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OAK RIDGE NATIONAL LABORATORY

MARTIN MARIETTA

ORNL/M-838

Environmental Surveillance Data Report for the Third Quarter of 1989

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B. M. Horwedel
I. L. McCollough
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OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
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Date Published–August 1990

Prepared by the
Environmental Monitoring and Compliance Section
Office of Environmental and Health Protection
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831

operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-84OR21400

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LIST OF ACRONYMS

ATDD	Atmospheric Turbulence and Diffusion Division
AQCA	Air Quality Control Act
CAA	Clean Air Act
CR	Clinch River
CWA	Clean Water Act
CYRTF	Coal Yard Runoff Treatment Facility
DOE	Department of Energy
DCG	derived concentration guide
DWL	National Primary or Secondary Drinking Water Regulation level
EMC	Environmental Monitoring and Compliance Section (ORNL)
EHP	Office of Environmental and Health Protection (ORNL)
EPA	Environmental Protection Agency
FRC	Federal Radiation Council
HEPA	high-efficiency particulate air
HFIR	High Flux Isotope Reactor
ICP	inductively coupled plasma
MB	Melton Branch
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWT	Northwest Tributary
O&G	oil and gas
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
QER	Quality Event Report
RAM	remote air monitoring
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SE	standard error of the mean
SI	Systeme Internationale
STP	Sewage Treatment Plant
SWSA	Solid Waste Storage Area
SWMU	Solid Waste Management Unit
TOC	total organic compounds
TRU	Transuranium Processing Plant
TSS	total suspended solids
WAG	waste area grouping
WOC	White Oak Creek
WOD	White Oak Dam
WOL	White Oak Lake

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EXECUTIVE SUMMARY

During the third quarter of 1989, over 2400 samples, which represent more than 5000 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 for various tower heights to a host computer every 15 min.

Six isotopes, ^{3}H, ^{131}I, ^{133}I, ^{135}I, ^{191}Os, and ^{212}Pb, were the primary isotopes emitted from ORNL stacks during this quarter. Approximately 73% of the ^{3}H released came from the Tritium Target Facility and 23% came from the Isotope Solid State Ventilation System. The Melton Valley Complex emitted virtually all of the radioactive iodines at levels that were about the same as that for the previous quarter. The ^{212}Pb source term for ORNL decreased over the previous two quarters. The third quarter ^{191}Os emissions (2.9×10^{9} Bq) were the highest of the year to date. Data are not reported for noble gas or ^{125}I and ^{129}I emissions because of problems in data validation and analytical interferences.

Ambient air activity for gross alpha, gross beta, and ^{131}I was consistent with the previous quarter. All of the ^{131}I concentrations were less than 0.01% of the derived concentration guide (DCG) for ^{131}I. Tritium data are not reported for this quarter because of mechanical problems with the sampling equipment. Similar problems were experienced at some of the remote air monitoring stations.

The Melton Branch 1 station had the highest radionuclide concentrations of all the stream locations monitored. Total radioactive strontium and ^{3}H were the two measurements that showed elevated values. Tritium ranged from 18 to 85% of its DCG, and total radioactive strontium ranged from 38 to 62% of its DCG. Solid Waste Storage Area (SWSA) 5 appears to be the primary contributor to total radioactive strontium in Melton Branch because the average strontium activity at the Melton Branch station located above SWSA 5 is less than 0.5% of the average strontium activity at the station downstream of SWSA 5. Radioactive strontium in First Creek may be the result of old waste line leaks or previously contaminated soils.

Effluents from the processes at ORNL were sampled for radioactivity. The highest total radioactive strontium concentrations (4.1 Bq/L) were found in the discharge from the Sewage Treatment Plant. The average strontium level for this facility was 1.9 Bq/L, which is consistent with the previous quarter. The concentration of ^{60}Co averaged 5.3 Bq/L at the High Flux Isotope Reactor (HFIR) ponds (2.8% of DCG). This is a substantial reduction from last quarter when the average concentration was 45% of the DCG. Average ^{137}Cs concentrations were highest (63 Bq/L, 57% of DCG) in the discharge from the PWTP.

There were a total of 46 noncompliances associated with the National Pollutant

Discharge Elimination System (NPDES) permit. Twenty-three of these were associated with Category I and Category II outfalls. This is a persistent problem that is being evaluated. The other violations were associated with the Vehicle Cleaning Facility, cooling systems, and the Sewage Treatment Plant.

Water samples were collected at 12 sites and analyzed for polychlorinated biphenyls (PCBs). All concentrations of PCBs were below the Environmental Protection Agency's acute criteria for protection of aquatic organisms and the analytical quantitation limits for the various arochlors.

No groundwater samples were collected during this quarter.

Milk samples from within the immediate environs of ORNL showed that concentrations of ^{131}I and radioactive strontium were always within the lowest range of the Federal Radiation Council guidelines. The effective dose equivalents from consumption of this milk is less than 1% of the DCG.

1. INTRODUCTION

The Environmental Monitoring and Compliance Section (EMC) within the Office of Environmental and Health Protection (EHP) at the Oak Ridge National Laboratory (ORNL) is responsible for the development and implementation of an environmental program to (1) ensure compliance with all federal, state, and 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 measurements 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 the precision of the measurements and to increase 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 mean (SE) values of parameters for which determinations were made. This value is based on multiple samples collected throughout the period. It includes the random uncertainty over time and space associated with sampling, analysis, and the intrinsic variability of the media. The random uncertainty is a statement of precision (or imprecision), a measure of the reproducibility or scatter in a set of successive measurements, and an indication of the stability of the average value for the parameter. When differences in the magnitudes of the observations are small, the SE is small and the precision is said to be high; when the differences are large, the SE is large and the precision is low. Average values have been compared where possible to applicable guidelines, criteria, or standards as a means of evaluating the impact of effluent releases or environmental concentrations.

In some of the tables, radionuclide concentrations are compared with derived concentration guides (DCGs) as published in 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, submersion) for 1 year, a "reference man" would receive the most restrictive of (1) an effective dose equivalent of 100 mrem or (2) a dose equivalent of 5 rem to any tissue, including skin and lens of the eye. A "reference man" is a hypothetical human who is assumed to inhale 8400 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, 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 Sr is measured, it is compared with the DCG for ^{90}Sr, 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 units of becquerel (Bq). A Bq is 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 than 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 Office of Environmental and Health Protection (EHP). 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 and external pathways of exposure.

2.1 AIRBORNE EMISSIONS

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	Radiochemical Processing Plant
3039	Duct 1 - 3500 and 4500 areas cell ventilation systems
	Duct 2 - central off-gas and scrubber system
	Duct 3 - isotope-solid state ventilation system
	Duct 4 - 3025 and 3026 areas cell ventilation systems
7025	Tritium Target Fabrication Facility
7830	Hydrofracture Facility
7911	Melton Valley complex (High Flux Isotope Reactor, Radiochemical Engineering Design Center)
7512	Molten Salt Reactor Facility
6010	Electron Linear Accelerator Facility

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

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

The sampling systems generally consist of in-stack sampling probes, sample transport piping, a 47-mm-diam particulate filter, a 47-mm-diam by 25-mm-thick activated-charcoal canister, a silica-gel tritium trap, flow measurement and totalizing instruments, a sampling pump, and return piping to the stack. The sampling system for the tritium target 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, ^{131}I, and ^{133}I measurements. This is the number of samples for the quarter. There are six values for each tritium emission sampler because the weekly samples are analyzed as biweekly composites. Many of the other isotopes reported are represented by less than 13 values because they were not detected in all of the sampling events.

The current convention for data at the instrument detection limit is to treat it 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 so reported may be reduced with summary statistics without incurring the difficulties of performing calculations on "less than" values.

All data are rounded to two significant digits and presented as 10^6 Bq. Negative sample values are converted into negative emissions. These values represent the random uncertainty associated with quantifying emissions. Although negative emissions values can be used to infer the total measurement system uncertainty for a given isotope, the inference must be isotope specific. The uncertainty for each isotope is unique; therefore, extrapolating across isotopes is not valid.

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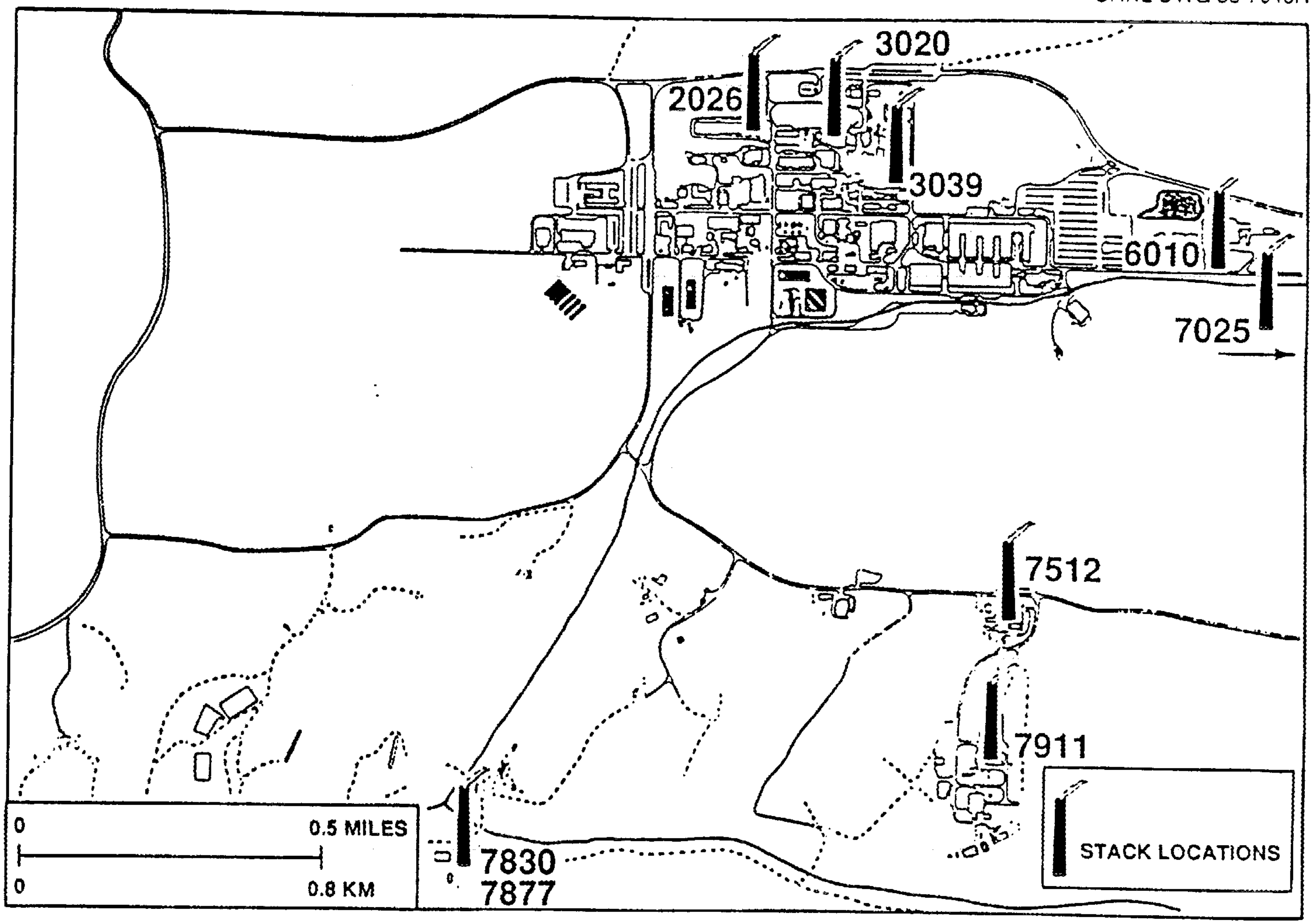

Fig. 1. Location map of major stacks (emission points) at ORNL.

Tables 1 through 10 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, the standard error is also provided. Tables 11 through 20 present the emission totals by month and for the quarter by stack and analyte.

On upgraded systems in which 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 consisted primarily of ^{3}H, ^{191}Os, ^{131}I, ^{133}I, ^{135}I, and ^{212}Pb. Tritium came mostly from the Tritium Target Fabrication Facility (73%, 6.3E13 Bq) and the Isotope Solid State Ventilation System (23%, 1.9E13 Bq). The total tritium release for the third quarter is 4.5 times higher than the total tritium release for the second quarter. This increase is attributed to the production of targets at the Tritium Target Fabrication Facility in July. All production work will be discontinued at this facility by the end of the calendar year. 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 (99.9%, 2.5E8 Bq), ^{133}I (99.9%, 2.8E8 Bq), and ^{135}I (100%, 1.8E8 Bq) associated with fission products. These levels are consistent with the previous quarter.

Ninety-seven percent of the ^{212}Pb came from five locations: central off-gas and scrubber system (21%, 1.4E8 Bq); Radioactive Materials Analytical Laboratory (26%, 1.2E8 Bq); Melton Valley complex (16%, 7.4E7 Bq); Radiochemical Processing Plant (16%, 7.3E7 Bq); and 3500 and 4500 areas cell ventilation systems (8.6%, 4.0E7 Bq). The total ^{212}Pb source term for the third quarter shows a decrease over the first two quarters (8.7E8 Bq, 1.1E9 Bq, and 4.6E8 Bq, respectively). The 3025 and 3026 cell ventilation systems released 99.9% of the ^{191}Os (2.9E9 Bq). The third quarter osmium release from this facility is the highest for the year to date.

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 (fourth quarter, 1989).

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

Analysis	Number of samples	Total emissions per week (10^6 Bq) Max	Min	Av	Standard error[b]
^{131}I	13	0.005	-0.005	-0.000	0.00080
^{133}I	13	0.006	-0.003	0.000	0.00067
^{135}I	10	0.027	-0.020	0.003	0.0043
^{137}Cs	3	0.090	0.016	0.050	0.022
^{212}Pb	11	21	2.7	11	1.9
Gross alpha	13	0.016	0.000	0.008	0.0013
Gross beta	13	0.058	0.001	0.023	0.0041

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

Table 2. Summary of weekly emissions at the Radiochemical Processing Plant ventilation stack, Building 3020,[a] July-September 1989

		Total emissions per week (10^6 Bq)			
Analysis	Number of samples	Max	Min	Av	Standard error[b]
^{131}I	14	0.014	-0.004	0.003	0.0014
^{133}I	14	0.008	-0.030	-0.003	0.0030
^{135}I	2	0.016	0.011	0.014	0.0023
^{212}PB	1	73	73	73	
Gross alpha	14	0.006	0.000	0.002	0.00051
Gross beta	14	0.015	0.002	0.008	0.0010

[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] July-September 1989

Analysis	Number of samples	Total emissions per week (10^6 Bq)			
		Max	Min	Av	Standard error[b]
^{131}I	13	0.005	-0.001	0.001	0.00051
^{133}I	13	0.006	-0.000	0.001	0.00057
^{135}I	13	0.014	-0.010	-0.001	0.0020
^{212}Pb	13	9.9	1.9	3.0	0.59
^{3}H	6	3300	96	750	510
^{60}Co	2	0.028	0.011	0.019	0.0088
Gross alpha	13	0.012	-0.002	0.001	0.00094
Gross beta	13	0.095	0.007	0.025	0.0063

[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] July-September 1989

Analysis	Number of samples	Total emissions per week (10^6 Bq) Max	Min	Av	Standard error[b]
^{106}Ru	1	0.22	0.22	0.22	
^{131}I	13	0.014	-0.003	0.004	0.0015
^{133}I	13	0.042	0.000	0.010	0.0033
^{135}I	13	0.008	-0.020	-0.003	0.0025
^{137}Cs	1	0.046	0.046	0.046	
^{194}Au	8	0.99	0.048	0.35	0.12
^{212}Pb	13	25	5.1	11	1.4
^{3}H	6	130	-3.0	58	17
^{60}Co	2	1.1	0.015	0.54	0.52
Gross alpha	13	0.000	0.000	0.000	0.000080
Gross beta	13	0.043	0.000	0.005	0.0031

[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] July-September 1989

Analysis	Number of samples	Total emissions per week (10^6 Bq) Max	Min	Av	Standard error[b]
^{131}I	13	0.014	-0.001	0.005	0.0014
^{133}I	13	0.003	-0.020	-0.001	0.0013
^{135}I	13	0.008	-0.050	-0.008	0.0050
^{191}Os	4	1.1	0.021	0.29	0.26
^{212}Pb	13	2.2	0.61	0.97	0.12
^{3}H	6	14,000,000	10,000	3,200,000	2,200,000
^{60}Co	12	0.24	0.046	0.10	0.015
^{75}Se	9	0.042	0.015	0.027	0.0031
^{82}Br	9	0.26	0.056	0.13	0.025
Gross alpha	13	0.000	-0.000	0.000	0.000096
Gross beta	13	0.014	0.004	0.008	0.00076

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

Table 6. Summary of weekly emissions at the 3035 and 3026 area cell ventilation system, Building 3039, Duct 4,[a] July-September 1989

Analysis	Number of samples	Total emissions per week (10^6 Bq)			
		Max	Min	Av	Standard error[b]
^{131}I	12	0.003	-0.004	0.000	0.00065
^{133}I	12	0.001	-0.020	-0.003	0.0014
^{135}I	12	0.018	-0.050	-0.004	0.0056
^{191}Os	10	2,600	0.84	290	260
^{212}Pb	6	0.22	0.035	0.10	0.026
^{3}H	6	47,000	10,000	23,000	5,400
Gross alpha	12	0.002	-0.000	0.001	0.00028
Gross beta	12	5.0	0.018	1.8	0.45

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

Table 7. Summary of weekly emissions at the Tritium Target Fabrication Facility, Building 7025,[a] July-September 1989

Analysis	Number of samples	Total emissions per week (10^6 Bq)			
		Max	Min	Av	Standard error[b]
^3H	6	51,000,000	280,000	10,000,000	8,300,000

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

Table 8. Summary of weekly emissions at the Hydrofracture Facility, Building 7830,[a] July-September 1989

Analysis	Number of samples	Total emissions per week (10^6 Bq)			
		Max	Min	Av	Standard error[b]
^{131}I	9	0.000	-0.0000	0.000	0.0000083
^{133}I	9	0.000	-0.00	0.000	0.000015
^{135}I	9	0.000	-0.000	0.000	0.000061
^{212}Pb	8	0.032	0.002	0.019	0.0037
^{60}Co	3	0.001	0.000	0.000	0.00028
Gross alpha	9	0.000	-0.00	0.000	0.0000019
Gross beta	9	0.000	0.000	0.000	0.000034

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

Table 9. Summary of weekly emissions at the Melton Valley complex, Building 7911,[a] July-September 1989

Analysis	Number of samples	Total emissions per week (10^6 Bq) Max	Min	Av	Standard error[b]
^{131}I	13	29	8.3	19	2.1
^{132}I	2	1.1	0.55	0.84	0.29
^{133}I	13	47	0.41	22	3.2
^{135}I	13	26	-0.003	14	1.7
^{212}Pb	12	7.9	3.2	6.2	0.46
^{3}H	6	7500	190	1900	1100
Gross alpha	13	0.000	-0.0000	0.000	0.000065
Gross beta	13	0.67	0.004	0.058	0.051

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

Table 10. Summary of weekly emissions at the Molten Salt Reactor Facility, Building 7512,[a] July-September 1989

Analysis	Number of samples	Total emissions per week (10^6 Bq)			
		Max	Min	Av	Standard error[b]
^{131}I	13	0.000	-0.004	-0.000	0.00037
^{133}I	13	0.001	-0.005	-0.000	0.00058
^{135}I	4	0.017	-0.007	0.001	0.0052
^{137}Cs	1	0.009	0.009	0.009	
^{212}Pb	1	0.11	0.11	0.11	
Gross alpha	13	0.001	0.000	0.000	0.00012
Gross beta	13	0.003	0.000	0.001	0.00022

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

Table 11. Monthly airborne emissions at the Radioactive Materials Analytical Laboratory, Building 2026,[a] July-September 1989

Analysis	Emissions per month (10^6 Bq) July	August	September	Total (10^6 Bq)
^{131}I	0.0021	-0.0010	-0.0050	-0.0050
^{133}I	0.0067	0	0.0020	0.0087
^{135}I	0	-0.0090	0.041	0.031
^{137}Cs	0.090	0.045	0.016	0.15
^{212}Pb	39	23	57	120
Gross alpha	0.034	0.034	0.042	0.11
Gross beta	0.088	0.093	0.11	0.30

[a]See Fig. 1.

Table 12. Monthly airborne emissions at the Radiochemical Processing Plant ventilation stack, Building 3020,[a] July-September 1989

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	July	August	September	
^{131}I	0.031	0.012	0.0091	0.052
^{133}I	-0.030	0.0071	-0.020	-0.040
^{135}I	0.016		0.011	0.027
^{212}Pb			73	73
Gross alpha	0.012	0.011	0.010	0.034
Gross beta	0.035	0.035	0.049	0.12

[a]See Fig. 1.

Table 13. Monthly airborne emissions at the 3500 and 4500 areas cell ventilation systems, Building 3039, Duct 1,[a] July-September 1989

Analysis	Emissions per month (10^6 Bq) July	August	September	Total (10^6 Bq)
^{131}I	0.0081	0.0085	0.0027	0.019
^{133}I	0.0047	0.011	0.0081	0.024
^{135}I	0.0036	-0.010	-0.0070	-0.020
^{212}Pb	17	12	11	39
^{3}H	3600	340	620	4500
^{60}Co	0.028	0.011		0.039
Gross alpha	0.013	-0.00090	0.0017	0.014
Gross beta	0.066	0.11	0.15	0.33

[a]See Fig. 1.

Table 14. Monthly airborne emissions at the central off-gas and scrubber system, Building 3039, Duct 2,[a] July-September 1989

Analysis	Emissions per month (10^6 Bq) July	August	September	Total (10^6 Bq)
^{106}Ru			0.22	0.22
^{131}I	0.015	0.028	0.018	0.061
^{133}I	0.029	0.032	0.070	0.13
^{135}I	-0.0080	-0.010	-0.020	-0.040
^{137}Cs			0.046	0.046
^{194}Au	0.71	0.15	1.9	2.8
^{212}Pb	45	49	49	140
^{3}H	180	58	110	350
^{60}Co	1.1		0.015	1.1
Gross alpha	0.0027	0.00065	0.00027	0.0036
Gross beta	0.0067	0.010	0.048	0.065

[a]See Fig. 1.

Table 15. Monthly airborne emissions at the isotope-solid state ventilation system, Building 3039, Duct 3,[a] July-September 1989

Analysis	Emissions per month (10^6 Bq) July	August	September	Total (10^6 Bq)
^{131}I	0.029	0.016	0.022	0.067
^{133}I	0.0014	-0.010	-0.0020	-0.010
^{135}I	0.0063	-0.050	-0.070	-0.10
^{191}Os	1.1	0.052	0.032	1.2
^{212}Pb	3.4	4.3	4.9	13
^{3}H	4,900,000	64,000	14,000,000	19,000,000
^{60}Co	0.39	0.43	0.38	1.2
^{75}Se	0.10	0.091	0.048	0.24
^{82}Br	0.17	0.75	0.20	1.1
Gross alpha	0.0012	0.0018	0.0014	0.0043
Gross beta	0.037	0.041	0.034	0.11

[a]See Fig. 1.

Table 16. Monthly airborne emissions at the 3025 and 3026 area cell ventilation systems, Building 3039, Duct 4,[a] July-September 1989

Analysis	Emissions per month (10^6 Bq)			Total (10^6 Bq)
	July	August	September	
^{131}I	0.0032	0.0030	-0.0030	0.0027
^{133}I	-0.0060	-0.0080	-0.020	-0.040
^{135}I	-0.040	-0.0080	-0.0030	-0.050
^{191}Os	2,600	270	17	2,900
^{212}Pb	0.15	0.035	0.43	0.62
^{3}H	27,000	66,000	44,000	140,000
Gross alpha	0.0052	0.0059	0.0023	0.013
Gross beta	6.3	10	5.3	22

[a]See Fig. 1.

Table 17. Monthly airborne emissions at the Tritium Target Fabrication Facility, Building 7025,[a] July-September 1989

Analysis	Emissions per month (10^6 Bq) July	August	September	Total (10^6 Bq)
^3H	61,000,000	620,000	1,000,000	63,000,000

[a]See Fig. 1.

Table 18. Monthly airborne emissions at the Hydrofracture Facility, Building 7830,[a] August-September 1989

Analysis	Emissions per month (10^6 Bq) August	September	Total (10^6 Bq)
^{131}I	0.00005	0.00010	0.00015
^{133}I	0.00019	-0.000010	0.00018
^{135}I	0.00006	0.000012	0.000074
^{212}Pb	0.093	0.061	0.15
^{60}Co	0.00012	0.0013	0.0014
Gross alpha	0.00004	0.000016	0.000060
Gross beta	0.0010	0.00042	0.0015

[a]See Fig. 1.

Table 19. Monthly airborne emissions at the Melton Valley complex, Building 7911,[a] July-September 1989

Analysis	Emissions per month (10^6 Bq) July	August	September	Total (10^6 Bq)
^{131}I	110	81	59	250
^{132}I	1.1	0.55		1.7
^{133}I	110	75	94	280
^{135}I	65	45	68	180
^{212}Pb	20	29	25	74
^{3}H	8,000	1,300	2,100	11,000
Gross alpha	0.00029	0.0014	0.00012	0.0018
Gross beta	0.024	0.71	0.023	0.76

[a]See Fig. 1.

Table 20. Monthly airborne emissions at the Molten Salt Reactor Facility, Building 7512,[a] July-September 1989

Analysis	Emissions per month (10^6 Bq) July	August	September	Total (10^6 Bq)
^{131}I	-0.0060	-0.0030	-0.0010	-0.010
^{133}I	-0.0050	-0.0020	-0.0040	-0.010
^{135}I	0.0087		-0.0020	0.0070
^{137}Cs			0.0091	0.0091
^{212}Pb			0.11	0.11
Gross alpha	0.0029	0.00075	0.0014	0.0051
Gross beta	0.0069	0.0032	0.0044	0.015

[a]See Fig. 1.

2.2 AMBIENT AIR

Most gaseous wastes from ORNL are released to the atmosphere from stacks. Radioactivity may be present in gaseous waste streams as a solid (particulates), as an absorbable gas (e.g., iodine), or as a nonabsorbable species (noble gas). Gaseous wastes that may contain radioactivity are processed to reduce the radioactivity to acceptable levels before they are discharged. In addition to the monitoring of stack effluents, atmospheric concentrations of materials can be continuously monitored at 18 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, 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 23, 33, 34, and 40 through 46 (Fig. 3). Stations 33 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 52 and 58. 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 biweekly for gross alpha and gross beta activities. To minimize artifacts from short-lived radionuclides, the filter papers are analyzed 3 to 4 days after collection. The airborne ^{131}I is collected biweekly 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 for the ORNL

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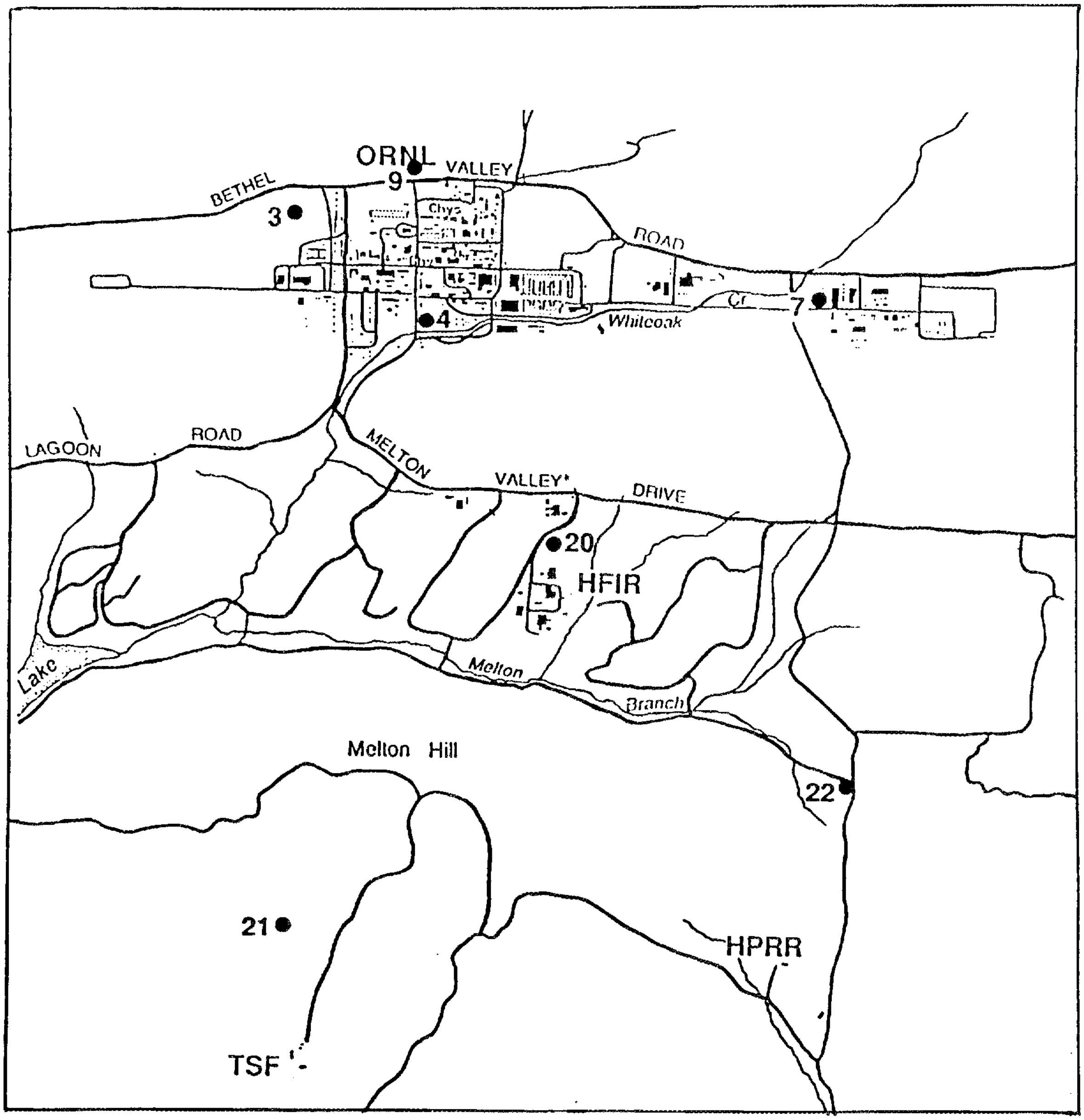

Fig. 2. Location map of the ORNL perimeter air monitoring stations.

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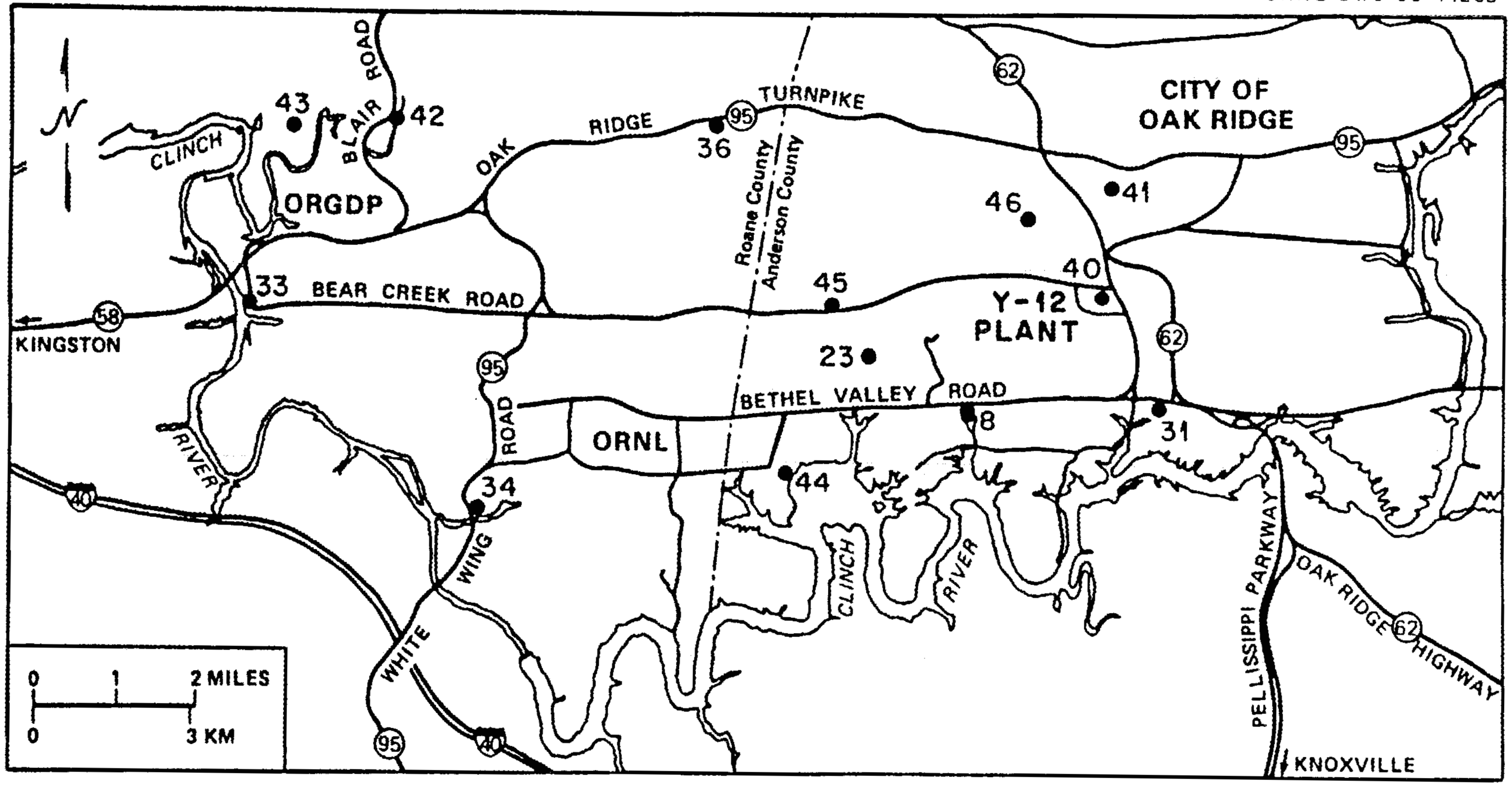

Fig. 3. Location map of Oak Ridge Reservation air monitoring stations.

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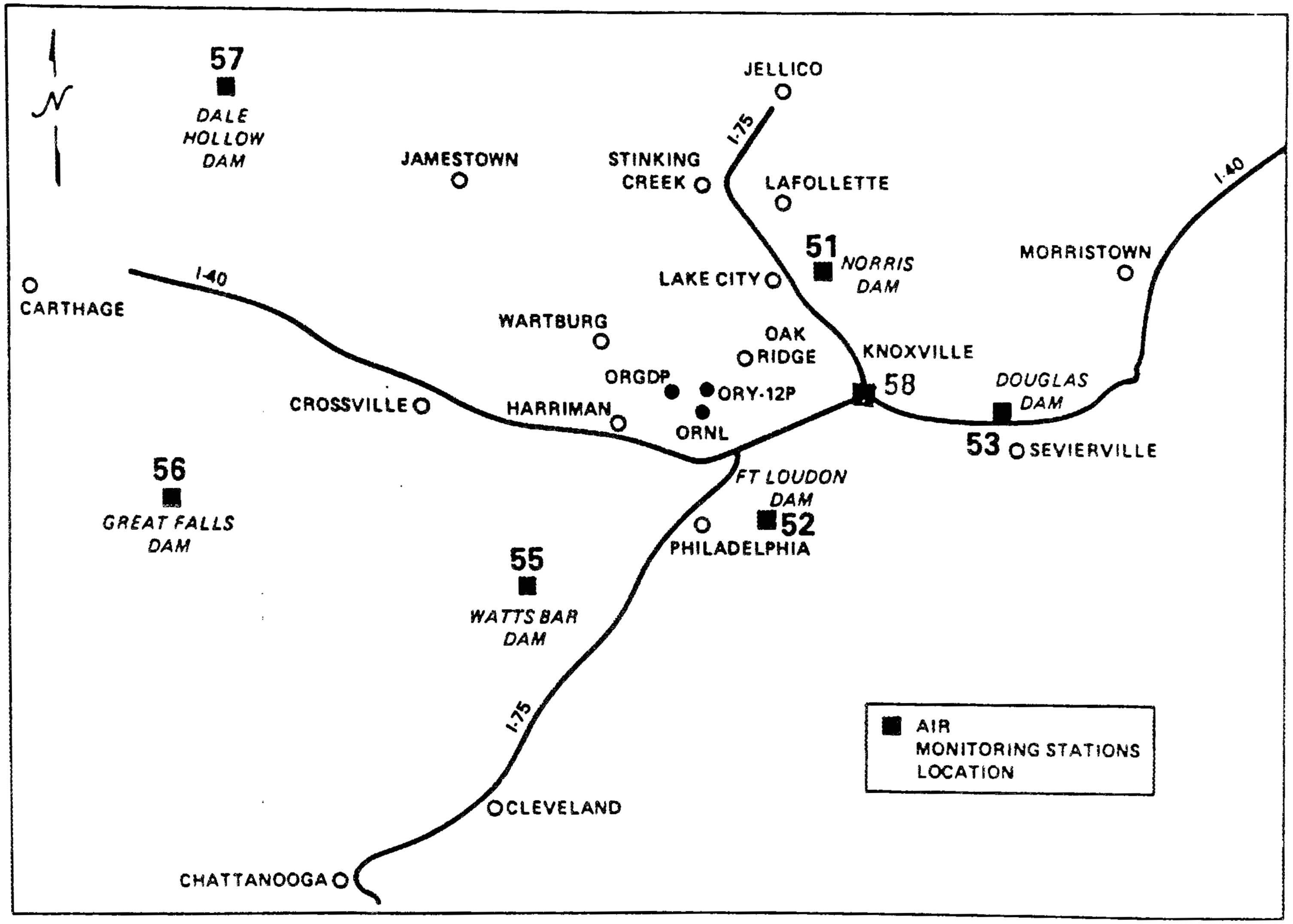

Fig. 4. Location map of the remote air monitoring stations.

PAM stations and for the reservation PAM stations 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 historical data and an evaluation of program requirements, filter papers and charcoal cartridges were no longer collected at stations 4, 8, 31, and 36 after May 1, 1989. Charcoal cartridges were no longer collected at stations 33, 42, and 43 after May 1, 1989. Filter paper sampling at stations 51, 53, and 55 through 57 was dropped May 1, 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. These data will be included in the fourth-quarter report.

Concentrations of gross alpha, gross beta, and atmospheric ^{131}I are summarized in Tables 21-23. 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. The values for Stations 33, 42, and 43 represent data for the second and third quarter.

Alpha activity this quarter is similar to that of the second quarter. Because filter papers are now being collected and analyzed biweekly, negative values do not appear, as in the first quarter of this year and in previous years. The weekly results were consistently at the analytical instrument background levels. The sampling period was increased from 1 week to 2 weeks in May 1989. This results in doubling the total sample volume and increasing the sample activity sufficiently to discriminate it from analytical background. There is little difference in the average for the three networks. Average beta activity does not differ from the second quarter. Values for the ORNL stations and for reservation stations were similar to values for the remote stations.

Iodine-131 concentrations (Table 23) were similar to concentrations from the previous quarter. Although there are some high values this quarter, the maximum value, 35×10^{-8} Bq/L, at station 44 is only 0.0023% of the derived concentration guideline for ^{131}I.

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. Because of problems in calculating the volume of air sampled, this table will not be reported this quarter.

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 21. Long-lived gross alpha activity in air, July-September 1989

Location	Number of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	Standard error[a]
		ORNL PAM Stations[b]			
3	7	4.8	1.1	3.1	0.44
7	7	5.4	0.78	2.9	0.69
9	4	3.5	2.0	2.9	0.34
20	6	6.5	2.3	4.0	0.64
21	6	6.2	2.9	4.1	0.51
22	6	6.5	2.7	3.9	0.57
Network summary	36	6.5	0.78	3.5	0.23
		Reservation PAM Stations[c]			
23	6	5.2	2.5	3.6	0.49
33	11	4.5	1.8	3.2	0.25
34	6	5.5	1.8	3.7	0.65
40	4	5.5	2.1	3.9	0.71
41	6	6.4	2.6	3.9	0.67
42	11	5.1	1.2	3.4	0.34
43	11	5.4	1.6	3.2	0.34
44	7	5.5	1.3	3.2	0.60
45	4	5.5	2.4	3.9	0.66
46	5	6.3	2.9	4.6	0.70
Network summary	71	6.4	1.2	3.5	0.15

Table 21. (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	Standard error[a]
		RAM Stations[d]			
52	4	4.5	1.6	3.0	0.59
58	4	6.1	2.9	4.9	0.72
	—				
Network summary	8	6.1	1.6	4.0	0.56
Overall summary	115	6.5	0.78	3.6	0.12

[a]Standard error of the mean.
[b]See Fig. 2.
[c]See Fig. 3.
[d]See Fig. 4.

Table 22. Long-lived gross beta activity in air, July-September 1989

Location	Number of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	Standard error[a]
		ORNL PAM Stations[b]			
3	7	110	65	81	5.8
7	7	87	54	72	4.5
9	4	85	48	68	8.6
20	6	99	69	86	4.1
21	6	97	66	82	4.7
22	6	91	67	79	4.2
Network summary	36	110	48	78	2.2
		Reservation PAM Stations[c]			
23	6	82	66	73	2.8
33	11	98	45	64	4.7
34	6	92	47	70	7.0
40	4	95	57	79	8.8
41	6	97	55	76	5.9
42	11	94	39	68	5.6
43	11	92	38	64	5.2
44	7	87	18	65	8.7
45	4	95	69	79	5.7
46	5	100	67	84	5.7
Network summary	71	100	18	70	2.0

Table 22. (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	Standard error[a]
		RAM Stations[d]			
52	4	99	61	85	8.2
58	4	110	85	100	6.9
Network summary	8	110	61	92	5.8
Overall summary	115	110	18	74	1.6

[a]Standard error of the mean.
[b]See Fig. 2.
[c]See Fig. 3.
[d]See Fig. 4.

Table 23. ^{131}I concentrations in air, July-September 1989

Location	Number of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	Standard error[a]	Percentage DCG[b]
		ORNL PAM Stations[c]				
3	7	7.1	-70	-13	10	< 0.01
7	7	8.5	-6.0	0.36	1.8	< 0.01
9	4	20	-3.5	7.3	6.1	< 0.01
20	6	9.0	-4.6	2.6	2.2	< 0.01
21	6	33	-2.6	6.0	5.5	< 0.01
22	6	33	-8.6	4.1	6.0	< 0.01
Network summary	36	33	-70	0.39	2.7	< 0.01
		Reservation PAM Stations[d]				
23	6	17	-8.6	2.3	3.8	< 0.01
34	6	6.9	-7.2	2.0	2.3	< 0.01
40	4	4.1	-1.2	2.1	1.3	< 0.01
41	6	14	-3.5	4.1	2.6	< 0.01
44	7	35	-4.0	6.5	4.9	< 0.01
45	4	4.0	0.83	2.4	0.67	< 0.01
46	5	5.6	-8.2	-0.88	2.6	< 0.01
Network summary	38	35	-8.6	2.9	1.2	< 0.01
Overall summary	74	35	-70	1.7	1.4	< 0.01

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

Average gamma radiation measurements are recorded at 10-min intervals at ORNL and PAMs stations 3, 4, 7, 8, 20, 31, 33, 34, 40, 41, 44 and 45 (Figs. 2 and 3). From these data, hourly averages are computed. Table 24 summarizes the valid hourly measurements for the third quarter of 1989. Typical values for cities in the United States are usually between 1.5 and 4.2 nC/kg/h according to the recent issues of EPA Environmental Radiation Data. The median value for cities in the contiguous United States for the last three quarters of 1988 and the first quarter of 1989 was 2.5 nC/kg/h. The last value given for Knoxville (January through March 1989) was 2.5 nC/kg/h. All of the values given in Table 24 are close to these ranges of background values. High readings at station 4 can be attributed to its location near the Process Waste Treatment Plant.

Table 24. External gamma radiation measurements at ORNL and reservation perimeter air monitoring stations, July-September 1989

Location	Number of samples[a]	Concentration (nC/kg/h) Max	Min	Av	Standard error[b]
		ORNL PAM Stations[c]			
03	2132	3.0	1.6	1.7	0.0016
04	703	32	2.5	22	0.28
07	61	1.6	1.4	1.5	0.0081
20	675	13	2.1	2.2	0.017
Network summary	3571	32	1.4	5.9	0.15
		Reservation PAM Stations[d]			
08	547	2.3	1.6	1.8	0.0041
31	2040	2.7	1.9	2.0	0.0015
33	1550	5.0	1.6	1.9	0.0045
34	164	3.2	1.8	2.0	0.010
40	39	2.3	2.0	2.1	0.011
41	2208	2.1	1.5	1.5	0.00073
44	2116	2.5	1.5	1.7	0.0026
45	54	2.1	1.7	1.9	0.012
Network summary	8718	5.0	1.5	1.8	0.0022

[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

The Oak Ridge National Laboratory (ORNL) site is drained by two main streams, White Oak Creek (WOC) and Melton Branch (MB). With the exception of two small discharges from the 7600 area into Melton Hill Lake, all ORNL effluents discharge to these two streams or their tributaries. WOC flows through Bethel Valley where Fifth Creek, First Creek, and the Northwest Tributary join it (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, which is controlled by White Oak Dam (WOD), and is the last sampling point before effluents leave the ORNL site. The majority of the drainage or liquid effluent from ORNL flows into the Clinch River by way of WOC. The Clinch River flows southwest from Virginia to its mouth near Kingston, Tennessee, where it joins with the Tennessee River. Process effluents discharged to these streams are handled in a number of ways which include: treatment [Process Waste Treatment Plant (PWTP), Coal Yard Runoff], holding basins [190 ponds, High Flux Isotope Reactor/Transuranium Processing Facility (HFIR/TRU) ponds], and direct discharge to the stream. 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 which 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. Samples are analyzed for radionuclides and nonradioactive chemicals.

3.1 SURFACE WATER

White Oak Creek drains 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, MB. WOD, located above the mouth of WOC, forms White Oak Lake (WOL) and serves as a point for monitoring flow and discharges of contaminants from the ORNL site.

Samples are collected for radiological analyses at off-site and on-site locations, at background or reference locations, in streams on the ORNL site, and from all process discharge point sources. A summary of locations, parameters analyzed, and frequencies of sample collection and analysis for all radiological samples is provided in Table 25. Changes in the sampling procedures were implemented during the second quarter. In early May, the sampling stations 190 Ponds, 1500 Area, and 2000 Area were combined and called X06.A. At the end of May, stations HFIR Ponds and TRU Ponds were combined and called X09A. Tritium and total strontium analysis frequencies for WOD were changed from weekly to monthly. For Kingston and Gallaher, total uranium analysis was substituted for specific uranium isotope analysis. This section contains summaries of results of samples collected from each location and reflects the changes made during the second quarter.

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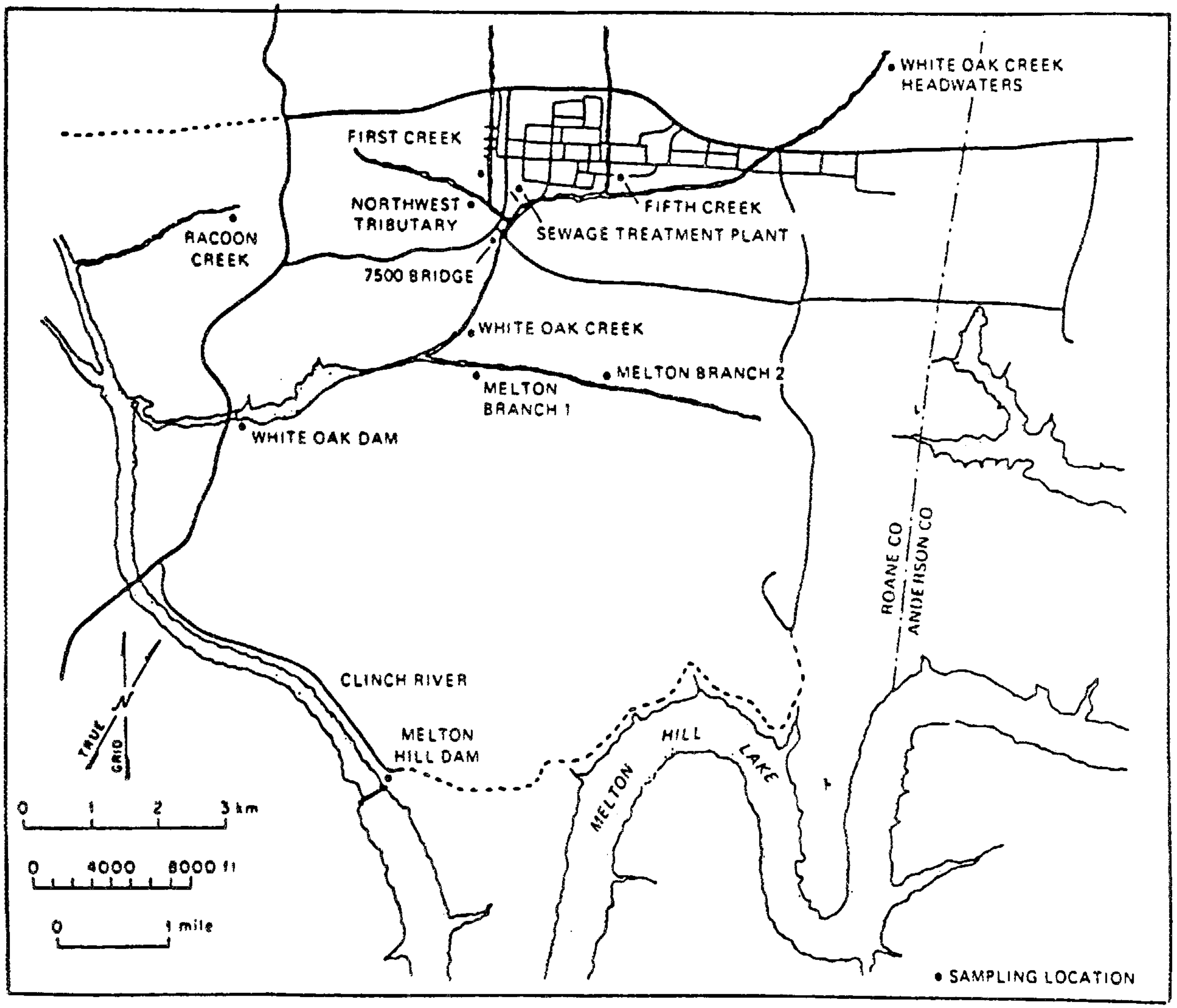

Fig. 5. Location map of ORNL streams and sampling stations.

Table 25. Summary of collection and analysis frequencies of surface, pond, and effluent water samples

Station	Parameter	Collection frequency	Type	Analysis frequency
3518	Gross alpha, gross beta	Weekly	Flow proportional	Monthly
STP	Gamma scan, gross beta, total Sr[a]	Weekly	Flow proportional	Monthly
3544	Gross alpha, gross beta, gamma scan, total Sr[a]	Weekly	Flow proportional	Monthly
7500 Bridge, MB1 WOC, MB2	Gamma scan, total Sr[a], ^{3}H	Weekly	Flow proportional	Monthly
First Creek, Fifth Creek, Raccoon Creek	Gamma scan, total Sr[a]	Weekly	Grab	Monthly
Gallaher	^{3}H, gamma scan, gross alpha, gross beta, Pu isotopes, total Sr[a], total U	Weekly	Time proportional	Quarterly
Kingston	^{3}H, gamma scan, gross alpha, gross beta, Pu isotopes, total Sr[a], total U	Weekly	Grab	Quarterly
Melton Hill Dam	Gamma scan, gross alpha, gross beta	Weekly	Flow proportional	Monthly
NWT	Gamma scan, Total Sr[a]	Weekly	Flow proportional	Monthly
WOC Headwaters	Gamma scan, gross alpha, gross beta	Weekly	Flow proportional	Monthly

Table 25. (continued)

Station	Parameter	Collection frequency	Type	Analysis frequency
WOD	Gross alpha, gamma scan, gross beta	Weekly	Flow proportional	Weekly
	Total Sr[a], ^{3}H	Weekly	Flow proportional	Monthly
TRU Ponds	Gross beta	After discharge	Flow proportional	Monthly
X06A	Gross alpha, gross beta, gamma scan, total Sr[a]			Monthly
X09A	Gross alpha, gross beta, gamma scan			Monthly

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

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. Third-quarter radionuclide concentrations in water sampled at Gallaher and Kingston are unavailable at this time. Tables 26 and 27 contain the concentrations measured at these stations during the first and second quarters. Except for the tritium concentrations, all values listed in Table 26 were reported in earlier reports. Concentrations are compared with the Environmental Protection Agency (EPA) drinking water standards that apply at the outlet of a public water distribution system. Percentage of the EPA drinking water standard is reported. All percentages were less than 100%.

Melton Hill Dam and WOC headwater, two locations above ORNL discharge points, serve as references for other water sampling locations at the ORNL site. Water samples are collected there and from six streams: WOC, MB, First Creek, Fifth Creek, Northwest Tributary, and Raccoon Creek (Fig. 5). Summary statistics for each radionuclide at each surface water sampling location are given in Table 28.

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 28. All parameters, except for total radioactive strontium, were less than 8% of the DCG. Average total radioactive strontium concentration was highest in First Creek (average of 16 Bq/L), which was 43% 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 are given in Table 25. Table 29 contains a summary of the concentrations for each of these locations during this quarter. The average concentration is expressed as a percentage of the DCG in the last column of this table. No parameter average concentration exceeded 59% of its DCG.

The discharge of radioactive contaminants from ORNL is affected by the stream flows. Flows in MB (as measured at station MB1), WOC (as measured at the confluence of MB and at WOD), and the Clinch River (as measured at Melton Hill Dam) are given in Table 30. The flow in Melton Branch is usually about one-third that in WOC. The ratio of WOC flow to Clinch River flow is also reported in Table 30. 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 500 to 610. Clinch River flows are regulated by a series of TVA dams, one of which is Melton Hill Dam.

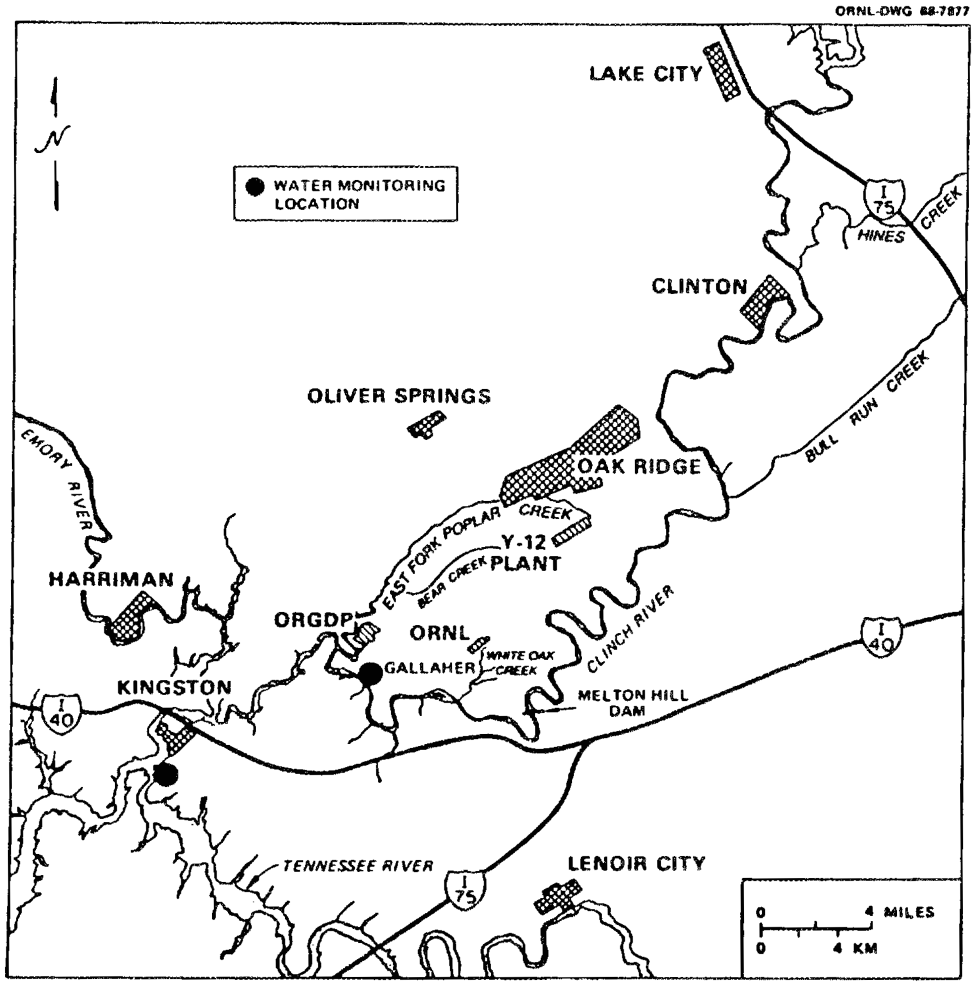

Fig. 6. Location map of Gallaher and Kingston sampling points.

Table 26. Summary of radionuclide concentrations in water off-site of ORNL, January-March 1989

Radionuclide	Concentration (Bq/L)	Drinking Water Standard[a] (DWS) (Bq/L)	Percentage of DWS[b]
		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
^{3}H	270	740	36
^{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
^{3}H	72	740	9.7
^{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 strontium (^{89}Sr + ^{90}Sr).

Table 27. Summary of radionuclide concentrations in water off-site of ORNL, April-June 1989

Radionuclide	Concentration (Bq/L)	Drinking Water Standard[a] (DWS) (Bq/L)	Percentage of DWS[b]
		Gallaher[c]	
^{60}Co	0.022	NA[d]	NA
^{137}Cs	0.045	NA	NA
Gross alpha	0.034	0.056	61
Gross beta	0.24	1.9	13
^{238}Pu	0.00011	NA	NA
^{239}Pu	0.00014	NA	NA
Total Sr[e]	0.079	0.30	26
Total U	0.0010	NA	NA
^{3}H	49	740	6.6
		Kingston[c]	
^{60}Co	0.012	NA	NA
^{137}Cs	0.012	NA	NA
Gross alpha	0.049	0.056	88
Gross beta	0.15	1.9	8.1
^{238}Pu	0.00036	NA	NA
^{239}Pu	-0.00021	NA	NA
Total Sr[e]	0.064	0.30	21
Total U	0.00060	NA	NA
^{3}H	4.4	740	0.59

[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 radioactive strontium (^{89}Sr + ^{90}Sr).

Table 28. Radionuclide concentrations in surface waters around ORNL,[a] July-September 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			
^{60}Co	3	0.80	-0.60	-0.10	0.45	190	<0.001
^{137}Cs	3	-0.20	-0.90	-0.57	0.20	110	<0.001
Gross alpha	3	0.70	0.30	0.52	0.12	NA[e]	NA
Gross beta	3	1.6	0.40	1.0	0.35	NA	NA
				White Oak Creek Headwaters			
^{60}Co	3	1.8	-0.60	0.70	0.70	190	0.38
^{137}Cs	3	0.90	-0.90	0.17	0.55	110	0.15
Gross alpha	3	1.7	-0.20	0.80	0.55	NA"	NA
Gross beta	3	1.0	0.10	0.60	0.26	NA	NA
				7500 Bridge			
^{60}Co	3	1.3	0.20	0.77	0.32	190	0.41
^{137}Cs	3	6.7	3.3	4.5	1.1	110	4.1
Total Sr[f]	3	2.7	1.9	2.4	0.24	37	6.4
^{3}H	3	280	87	200	57	74,000	0.26

Table 28. (continued)

Radionuclide	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Derived Concentration Guide[c] (DCG)	Percentage of DCG[d]
First Creek							
^{60}Co	3	0.40	-0.20	0.17	0.19	190	0.090
^{137}Cs	3	0.80	-0.30	0.33	0.33	110	0.30
Total Sr[f]	3	19	11	16	2.5	37	43
Fifth Creek							
^{60}Co	3	1.9	0.10	0.83	0.55	190	0.45
^{137}Cs	3	0.50	-0.60	-0.23	0.37	110	<0.001
Total Sr[f]	3	1.3	1.1	1.2	0.067	37	3.3
Melton Branch 2							
^{60}Co	3	1.0	-0.40	0.53	0.47	190	0.29
^{137}Cs	3	1.2	0.20	0.60	0.31	110	0.54
Total Sr[f]	3	0.11	0.010	0.073	0.032	37	0.20
^{3}H	3	17,000	33	5,700	5,700	74,000	7.7

Table 28. (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	0.50	0.10	0.33	0.12	190	0.18
^{137}Cs	3	0.40	-0.30	0.067	0.20	110	0.060
Total Sr[f]	3	2.2	0.86	1.5	0.39	37	4.0
				Raccoon Creek			
^{60}Co	3	-0.30	-0.50	-0.40	0.058	190	<0.001
^{137}Cs	3	1.1	-0.30	0.30	0.42	110	0.27
Total Sr[f]	3	3.0	1.0	1.8	0.62	37	4.8

[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 strontium (^{89}Sr + ^{90}Sr).

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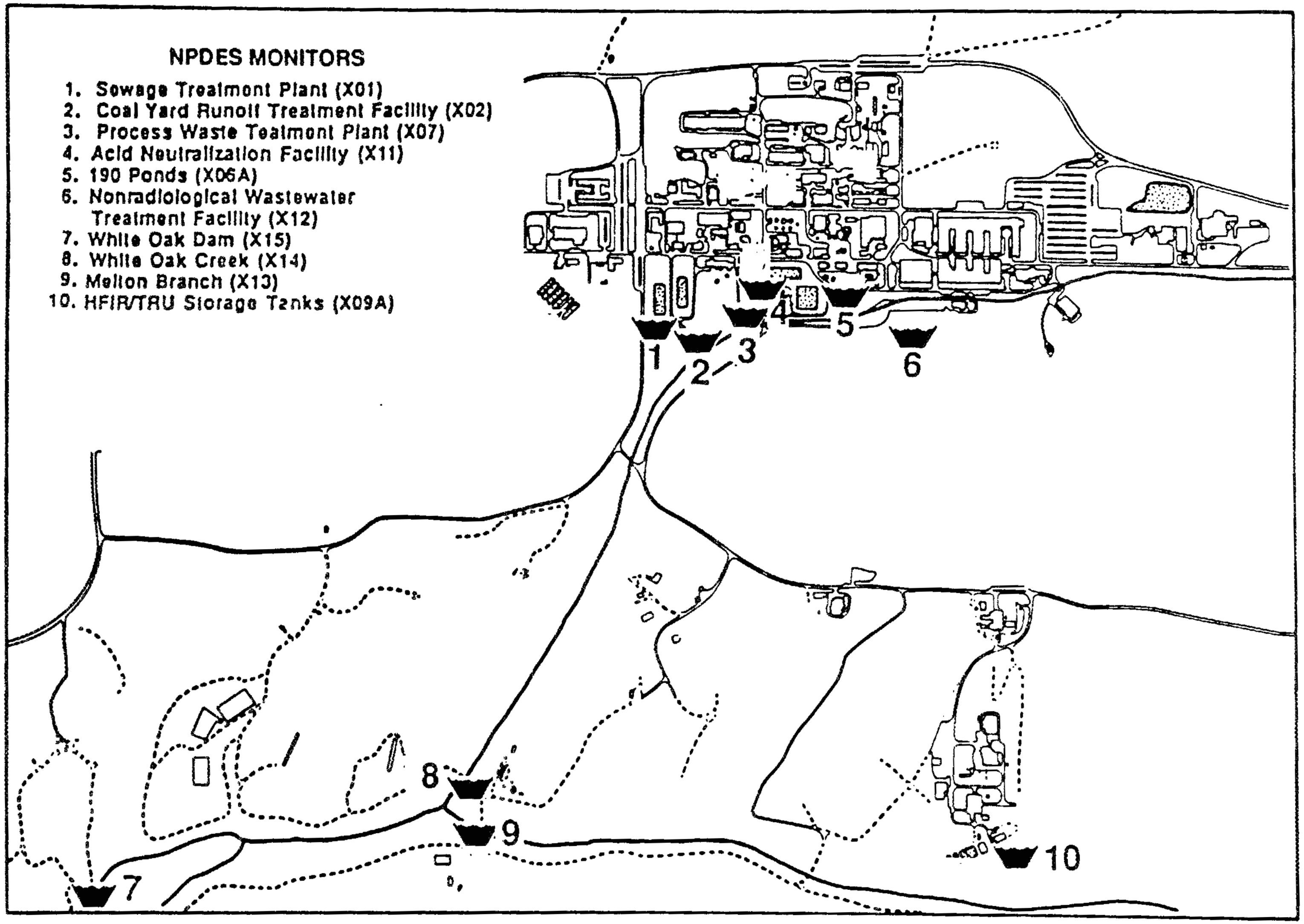

Fig. 7. Location map of ORNL NPDES and radioactivity sampling locations.

Table 29. Radionuclide concentrations at ORNL NPDES locations,[a] July-September 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	-0.10	-0.50	-0.27	0.12	190	<0.001
^{137}Cs	3	1.2	-0.40	0.63	0.52	110	0.57
Gross beta	3	8.6	2.2	5.5	1.9	NA[e]	NA
Total Sr[f]	3	4.1	0.44	1.9	1.1	37	5.2
				190 Ponds, 1500 Area and 2000 Area (X06A)			
^{60}Co	3	0.50	-1.2	-0.25	0.50	190	<0.001
^{137}Cs	3	0.70	-0.30	0.23	0.29	110	0.21
Gross alpha	3	0.60	0.17	0.32	0.14	NA	NA
Gross beta	3	3.0	0.50	1.6	0.74	NA	NA
Total Sr[f]	3	0.62	0.30	0.44	0.095	37	1.2
				Process Waste Treatment Plant (X07)			
^{60}Co	3	97	0.60	34	32	190	18
^{137}Cs	3	100	2.1	63	31	110	57
Gross alpha	3	3.0	2.4	2.7	0.18	NA	NA
Gross beta	3	120	75	95	13	NA	NA
Total Sr[f]	3	1.9	1.1	1.4	0.27	37	3.7

Table 29. (continued)

Radionuclide	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Derived Concentration Guide[c] (DCG)	Percentage of DCG[d]
		TRU/TURF and HFIR Ponds (X09A)					
^{60}Co	3	9.4	1.2	5.3	2.4	190	2.8
^{137}Cs	3	16	0.60	6.0	5.0	110	5.4
^{154}Eu	2	18	9.2	14	4.4	740	1.8
^{155}Eu	2	6.5	5.7	6.1	0.40	3,700	0.16
Gross alpha	3	0.70	0.010	0.47	0.23	NA	NA
Gross beta	3	37	25	31	3.5	NA	NA
		Acid Neutralization Facility (X11)					
Gross alpha	3	1.6	-0.040	0.69	0.48	NA	NA
Gross beta	3	1.1	-0.80	0.23	0.55	NA	NA
		Melton Branch 1 (X13)					
^{60}Co	3	3.2	-0.10	1.4	0.97	190	0.74
^{137}Cs	3	1.0	-0.50	0.033	0.48	110	0.030
Total Sr[f]	3	23	14	18	2.6	37	49
^{3}H	3	63,000	13,000	43,000	15,000	74,000	58

Table 29. (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 Creek (X14)			
^{60}Co	3	1.5	0.40	0.80	0.35	190	0.43
^{137}Cs	3	5.1	1.9	3.5	0.92	110	3.2
Total Sr[f]	3	3.9	2.4	3.1	0.43	37	8.5
^{3}H	3	1,300	290	930	320	74,000	1.3
				White Oak Dam (X15)			
^{60}Co	13	0.47	0.095	0.24	0.030	190	0.13
^{137}Cs	13	12	0.91	3.4	0.99	110	3.0
Gross alpha	13	1.2	-1.4	0.23	0.17	NA[e]	NA
Gross beta	13	23	7.9	14	1.3	NA	NA
Total Sr[f]	3	6.6	4.1	5.0	0.82	37	13
^{3}H	3	9,600	2,800	6,400	2,000	74,000	8.7

[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 strontium (^{89}Sr + ^{90}Sr).

Table 30. Stream[a] flows, July-September 1989

Month	Flow (10^9 L) Melton Branch 1	White Oak Creek[b]	White Oak Dam[c]	Clinch River	Average Ratio[d]
July	0.26	1.0	1.1	500	500
August	0.11	0.67	0.78	460	610
September	0.29	0.68	1.1	490	550

[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.

Discharges of radioactivity into WOC at the Sewage Treatment Plant (STP), at the confluence of WOC and MB, at WOD, and into MB were calculated from concentration and flow. A single flow-proportional sample was obtained weekly at each of WOD, WOC, MB1, and STP stations and analyzed at monthly intervals. (WOD monthly analyses were done for tritium and total strontium only.) The discharge during that period was calculated as the product of the flow-weighted concentration and the total flow for the sampling period (Tables 31-33).

In addition, weekly flow-proportional samples were obtained at WOD and analyzed (for radionuclides other than tritium and total strontium) at weekly intervals. The average concentration during the calendar month was calculated as a weighted sum of all concentrations obtained for sampling periods overlapping the calendar month. The weights were proportional to the calendar period total flow attributable to the sampling periods. This average concentration was multiplied by the calendar month total flow to arrive at the discharge.

Each average flow-weighted concentration was compared with a corresponding DCG. In most cases, parameter concentrations were less than 19% of the DCG. However, the percentages for total radioactive strontium and tritium at MB1 are higher than that for most parameters but less than 85% of the DCG. During this quarter, concentrations at MB1 ranged from 38 to 62% of the DCG for total radioactive strontium and from 18 to 85% of the DCG for tritium. Total radioactive strontium and tritium concentrations ranged from 1.2 to 62% and 0.39 to 85% of the DCG, respectively, at all four locations. SWSA 5 appears to be a major contributor of strontium because MB1 average strontium concentration is 250 times higher than MB2.

Monthly surface water samples are collected at two sampling locations for the purpose of determining background contamination levels. One sample collection location is at Melton Hill Dam above ORNL's discharge point into the Clinch River (Fig. 5). The other sample location is at WOC headwaters above the point where ORNL discharges to WOC (Fig. 5). Analyses are performed to detect inorganic compounds, along with total organic compounds (TOC) that may be present in the water. TOC provides a measure of organic compounds present in the sample. If a significant amount of TOC is detected, a more complete organic analysis will be performed. The results of these analyses help to determine which compounds ORNL may be discharging.

The inorganics, oil and grease, and dissolved solids were collected flow-proportionally by a sampling station at each location. Field measurements for temperature, conductivity, pH, turbidity and dissolved oxygen are made in grab samples at the time of collection.

Table 34 contains a summary of the analytical results. The column entitled "Percentage of 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 analytical results show a wide range of detection limits because the samples require dilution prior to analysis. Multiple-element analyzers, such as inductively coupled plasma (ICP) equipment, are subject to spectral interference when one element is at a relatively high concentration. Diluting the sample compensates for the interference, but also changes the detection element limits for the sample.

Table 31. Radionuclide concentrations and releases at ORNL,[a] July 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 (06/30-08/01)			
^{60}Co	270	-0.0027	-0.10	190	<0.001
^{137}Cs	270	-0.011	-0.40	110	<0.001
Total Sr[d]	270	0.45	17	37	46
^{3}H	270	1,700	63,000	74,000	85
		Sewage Treatment Plant (06/30-08/01)			
^{60}Co	31	-0.00063	-0.20	190	<0.001
^{137}Cs	31	0.0034	1.1	110	0.99
Gross beta	31	0.018	5.7	NA[e]	NA
Total Sr[d]	31	0.0014	0.44	37	1.2
		White Oak Creek (06/30-08/01)			
^{60}Co	1,100	0.042	0.40	190	0.22
^{137}Cs	1,100	0.37	3.5	110	3.2
Total Sr[d]	1,100	0.41	3.9	37	11
^{3}H	1,100	140	1,300	74,000	1.8
		White Oak Dam[f] (07/01-08/01)			
^{60}Co	1,100	0.022	0.20	190	0.11
^{137}Cs	1,100	0.19	1.6	110	1.5
Gross alpha	1,100	0.0054	0.048	NA	NA
Gross beta	1,100	1.8	16	NA	NA
		White Oak Dam[f] (06/30-08/01)			
Total Sr[d]	1,200	0.77	6.6	37	18
^{3}H	1,200	1,100	9,600	74,000	13

[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 strontium (^{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. Radionuclide concentrations and releases at ORNL,[a] August 1989

Radionuclide	Flow (10^6 L)	Discharge (10^{10}p Bq)	Concentration (Bq/L)	Concentration Guide[b] (DCG) (Bq/L)	Percentage of DCG[c]
			Melton Branch 1 (08/01-09/05)		
^{60}Co	140	0.014	1.0	190	0.54
^{137}Cs	140	-0.0069	-0.50	110	<0.001
Total Sr[d]	140	0.32	23	37	62
^{3}H	140	710	52,000	74,000	70
			Sewage Treatment Plant (08/01-09/05)		
^{60}Co	31	-0.0015	-0.50	190	<0.001
^{137}Cs	31	-0.0012	-0.40	110	<0.001
Gross beta	31	0.0068	2.2	NA[e]	NA
Total Sr[d]	31	0.0037	1.2	37	3.2
			White Oak Creek (08/01-09/05)		
^{60}Co	760	0.038	0.50	190	0.27
^{137}Cs	760	0.14	1.9	110	1.7
Total Sr[d]	760	0.18	2.4	37	6.5
^{3}H	760	22	290	74,000	0.39
			White Oak Dam[f]		
^{60}Co	780	0.020	0.25	190	0.13
^{137}Cs	780	0.30	3.8	110	3.4
Gross alpha	780	0.022	0.28	NA	NA
Gross beta	780	0.98	13	NA	NA
			White Oak Dam[f] (08/01-09/05)		
Total Sr[d]	900	0.37	4.1	37	11
^{3}H	900	620	6,900	74,000	9.3

[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 strontium (^{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 33. Radionuclide concentrations and releases at ORNL,[a] September 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 (09/05-10/06)		
^{60}Co	300	0.097	3.2	190	1.7
^{137}Cs	300	0.030	1.0	110	0.90
Total Sr[d]	300	0.42	14	37	38
^{3}H	300	390	13,000	74,000	18
			Sewage Treatment Plant (09/05-10/06)		
^{60}Co	32	-0.00032	-0.10	190	<0.001
^{137}Cs	32	0.0038	1.2	110	1.1
Gross beta	32	0.027	8.6	NA[e]	NA
Total Sr[d]	32	0.013	4.1	37	11
			White Oak Creek (09/05-10/06)		
^{60}Co	730	0.11	1.5	190	0.81
^{137}Cs	730	0.37	5.1	110	4.6
Total Sr[d]	730	0.23	3.1	37	8.4
^{3}H	730	88	1,200	74,000	1.6
			White Oak Dam[f] (09/01-10/01)		
^{60}Co	1,100	0.034	0.30	190	0.16
^{137}Cs	1,100	0.60	5.4	110	4.9
Gross alpha	1,100	0.056	0.50	NA	NA
Gross beta	1,100	1.8	16	NA	NA
			White Oak Dam[f] (09/05-10/06)		
Total Sr[d]	1,300	0.54	4.2	37	11
^{3}H	1,300	360	2,800	74,000	3.8

[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 strontium (^{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 34. Surface water analyses at reference locations,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error	Percentage of DWL[b]
		Melton Hill Dam[a]				
Conductivity, mS/cm	3	1.6	0.36	1.1	0.37	
Temperature, °C	3	21	18	20	0.85	
Turbidity, NTU	3	93	0.33	45	26	
pH, standard units	3	8.8	7.7	8.1	0.33	
Aluminum-total	3	3.4	0.51	1.5	0.95	
Antimony-total	3	0.085	<0.040	<0.055	0.015	
Arsenic-total	3	<0.050	<0.050	<0.050	0	<100
Barium-total	3	0.069	0.0099	0.031	0.018	3.1
Beryllium-total	3	<0.0005	<0.0004	<0.0004	0.00003	
Boron-total	3	<0.080	<0.080	<0.080	0	
Cadmium-total	3	<0.0020	<0.0020	<0.0020	0	<20
Calcium-total	3	38	34	36	1.2	
Chromium-total	3	0.016	0.0043	0.0085	0.0037	17
Cobalt-total	3	<0.0030	<0.0030	<0.0030	0	
Copper-total	3	0.017	<0.010	<0.012	0.0023	<1.2
Dissolved solids-total	3	190	160	180	8.4	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Iron-total	3	2.9	0.37	1.2	0.83	410
Lead-total	3	<0.030	<0.030	<0.030	0	<60
Lithium-total	3	<15	<15	<15	0	
Magnesium-total	3	11	8.8	9.9	0.63	
Manganese-total	3	0.70	0.075	0.30	0.20	590
Molybdenum-total	3	<0.040	<0.040	<0.040	0	
Nickel-total	3	0.043	<0.0060	<0.018	0.012	
Nitrate	3	<5.0	0.60	<3.5	1.4	<35
Oil and grease	3	<2.0	<2.0	<2.0	0	
Organic carbon-total	3	2.9	1.5	2.1	0.40	
Oxygen-dissolved	3	12	6.6	9.1	1.5	
Phosphorus-total	3	<0.30	<0.30	<0.30	0	
Selenium-total	3	<0.080	<0.080	<0.080	0	<800
Silicon-total	3	7.6	2.3	4.1	1.7	
Silver-total	3	0.014	<0.0050	<0.0080	0.0030	<16
Sodium-total	3	4.8	<2.0	<3.1	0.87	
Strontium-total	3	0.11	0.080	0.091	0.0094	

Table 34. (continued)

Parameter	Number of samples	Concentration (mg/L)				Percentage of DWL[b]
		Max	Min	Av	Standard error	
Sulfate(as SO_4)	3	25	22	24	0.88	9.5
Suspended solids-total	3	90	<5.0	<35	27	
Tin-total	3	<0.050	<0.050	<0.050	0	
Titanium-total	3	0.098	<0.020	<0.046	0.026	
Vanadium-total	3	0.017	<0.0040	<0.0083	0.0043	
Zinc-total	3	0.021	<0.0080	<0.014	0.0037	<0.29
Zirconium-total	3	<0.020	<0.020	<0.020	0	
White Oak Creek[a]						
Conductivity, mS/cm	3	1.1	0.25	0.72	0.24	
Temperature, °C	3	16	16	16	0.066	
Turbidity, NTU	3	100	1.2	38	32	
pH, standard units	3	8.1	7.7	7.9	0.11	
Aluminum-total	3	4.5	0.30	2.4	1.2	
Antimony-total	3	<0.040	<0.040	<0.040	0	
Arsenic-total	3	<0.050	<0.050	<0.050	0	<100
Barium-total	3	0.12	0.045	0.092	0.023	9.2
Beryllium-total	3	<0.0005	<0.0004	<0.0004	0.00003	
Boron-total	3	<0.080	<0.080	<0.080	0	
Cadmium-total	3	<0.0020	<0.0020	<0.0020	0	<20
Calcium-total	3	32	24	28	2.3	
Chromium-total	3	0.022	0.0074	0.013	0.0044	26
Cobalt-total	3	0.0057	<0.0030	<0.0041	0.00082	
Copper-total	3	<0.010	<0.0080	<0.0093	0.00066	<0.93
Dissolved solids-total	3	130	94	110	11	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Iron-total	3	5.3	0.24	2.7	1.4	890
Lead-total	3	<0.030	<0.030	<0.030	0	<60
Lithium-total	3	<15	<15	<15	0	
Magnesium-total	3	14	9.8	12	1.2	
Manganese-total	3	0.87	0.042	0.45	0.23	900
Molybdenum-total	3	<0.040	<0.040	<0.040	0	
Nickel-total	3	<0.0060	<0.0060	<0.0060	0	
Nitrate	3	<5.0	<0.50	<3.5	1.5	<35
Oil and grease	3	3.0	<2.0	<2.3	0.33	
Organic carbon-total	3	1.4	0.80	1.1	0.17	
Oxygen-dissolved	3	12	7.7	9.4	1.1	

Table 34. (continued)

Parameter	Number of samples	Concentration (mg/L)			Standard error	Percentage of DWL[b]
		Max	Min	Av		
Phosphorus-total	3	<0.30	<0.30	<0.30	0	
Selenium-total	3	<0.080	<0.080	<0.080	0	<800
Silicon-total	3	8.6	2.8	6.1	1.7	
Silver-total	3	0.0067	<0.0050	<0.0056	0.00056	<11
Sodium-total	3	<2.0	<2.0	<2.0	0	
Strontium-total	3	0.035	0.017	0.024	0.0054	
Sulfate(as SO_4)	3	<5.0	<5.0	<5.0	0	<2.0
Suspended solids-total	3	150	<5.0	<53	48	
Tin-total	3	<0.050	<0.050	<0.050	0	
Titanium-total	3	0.058	<0.020	<0.043	0.011	
Vanadium-total	3	<0.0040	0.0039	<0.004	0.00003	
Zinc-total	3	0.016	<0.0080	<0.011	0.0026	<0.21
Zirconium-total	3	<0.020	<0.020	<0.020	0	

[a]See Fig. 5.

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

Most of the analytical results were 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 the result of high analytical reporting limits for these analytes. The average concentration of manganese at Melton Hill Dam was found to be 590% of the National Secondary Drinking Water Limit, which is 0.05 mg/L. The average concentration of manganese at WOC was 900% of the drinking water limit. The average concentration of iron at Melton Hill Dam was 410% of the National Secondary Drinking Water Limit, and at WOC this figure was 890%. The standard error of these averages are all high; however, the data indicate that these analytes have exceeded the drinking water limits, using 95% confidence intervals about the averages. More samples would be required to confirm this suspicion. The National Secondary Drinking Water Limits are associated with aesthetic qualities of drinking water and not adverse health impacts.

3.2 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REQUIREMENTS

ORNL's current NPDES permit requires that seven point-source outfalls be sampled prior to their discharge into receiving waters or before mixing with any other wastewater stream. One of these points, the Nonradiological Wastewater Treatment Plant, will not be in operation until March 1990. In addition, there are three sampling locations that are located in the streams as reference points or for additional information. The ORR Resin Regeneration Facility was taken out of operation in December 1986. The 1500 area (X03), 2000 area (X04), and 3539/40 ponds (X06) were combined into one outfall (X06A) in May 1989. The TRU ponds (X08) and the HFIR ponds (X09) were combined into one outfall (X09A) in May 1989. The ten 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.

Quarterly summary statistics for the third quarter of 1989 are given for each sampling location in Tables 35 through 49. Category I outfalls are required to be sampled annually. Some outfalls were sampled in June; the rest in September.

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. The noncompliances listed in Table 50 are in addition to the noncompliances listed in the report for second quarter. Noncompliances are listed in Tables 50 through 53. A brief summary of the noncompliances follows.

Table 35. NPDES discharge point X01,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Ammonia (as N)	39	0.12	0.018	0.049	0.0043
Biochemical oxygen demand	39	<5.0	<5.0	<5.0	0
Bromodichloromethane	3	<0.0050	~0.0020	~0.0030	0.0010
Chlorine-total residual	39	0.42	<0.010	<0.24	0.022
Copper-total	3	0.013	<0.0080	<0.011	0.0015
Cyanide-total	3	<0.0020	<0.0020	<0.0020	0
Downstream pH, standard units	13	7.9	7.2	NA[c]	NA
Fecal coliform, col/100 mL[d]	39	190	<1.0	<1.5	1.2
Flow, Mgd	63	0.33	0.18	0.25	0.0045
Mercury-total	3	0.00008	<0.00005	<0.00006	0.00001
Oil and grease	39	160	<2.0	<6.5	4.1
Oxygen-dissolved	62	14	6.1	8.9	0.27
pH, standard units	13	7.6	6.9	NA	NA
Recoverable phenolics-total	3	<0.0010	<0.0010	<0.0010	0
Silver-total	3	0.0050	<0.0050	<0.0050	0
Suspended solids-total	39	11	<5.0	<5.2	0.15
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Zinc-total	3	0.069	0.058	0.065	0.0034

[a]See Fig. 7.
[b]Standard error of the mean.
[c]NA - not applicable.
[d]Geometric mean.

Table 36. NPDES discharge point X02,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Arsenic-total	13	0.26	<0.050	<0.19	0.017
Cadmium-total	13	<0.0020	<0.0020	<0.0020	0
Chromium-total	13	0.022	<0.0030	<0.012	0.0017
Copper-total	13	0.012	<0.0080	<0.0097	0.00031
Downstream pH, standard units	61	8.5	6.9	NA[c]	NA
Flow, Mgd	62	0.097	0	0.014	0.0027
Iron-total	13	0.37	<0.010	<0.080	0.031
Lead-total	13	0.043	<0.030	<0.031	0.00099
Manganese-total	13	0.097	0.0095	0.027	0.0065
Nickel-total	13	0.0075	<0.0060	<0.0061	0.00012
Oil and grease	13	120	<2.0	<11	9.4
pH, standard units	61	8.9	6.4	NA	NA
Selenium-total	13	<0.080	<0.080	<0.080	0
Silver-total	13	0.0075	<0.0050	<0.0057	0.00021
Sulfate(as SO_4)	3	1900	1300	1600	180
Suspended solids-total	13	17	<5.0	<6.7	0.92
Temperature, °C	61	30	17	25	0.39
Zinc-total	13	0.064	<0.0080	<0.019	0.0045

[a]See Fig. 7.
[b]Standard error of the mean.
[c]NA = not applicable.

Table 37. NPDES discharge point X06A,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Arsenic-total	6	<0.050	<0.050	<0.050	0
Cadmium-total	6	<0.0020	<0.0020	<0.0020	0
Chromium-total	6	0.014	<0.0030	<0.0076	0.0017
Copper-total	6	0.095	0.028	0.064	0.011
Downstream pH, standard units	13	8.2	7.1	NA[c]	NA
Flow, Mgd	3	0.23	0.21	0.21	0.0067
Iron-total	6	0.078	0.043	0.059	0.0058
Lead-total	6	0.088	<0.030	<0.041	0.0095
Mercury-total	6	0.0035	0.00069	0.0021	0.00043
Nickel-total	6	<0.0060	<0.0060	<0.0060	0
Oil and grease	6	<2.0	<2.0	<2.0	0
Organic carbon-total	6	5.8	2.0	3.9	0.62
pH, standard units	13	8.6	7.0	NA	NA
Phosphorus-total	6	0.50	0.30	0.38	0
Selenium-total	6	<0.080	<0.080	<0.080	0
Silver-total	6	0.015	<0.0050	<0.0070	0.0016
Sulfate(as SO_4)	6	26	24	25	0.37
Suspended solids-total	6	<5.0	<5.0	<5.0	0
Temperature, °C	13	25	20	23	0.42
Zinc-total	6	0.14	0.060	0.10	0.011

[a]See Fig. 7.
[b]Standard error of the mean.
[c]NA - not applicable.

Table 38. NPDES discharge point X07,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Arsenic-total	6	<0.050	<0.050	<0.050	0
Cadmium-total	6	<0.0020	<0.0020	<0.0020	0
Chromium-total	6	0.023	<0.0030	<0.0067	0.0033
Copper-total	6	<0.010	<0.0080	<0.0093	0.00042
Downstream pH, standard units	13	8.2	7.2	NA[c]	NA
Flow, Mgd	62	0.31	0.094	0.18	0.0058
Lead-total	6	0.032	<0.030	<0.030	0.00033
Nickel-total	6	0.0095	<0.0060	<0.0070	0.00064
Nitrate	6	7.6	<5.0	<5.4	0.43
Oil and grease	6	<2.0	<2.0	<2.0	0
Organic carbon-total	6	1.8	1.3	1.6	0.087
pH, standard units	13	8.8	6.8	NA	NA
Silver-total	6	<0.0050	<0.0050	<0.0050	0
Sulfate(as SO_4)	6	770	310	470	72
Suspended solids-total	6	7.0	<5.0	<5.3	0.33
Temperature, °C	13	28	22	26	0.43
Total toxic organics	6	0.091	B0.0060	B0.031	0.013
Zinc-total	6	0.026	0.0073	0.012	0.0031

[a]See Fig. 7.
[b]Standard error of the mean.
[c]NA - not applicable.

Table 39. NPDES discharge point X09A,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Arsenic-total	16	0.057	<0.050	<0.050	0.00044
Cadmium-total	16	0.0035	<0.0020	<0.0021	0.000094
Chromium-total	16	0.020	<0.0030	<0.0080	0.0012
Copper-total	16	0.27	<0.0080	<0.11	0.018
Downstream pH, standard units	16	8.2	7.3	NA[c]	NA
Flow, Mgd	16	0.0030	0.0017	0.0024	0.00011
Lead-total	16	0.041	<0.030	<0.031	0.00069
Nickel-total	16	0.0076	<0.0060	<0.0062	0.00011
Nitrate	16	<5.0	1.0	4.8	0.25
Oil and grease	16	5.0	<2.0	<2.2	0.19
Organic carbon-total	16	2.6	1.7	2.1	0.063
pH, standard units	16	8.5	7.2	NA	NA
Sulfate(as SO_4)	16	59	25	35	2.2
Suspended solids-total	16	12	2.0	5.4	0.52
Temperature, °C	16	32	19	28	0.75
Zinc-total	16	0.15	0.025	0.084	0.

[a]See Fig. 7.
[b]Standard error of the mean.
[c]NA - not applicable.

Table 40. NPDES discharge point X11,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Arsenic-total	6	0.22	0.10	0.17	0.019
Cadmium-total	6	0.0022	<0.0020	<0.0020	0.000033
Chromium-total	6	0.061	0.021	0.042	0.0079
Copper-total	6	0.022	<0.010	<0.015	0.0022
Downstream pH, standard units	13	8.3	7.5	NA[c]	NA
Flow, Mgd	3	0.021	0.014	0.016	0.0022
Lead-total	6	<0.030	<0.030	<0.030	0
Nickel-total	6	0.047	<0.0060	<0.014	0.0067
Nitrate	13	5.4	<5.0	<5.0	0.031
Oil and grease	6	<2.0	<2.0	<2.0	0
Organic carbon-total	13	7.5	0.70	2.8	0.48
pH, standard units	13	8.8	6.7	NA	NA
Phosphorus-total	6	5.9	0.60	2.6	0.97
Sulfate(as SO_4)	13	2300	900	1600	130
Suspended solids-total	6	46	<5.0	<17	6.4
Temperature, °C	13	26	18	23	0.57
Zinc-total	6	1.2	0.45	0.91	0.11

[a]See Fig. 7.
[b]Standard error of the mean.
[c]NA - not applicable

Table 41. NPDES discharge point X13,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L)			
		Max	Min	Av	Standard error[b]
Aluminum-total	3	0.57	0.27	0.38	0.094
Ammonia (as N)	3	0.070	0.028	0.046	0.012
Arsenic-total	3	0.054	<0.050	<0.051	0.0013
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	<0.025	−0.00050	−0.0087	0.0082
Chromium-total	3	0.013	0.0077	0.0095	0.0018
Conductivity, mS/cm	3	1.3	0.16	0.55	0.37
Copper-total	3	<0.010	<0.0080	<0.0093	0.00067
Dissolved solids-total	3	280	160	210	37
Flow, Mgd	62	13	0.58	1.6	0.25
Fluoride-total	3	1.0	1.0	1.0	0
Iron-total	3	0.41	0.12	0.22	0.094
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.081	0.073	0.077	0.0[illegible]
Mercury-total	3	0.00007	<0.00005	<0.000057	[illegible]
Nickel-total	3	0.0061	<0.0060	<0.0060	0.00003
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	87	<2.0	<11	6.5
Organic carbon-total	3	3.5	2.8	3.1	0.22
Oxygen-dissolved	13	14	5.1	10	0.73
PCBs-total	3	<0.00050	<0.00050	<0.00050	0
pH, standard units	3	7.8	7.8	NA[c]	NA
Phosphorus-total	3	0.60	0.20	0.37	0.12
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	27	20	23	2.0
Suspended solids-total	3	<5.0	<5.0	<5.0	0
Temperature, °C	16	27	17	22	0.72
Trichloroethene	3	<0.025	−0.00090	−0.010	0.0074
Turbidity, JTU[d]	3	220	48	110	54
Zinc-total	3	0.021	<0.0080	<0.012	0.0043

[a]See Fig. 7.
[b]Standard error of the mean.
[c]NA - not applicable.
[d]Measured in Jackson Turbidity Units.

Table 42. NPDES discharge point X14,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Aluminum-total	3	0.47	0.24	0.36	0.066
Ammonia (as N)	3	0.040	0.028	0.033	0.0037
Arsenic-total	3	<0.050	<0.050	<0.050	0
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium-total	3	<0.0020	<0.0020	<0.0020	0
Chlorine-total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.025	−0.0040	−0.011	0.0070
Chromium-total	3	0.013	0.0083	0.010	0.0015
Conductivity, mS/cm	3	1.8	0.20	1.1	0.47
Copper-total	3	<0.010	<0.0080	<0.0093	0.00067
Dissolved solids-total	3	300	180	230	36
Flow, Mgd	62	32	2.7	6.7	0.54
Fluoride-total	3	1.0	1.0	1.0	0
Iron-total	3	0.40	0.16	0.26	0.072
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.050	0.017	0.034	0.0095
Mercury-total	3	0.00011	0.00006	0.00009	0.000015
Nickel-total	3	0.0081	<0.0060	<0.0067	0.00070
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	42	<2.0	<6.9	3.1
Organic carbon-total	3	2.9	2.2	2.5	0.20
Oxygen-dissolved	13	13	6.8	9.7	0.64
PCBs-total	3	<0.00050	<0.00050	<0.00050	0
pH, standard units	3	7.9	7.8	NA[c]	NA
Phosphorus-total	3	0.40	0.20	0.30	0.058
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	58	34	45	7.1
Suspended solids-total	3	9.0	<5.0	<6.3	1.3
Temperature, °C	16	26	17	22	0.55
Trichloroethene	3	<0.025	<0.0050	<0.012	0.0067
Turbidity, JTU[d]	3	270	50	140	67
Zinc-total	3	0.055	0.023	0.040	0.0093

[a]See Fig. 7.
[b]Standard error of the mean.
[c]NA - not applicable.
[d]Measured in Jackson Turbidity Units.

Table 43. NPDES discharge point X15,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Aluminum-total	3	0.62	0.42	0.53	0.059
Ammonia (as N)	3	0.16	0.033	0.091	0.037
Arsenic-total	3	<0.050	<0.050	<0.050	0
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium-total	3	<0.0020	<0.0020	<0.0020	0
Chlorine-total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.025	~0.0020	~0.0097	0.0077
Chromium-total	3	0.020	0.015	0.018	0.0015
Conductivity, mS/cm	3	1.7	0.23	1.1	0.46
Copper-total	3	<0.010	<0.0080	<0.0093	0.00067
Dissolved solids-total	3	230	200	210	9.3
Flow, Mgd	62	32	4.2	8.4	0.64
Fluoride-total	3	1.0	1.0	1.0	0
Iron-total	3	0.54	0.48	0.51	0.017
Lead-total	3	0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.076	0.049	0.063	0.0078
Mercury-total	3	0.00011	<0.00005	<0.00007	0.00002
Nickel-total	3	0.0066	<0.0060	<0.0062	0.00020
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	>200	<2.0	<32	16
Organic carbon-total	3	3.5	2.8	3.1	0.22
Oxygen-dissolved	13	11	4.0	8.6	0.58
PCBs-total	3	<0.00050	<0.00050	<0.00050	0
pH, standard units	3	8.0	7.7	NA[c]	NA
Phosphorus-total	3	0.50	0.20	0.33	0.088
Silver-total	3	<0.0050	<0.0050	<0.0050	0
Sulfate(as SO_4)	3	48	39	43	2.6
Suspended solids-total	3	9.0	<5.0	<6.3	1.3
Temperature, °C	16	27	16	23	0.66
Trichloroethene	3	<0.025	<0.0050	<0.012	0.0067
Turbidity, JTU[d]	3	50	27	36	6.9
Zinc-total	3	0.020	<0.0080	<0.013	0.0035

[a]See Fig. 7.
[b]Standard error of the mean.
[c]NA = not applicable.
[d]Measured in Jackson Turbidity Units.

Table 44. NPDES miscellaneous source VC7002,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Biochemical oxygen demand	2	22	12	17	4.8
Fecal coliform, col/100 mL	2	>600	>600	>600	0
Flow, Mgd	62	0.00038	0	0.000074	0.000011
Oil and grease	2	160	7.0	83	76
pH, standard units	2	7.3	7.3	NA[c]	NA
Recoverable phenolics-total	2	0.058	0.0010	0.030	0.029
Suspended solids-total	2	1200	12	580	570

[a]Vehicle and Equipment Cleaning Facility, Building 7002.
[b]Standard error of the mean.
[c]NA = not applicable.

Table 45. NPDES cooling towers,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Chlorine-total residual	17	0.18	<0.010	<0.12	0.016
Chromium-total	17	0.095	0.0097	0.031	0.0055
Copper-total	17	1.4	<0.010	<0.19	0.080
Downstream pH, standard units	13	8.6	7.4	NA[c]	NA
Flow, Mgd	17	0.18	0.0010	0.015	0.010
pH, standard units	17	9.0	7.5	NA	NA
Temperature, °C	17	30	23	27	0.50
Zinc-total	17	10	0.11	1.1	0.57

[a]ORNL.
[b]Standard error of the mean.
[c]NA = not applicable.

Table 46. NPDES miscellaneous outfalls, July-September 1989

	Concentration (mg/L)	
	Location	
Parameter	EF7002[a]	SP2519[b]
Flow, Mgd		0.00095
Oil and grease	9.0	
pH, standard units	7.8	10
Temperature, °C		27

[a]Vehicle and Equipment Maintenance Facility, Building 7002.

[b]Central Steam Plant, Building 2519.

Table 47. NPDES discharge point category I outfalls,[a] April-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Downstream pH, standard units	25	8.8	6.9	NA[c]	NA
Flow, Mgd	25	0.11	0.00014	0.012	0.0055
Oil and grease	25	210	<2.0	<19	8.5
pH, standard units	25	8.5	3.3	NA	NA
Suspended solids-total	25	3700	<5.0	<300	160
Temperature, °C	25	38	15	21	0.81

[a]ORNL.
[b]Standard error of the mean.
[c]NA - not applicable.

Table 48. NPDES discharge point category II outfalls,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Downstream pH, standard units	44	8.2	6.8	NA[c]	NA
Flow, Mgd	44	0.26	0.00014	0.026	0.0078
Oil and grease	44	130	<2.0	<15	4.3
pH, standard units	44	8.3	6.7	NA	NA
Suspended solids-total	44	93	<5.0	<15	3.3
Temperature, °C	44	34	19	24	0.48

[a]ORNL.
[b]Standard error of the mean.
[c]NA = not applicable.

Table 49. NPDES discharge point category III outfalls,[a] July-September 1989

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Flow, Mgd	21	0.32	0.00019	0.033	0.015
pH, standard units	21	8.3	7.0	NA[c]	NA

[a]ORNL.
[b]Standard error of the mean.
[c]NA = not applicable.

Table 50. NPDES noncompliances, June 1989

Station	Parameter	Daily max concentration (mg/L)	Permit limit (mg/L)
Category I			
102	Total suspended solids	163	50
106	Temperature[a]	38.4	30.5
109	pH[b,c]	= 3.3	6.0
109	Total suspended solids	911	50
111	Total suspended solids	514	50
113	Total suspended solids	1332	50
116	Total suspended solids	3692	50
143	Total suspended solids	109	50
144	Total suspended solids	241	50
191	Total suspended solids	56	50

[a]Degrees centigrade
[b]Standard units.
[c]Minimum limit.

Table 51. NPDES noncompliances, July 1989

Station	Parameter	Daily max concentration (mg/L)	Permit limit (mg/L)
Cooling systems			
2000	Zinc	1.6	1.0
3025-E	Zinc	10.0	1.0
3047-E	Zinc	1.2	1.0
3517-3	Zinc	1.6	1.0
4510	Downsteam pH[a]	9.0	8.5
7710	Copper	1.4	1.0
Vehicle cleaning (VC7002)	Fecal coliform[b]	>600	200
	Total suspended solids	1152	40
	Oil and grease	159	10

[a]Measured in standard units.
[b]Measured in colonies per 100 mL.

Table 52. NPDES noncompliances, August 1989

Station	Parameter	Daily max concentration (mg/L)	Permit limit (mg/L)
Steam plant (SP2519)	pH[a]	10.1	9.0
Vehicle cleaning (VC7002)	Fecal coliform[b]	>600	200

[a]Measured in standard units.
[b]Measured in colonies per 100 mL.

Table 53. NPDES noncompliances, September 1989

Station	Parameter	Daily max concentration (mg/L)	Permit limit (mg/L)
Category I			
108	Oil and grease	32	15
108	Total suspended solids	103	50
141	Total suspended solids	66	50
165	Oil and grease	20	15
168	Oil and grease	67	15
169	Oil and grease	211	15
169	Total suspended solids	67	50
173	Oil and grease	25	15
Category II			
204	Oil and grease	61	15
206	Total suspended solids	79	50
207	Total suspended solids	93	50
209	Oil and grease	128	15
214	Oil and grease	26	15
216	Oil and grease	132	15
224	Oil and grease	35	15
224	Total suspended solids	83	50
231	Oil and grease	19	15
248	Oil and grease	18	15
248	Total suspended solids	55	50
250	Oil and grease	16	15
266	Oil and grease	40	15
267	Oil and grease	41	15
268	Oil and grease	36	15
Sewage Treatment Plant			
(X01)	Oil and grease	162	15
	Oil and grease, kg/d	193	13.1
	Oil and grease[a]	15	10
	Oil and grease,[a] kg/d	18	8.7

Table 53 (continued).

Station	Parameter	Daily max concentration (mg/L)	Permit limit (mg/L)
Vehicle Cleaning Facility (VC7002)	Biological oxygen demand	Not taken	
	Fecal coliform	Not taken	
	Oil and grease	Not taken	
	pH	Not taken	
	Phenols	Not taken	
	Total suspended solids	Not taken	
Coal Yard Facility (X02)	Oil and grease	124	20
	Oil and grease[a]	32.5	15

[a]Average for the month.

VC7002

Several NPDES permit limit exceedances were reported for the ORNL Vehicle and Equipment Cleaning Facility, VC7002. The VC7002 effluent is floor drainage from a cleaning service bay; the wastewater is piped underground from the floor drain to a below-grade grease trap; overflow from the trap flows into the 7000 Area storm sewer system. EMC personnel are in the process of evaluating the validity of the current VC7002 sampling point concurrent with a newly established cleanout procedure for the VC7002 grease trap. If the current monitoring point is determined to provide valid, representative effluent samples, preliminary indications are that the existing grease trap, even after proper cleaning, may not achieve the effluent water quality that is required by ORNL's NPDES permit. The VC7002 grease trap was cleaned out in September 1989. Samples were not obtained in September 1989 because it was not certain that representative samples could be obtained based on the condition of the trap after cleaning. A Quality Event Report (QER) exercise is in progress to address all aspects of this issue.

Cooling Systems (Cooling Tower Blowdown)

NPDES permit limits for copper and zinc were exceeded at five ORNL cooling towers. The downstream pH at one tower location exceeded a Tennessee water quality standard for stream, pH; however, the ORNL NPDES Permit contains no numeric limit for this parameter. Operating personnel have attributed the presence of the metals to corrosion of tower piping and other components, and further investigation by ORNL Plant and Equipment Division staff is in progress. EMC staff will initiate a QER during the fourth quarter 1989 as an additional mechanism to verify the cause of the limit exceedances and to identify appropriate corrective measures if possible.

SP2519 (ORNL Steam Plant)

Boiler drainage and periodic boiler blowdown from the ORNL Steam Plant (NPDES outfall SP2519) sometimes exceeds permit limits for pH and temperature. The latest exceedance was on August 10, 1989, when a pH reading of 10.2 standard units occurred.

ORNL submitted a request to DOE for transmittal to TDHE that the compliance monitoring requirement for this outfall be discontinued. According to the permit, effluent limits listed are not applicable if the effluent is less than 10,000 gal/day and water quality standards are not violated.

After one year of evaluation, it has been demonstrated that the SP2519 effluent does not violate water quality standards and that the average discharge is approximately 120 gal/day. Also, the ORNL SP is specifically utilized for space heating, another one of the exemption requirements listed for this outfall in the NPDES Permit. Monitoring continues as scheduled until a determination is made by TDHE concerning ORNL's request.

Category I and II (storm/street/parking lot/cooling water drains) Outfalls

Numerous ORNL category I and II outfalls exceed permit limits for total suspended solids (TSS) and/or oil and grease (O&G) parameters, especially those that are precipitation dependent. This occurrence has been attributed to the fact that precipitation-dependent outfalls must be sampled during significant rainfall to obtain samples, and rain events flush accumulated dust, oil, and grease from locations such as streets and parking areas. EMC staff members are conducting a feasibility study for corrective measures to address this situation; a draft report on the first phase of the study was completed in November 1989.

ORNL Sewage Treatment Plant (X01)

One exceedance of the NPDES O&G daily maximum concentration limit at the STP in September 1989 resulted in three additional calculated exceedances for that facility. No reason for the exceedance could be determined; plant operators had no evidence or record of upset or unusual operating conditions on or around the date of the exceedance, and the condition of the facility and the effluent appeared normal during EMC inspection following the date that the noncompliant sample was collected. The three additional exceedances occurred when mass-load and monthly average calculations were elevated above the respective limits by the one high value that was recorded. A QER exercise is in progress to further investigate the O&G exceedance.

Coal Yard Runoff Treatment Facility (X02)

An O&G exceedance occurred at the Coal Yard Runoff Treatment Facility (CYRTF) in September 1989 for which no cause could be determined. No evidence of spills, upsets, or unusual operating conditions at the facility was found during the EMC investigation of the incident. The QER being conducted for the O&G exceedance at the STP may determine factors that will apply to the CYRTF exceedance as well.

3.3 POLYCHLORINATED BIPHENYLS (PCBs) IN THE AQUATIC ENVIRONMENT

Water samples were collected from various locations along WOC, MB, Northwest Tributary (NWT) and the Clinch River (CR) to determine PCB concentrations in these areas (Fig. 8). A total of twelve sites were sampled; eight on WOC (including one at WOD), one on MB, one on NWT and two on the CR. Two samples per site were taken for water during August 1989. This was done to comply with the CWA and is an integral part of ORNL's NPDES activities. Water samples are being analyzed quarterly for aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260. Sediment samples are being analyzed for the same aroclors semiannually.

Water samples were taken by manual grab 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. The samples were analyzed by electron capture gas chromatography. This provides a method to determine individual aroclors, as well as total PCB content. The results from these samples will be used to help detect sources of PCB contamination and provide a history of PCB concentrations in the ORNL area.

The EPA acute criteria for the protection of fish and aquatic life is 2.0 μg/L for PCBs. The concentrations of PCBs in water during August 1989 were below

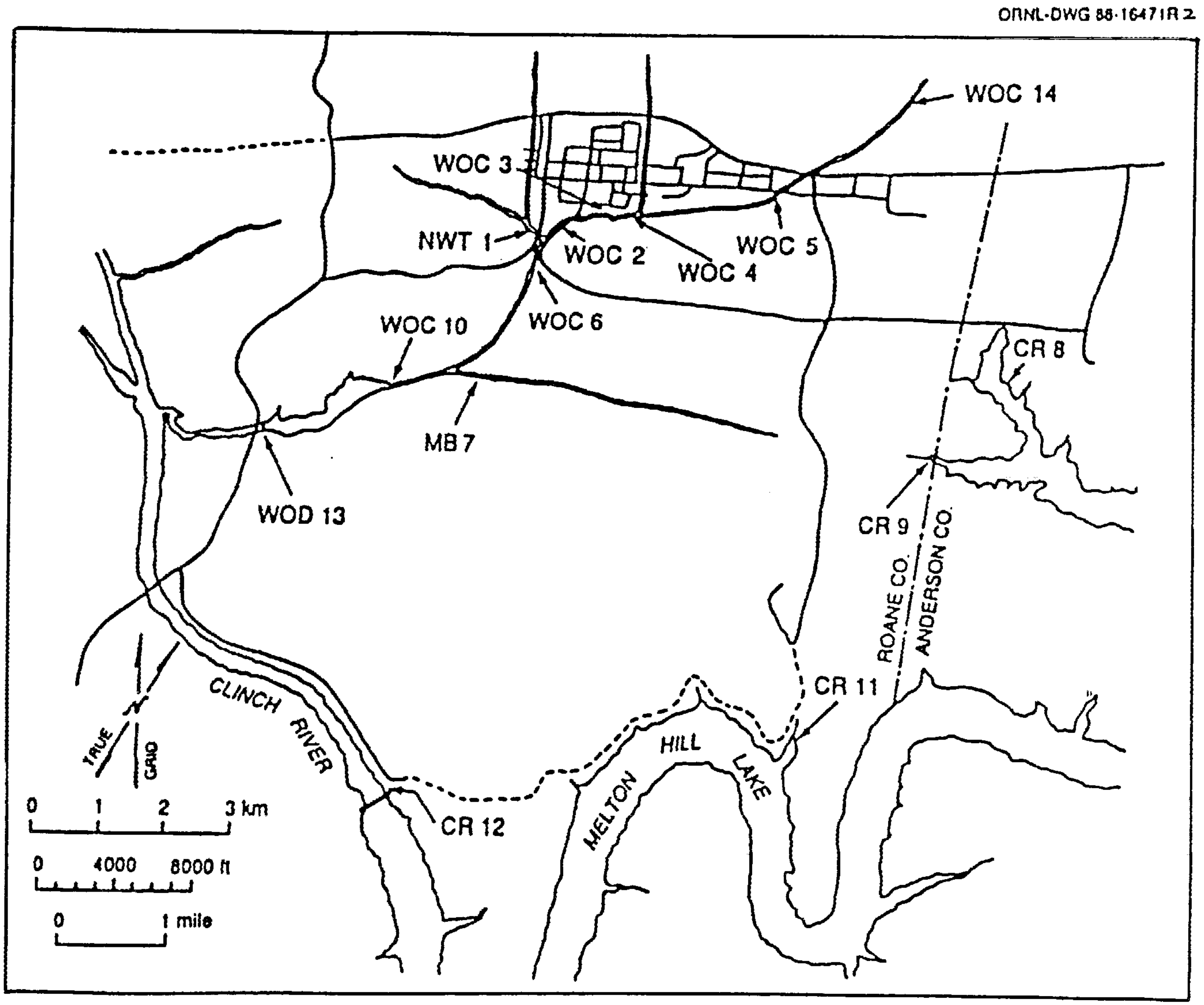

Fig. 8. Location map of PCB sampling points.

the analytical quantitation limit at all sampling sites. Analyses were performed for seven aroclors of PCBs. The quantitation limit for PCB aroclors 1016, 1221, 1232, 1242, and 1248 is 0.5 $\mu g/L$. The quantitation limit for PCB aroclors 1254 and 1260 is 1.0 $\mu g/L$.

3.4 GROUNDWATER

No groundwater samples were collected during July-September of 1989. The first four quarters of required data for WAG 6 were completed during the previous quarter, and a Groundwater Quality Assessment Plan for WAG 6 is currently under development. Quarterly sampling in WAG 6 will resume once the assessment plan is approved. Sampling of WAG 1 will be done on a semiannual basis in the future; the next round of sampling is scheduled for collection in October. Samples will be collected during the high (March-April) and low (September-October) water level periods.

4. METEOROLOGICAL PROCESSES

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

4.1 PRECIPITATION

Monthly precipitation totals for several sites are averaged to obtain representative monthly values for ORNL and the surrounding area. The stations included are indicated by three-character identifiers on the location map in Fig. 9. These stations provide data for climatological studies. Most of the other sites in Fig. 9 are represented by five-character identifiers, the last two digits of which identify the air monitoring station at which each gauge is located. Precipitation gauges located at the air monitoring stations report real-time data for short-term studies and emergency response situations. Much of the data summarized in this report comes from the precipitation measuring network of the Environmental Sciences Division of ORNL. In addition, the Atmospheric Turbulence and Diffusion Division (ATDD) of the National Oceanic and Atmospheric Administration (NOAA) maintains a weather station in the city of Oak Ridge (Illinois Avenue). Observations have been made at that station for a long enough period to provide 30-year (1951 through 1980) normals for comparison with amounts for the current year. Table 54 shows the total precipitation at ATDD and departure from ATDD long-term normal, along with the ORNL representative value, for July through September of 1989.

4.2 WIND

The ORNL wind-tower network consists of towers A and B, each with sensors mounted at 10 and 30 m, and tower C with sensors mounted at 10, 30, and 100 m. Locations of these towers are shown in Fig. 10. 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 hours. 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 one day and the hourly averages, from which wind roses in Figs. 11-17 are obtained, are stored for at least 1 year and are eventually archived.

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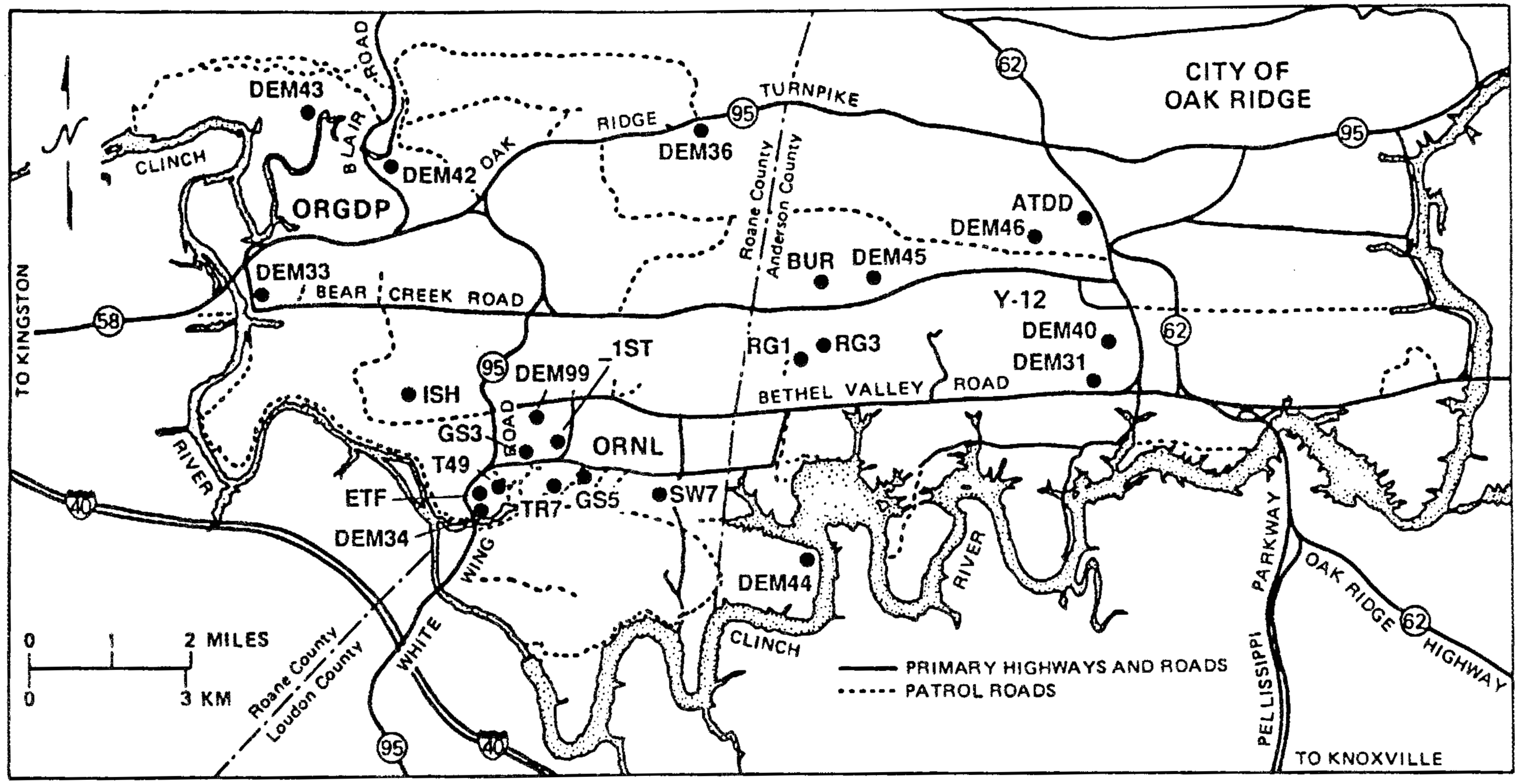

Fig. 9. Location map of precipitation gauges on or near the Oak Ridge Reservation.

Table 54. Precipitation for ORNL and nearby sites,[a] July-September 1989

Month	Number of sites reporting	Precipitation (mm)		
		ORNL average[b]	ATDD	ATDD departure from normal
July	10	110	92	-40
August	10	91	99	+3.8
September	10	260	230	+129

[a]ORNL data are stored in the ORNL Remedial Action Program data base; Larry Vorhees, Coordinator, 574-7309.

[b]Average of ORNL and United States Geological Service (USGS) sites reporting for each month; ATDD not included.

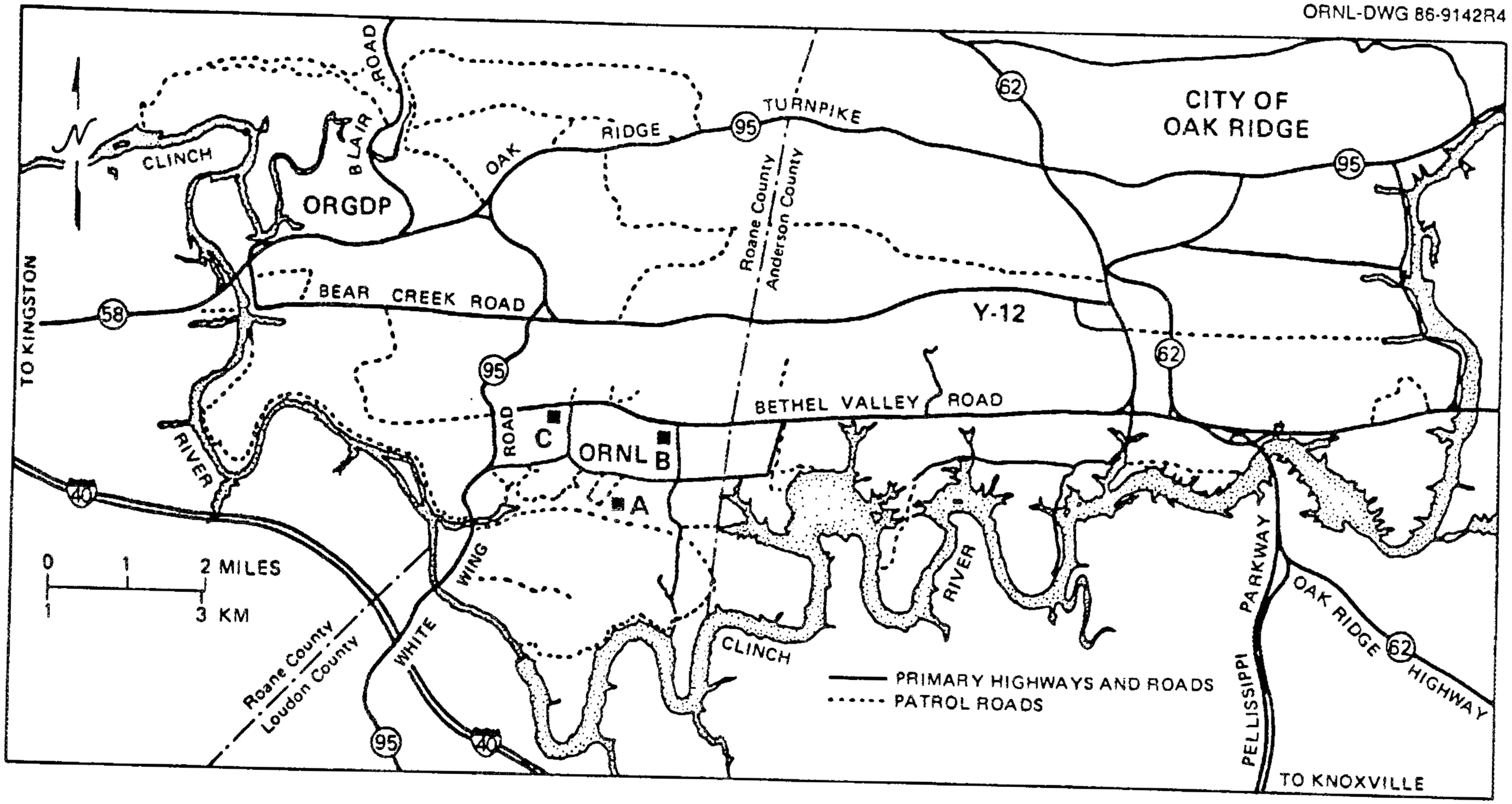

Fig. 10. Location map of meteorological towers at ORNL.

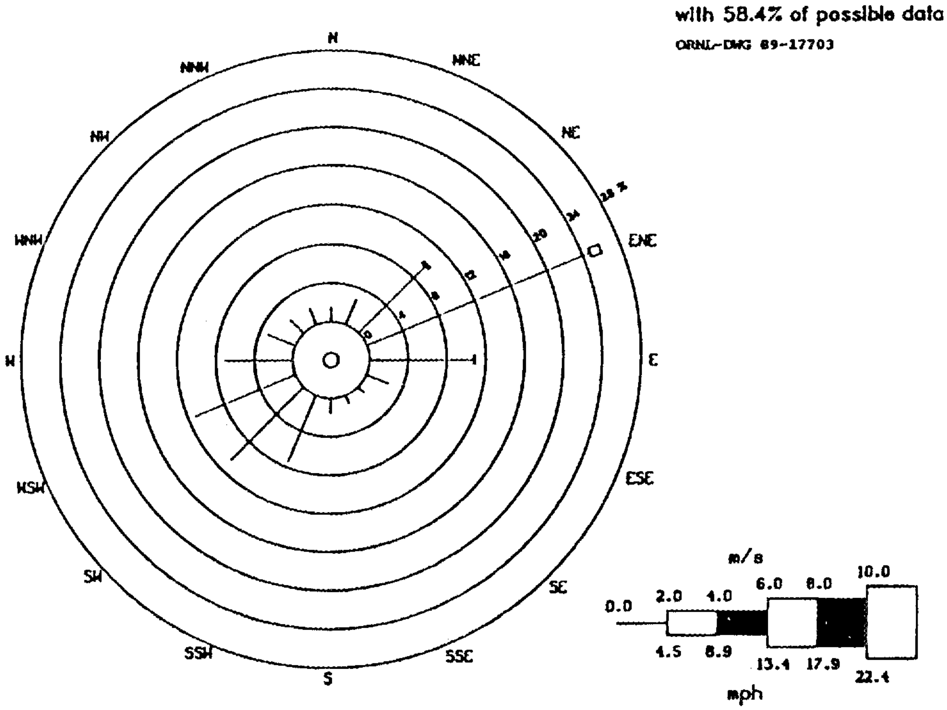

Fig. 11. Wind rose at 10-m level of meteorological tower A, July-September 1989.

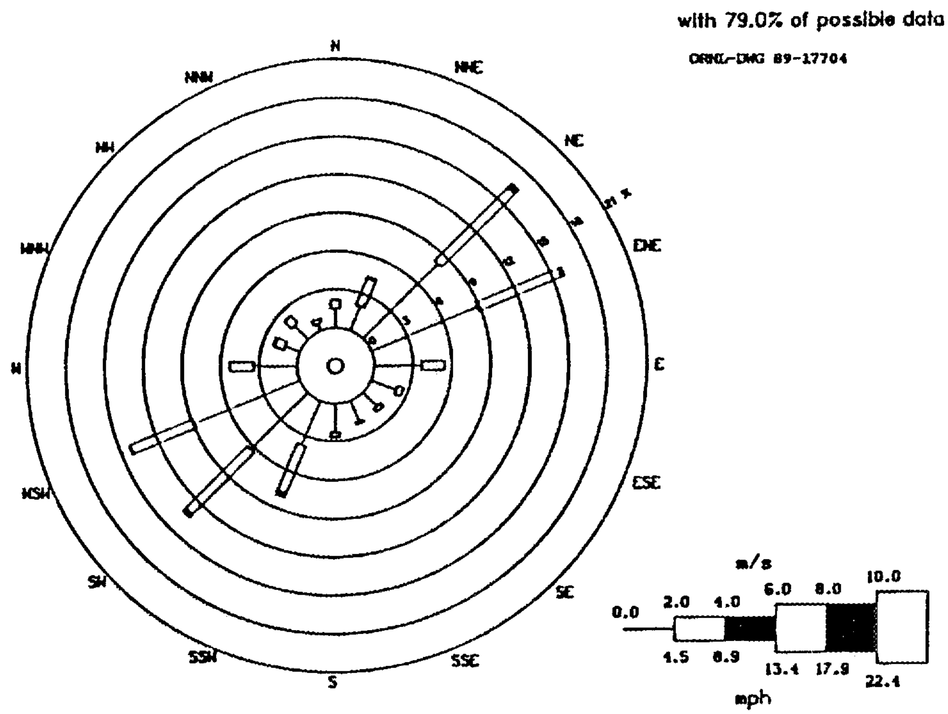

Fig. 12. Wind rose at 30-m level of meteorological tower A, July-September 1989.

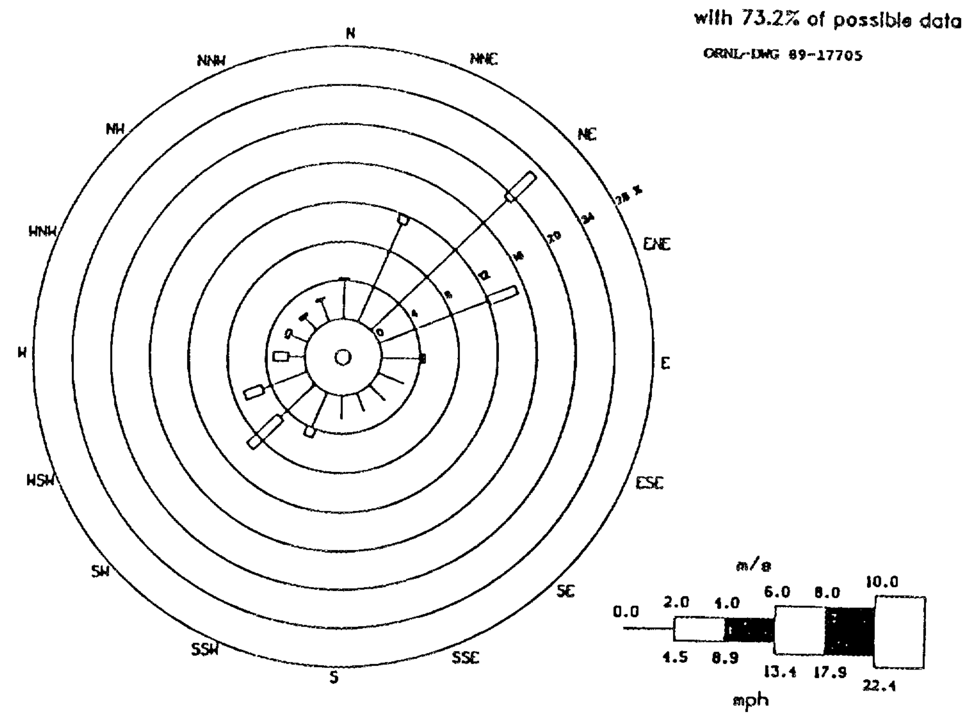

Fig. 13. Wind rose at 10-m level of meteorological tower B, July-September 1989.

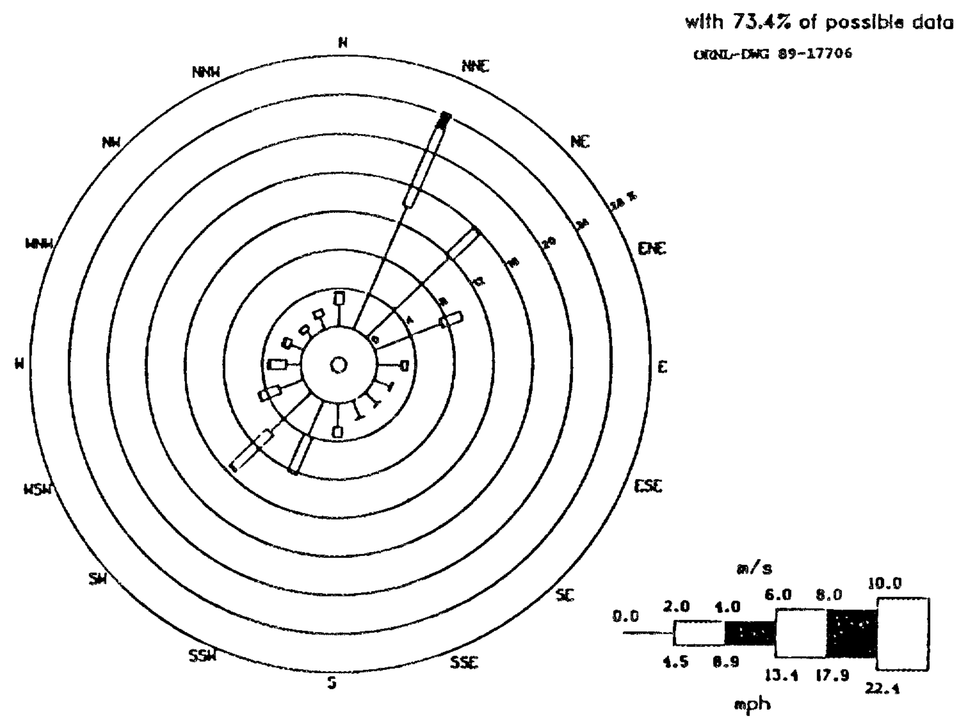

Fig. 14. Wind rose at 30-m level of meteorological tower B, July-September 1989.

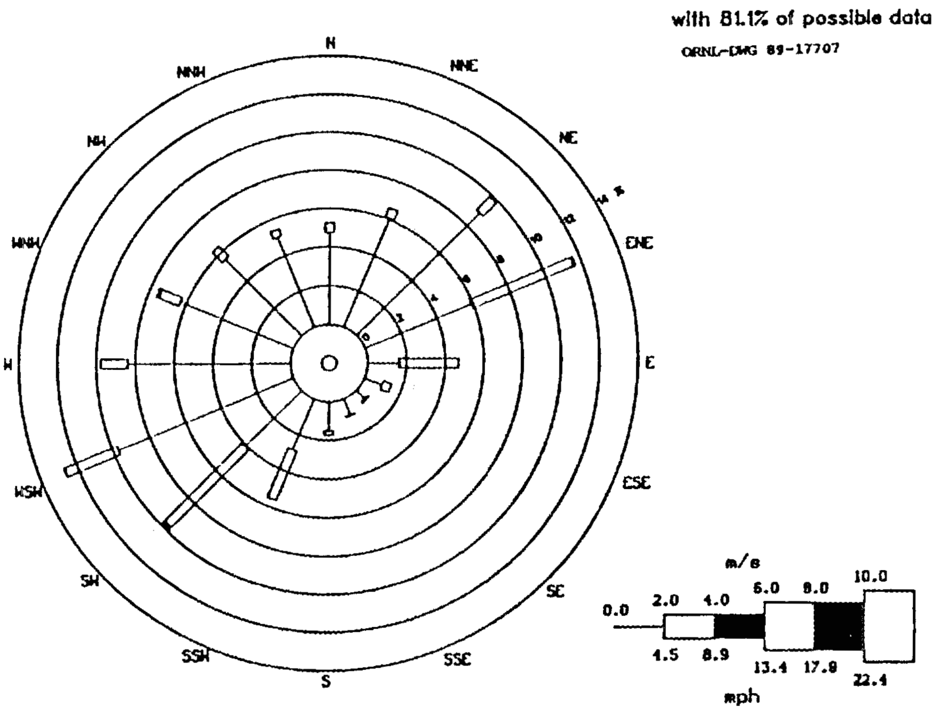

Fig. 15. Wind rose at 10-m level of meteorological tower C, July-September 1989.

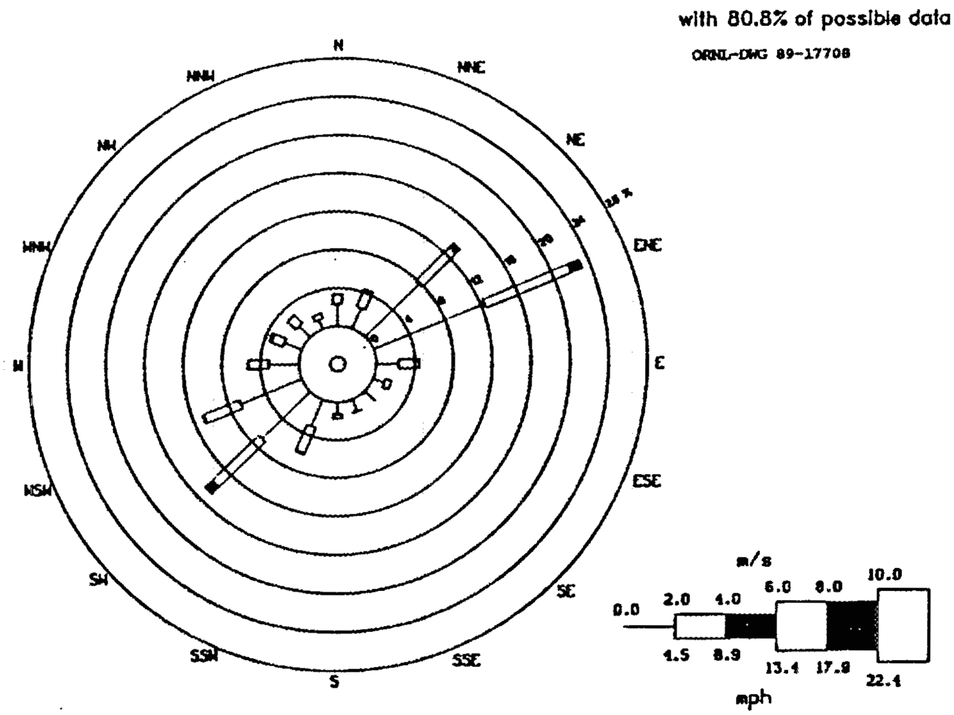

Fig. 16. Wind rose at 30-m level of meteorological tower C, July-September 1989.

with 81.2% of possible data

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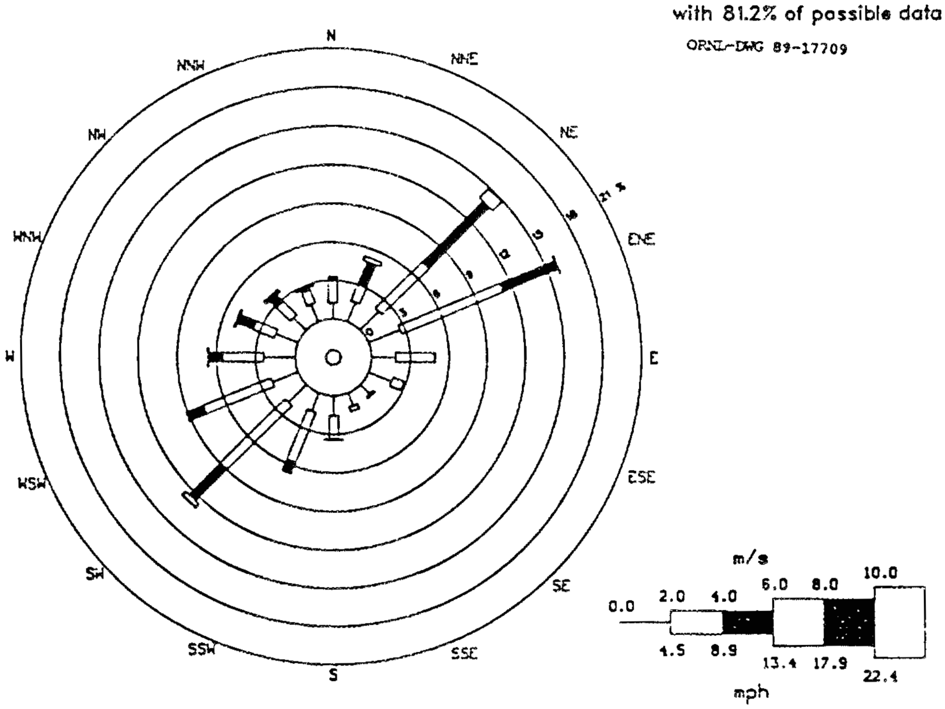

Fig. 17. Wind rose at 100-m level of meteorological tower C, July-September 1989.

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

5. BIOLOGICAL MONITORING - MILK

The environmental surveillance programs include biotic and abiotic environments that may be affected by the releases from the Oak Ridge DOE facilities or may provide pathways of exposure to people. Biological monitoring consists of analyses of milk samples for radionuclides and nonradioactive chemicals.

Milk is a potentially significant pathway for the transfer of radionuclides from their point of release to humans because of the relatively large surface area that can be grazed daily by a cow, the rapid transfer of milk from producer to consumer, and the importance of milk in the diet. Strontium-90 and ^{131}I are radionuclides that are especially important in this atmosphere-to-pasture-to-cow-to-milk food chain. The milk samples are collected monthly.

Measured average concentrations of total radioactive strontium (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 55 and 56. 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 were collected biweekly during April and collected monthly during May and June from the stations located near the Oak Ridge area (Fig. 18). Samples were not collected at the Solway station because the sample source (a cow) was pregnant. The Clinton station did not supply any milk samples when the sampling team collected milk on July 12, 1989, thus the number of samples collected is two instead of three. 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 third quarter were often less than instrument background, as is indicated by negative values in Table 55. The average concentration of ^{131}I at the stations in the immediate Oak Ridge area was 0.021 Bq/L.

Concentrations of total radioactive strontium are shown in Table 56. The average concentration of total radioactive strontium at the stations in the immediate Oak Ridge area was 0.073 Bq/L.

Table 55. Concentrations of ^{131}I in milk and calculated doses,[a] July-September 1989

Station	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Dose (μSv)[c]
		Immediate Environs[d]				
1	3	0.090	0.010	0.040	0.025	0.20
2	3	0.010	-0.020	0	0.010	0
3	2	0.040	0.020	0.030	0.010	0.15
4	3	0.030	0.010	0.017	0.0067	0.083
Network summary	11	0.090	-0.020	0.021	0.0083	0.10

[a]Raw milk samples; Station 2 is a dairy.
[b]Standard error of the mean.
[c]Potential 50-year committed effective dose equivalents from drinking 365 L of milk per year using average radionuclide concentrations at each location.
[d]See Fig. 18.

Table 56. Concentrations of total radioactive strontium in milk and calculated doses,[a] July-September 1989

Station	Number of samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Dose (μSv)[c]
		Immediate Environs[d]				
1	3	0.13	0.032	0.069	0.031	0.89
2	3	0.046	0.0070	0.031	0.012	0.40
3	2	0.11	0.016	0.063	0.047	0.81
4	3	0.16	0.11	0.13	0.017	1.6
Network summary	11	0.16	0.0070	0.073	0.016	0.94

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

[b]Standard error of the mean.

[c]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.

[d]See Fig. 18.

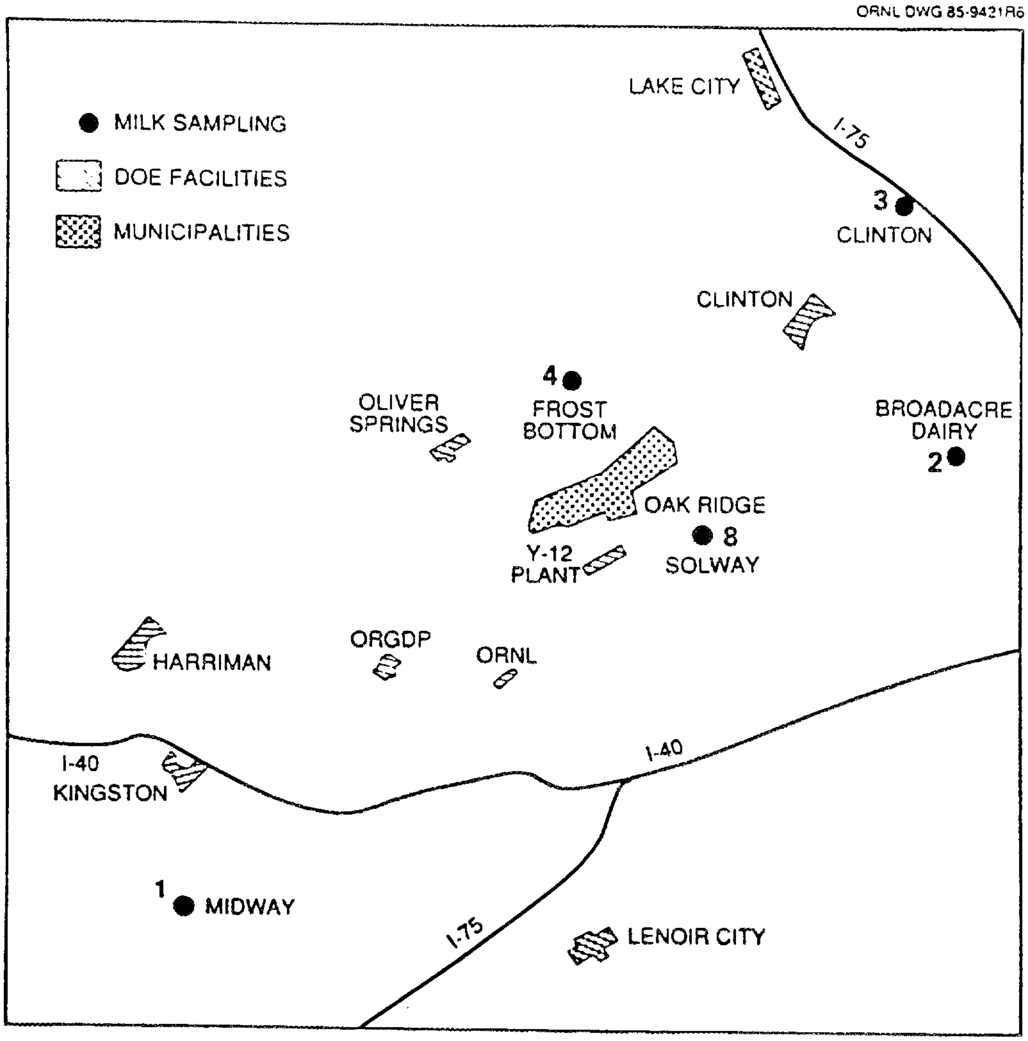

Fig. 18. Location map of milk sampling stations near the Oak Ridge facilities.

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