard units	13	7.8	6.5	NA	NA
Phosophorus-total	6	0.50	0.20	0.35	0.043
Silver-total	6	0.029	<0.0050	<0.0097	0.0039
Suspended solids-total	6	<5.0	<5.0	<5.0	0
Temperature, °C	13	14	9.8	12	0.38
Zinc-total	6	0.17	0.025	0.11	0.022

[a]2000 area, ORNL.
[b]NA = not applicable.

Table 38. NPDES discharge point X06,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error
Arsenic-total	6	<0.060	0.040	0.053	0.0033
Cadmium-total	6	0.022	<0.0020	<0.0058	0.0032
Chromium-total	6	0.11	<0.010	<0.043	0.016
Copper-total	6	0.15	0.012	0.050	0.020
Downstream pH, standard units	13	7.9	6.5	NA[b]	NA
Flow, Mgd	3	0.17	0.15	0.16	0.0055
Lead-total	6	0.13	<0.050	<0.065	0.013
Nickel-total	6	0.017	<0.0050	<0.010	0.0018
Oil and grease	6	3.0	<2.0	<2.2	0.17
Organic carbon-total	6	6.3	2.9	4.5	0.57
pH, standard units	13	7.7	6.2	NA	NA
Selenium-total	6	<0.060	<0.030	<0.052	0.0048
Sulfate (as SO_4)	6	35	28	32	1.2
Suspended solids-total	6	22	<5.0	<7.8	2.8
Temperature, °C	13	17	11	14	0.53
Zinc-total	6	0.13	0.090	0.12	0.0077

[a]3539/40 Ponds, ORNL.
[b]NA = not applicable.

Table 39. NPDES discharge point X07,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L)			
		Max	Min	Av	Standard error
Arsenic-total	6	<0.060	<0.050	<0.055	0.0022
Cadmium-total	6	0.018	<0.0020	<0.0052	0.0026
Chromium-total	6	0.014	<0.0050	<0.0092	0.0014
Copper-total	6	0.011	<0.0040	<0.0082	0.0013
Downstream pH, standard units	13	7.9	6.3	NA[b]	NA
Flow, Mgd	61	0.30	0.073	0.21	0.0055
Lead-total	6	<0.050	<0.050	<0.050	0
Nickel-total	6	0.029	<0.0050	<0.011	0.0038
Nitrate	6	9.1	<5.0	<6.1	0.70
Oil and grease	6	3.0	<2.0	<2.2	0.17
Organic carbon-total	6	2.2	1.0	1.4	0.17
pH, standard units	13	7.9	6.3	NA	NA
Silver-total	6	<0.0060	<0.0050	<0.0055	0.00022
Sulfate, as (SO_4)	6	270	180	220	16
Suspended solids-total	6	<5.0	<5.0	<5.0	0
Temperature, °C	13	18	9.2	13	0.69
Total toxic organics	6	0.039	0	0.022	0.0061
Zinc-total	6	0.025	0.0040	0.012	0.0031

[a]Process Waste Treatment Plant (3544), ORNL.
[b]NA = not applicable.

Table 40. NPDES discharge point X09,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error
Arsenic-total	6	0.096	<0.060	<0.066	0.0060
Cadmium-total	6	0.012	<0.0020	<0.0053	0.0020
Chromium-total	6	0.041	<0.0050	<0.017	0.0056
Copper-total	6	0.041	<0.010	<0.023	0.0060
Downstream pH, standard units	3	8.3	7.3	NA[b]	NA
Flow, Mgd	6	0.0097	0.0048	0.0063	0.00074
Lead-total	6	<0.050	<0.050	<0.050	0
Nickel-total	6	0.018	<0.0050	<0.010	0.0025
Nitrate	6	7.9	<5.0	<5.7	0.46
Oil and grease	6	8.0	<2.0	<3.6	0.97
Organic carbon-total	6	5.2	2.1	3.7	0.42
pH, standard units	6	8.5	7.7	NA	NA
Sulfate (as SO_4)	6	84	32	49	7.9
Suspended solids-total	6	12	<5.0	<7.3	1.1
Temperature, °C	6	16	5.4	12	2.0
Zinc-total	6	0.055	<0.0080	<0.035	0.0076

[a]HFIR waste basins, ORNL.
[b]NA = not applicable.

Table 41. NPDES discharge point X11,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error
Arsenic-total	6	<0.060	<0.050	<0.055	0.0022
Cadmium-total	6	0.016	<0.0020	<0.0048	0.0022
Chromium-total	6	0.022	<0.0050	<0.011	0.0024
Copper-total	6	0.020	<0.010	<0.015	0.0020
Downstream pH, standard units	13	8.1	6.5	NA[b]	NA
Flow, Mgd	3	0.29	0.023	0.12	0.085
Lead-total	6	<0.050	<0.050	<0.050	0
Nickel-total	6	<0.010	<0.0050	<0.0081	0.00091
Nitrate	13	<50	<5.0	<8.5	3.5
Oil and grease	6	3.0	<2.0	<2.3	0.21
Organic carbon-total	13	8.5	1.1	5.5	0.61
pH, standard units	13	7.9	6.2	NA	NA
Phosophorus-total	6	4.6	1.7	3.4	0.39
Sulfate (as SO_4)	13	2700	930	1900	160
Suspended solids-total	6	35	8.0	25	4.7
Temperature, °C	13	21	13	15	0.71
Zinc-total	6	0.97	0.37	0.65	0.094

[a]3518 Acid Neutralization Plant, ORNL.
[b]NA = not applicable.

Table 42. NPDES discharge point X13,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error
Aluminum-total	3	0.70	0.34	0.54	0.11
Ammonia (as N)	3	0.023	0.0090	0.017	0.0043
Arsenic-total	3	<0.060	<0.050	<0.053	0.0033
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	~0.00060	~0.0035	0.0015
Chromium-total	3	0.016	<0.010	<0.012	0.0020
Conductivity, mS/cm	3	1.4	0.60	0.90	0.25
Copper-total	3	0.23	<0.0040	<0.080	0.075
Dissolved solids-total	3	200	150	170	15
Flow, Mgd	62	73	0.64	7.1	2.1
Fluoride-total	3	<1.0	<1.0	<1.0	0
Iron-total	3	0.45	0.18	0.35	0.084
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.090	<0.0020	<0.058	0.028
Mercury-total	3	<0.00005	<0.00005	<0.00005	0
Nickel-total	3	<0.010	0.0072	0.0091	0.00093
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	88	<2.0	<9.5	6.6
Organic carbon-total	3	2.3	1.6	1.9	0.21
Oxygen-dissolved	13	15	6.3	9.7	0.57
PCB-total	3	<0.00050	<0.00050	<0.00050	0
pH, standard units	3	8.0	7.3	NA[b]	NA
Phosophorus-total	3	0.10	0.10	0.10	0
Recoverable phenolics-total	3	0.0030	<0.0010	<0.0023	0.00067
Silver-total	3	<0.0050	<0.0050	<0.0050	0
Sulfate, as SO_4	3	25	22	23	1.0
Suspended solids-total	3	14	<5.0	<9.7	2.6
Temperature, °C	16	18	5.2	8.6	0.92
Trichloroethene	3	~0.0020	~0.00030	~0.00093	0.00054
Turbidity, JTU[c]	3	140	10	57	42
Zinc-total	3	0.014	<0.0080	<0.011	0.0017

[a]Melton Branch, ORNL.
[b]NA = not applicable.
[c]Measured in Jackson Turbidity Units.

Table 43. NPDES discharge point X14,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error
Aluminum-total	3	1.0	0.13	0.44	0.28
Ammonia (as N)	3	0.10	0.018	0.066	0.025
Arsenic-total	3	<0.060	<0.050	<0.053	0.0033
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	~0.0040	~0.0043	0.00033
Chromium-total	3	0.035	<0.010	<0.018	0.0083
Conductivity, mS/cm	3	1.4	0.60	0.90	0.25
Copper-total	3	0.15	<0.0040	<0.055	0.048
Dissolved solids-total	3	200	160	190	12
Flow, MGD	62	81	4.1	12	1.5
Fluoride-total	3	1.0	1.0	1.0	0
Iron-total	3	0.79	0.20	0.43	0.18
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.089	0.032	0.054	0.018
Mercury-total	3	0.00006	<0.00005	<0.000053	0.0000033
Nickel-total	3	<0.010	<0.0050	<0.0083	0.0017
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	4.0	<2.0	<2.5	0.24
Organic carbon-total	3	2.1	1.5	1.9	0.19
Oxygen-dissolved	13	12	6.1	9.4	0.44
PCB-total	3	<0.00050	<0.00050	<0.00050	0
pH, standard units	3	8.3	7.2	NA[b]	NA
Phosophorus-total	3	0.40	0.20	0.27	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	47	36	41	3.3
Suspended solids-total	3	5.0	<5.0	<5.0	0
Temperature, °C	16	20	7.7	11	0.77
Trichloroethene	3	<0.0050	~0.00060	~0.0035	0.0015
Turbidity, JTU[c]	3	36	16	26	5.8
Zinc-total	3	0.050	0.035	0.042	0.0044

[a]White Oak Creek, ORNL.
[b]NA = not applicable.
[c]Measured in Jackson Turbidity Units.

Table 44. NPDES discharge point X15,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error
Aluminum-total	3	0.81	0.46	0.68	0.11
Ammonia (as N)	3	0.060	0.011	0.033	0.014
Arsenic-total	3	0.090	<0.050	<0.067	0.012
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	~0.0020	~0.0020	~0.0020	0
Chromium-total	3	0.024	<0.010	<0.018	0.0043
Conductivity, mS/cm	3	1.2	0.60	0.83	0.19
Copper-total	3	0.13	0.0050	0.049	0.041
Dissolved solids-total	3	200	140	180	19
Flow, Mgd	62	150	6.5	22	3.3
Fluoride-total	3	1.0	<1.0	<1.0	0
Iron-total	3	0.95	0.20	0.48	0.24
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.10	<0.0020	<0.050	0.028
Mercury-total	3	0.00009	<0.00005	<0.000063	0.000013
Nickel-total	3	<0.010	<0.0050	<0.0083	0.0017
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	10	<2.0	<3.6	0.66
Organic carbon-total	3	2.0	1.7	1.9	0.10
Oxygen-dissolved	13	14	5.5	9.3	0.68
PCB-total	3	<0.00050	<0.00050	<0.00050	0
pH, standard units	3	8.2	7.1	NA[b]	NA
Phosophorus-total	3	0.20	0.10	0.17	0.033
Silver-total	3	<0.0050	<0.0050	<0.0050	0
Sulfate, as SO_4	3	38	30	33	2.5
Suspended solids-total	3	32	<5.0	<19	7.8
Temperature, °C	16	20	5.5	11	1.0
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU[c]	3	32	10	24	7.0
Zinc-total	3	0.038	0.020	0.031	0.0057

[a]White Oak Dam, ORNL.
[b]NA = not applicable.
[c]Measured in Jackson Turbidity Units.

Table 45. NPDES miscellaneous source VC7002,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Fecal coliform, col/100 mL	3	60	<1.0	<36	18
Oil and grease	3	7.0	<2.0	<4.7	1.5
pH, standard units	3	7.0	6.5	NA[b]	NA
Recoverable phenolics-total	3	0.14	<0.0010	<0.046	0.045
Suspended solids-total	3	16	<5.0	<8.7	3.7

[a]Vehicle and Equipment Cleaning Facility, Building 7002.
[b]NA = not applicable.

Table 46. NPDES cooling towers,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L)			
		Max	Min	Av	Standard error
Chlorine-total residual	9	1.3	<0.010	<0.26	0.16
Chromium-total	9	<0.010	<0.010	<0.010	0
Copper-total	9	0.15	<0.0040	<0.052	0.015
Downstream pH, standard units	7	8.4	7.9	NA[b]	NA
Flow, Mgd	9	0.18	0.0026	0.026	0.019
pH, standard units	9	8.6	8.0	NA	NA
Temperature, °C	9	23	9.9	18	1.5
Zinc-total	9	0.88	0.10	0.32	0.083

[a]ORNL.
[b]NA = not applicable.

Table 47. NPDES miscellaneous outfalls, January-March 1989

Parameter	Concentration (mg/L)	
	EF7002[a]	SP2519[b]
Flow		0.000046
Oil and grease	9.0	
pH	7.1	7.7
Temperature		21

[a]Vehicle and Equipment Maintenance Facility, Building 7002.
[b]Central Steam Plant, Building 2519.

Table 48. NPDES discharge point: category II outfalls,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L)			
		Max	Min	Av	Standard error
Downstream pH, standard units	39	8.3	7.4	NA[b]	NA
Flow, Mgd	39	0.19	0.00014	0.033	0.0063
Oil and grease	39	150	<2.0	<12	4.1
pH, standard units	39	8.5	6.9	NA	NA
Suspended solids-total	39	310	<5.0	<37	9.3
Temperature, °C	39	48	5.2	12	1.3

[a]ORNL.
[b]NA = not applicable.

Table 49. NPDES discharge point: category III outfalls,[a] January-March 1989

Parameter	Number of samples	Concentration (mg/L)			
		Max	Min	Av	Standard error
Flow, Mgd	24	0.16	0.00014	0.015	0.0071
pH, standard units	24	8.2	7.1	NA[b]	NA

[a]ORNL.
[b]NA = not applicable.

Table 50. NPDES noncompliances, January 1989

Station	Parameter	Concentration (mg/L) Daily Maximum	Permit limit (mg/L)
Sewage Treatment Plant (X01)	Total suspended solids[a]	41.5	39.2
1500 Area (X03)	pH[b]	3.4 (daily minimum)	6.0
Cooling Systems (CS2535)	Residual chlorine	0.85	0.20
Cooling Systems (CS2539)	Residual chlorine	1.3	0.20

[a]Measured in kilograms per day.
[b]Measured in standard units.

Table 51. NPDES noncompliances, February 1989

Station	Daily max concentration (mg/L)		Permit limit (mg/L)	
	Total suspended solids	Oil and grease	Total suspended solids	Oil and grease
Category II Outfall 204	56.0	16.0	50.0	15.0
Category II Outfall 209	69.0	149.0	50.0	15.0
Category II Outfall 216	120.0		50.0	
Category II Outfall 218		17.4		15.0
Category II Outfall 225	308.0	30.0	50.0	15.0
Category II Outfall 230		17.0		15.0
Category II Outfall 233		24.0		15.0
Category II Outfall 243	94.0		50.0	
Category II Outfall 263	161.0		50.0	
Category II Outfall 281	121.0		50.0	

Table 52. NPDES noncompliances, March 1989

Station	Parameter	Concentration (mg/L) Daily Maximum	Permit limit (mg/L)
Coal Yard Runoff Treatment Facility (X02)	pH[a]	3.1 (daily minimum)	6.0
Coal Yard Runoff Treatment Facility (X02)	pH	11.4	9.0
Category II Outfall 227	Oil and grease	43.0	15.0
Category II Outfall 244	Oil and grease	55.0	15.0
Coal Yard Runoff Treatment Facility (X02)	Oil and grease	31.0	20.0

[a]Measured in standard units.

February 1989

The total suspended solids violation reported on February 17 at category II outfall 209 was attributed to debris in runoff from a street drain.

The February 17 total suspended solids violations at category II outfalls 243 and 281 were attributed to dirt and debris being washed from a parking lot by rainfall.

Washing of debris by rainfall from a construction area (Steam Distribution System Project) was the cause for the total suspended solids violations at category II outfalls 204, 209, 216, 225, 243, 263, and 281 on February 17.

The oil and grease exceedances on February 17 at Category II Outfalls 204 and 233 were caused by rain runoff from a construction area. The oil and grease exceedance on the same date at Category II Outfall 225 is under investigation.

Normal street drain runoff was the reason for the Outfall 209, 218, and 230 oil and grease exceedances.

March 1989

Equipment malfunction was the cause for the Coal Yard Runoff Treatment Facility (X02) minimum pH exceedance on March 14 and the maximum pH exceedance on March 15. The equipment was repaired on March 16.

The oil and grease exceedance of March 20 at Category II Outfall 227 was caused by rain runoff from a construction area.

Normal street drain runoff was the reason for the Category II Outfall 244 oil and grease violation that occurred on March 20.

The oil and grease exceedance on March 28 at X02 was attributed to heavy equipment present during sludge removal.

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 (Fig. 8). A total of nine sites was sampled; four on White Oak Creek (including one at White Oak Dam), one on Melton Branch, and four on the Clinch River. Two samples per site were taken for water, and one sample per site was taken for sediment during January through March, 1989. This was done to comply with the Clean Water Act (CWA) and is a requirement of ORNL's NPDES permit. 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 samples are being analyzed quarterly for aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260. Sediment samples are being analyzed semiannually.

Water and sediment 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 days before extraction, and the sediment can be

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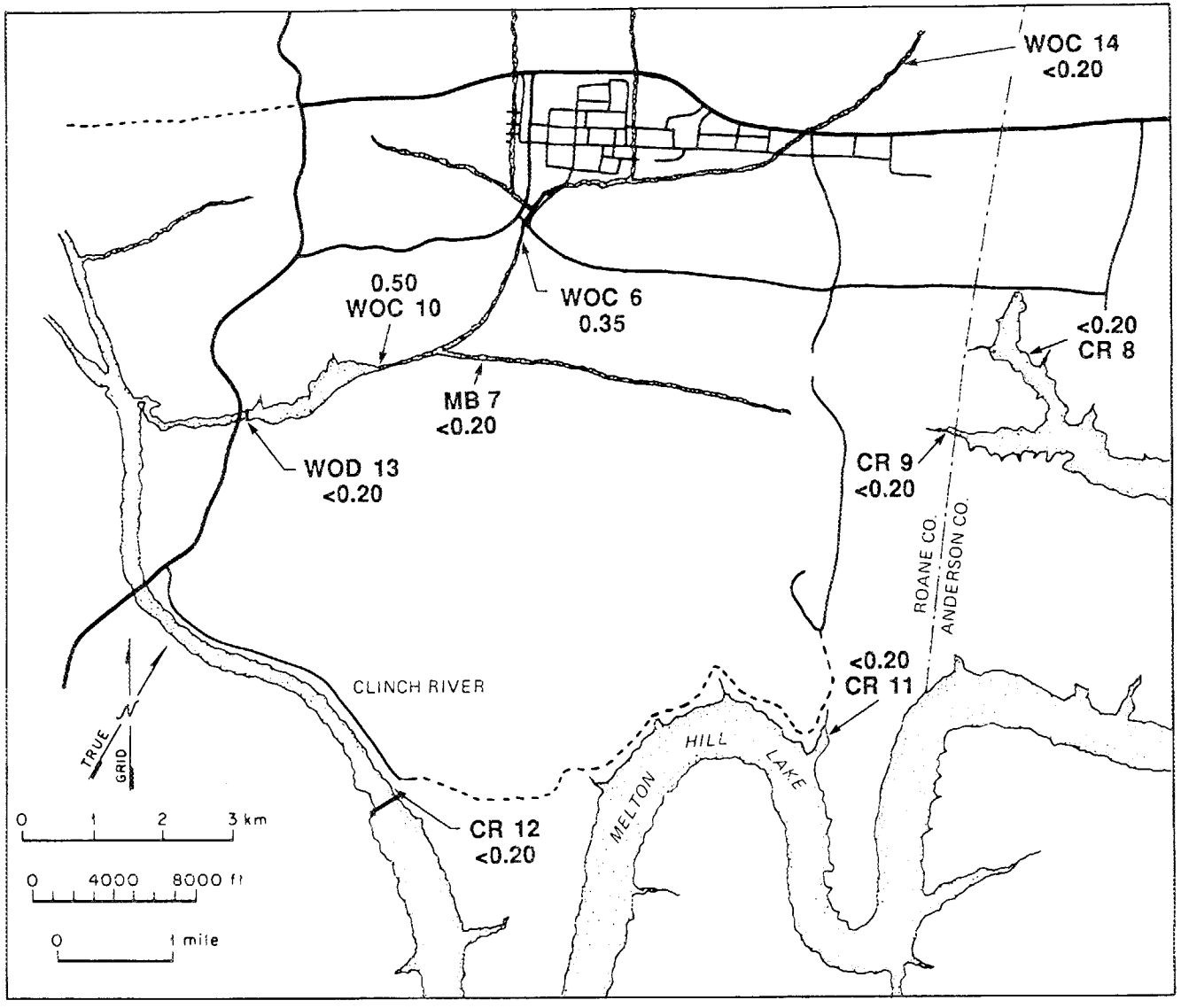

Fig. 8. PCB sampling points and sediment concentrations in $\mu g/g$.

held for a maximum of 3 days 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, as well as total PCB content.

There are currently no regulatory guidelines for PCB concentrations in stream sediment. The EPA acute criteria for the protection of fish and aquatic life is 2.0 μg/L for PCBs. The data 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 January-March 1989 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 μg/L. The detection limit for PCB aroclors 1254 and 1260 is 1.2 μg/L. Data from the water samples are not listed because all were below detection limits.

The results from the total PCB analyses in sediment are shown in Fig. 8. Two locations had results above detection limits. WOC6 had a concentration of 0.35 μg/g, and WOC10 had a concentration of 0.50 μg/g. All other locations were below detection limits. The data support findings from 1988 sampling, and suggest that PCB contamination originates primarily at ORNL buildings. WOC6 and WOC10 are the closest sampling locations downstream from the ORNL buildings.

3.4 MERCURY IN THE AQUATIC ENVIRONMENT

During January through March 1989, monthly samples of surface water and stream sediment in the Bethel and Melton valleys were analyzed for mercury content. A total of 267 surface water samples and 36 sediment samples were taken from 89 surface water locations and 12 sediment locations (Figs. 9 and 10). This was done in compliance with the Clean Water Act and ORNL's National Pollutant Discharge Elimination System (NPDES) permit. The primary purpose of this effort is to identify, locate, and minimize all sources of mercury contamination in ORNL discharges to the aquatic environment.

In previous years, before stringent regulations came into effect, 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 (Fig. 9). These processes are no longer in operation at ORNL. During the time of operation, an unknown number of mercury spills took place. The spills were cleaned up; however, quantities of mercury escaped and reached the surrounding environment. The sampling locations have been placed in areas surrounding known mercury spills. Sampling locations have also been placed near outfalls from building areas with a past history of mercury concern and outfalls from storage area, spill area, roof, and parking lot drains. Additional sampling locations have been placed downstream from the outfalls and drains to determine the extent to which any mercury is being transported in the surface water and sediment. The surface water sampling

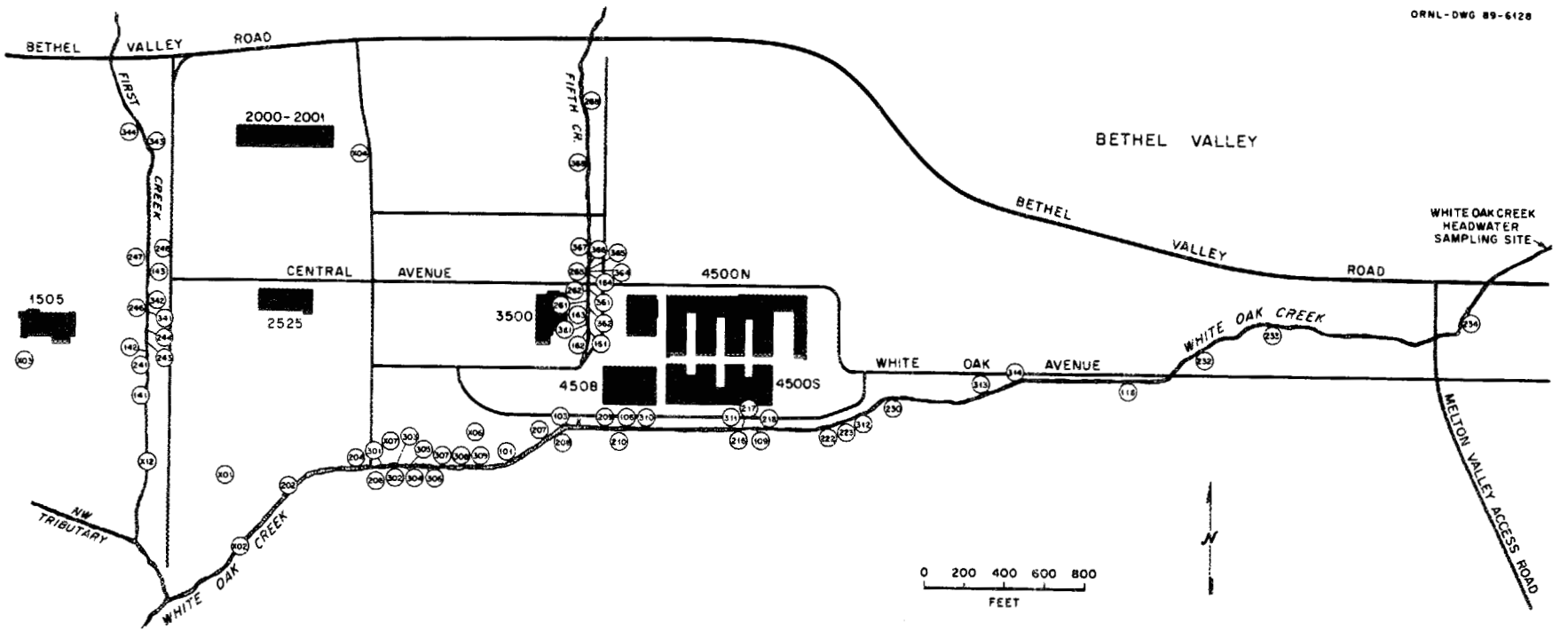

Fig. 9. Location map of mercury sampling points around ORNL in Bethel Valley.

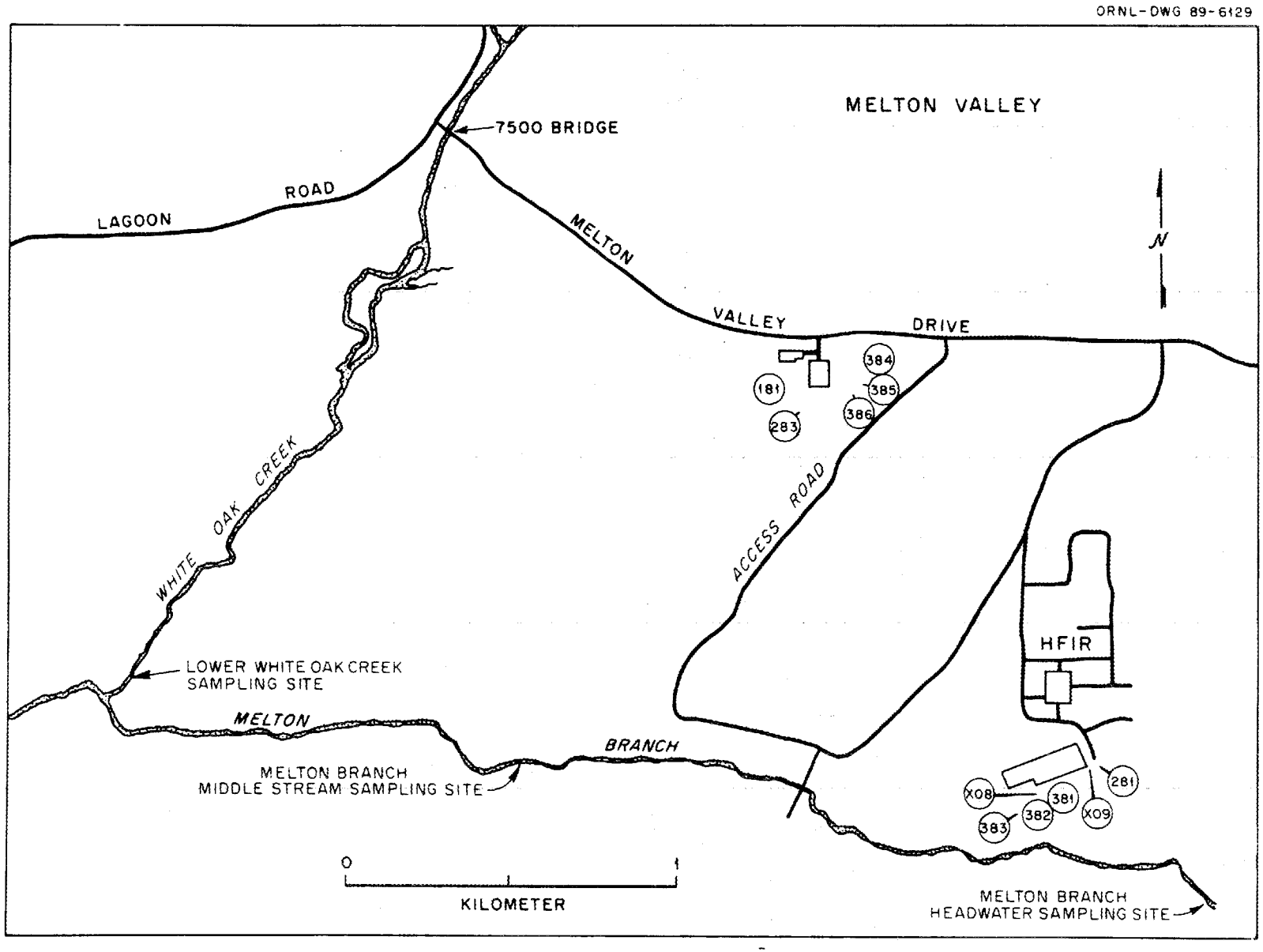

Fig. 10. Location map of mercury sampling points in Melton Valley.

locations are shown on Figs. 9 and 10. Many of the sediment locations are not currently shown on the map. These include: 1STUNW and NWTU1S, both of which are near the confluence of First Creek and the Northwest Tribuary; MB2UWE, which is located at the Melton Branch Middle Stream Sampling Site; MBUWOC and WOCMBS, which are located near the Lower White Oak Creek Sampling Site; WOCD1S, which is located near the confluence of White Oak Creek and First Creek; WOCHWS, which is located at the White Oak Creek headwaters sampling site; and WOCU5T, which is located near the confluence of White Oak Creek and Fifth Creek.

The surface water samples were collected by the manual grab method and placed in 1-L polyethylene bottles with polyethylene caps. The sediment samples were also collected by manual grab and placed in glass containers. The samples were analyzed for total mercury content by manual cold vapor atomic absorption.

Table 53 shows the maximum, minimum, and average concentrations in surface water for the period of January through March 1989. The standard error of the mean is also included. The proposed Tennessee Water Quality Standard for the protection of fish and aquatic life is 2.4 μg/L (ppb) for the acute criteria. The percentage TWQ column shows the average value as a percentage of this limit for each sampling location. The highest average values reported during this period were at locations 304 and 367. Sampling location 304, near Building 3544—the Process Waste Water Treatment Plant, had an average concentration of 2.0 μg/L, which is 82% of the proposed fish and aquatic life standard limit. Sampling location 367, near Building 3036—the Isotopes Area Storage and Service Building, had an average concentration of 3.0 μg/L, which is 130% of the proposed standard.

Table 54 shows the maximum, minimum, and average concentrations in sediment for the period of January through March 1989. The standard error of the mean is also included. There is no established state or EPA standard for mercury in sediment. The highest average values reported during this period were at locations 2615TH and 362BOX. Sampling location 2615TH had an average concentration of 560 μg/g, which is higher than the other sediment samples during this time period. This location is downstream from the 3675TH water sampling point and reflects the high mercury levels found in the surface water at that point. Sampling location 362BOX had an average concentration of 160 μg/g. This sampling location is slightly farther downstream from 2615TH and also shows a relatively higher level of mercury than other sampling locations during this period.

Table 53. Mercury concentrations in surface water, January-March 1989[a]

Station	Number of samples	Concentration (μg/L) Max	Min	Av	Standard error	Percentage[b] TWQ
			First Creek			
141	3	<0.050	<0.050	<0.050	0	<2.1
142	3	<0.050	<0.050	<0.050	0	<2.1
143	3	<0.050	<0.050	<0.050	0	<2.1
241	3	<0.050	<0.050	<0.050	0	<2.1
243	3	<0.050	<0.050	<0.050	0	<2.1
244	3	<0.050	<0.050	<0.050	0	<2.1
246	3	<0.050	<0.050	<0.050	0	<2.1
247	3	<0.050	<0.050	<0.050	0	<2.1
248	3	<0.050	<0.050	<0.050	0	<2.1
341	3	<0.050	<0.050	<0.050	0	<2.1
342	3	<0.050	<0.050	<0.050	0	<2.1
343	3	<0.050	<0.050	<0.050	0	<2.1
344	3	<0.050	<0.050	<0.050	0	<2.1
X12	3	<0.050	<0.050	<0.050	0	<2.1
Stream summary	42	<0.050	<0.050	<0.050	0	<2.1
			Fifth Creek			
161	3	<0.050	<0.050	<0.050	0	<2.1
162	3	<0.050	<0.050	<0.050	0	<2.1
163	3	<0.050	<0.050	<0.050	0	<2.1
164	3	<0.050	<0.050	<0.050	0	<2.1
261	3	0.50	<0.050	<0.25	0.13	<10
262	3	<0.050	<0.050	<0.050	0	<2.1
265	3	<0.050	<0.050	<0.050	0	<2.1
268	3	<0.050	<0.050	<0.050	0	<2.1
361	3	<0.050	<0.050	<0.050	0	<2.1
362	3	<0.050	<0.050	<0.050	0	<2.1
363	3	0.60	0.30	0.50	0.10	21
364	3	<0.050	<0.050	<0.050	0	<2.1
365	3	<0.050	<0.050	<0.050	0	<2.1
366	3	<0.050	<0.050	<0.050	0	<2.1
367	3	3.7	2.6	3.0	0.34	130
368	3	<0.050	<0.050	<0.050	0	<2.1
X10	3	<0.050	<0.050	<0.050	0	<2.1
Stream summary	51	3.7	<0.050	<0.26	0.10	<11

Table 53 (continued)

Station	Number of samples	Concentration (μg/L) Max	Min	Av	Standard error	Percentage[b] TWQ
			Melton Branch			
181	3	<0.050	<0.050	<0.050	0	<2.1
281	3	<0.050	<0.050	<0.050	0	<2.1
283	3	<0.050	<0.050	<0.050	0	<2.1
381	3	<0.050	<0.050	<0.050	0	<2.1
382	3	<0.050	<0.050	<0.050	0	<2.1
383	3	<0.050	<0.050	<0.050	0	<2.1
385	3	<0.050	<0.050	<0.050	0	<2.1
386	3	<0.050	<0.050	<0.050	0	<2.1
HDWTR	3	<0.050	<0.050	<0.050	0	<2.1
MBS	3	<0.050	<0.050	<0.050	0	<2.1
MHD	3	<0.050	<0.050	<0.050	0	<2.1
X08	3	<0.050	<0.050	<0.050	0	<2.1
X09	3	<0.050	<0.050	<0.050	0	<2.1
Stream summary	42	<0.050	<0.050	<0.050	0	<2.1
			Northwest Tributary			
X03	3	<0.050	<0.050	<0.050	0	<2.1
Stream summary	3	<0.050	<0.050	<0.050	0	<2.1
			White Oak Creek			
101	3	0.20	0.10	0.13	0.033	5.6
103	3	<0.050	<0.050	<0.050	0	<2.1
106	3	<0.050	<0.050	<0.050	0	<2.1
109	3	<0.050	<0.050	<0.050	0	<2.1
116	3	<0.050	<0.050	<0.050	0	<2.1
202	3	0.70	0.50	0.60	0.058	25
204	3	<0.050	<0.050	<0.050	0	<2.1
206	3	1.0	0.30	0.70	0.21	29
207	3	0.20	0.070	0.16	0.043	6.5
208	3	<0.050	<0.050	<0.050	0	<2.1
209	3	<0.050	<0.050	<0.050	0	<2.1
210	3	<0.050	<0.050	<0.050	0	<2.1
216	3	<0.050	<0.050	<0.050	0	<2.1
217	3	<0.050	<0.050	<0.050	0	<2.1
218	3	<0.050	<0.050	<0.050	0	<2.1

Table 53 (continued)

Station	Number of samples	Concentration (μg/L) Max	Min	Av	Standard error	Percentage[b] TWQ
222	3	<0.050	<0.050	<0.050	0	<2.1
223	3	<0.050	<0.050	<0.050	0	<2.1
230	3	<0.050	<0.050	<0.050	0	<2.1
232	3	<0.050	<0.050	<0.050	0	<2.1
233	3	<0.050	<0.050	<0.050	0	<2.1
234	3	<0.050	<0.050	<0.050	0	<2.1
301	3	0.050	0.050	0.050	0	2.1
302	3	0.050	0.050	0.050	0	2.1
303	3	<0.050	<0.050	<0.050	0	<2.1
304	3	3.3	0.50	2.0	0.81	82
305	3	0.10	0.050	0.067	0.017	2.8
306	3	<0.050	<0.050	<0.050	0	<2.1
307	3	<0.050	<0.050	<0.050	0	<2.1
308	3	<0.050	<0.050	<0.050	0	<2.1
309	3	0.70	0.40	0.60	0.10	25
310	3	<0.050	<0.050	<0.050	0	<2.1
311	3	<0.050	<0.050	<0.050	0	<2.1
312	3	<0.050	<0.050	<0.050	0	<2.1
313	3	<0.050	<0.050	<0.050	0	<2.1
314	3	<0.050	<0.050	<0.050	0	<2.1
7500	3	<0.050	<0.050	<0.050	0	<2.1
FLUME	3	0.10	0.10	0.10	0	4.2
HDW	3	<0.050	<0.050	<0.050	0	<2.1
LSC	3	<0.050	<0.050	<0.050	0	<2.1
WOD	3	<0.050	<0.050	<0.050	0	<2.1
X01	3	<0.050	<0.050	<0.050	0	<2.1
X02	3	<0.050	<0.050	<0.050	0	<2.1
X04	3	0.10	0.10	0.10	0	4.2
X06	3	0.80	0.80	0.80	0	33
X07	3	<0.050	<0.050	<0.050	0	<2.1
X11	3	0.050	0.050	0.050	0	2.1
Stream summary	138	3.3	<0.050	<0.15	0.031	<6.4
Overall summary	276	3.7	<0.050	<0.14	0.025	<5.9

[a]See Figs. 9 and 10.

[b]Percentage of proposed Tennessee Water Quality Standards for the protection of fish and aquatic life.

Table 54. Mercury concentrations in stream sediment, January-March 1989[a]

Station	No. of samples	Concentration (μg/g) Max	Min	Av	Standard Error
		First Creek			
1STUNW	3	1.8	0.75	1.4	0.32
NWTU1S	3	0.39	0.17	0.27	0.064
Stream summary	6	1.8	0.17	0.82	0.28
		Fifth Creek			
2615TH	3	1100	82	560	310
3625TH	3	26	17	23	2.8
362BOX	3	420	8.8	160	130
Stream summary	9	1100	8.8	240	130
		Melton Branch			
MB2UWE	3	0.051	0.046	0.049	0.0017
Stream summary	3	0.051	0.046	0.049	0.0017
		White Oak Creek			
309WOC	3	30	11	18	6.3
MBUWOC	3	0.10	0.058	0.076	0.012
WOCD1S	3	3.6	1.9	2.8	0.50
WOCHWS	3	0.18	0.10	0.15	0.025
WOCMBS	3	3.0	0.24	1.3	0.86
WOCU5T	3	8.2	2.5	4.7	1.8
Stream summary	18	30	0.058	4.5	1.8
Overall summary	36	1100	0.046	64	35

[a]See Figs. 9 and 10.

3.5 GROUNDWATER

Groundwater in waste area grouping (WAG) 6 is monitored to comply with Federal Regulation 40 CFR, Part 265 and Tennessee's Hazardous Waste Management Rule 1200-1-11.05 for interim status facilities. Groundwater in WAG 1 is monitored to comply with 3004(u) of the Resource Conservation and Recovery Act (RCRA). Monitoring in both WAGs is 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 many types of SWMU (tanks, ponds, waste treatment facilities, leak sites, spill sites, and landfills) listed by EPA in the definition of a SWMU. A listing of the type and number of sites within WAG 1 is given in Table 55. 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 it still receives radioactive wastes. In the course of its operation, SWSA 6 has received a broad spectrum of low-level waste (LLW) materials, including radioactive and chemical hazardous wastes. The Emergency Waste Basin was constructed as a temporary emergency diversion for process wastes. 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 WAGs 1 and 6 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 first quarter of 1989 are presented in Table 56. Analyses for which no results were detected in any of the wells in the WAG were excluded from the summary tables. Table 57 is a summary of the wells in WAG 1, where several of the primary drinking water standards were exceeded. Similar tables are given for WAG 6 (Tables 58 and 59). The state of Tennessee guidelines require, for each well, four measurements of conductivity, pH, temperature, total organic carbon, and total organic halogens. In addition, per EPA guidelines, three field measurements (conductivity, pH, and temperature) are made during the course of sampling to ensure that the well water has remained stable. Thus, the number of samples listed will be four or seven times the number of samples listed for the other contaminant indicators. Some additional samples, which were analyzed for cyanide, were 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 57) except coliform in well 816. WAG 1

ORNL-DWG 87-8552

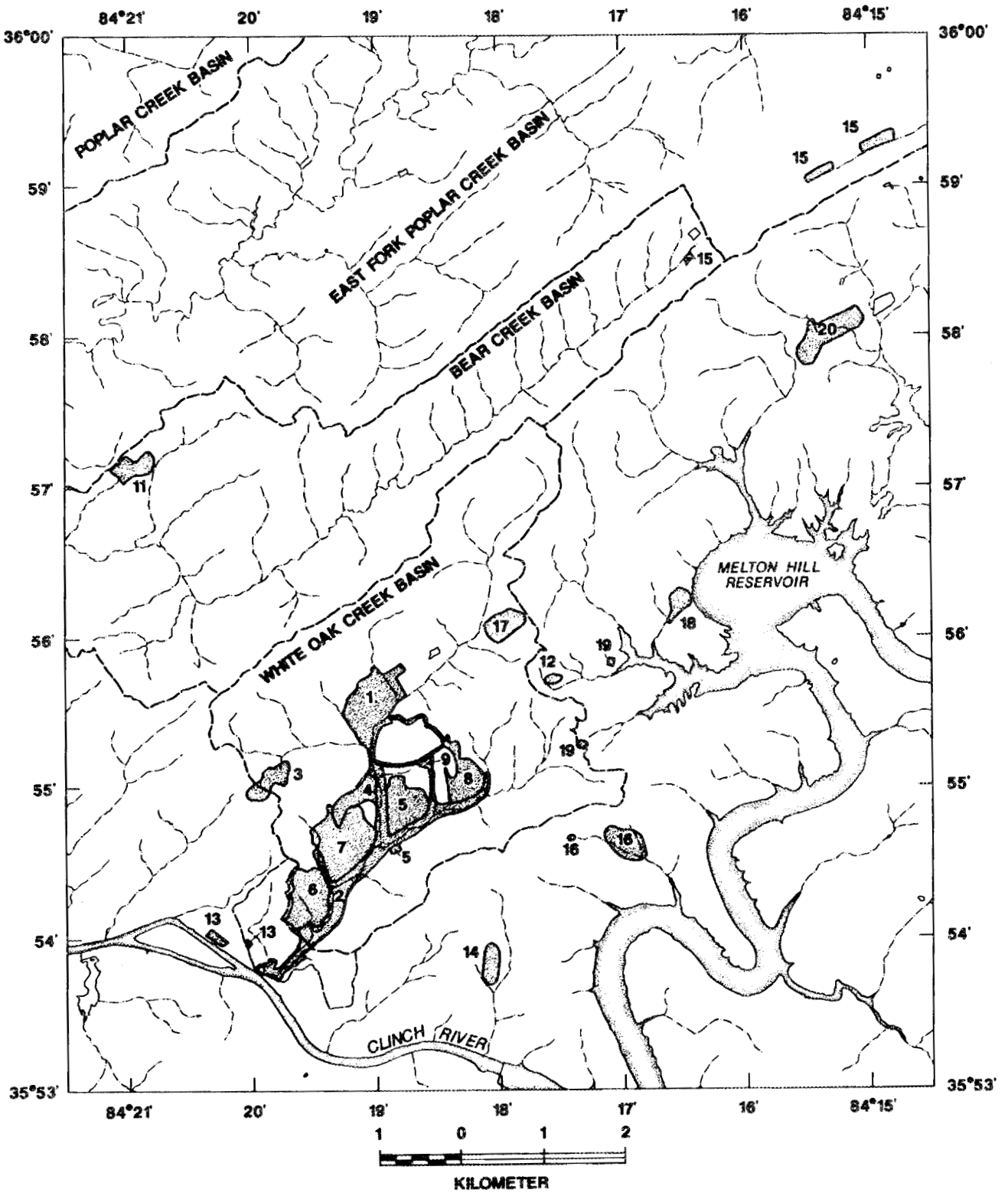

Fig. 11. Location map of ORNL WAGs.

Table 55. Listing of WAG 1 sites by type

Type of site	Number of sites
Collection and storage tanks (LLW)	
Inactive	22
Active	24
Leak/spill sites and contaminated soils	
Radioactive	30
Chemical	4
Ponds and impoundments	
Radioactive	6
Chemical	3
Waste treatment facilities	
Radioactive	2
Chemical and sewage waste	2
Solid waste storage areas	
Radioactive	3
Chemical and sewage waste	1
Miscellaneous facilities	
Chemical and sewage waste	2
Total	99

Table 56. WAG 1[a] Groundwater summary statistics, January-March 1989

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
		Perimeter Wells				
Anions, mg/L						
Chloride	17	3.1		29	92	
Cyanide-total	34	0.0020	U	0.0020	0.0020	U
Fluoride	17	1.0		1.2	3.8	
Nitrate (as N)	17	0.50	U	0.58	1.3	
Sulfate (as SO_4)	17	5.0	U	65	220	
Field measurements						
pH, standard units	119	7.0		7.6	9.3	
Conductivity, mS/cm	119	0.040		0.54	1.4	
Temperature, °C	119	12		16	30	
Metals, mg/L						
Aluminum-total	17	0.086		0.68	1.2	
Beryllium-total	17	0.00030	U	0.0003	0.00030	U
Boron-total	17	0.080	U	0.17	0.78	
Calcium-total	17	0.54		81	130	
Cobalt-total	17	0.0030	U	0.0031	0.0041	
Copper-total	17	0.010	U	0.021	0.20	
Iron-total	17	0.17		2.3	16	
Lithium-total	17	0.20	U	0.21	0.32	
Magnesium-total	17	0.43		8.0	14	
Manganese-total	17	0.010		1.1	5.6	

Table 56 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
Perimeter Wells						
Mercury-total	17	0.00010	U	0.0001	0.0010	
Nickel-total	17	0.0050	U	0.011	0.042	
Silicon-total	17	2.5		4.7	7.1	
Sodium-total	17	2.3		44	260	
Titanium-total	17	0.020	U	0.023	0.033	
Vanadium-total	17	0.0077		0.011	0.014	
Zinc-total	17	0.0080	U	0.014	0.029	
Miscellaneous						
Fecal coliform, col/100 mL	17	1.0	U	6.8	100	
Turbidity, NTU	17	0.28		9.0	50	
Radioactivity measurements, Bq/L						
^{60}Co	17	-0.50		0.33	1.5	
^{137}Cs	17	-0.50		0.17	1.2	
Gross alpha	17	-0.011		0.33	5.5	
Gross beta	17	0.0010		25	420	
Radioactive strontium-total[c]	17	-0.0030		14	230	
Radium-total	17	0.0010		0.023	0.070	
Tritium	17	-29		160	1400	

Table 56 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
		Perimeter Wells				
Extractable organics, mg/L						
Organic carbon-total	68	0.50		1.3	3.5	
Organic halides-total	68	0.0050	U	0.016	0.090	
		Upgradient Wells				
Anions, mg/L						
Chloride	6	3.5		8.7	22	
Cyanide-total	12	0.0020	U	0.0021	0.0030	
Fluoride	6	1.0	U	1.0	1.0	U
Nitrate (as N)	6	0.50	U	0.94	2.7	
Sulfate(as SO_4)	6	5.0		23	40	
Field Measurements						
pH, standard units	42	7.1		7.6	8.1	
Conductivity, mS/cm	42	0.17		0.31	0.57	
Temperature, °C	42	13		16	18	
Metals, mg/L						
Aluminum-total	6	0.050	U	0.96	2.4	
Beryllium-total	6	0.00030	U	0.0017	0.0088	
Boron-total	6	0.080	U	0.11	0.25	

Table 56 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
		Upgradient Wells				
Calcium-total	6	41		79	120	
Cobalt-total	6	0.0030	U	0.0030	0.0030	U
Copper-total	6	0.010	U	0.14	0.60	
Iron-total	6	0.22		0.65	2.3	
Lithium-total	6	0.20	U	0.20	0.20	U
Magnesium-total	6	6.2		11	24	
Manganese-total	6	0.010		0.032	0.070	
Mercury-total	6	0.00010	U	0.0001	0.00010	U
Nickel-total	6	0.0050	U	0.0087	0.015	
Silicon-total	6	3.1		6.8	8.6	
Sodium-total	6	2.6		11	23	
Titanium-total	6	0.020	U	0.030	0.059	
Vanadium-total	6	0.0040	U	0.010	0.014	
Zinc-total	6	0.0080	U	0.012	0.017	
Miscellaneous						
Fecal coliform, col/100 mL	6	1.0	U	4.2	20	
Turbidity, NTU	6	0.090		8.9	43	
Radioactivity measurements, Bq/L						
^{60}Co	6	-0.80		-0.028	0.36	
^{137}Cs	6	-0.28		-0.0050	0.40	
Gross alpha	6	0.010		0.022	0.047	
Gross beta	6	0.048		0.079	0.12	

Table 56 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
		Upgradient Wells				
Radioactive strontium-total	6	-0.017		0.044	0.16	
Radium-total	6	0.0040		0.032	0.089	
Tritium	6	13		63	110	
Extractable organics, mg/L						
Organic carbon-total	24	0.50	U	0.73	1.0	
Organic halides-total	24	0.0050	U	0.0082	0.058	

[a]See Fig. 11.
[b]U = Undetected.
[c]Radioactive strontium-total (^{89}Sr + ^{90}Sr).

Table 57. Groundwater sample analyses from monitoring wells in WAG 1, January-March 1989, whose values exceeded allowable concentrations under the primary drinking water standards[a]

Well identifier	Parameter	Concentration	Primary limit[b,c]	Units of measurement
		Perimeter Wells		
825	Fecal coliform	100	1.0	col/100 mL
811	Fluoride	3.8	1.4	mG/L
812	Gross alpha	5.5	0.56	Bq/L
812	Radioactive strontium-total[d]	230	0.30	Bq/L
806	Radioactive strontium-total[d]	2.9	0.30	Bq/L
830	Radioactive strontium-total[d]	1.5	0.30	Bq/L
829	Radioactive strontium-total[d]	0.97	0.30	Bq/L
830	Tritium	1400	740	Bq/L
		Upgradient Wells		
816	Fecal coliform	20	1.0	col/100 mL

[a]Standards are based on State of Tennessee Hazardous Waste Groundwater Regulations or EPA Federal Drinking Water Standards where no state standard exists.
[b]Safe Drinking Water Act-National Primary Drinking Water Regulations, 40 CFR 141, as amended.
[c]State of Tennessee Hazardous Waste Regulations TN 1200-1-11-05, Appendix 05/B.
[d]Radioactive strontium-total (^{89}Sr + ^{90}Sr).

Table 58. WAG 6[a] groundwater summary statistics, January-March 1989

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
Perimeter wells						
Anions, mg/L						
Chloride	15	1.0		5.3	14	
Fluoride	15	1.0	U	1.0	1.0	U
Nitrate (as N)	15	0.50	U	0.68	1.8	
Sulfate(as SO_4)	15	5.0	U	22	110	
Field measurements						
pH, standard units	105	4.7		6.5	7.4	
Conductivity, mS/cm	105	0.030		0.30	0.75	
Temperature, °C	105	9.5		13	15	
Metals, mg/L						
Aluminum-total	15	0.050	U	0.46	0.89	
Arsenic-dissolved	15	0.010	U	0.010	0.010	U
Arsenic-total	15	0.010	U	0.010	0.010	U
Barium-dissolved	15	1.0	U	1.0	1.0	U
Barium-total	15	1.0	U	1.0	1.0	U
Beryllium-total	15	0.00030	U	0.0003	0.00030	U
Calcium-total	15	0.10	U	55	130	
Cobalt-total	15	0.0030	U	0.0030	0.0030	U

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
Perimeter wells						
Copper-total	15	0.010	U	0.010	0.010	U
Iron-dissolved	15	0.050	U	0.056	0.12	
Iron-total	15	0.050	U	0.70	1.8	
Magnesium-total	15	0.010	U	5.7	8.8	
Manganese-dissolved	15	0.010	U	0.021	0.060	
Manganese-total	15	0.010		0.057	0.11	
Nickel-total	15	0.0050	U	0.0086	0.028	
Silicon-total	15	0.20	U	7.5	14	
Sodium-dissolved	15	1.1		9.6	46	
Sodium-total	15	1.1		9.9	49	
Titanium-total	15	0.024		0.028	0.033	
Vanadium-total	15	0.0080		0.011	0.012	
Zinc-total	15	0.0080	U	0.013	0.034	
Miscellaneous						
Alkalinity (as $CaCO_3$)	15	4.0		190	440	
Turbidity, NTU	15	0.10		6.2	33	
Pesticides, mg/L						
PCB-1254	15	0.00060	J	0.0011	0.0011	U

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
Perimeter wells						
Radioactivity measurements, Bq/L						
^{60}Co	15	-0.90		1.0	9.9	
^{137}Cs	15	-0.70		0.14	0.78	
Gross alpha	15	-0.0010		0.0095	0.024	
Gross beta	15	0.0040		0.59	6.8	
Radioactive strontium-total[c]	15	-0.040		0.033	0.23	
Radium-Total	15	0.0010		0.018	0.039	
Tritium	15	-50		5,400	46,000	
Extractable organics, mg/L						
Di-n-butylphthalate	15	0.011	U	0.012	0.019	
Diethyl phthalate	15	0.0030	J	0.012	0.048	
Naphthalene	15	0.0050	J	0.011	0.011	U
Organic carbon-total	60	0.50	U	0.90	4.7	
Organic halides-total	60	0.0050	U	0.032	0.41	
Recoverable phenolics-total	15	0.0010	U	0.0010	0.0010	U
2-Methylphenol	15	0.011	U	0.011	0.011	U
Volatile organics, mg/L						
Acetone	15	0.0020	JB	0.0075	0.010	U
Benzene	15	0.0030	J	0.0049	0.0050	U
Carbon tetrachloride	15	0.0050	U	0.010	0.086	
Chloroform	15	0.0050	U	0.0089	0.062	
Ethylbenzene	15	0.0020	J	0.0048	0.0050	U

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
Perimeter wells						
Methylene chloride	15	0.00080	JB	0.0009	0.0010	JB
Tetrachloroethene	15	0.0050	U	0.0050	0.0050	U
Toluene	15	0.0050	U	0.0050	0.0050	U
Trichloroethene	15	0.0050	U	0.029	0.36	E
Vinyl chloride	15	0.010	U	0.010	0.010	U
Xylene-total	15	0.0050	U	0.0054	0.011	
1,1-Dichloroethane	15	0.0030	J	0.0049	0.0050	U
1,1,1-Trichloroethane	15	0.0050	U	0.0050	0.0050	U
1,2-Dichloroethane	15	0.0050	U	0.0059	0.019	
1,2-Dichloroethene	15	0.0050	U	0.0052	0.0080	
Site Characterization Wells						
Anions, mg/L						
Chloride	8	7.8		15	33	
Fluoride	8	1.0	U	1.0	1.1	
Nitrate (as N)	8	0.50	U	0.51	0.58	
Sulfate(as SO_4)	8	5.0	U	14	48	
Field measurements						
pH, standard units	56	6.1		6.6	7.1	
Conductivity, mS/cm	56	0.26		0.54	0.88	
Temperature, °C	56	12		15	16	

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
Site Characterization Wells						
Metals, mg/L						
Aluminum-total	8	0.52		0.73	0.94	
Arsenic-dissolved	8	0.010	U	0.010	0.010	U
Arsenic-total	8	0.010	U	0.010	0.010	U
Barium-dissolved	8	1.0	U	1.2	2.7	
Barium-total	8	1.0	U	1.2	2.6	
Beryllium-total	8	0.00030	U	0.0003	0.00030	U
Calcium-total	8	51		98	140	
Cobalt-total	8	0.0030	U	0.0042	0.013	
Copper-total	8	0.010	U	0.010	0.010	U
Iron-dissolved	8	0.050	U	5.4	39	
Iron-total	8	0.25		6.1	40	
Magnesium-total	8	8.1		8.6	8.8	
Manganese-dissolved	8	0.010		1.8	12	
Manganese-total	8	0.020		1.9	13	
Nickel-total	8	0.0059		0.015	0.028	
Silicon-total	8	5.4		9.6	13	
Sodium-dissolved	8	5.9		8.2	13	
Sodium-total	8	5.6		8.0	13	
Titanium-total	8	0.024		0.028	0.031	
Vanadium-total	8	0.0082		0.010	0.014	
Zinc-total	8	0.0080	U	0.010	0.015	

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
Site Characterization Wells						
Miscellaneous						
Alkalinity (as $CaCO_3$)	8	150		340	610	
Turbidity, NTU	8	0.53		9.7	62	
Pesticides, mg/L						
PCB-1254	8	0.0010	J	0.0011	0.0011	U
Radioactivity measurements, Bq/L						
^{60}Co	8	-0.80		-0.065	0.60	
^{137}Cs	8	0.010		0.17	0.30	
Gross alpha	8	-0.010		0.016	0.029	
Gross beta	8	0.030		0.22	1.1	
Radioactive strontium-total[c]	8	-0.035		0.047	0.21	
Radium-total	8	0		0.013	0.025	
Tritium	8	110		15,000	74,000	
Extractable organics, mg/L						
Di-n-butylphthalate	8	0.011	U	0.011	0.011	U
Diethyl phthalate	8	0.011	U	0.011	0.011	U
Naphthalene	8	0.011	U	0.066	0.45	E
Organic carbon-total	32	0.60		3.4	10	
Organic halides-total	32	0.0050	U	0.25	2.1	

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
Site Characterization Wells						
Recoverable phenolics-total	8	0.0010	U	0.0045	0.029	
2-Methylphenol	8	0.011	U	0.012	0.022	
Volatile organics, mg/L						
Acetone	8	0.0020	JB	0.0081	0.024	B
Benzene	8	0.0050	U	0.018	0.096	
Carbon tetrachloride	8	0.0050	U	0.0050	0.0050	U
Chloroform	8	0.0050	U	0.0050	0.0050	U
Ethylbenzene	8	0.0050	U	0.092	0.70	E
Methylene chloride	8	0.00060	JB	0.0012	0.0020	JB
Tetrachloroethene	8	0.0040	J	0.0049	0.0050	U
Toluene	8	0.0050	U	0.24	1.9	E
Trichloroethene	8	0.0050	U	0.14	1.1	E
Vinyl chloride	8	0.010	U	0.017	0.063	
Xylene-total	8	0.0050	U	0.48	3.8	E
1,1-Dichloroethane	8	0.0050	U	0.0077	0.017	
1,1,1-Trichloroethane	8	0.0040	J	0.0049	0.0050	U
1,2-Dichloroethane	8	0.0050	U	0.0050	0.0050	U
1,2-Dichloroethene	8	0.0050	U	0.038	0.26	E

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
		Upgradient Wells				
Anions, mg/L						
Chloride	7	1.0		2.6	6.9	
Fluoride	7	1.0	U	1.0	1.0	U
Nitrate (as N)	7	0.50	U	0.50	0.50	U
Sulfate(as SO4)	7	5.0	U	65	260	
Field measurements						
pH, standard units	49	4.9		7.0	8.3	
Conductivity, mS/cm	49	0.020		0.37	0.90	
Temperature, °C	49	12		13	14	
Metals, mg/L						
Aluminum-total	7	0.050	U	0.36	0.58	
Arsenic-dissolved	7	0.010	U	0.010	0.010	U
Arsenic-total	7	0.010	U	0.010	0.010	
Barium-dissolved	7	1.0	U	1.0	1.0	U
Barium-total	7	1.0	U	1.0	1.0	U
Beryllium-total	7	0.00030	U	0.0009	0.0020	
Calcium-total	7	0.10	U	78	170	
Cobalt-total	7	0.0030	U	0.0030	0.0030	U
Copper-total	7	0.010	U	0.013	0.030	
Iron-dissolved	7	0.050	U	0.11	0.44	
Iron-total	7	0.14		0.55	1.7	
Magnesium-total	7	0.99		6.5	10	

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
		Upgradient Wells				
Manganese-dissolved	7	0.010		0.027	0.060	
Manganese-total	7	0.010		0.031	0.13	
Nickel-total	7	0.0050	U	0.0060	0.012	
Silicon-total	7	4.2		7.9	13	
Sodium-dissolved	7	0.83		7.0	17	
Sodium-total	7	0.86		7.3	18	
Strontium-total[d]	5[b]	0.060		0.20	0.35	
Titanium-total	7	0.020	U	0.022	0.027	
Vanadium-total[d]	2[b]	0.0093		0.010	0.011	
Zinc-total	7	0.0080	U	0.010	0.022	
Miscellaneous						
Alkalinity (as $CaCO_3$)	7	7.0		190	410	
Turbidity, NTU	7	0.080		20	120	
Pesticides, mg/L						
PCB-1254	7	0.0011	U	0.0011	0.0011	U
Radioactivity measurements, Bq/L						
^{60}Co	7	-0.32		0.026	0.50	
^{137}Cs	7	-0.30		-0.013	0.20	
Gross alpha	7	-0.0054		0.0041	0.017	
Gross beta	7	0.030		0.058	0.12	

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
		Upgradient Wells				
Radioactive strontium-total[c]	7	0.0050		0.044	0.087	
Radium-total	7	0.0080		0.017	0.028	
Tritium	7	-19		-7.1	9.0	
Extractable organics, mg/L						
Di-n-butylphthalate	7	0.0010	J	0.0053	0.011	U
Diethyl phthalate	7	0.011	U	0.011	0.011	U
Naphthalene	7	0.011	U	0.011	0.011	U
Organic carbon-total	28	0.40		0.66	1.1	
Organic halides-total	28	0.0050	U	0.0051	0.0080	
Recoverable phenolics-total	7	0.0010	U	0.0010	0.0010	U
2-Methylphenol	7	0.011	U	0.011	0.011	U
Volatile organics, mg/L						
Acetone	7	0.0040	JB	0.0097	0.014	B
Benzene	7	0.0050	U	0.0050	0.0050	U
Carbon tetrachloride	7	0.0050	U	0.0050	0.0050	U
Chloroform	7	0.0050	U	0.0050	0.0050	U
Ethylbenzene	7	0.0050	U	0.0050	0.0050	U
Methylene chloride	7	0.00060	JB	0.0015	0.0040	JB
Tetrachloroethene	7	0.0050	U	0.0050	0.0050	U
Toluene	7	0.0050	U	0.0050	0.0050	U
Trichloroethene	7	0.0050	U	0.0050	0.0050	U

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier[b]	Av	Max	Value qualifier[b]
		Upgradient Wells				
Vinyl chloride	7	0.010	U	0.010	0.010	U
Xylene-total	7	0.0050	U	0.0050	0.0050	U
1,1-Dichloroethane	7	0.0050	U	0.0050	0.0050	U
1,1,1-Trichloroethane	7	0.0050	U	0.0050	0.0050	U
1,2-Dichloroethane	7	0.0050	U	0.0050	0.0050	U
1,2-Dichloroethene	7	0.0050	U	0.0050	0.0050	U

[a]See Fig. 11.

[b]Organics: 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.

[c]Radioactive strontium-total (^{89}Sr + ^{90}Sr).

[d]Parameters were not measured by the Inductively Coupled Plasma (ICP) technique because the channels were not available.

Table 59. Groundwater sample analyses from monitoring wells in WAG 6, January-March 1989, whose values exceeded allowable concentrations under the primary drinking water standards[a]

Well identifier	Parameter	Concentration	Primary limit[b,c]	Units of measurement
		Site Characterization Wells		
852	Barium-dissolved	2.7	1.0	mG/L
850	Barium-dissolved	1.1	1.0	mG/L
852	Barium-total	2.6	1.0	mG/L
850	Barium-total	1.1	1.0	mG/L
852	Benzene	0.096	0.0050	mG/L
850	Benzene	0.020	0.0050	mG/L
849	Benzene	0.0070	0.0050	mG/L
849	Trichloroethene	1.1	0.0050	mG/L
848	Tritium	74,000	740	Bq/L
849	Tritium	38,000	740	Bq/L
854	Tritium	5,600	740	Bq/L
852	Tritium	1,900	740	Bq/L
845	Tritium	1,500	740	Bq/L
851	Tritium	1,500	740	Bq/L
850	Tritium	1,100	740	Bq/L
849	Vinyl chloride	0.063	0.020	mG/L
		Perimeter Wells		
842	Carbon tetrachloride	0.086	0.0050	mG/L
842	Trichloroethene	0.36	0.0050	mG/L
841	Trichloroethene	0.0090	0.0050	mG/L
843	Tritium	46,000	740	Bq/L
842	Tritium	21,000	740	Bq/L

Table 59. (continued)

Well identifier	Parameter	concentration	Primary limit[b,c]	Units of measurement
		Perimeter Wells		
841	Tritium	6,400	740	Bq/L
847	Tritium	3,100	740	Bq/L
844	Tritium	2,200	740	Bq/L
839	Tritium	880	740	Bq/L
835	Tritium	750	740	Bq/L
842	1,2-Dichloroethane	0.019	0.0050	mG/L

[a]Standards are based on State of Tennessee Hazardous Waste Groundwater Regulations or EPA Federal Drinking Water Standards where no state standard exists.

[b]Safe Drinking Water Act-National Primary Drinking Water Regulations, 40 CFR 141, as amended.

[c]State of Tennessee Hazardous Waste Regulations TN 1200-1-11-05, Appendix 05/B.

perimeter well number 811 had a fluoride level that exceeded the state limit (1.4 to 2.4 mg/L) but not the federal limits of 4.0 mg/L. Perimeter well 825 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.

Exceedances of the primary drinking water standard at WAG 6 are summarized in Table 59. For WAG 6 site characterization wells, total and dissolved barium exceeded the primary drinking water limit at wells 850 and 852. Tritium exceedances were recorded at wells 845, 848, 849, 850, 851, 852, and 854. The tritium concentrations at wells 848 and 849 were especially high, being more than an order of magnitude greater than the primary drinking water limit. The level in well 848, however, was less than half the value obtained in the previous two quarters. This apparent reduction in tritium concentrations may have been the result of the capping of several trench areas that was completed prior to this quarter of sampling. A plastic cover had been placed down in the area around this well and may have been instrumental in this decrease. Further monitoring will help to confirm if tritium levels are actually decreasing at this location. For organic parameters, benzene exceeded the EPA primary drinking water limit in site characterization wells 849, 850, and 852. Vinyl chloride and trichloroethene also exceeded the limits in well 849.

Seven perimeter wells from WAG 6 had tritium exceedances of the primary drinking water limit during this quarter. Tritium concentrations at wells 842 and 843 were by far the highest of the perimeter wells but still only about half that of the two highest tritium concentrations for the site characterization wells (wells 848 and 849). Two adjacent perimeter wells contained organics in excess of the EPA primary drinking water standards. Well 842 exceeded the standards for carbon tetrachloride, trichloroethene, and 1,2-dichloroethane, a breakdown product of trichloroethene. Well 841, a deeper well immediately adjacent to well 842, exceeded the standard for trichloroethene. The level of trichloroethene in well 841, the deeper well, was less than 3% of the level in well 842.

No exceedances of the EPA primary drinking water limits were noted in any of the upgradient wells.

4. METEOROLOGICAL PROCESSES

4.1 GENERAL

Meteorological processes are continuously monitored at Oak Ridge National Laboratory (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.

4.2 WIND

The ORNL wind tower network consists of towers A and B, each having sensors mounted at 10 and 30 m, and tower C, having sensors mounted at 10, 30, and 100 meters. Locations of these towers are shown in Fig. 12. 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 windspeed 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) windspeed 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 d, and the hourly averages, from which wind roses in Figs. 13-19 are obtained, are stored for at least 1 year and eventually archived.

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.

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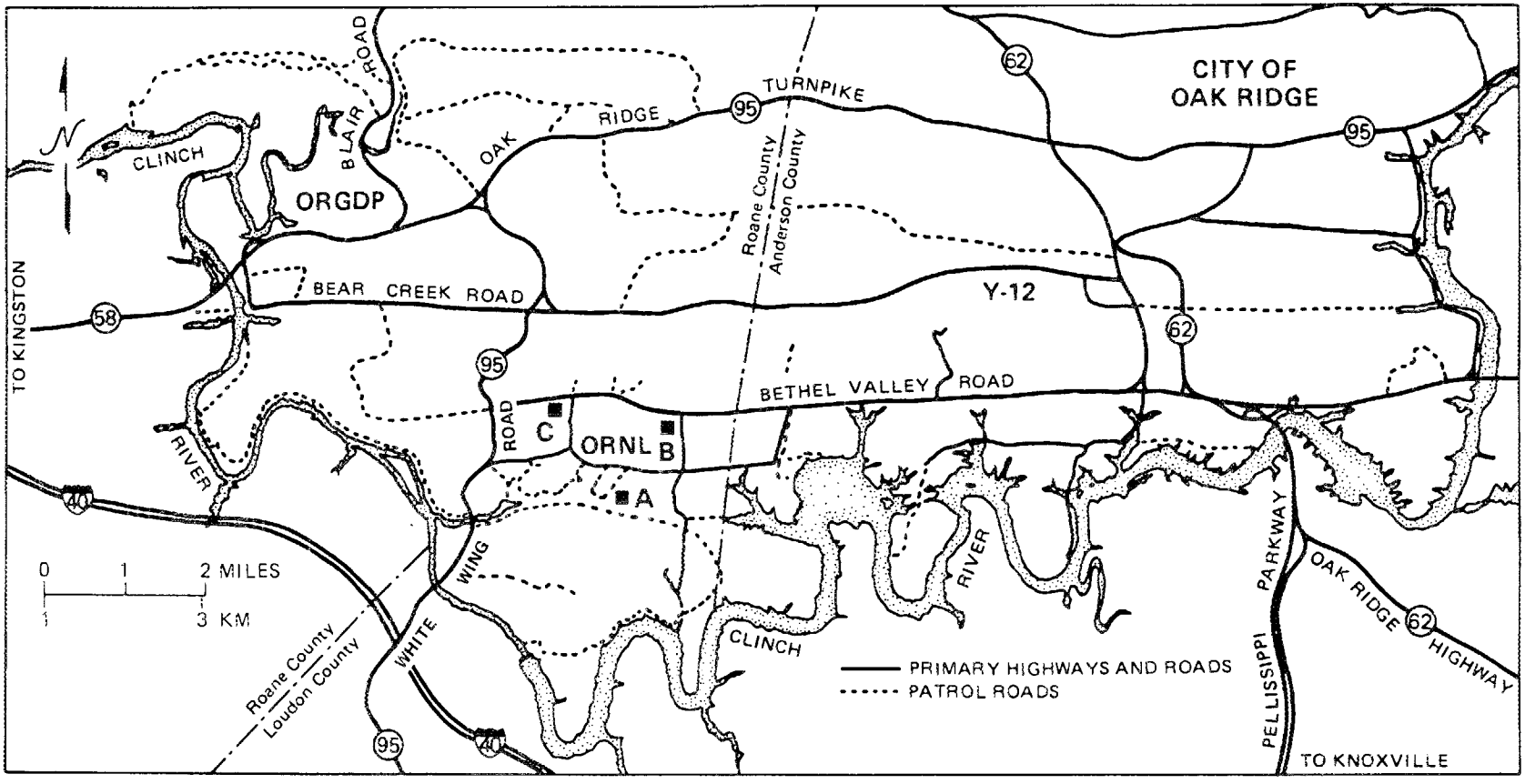

Fig. 12. Location map of metorological towers at ORNL.

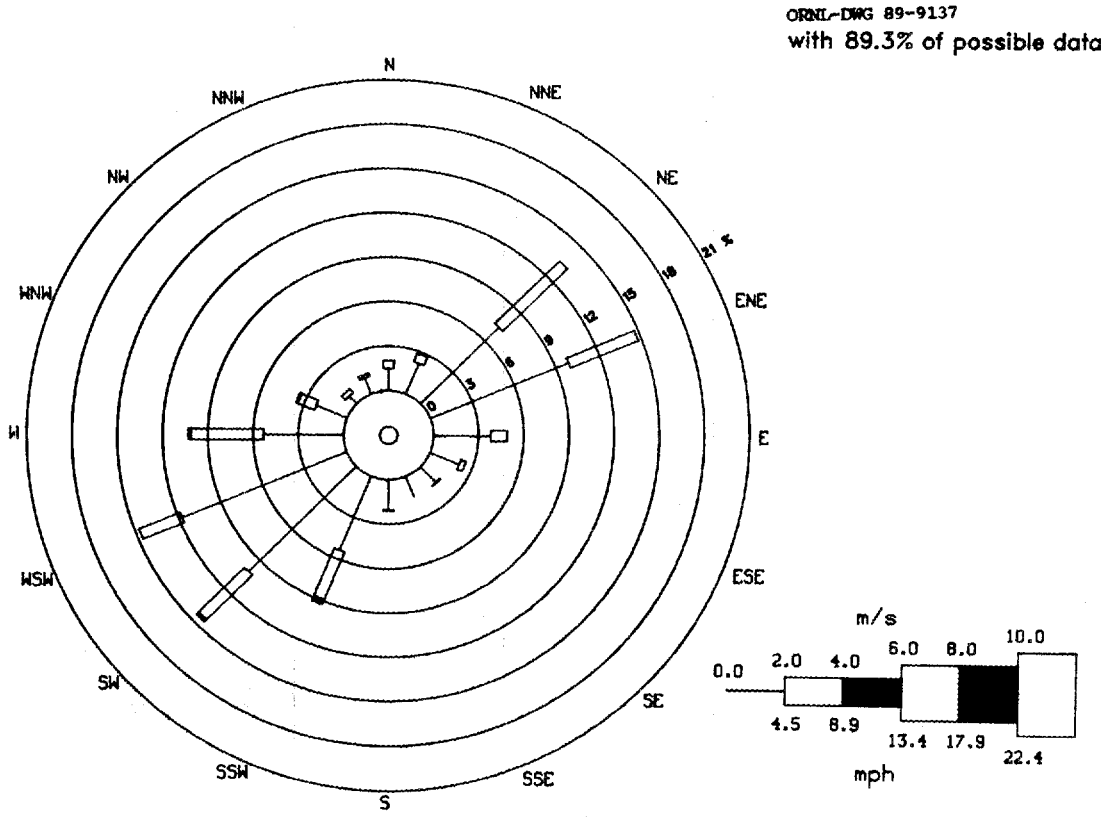

Fig. 13. Wind rose at 10-m level of meteorological tower A, January-March 1989.

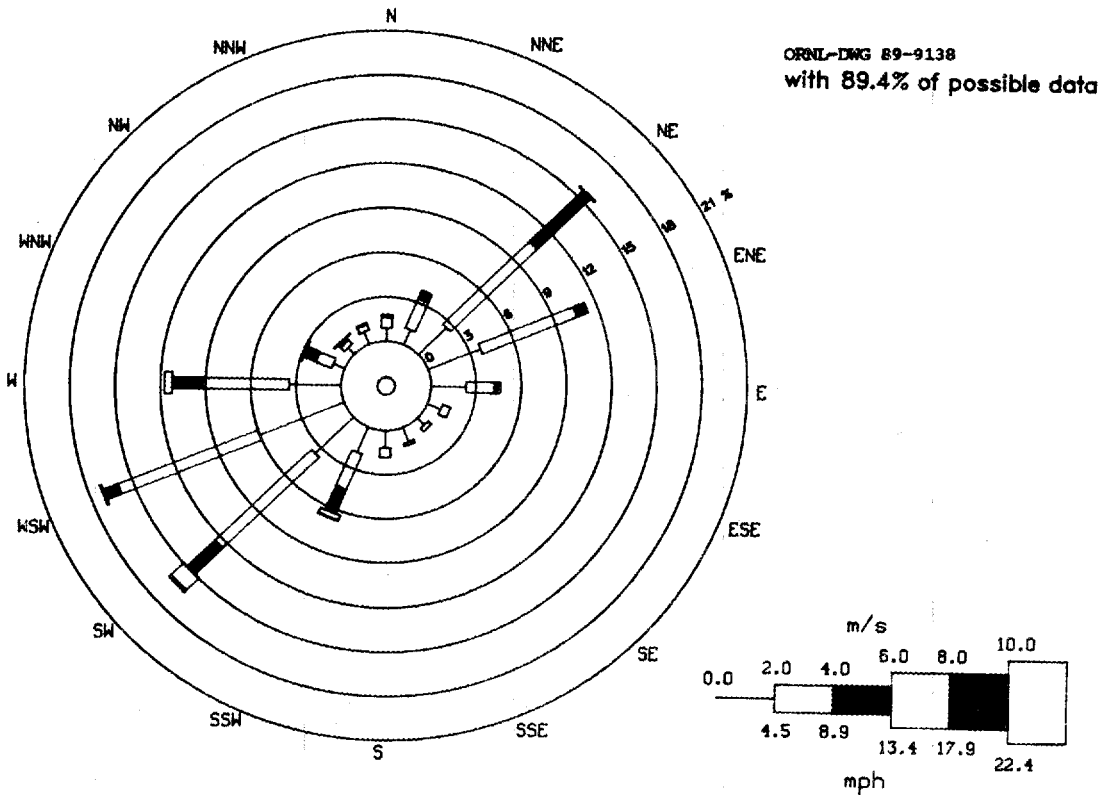

Fig. 14. Wind rose at 30-m level of meteorological tower A, January-March 1989.

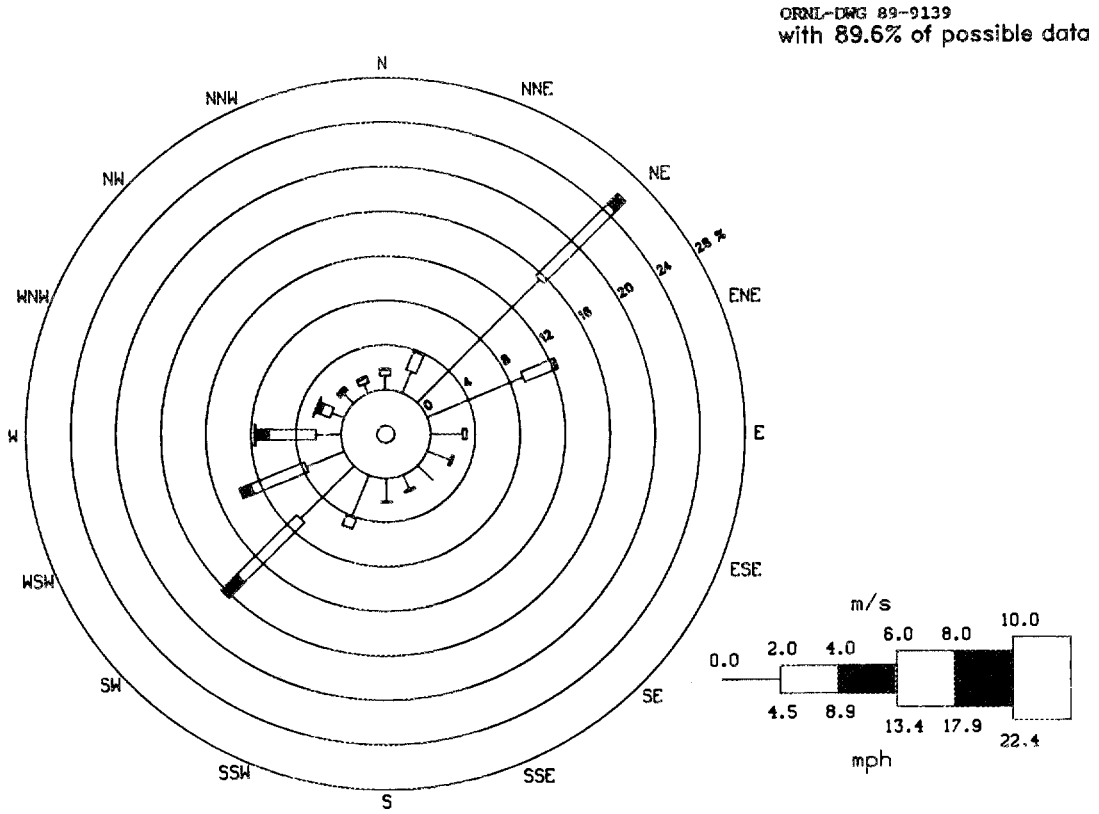

Fig. 15. Wind rose at 10-m level of meteorological tower B, January-March 1989.

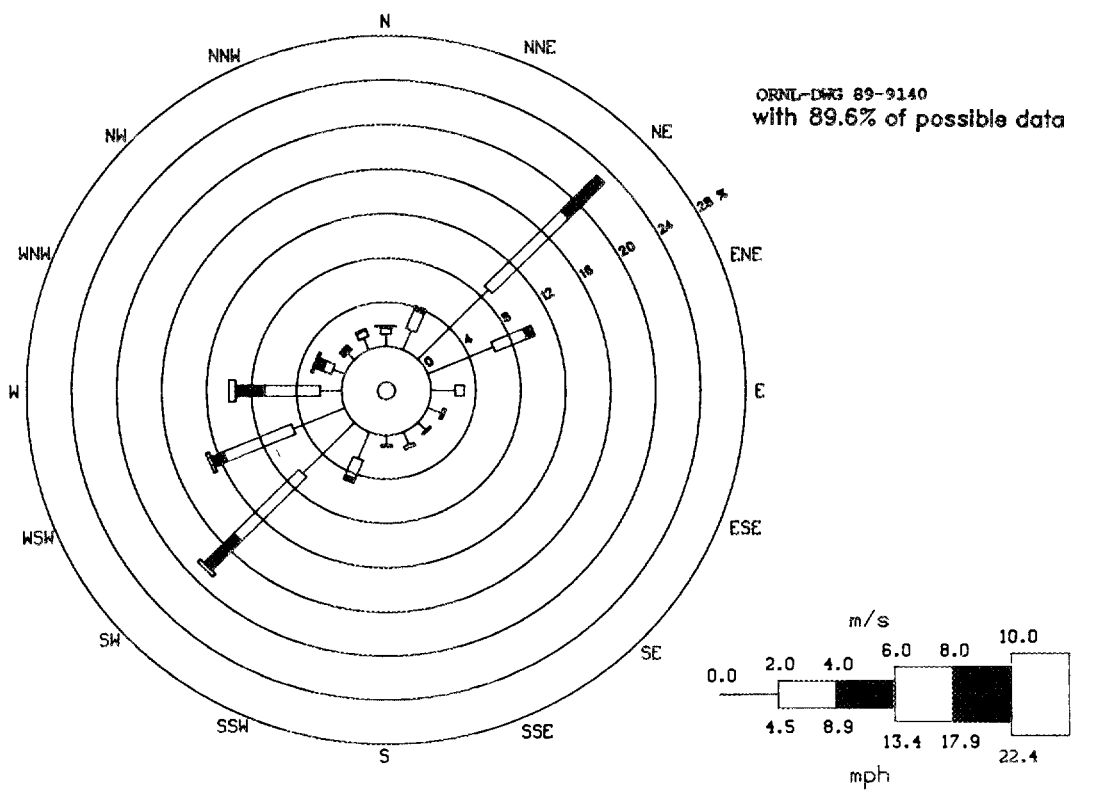

Fig. 16. Wind rose at 30-m level of meteorological tower B, January-March 1989.

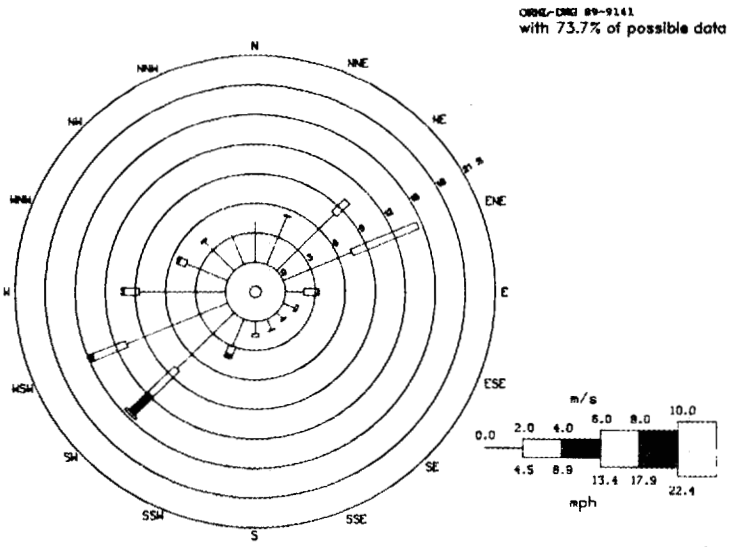

Fig. 17. Wind rose at 10-m level of meteorological tower C, January-March 1989.

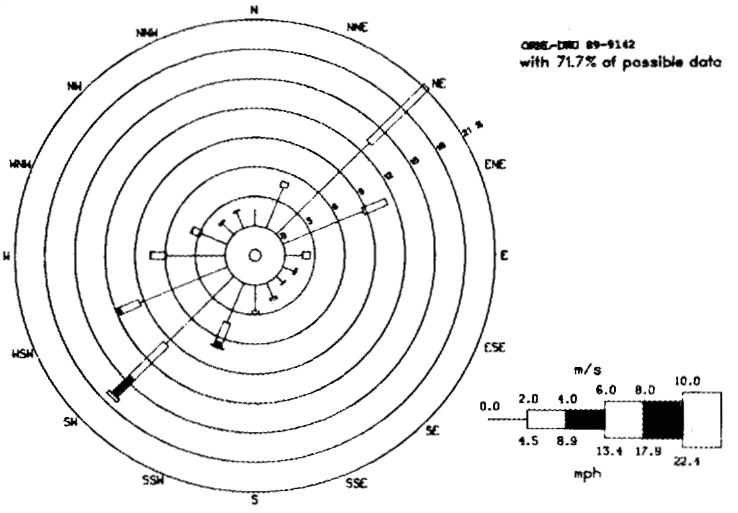

Fig. 18. Wind rose at 30-m level of meteorological tower C, January-March 1989

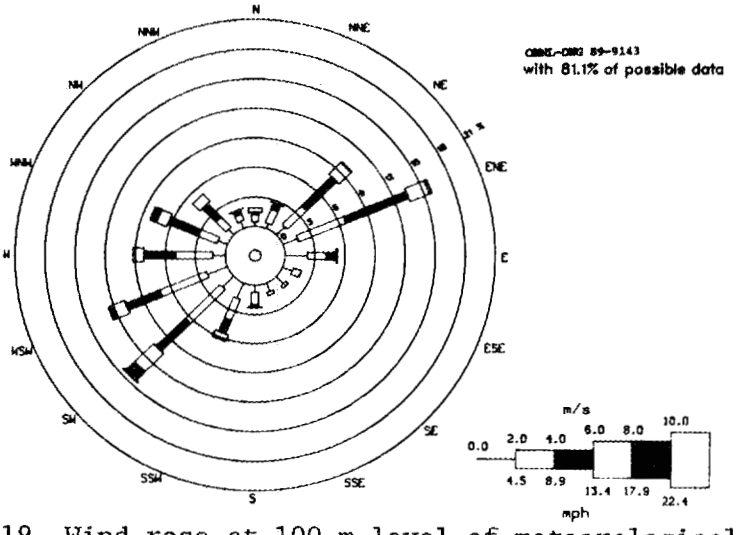

Fig. 19. Wind rose at 100-m level of meteorological tower C, January-March 1989.

5. BIOLOGICAL MONITORING—MILK

Measured average concentrations of total radioactive Sr (assuming 100% ^{90}Sr) and ^{131}I in milk from each location were used to calculate the potential 50-year committed effective dose equivalents given in Tables 60 and 61. This calculation is based on the assumption that 1 L/day of milk is ingested of these concentrations for 365 days. Doses resulting from ingestion of milk were less than 1% of DOE's guideline of 1000 μSv.

Raw milk from four 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. 20). Samples were not collected at the Solway station because the sample source (a cow) was pregnant. Two other stations are more remote with respect to the Oak Ridge facilities and are usually sampled semiannually (Fig. 21). 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 in milk samples, and actual results are reported. Values of ^{131}I for the first quarter were often less than instrument background, as is indicated by negative values in Table 60.

Concentrations of total radioactive strontium are shown in Table 61. The average concentration of total radioactive strontium at the stations in the immediate Oak Ridge area was 0.11 Bq/L.

One of the important pathways for movement of radionuclides from environmental media to man is through the atmosphere to pasture to cow to milk food chain. Strontium-90 and ^{131}I are radionuclides that are especially important in this terrestrial food chain.

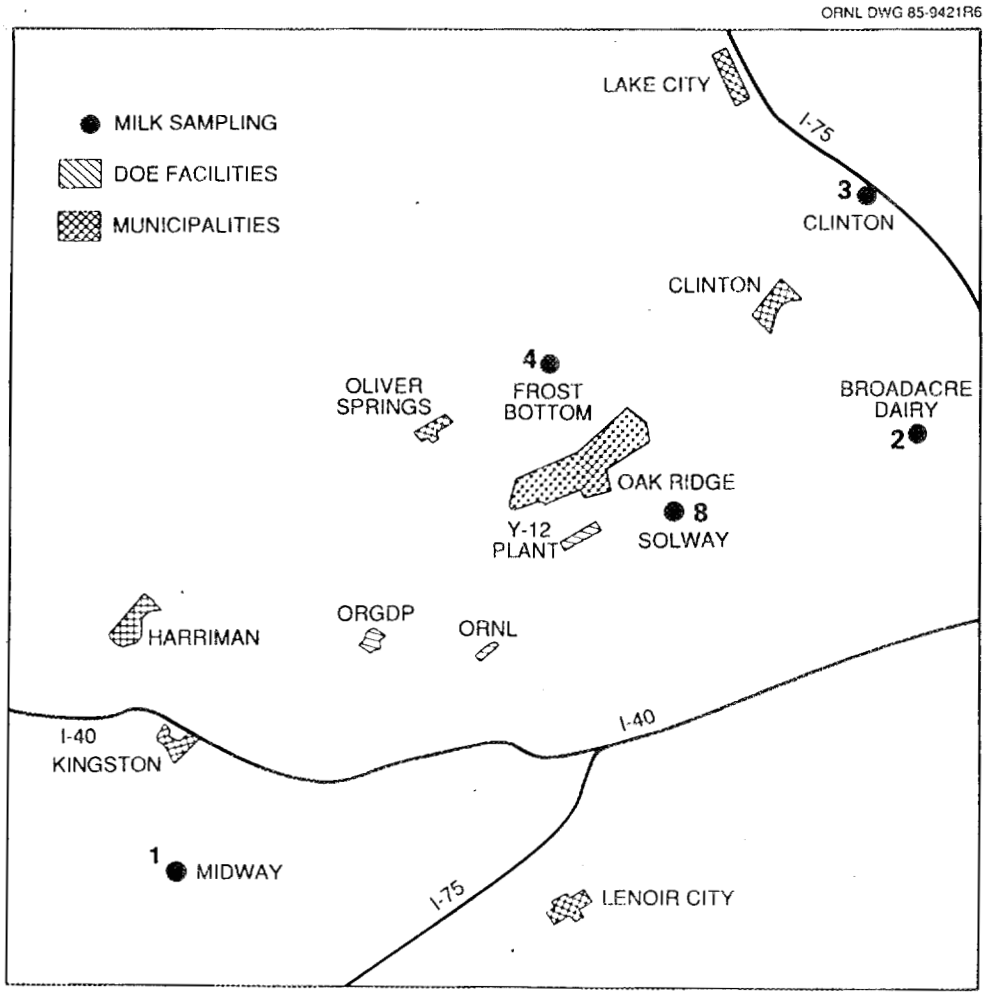

Fig. 20. Location map of milk sampling stations near the Oak Ridge Facilities.

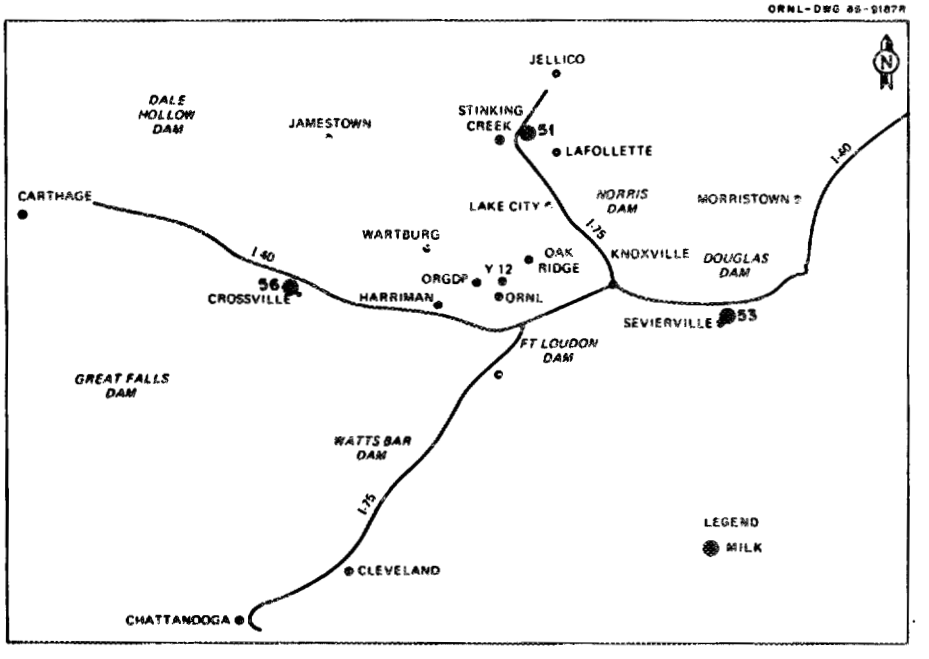

Fig. 21 Locations of milk sampling stations remote from the Oak Ridge facilities.

Table 60. Concentrations of ^{131}I in milk and calculated doses,[a] January-March 1989

Station	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error	Dose (μSv)[b]
		Immediate environs[c]				
1	6	0.080	-0.020	0.015	0.015	0.075
2	7	0.050	0.010	0.029	0.0070	0.14
3	7	0.020	-0.020	0.0023	0.0065	0.011
4	7	0.060	-0.010	0.017	0.010	0.085
Network summary	27	0.080	-0.020	0.016	0.0050	0.079
		Remote environs[d]				
51	1	0.050	0.050	0.050		0.25
53	1	0.010	0.010	0.010		0.050
Network summary	2	0.050	0.010	0.030	0.020	0.15

[a]Raw milk samples; station 2 is a dairy.

[b]Potential 50-year committed effective dose equivalents from drinking 365 L of milk per year using average radionuclide concentrations at each location.

[c]See Fig. 20.

[d]See Fig. 21.

Table 61. Concentrations of total radioactive strontium in milk and calculated doses,[a] January-March 1989

Station	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error	Dose (μSv)[b]
		Immediate environs[c]				
1	6	0.11	0.048	0.085	0.011	1.1
2	7	0.18	0.0030	0.055	0.022	0.71
3	7	0.14	0.061	0.10	0.011	1.3
4	7	0.46	0.010	0.21	0.058	2.7
Network summary	27	0.46	0.0030	0.11	0.020	1.5
		Remote environs[d]				
51	1	0.068	0.068	0.068		0.87
53	1	0.011	0.011	0.011		0.14
Network summary	2	0.068	0.011	0.040	0.029	0.51

[a]Raw milk samples; station 2 is a dairy.

[b]Potential 50-year committed effective dose equivalents from drinking 365 L of milk per year using average radionuclide concentrations at each location. All strontium is assumed to be ^{90}Sr.

[c]See Fig. 20.

[d]See Fig. 21.

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