ORNL/M-1155

OAK RIDGE
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LABORATORY

MARTIN MARIETTA

Environmental Surveillance Data Report for the Second Quarter of 1990

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M. R. Powell
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M. F. Tardiff
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FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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CONTENTS

LIST OF ACRONYMS

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

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EXECUTIVE SUMMARY

Mark F. Tardiff

Each section of this report consists of a program description; results for the quarter; and an analysis of trends over the previous two years, depending upon the availability of data. The analyst that produced each section is identified in order to facilitate the reader in following up any questions regarding the data or the analysis approach. The reader is directed to the trend subsections for more in-depth summaries of each data section.

Airborne Emissions and Ambient Air

Emissions of tritium to the atmosphere returned to levels consistent with the latter part of 1989. The first quarter 1990 had shown a ten fold reduction in emissions. The Isotope Solid-State Ventilation System (3039-3) is the major airborne source of tritium. Osmium-191 releases were down by a factor of fifty due to changes in operations. Other airborne emissions were consistent with recent monitoring results.

Ambient air sampling around ORNL and the reservation showed that I-131 and H-3 continue to be at concentrations of less than 0.01% of the derived concentration guides (DCG) for these isotopes.

Surface Water

Tritium and strontium concentrations at White Oak Dam were at 11% and 22% of their DCGs for the quarter respectively. All of the other radionuclides that were evaluated at the dam were at 2% or less of their DCGs. The concentration of total radioactive strontium has been increasing at Melton Branch. An investigation will be conducted to determine whether the discharge of total radioactive strontium is also increasing.

The NPDES compliance ratio for this quarter was 97% due to 20 noncompliances. Twelve of the exceedences were due to Category outfalls. This has been a chronic problem for ORNL. Six of the exceedences were associated with a process upset experienced at the Sewage Treatment Plant in May. The other two violations were associated with the Coal Yard Runoff Treatment Facility and a cooling tower.

Results for PCB in the surface waters around ORNL continue to show that this is not a transport pathway. Sediment samples indicate the presence of PCB at concentrations near the analytical detection limit.

Biological Monitoring

Iodine in milk was undetectable in all the samples for the quarter. Total radioactive strontium in milk was detected at two of the stations. The concentrations were less than 1% of the DCG for Sr-90.

Groundwater

Samples from the perimeter wells of SWSA 6 were consistent with the data collected during the assessment phase with the exception of one well that showed twice the concentration of tritium previously seen (920 Bq/L versus 530 Bq/L).

1. INTRODUCTION

The Environmental Surveillance and Protection Section (ESP) within the Office of Environmental and Health Protection (EHP) at the Oak Ridge National Laboratory (ORNL) is responsible for the development and implementation of an environmental program to (1) ensure compliance with all federal, state, and Department of Energy (DOE) reporting requirements to quantitatively demonstrate prevention, control, and abatement of environmental pollution; (2) monitor the adequacy of containment and effluent controls; and (3) assess impacts 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 assuring compliance with applicable Federal, State, and local environmental protection laws and regulations. This Order sets forth the requirements for both radiological and nonradiological monitoring. DOE's Order 5400.5, "Radiation Protection of the Public and the Environment," specifies the guidelines for releases of radionuclides to various media. Definitive radiological monitoring requirements have been established, and additional guidance on recommended procedures and activities is provided in Draft DOE 5400.6, "Radiological Effluent Monitoring and Environmental Surveillance."

Environmental monitoring, as defined by Draft DOE Order 5400.6, consists of two major activities: effluent monitoring and environmental surveillance. Effluent monitoring is the collection and analysis of samples or measurements of liquid and gaseous effluents. Environmental surveillance is the collection and analysis of samples, or direct measurements, of air, water, soil, foodstuff, biota, and other media from DOE sites and their environs.

Although Draft DOE Order 5400.6 has not been finalized, ORNL is evaluating the requirements and is revising the environmental program to reflect changing requirements. 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 DOE Order 5400.5. These concentration guides were established for drinking water and inhaled air and are guidelines for the protection of the public. DOE Order 5400.5 defines a DCG as the concentration of a radionuclide in air or water for which, under conditions of continuous exposure by one exposure pathway (i.e., drinking water, inhaling air, submersion) for 1 year, a "reference man" would receive the most restrictive of (1) an effective dose equivalent of 100 mrem or (2) a dose equivalent of 5 rem to any tissue, including skin and lens of the eye. A "reference man" is a hypothetical human who is assumed to inhale 8400 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 percent of the DCG is less than 0.01, the percent is reported as"<0.01." When total radioactive Sr is measured, it is compared to the DCG for Sr-90, 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 then the detection limit.

2. AIR

Airborne emissions from Department of Energy (DOE) facilities are regulated under the provisions of the Clean Air Act (CAA), DOE Orders, and the Tennessee Air Quality Control Act. The U.S. Environmental Protection Agency (EPA), which has authority and responsibility for enforcing the regulations associated with the CAA, has delegated authority for non-radioactive air pollutants to the state of Tennessee. Regulatory criteria for CAA are promulgated in 40 CFR 61, the National Emission Standards for Hazardous Air Pollutants (NESHAP). The DOE Orders are enforced at the local level through the Oak Ridge National Laboratory (ORNL) Directorate for Environmental, Safety, and Health Compliance. Air emissions are addressed in DOE Orders 5400.1 and 5400.5 and in Regulatory Guide 5400.6.

The Laboratory has monitoring requirements for radioactive emissions only. These are NESHAP standards based on calculated annual dose (10 mrem effective dose equivalent) to off-site individuals. In addition, the DOE Orders require that the collective dose be calculated for the population within 80 km of the site.

The monitoring and surveillance of airborne emissions at ORNL is a two-tiered program. The first tier consists of source-term-emissions sampling and quantification for each stack that is an emission point for processes involving radioactive materials. These data are used in calculating the annual dose associated with operations at the facility. The second tier consists of ambient-air sampling systems located within the boundary of the facility, on the reservation perimeter, and at remote locations assumed to be unaffected by facility operations. These data are used to measure directly the impact of ORNL operations on the surrounding area and to provide empirical data for assessing the inhalation and external pathways of exposure.

2.1 AIRBORNE EMISSIONS

Martha M. Stevens

2.1.1 Program Description

The major gaseous emission point sources at the Laboratory consist of eight stacks. They are as follows:

Building	Description
2026	High Radiation Level Analytical Laboratory
3020	Radiochemical Processing Plant
3039	Duct 1 - 3500 and 4500 Areas Cell Ventilation Systems Duct 2 - Central Off-gas and Scrubber System Duct 3 - Isotope Solid State Ventilation System Duct 4 - 3025 and 3026 Areas Cell Ventilation Systems
7025	Tritium Target Fabrication Facility
7830	Melton Valley Storage Tank (MVST) Facility
7911	Melton Valley Complex (High Flux Isotope Reactor and Radiochemical Engineering Design Center)
7512	Molten Salt Reactor Facility
6010	Electron Linear Accelerator Facility

The locations of the stacks are shown in Fig. 1. Each of these point sources is provided with a variety of surveillance instrumentation, including radiation alarms, near real-time monitors, and continuous sample collectors. Only data resulting from the analysis of the continuous samples are used in this report. The other equipment does not provide data of sufficient accuracy and precision to support the quantitation of emission source terms. Data are presented for all stacks except the Electron Linear Accelerator Facility (Building 6010), where continuous sampling equipment is not currently installed.

The sampling systems generally consist of in-stack sampling probes, sample transport piping, a 47-mm-diameter particulate filter, a 47-mm-diameter by 25-mm-thick activated-charcoal canister, a silica gel tritium trap, flow measurement and totalizing instruments, a sampling pump, and return piping to the stack. The sampling system for the tritium target facility (Stack 7025) is configured with a tritium trap only. The sampling systems at Stacks 2026, 3020, and 7512 do not have tritium traps.

The sampling media are collected and evaluated weekly. The particulate filters are analyzed for gross alpha and gross beta activity. Gross alpha and gross beta measurements are made eight days after the samples are collected to reduce the contribution of short-lived natural radionuclides to the measurement. The silica gel samples are composited and analyzed biweekly for tritium. The charcoal canisters are analyzed each week by gamma spectroscopy. Because of the prevalence of iodine isotopes in the point source emissions, values are reported for I-131 and I-133 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, I-131 and I-133 measurements. This is the usual number of samples for a quarter. In a particular quarter, some isotopes may be represented by fewer than 13 values because they were not detected in all of the sampling events. Normally there are six values for each tritium emission sampler because the weekly samples are analyzed as biweekly composites.

The particulate filters collected during a quarter are held and composited at the end of the quarter. A laboratory analysis identifies and measures the activity level of long-lived radionuclides present in the composite. In order to include all samples from the quarter in the analysis, results for a particular quarter are presented in the report for the following quarter.

Data are not presented in this report for noble gas or I-125 and I-129 emissions. A program is being developed to validate the noble gas data, and analytical methods are being investigated that will address spectral interferences associated with the detection and quantitation of the iodines. Noble gas data are presented in the Oak Ridge Reservation annual environmental report.

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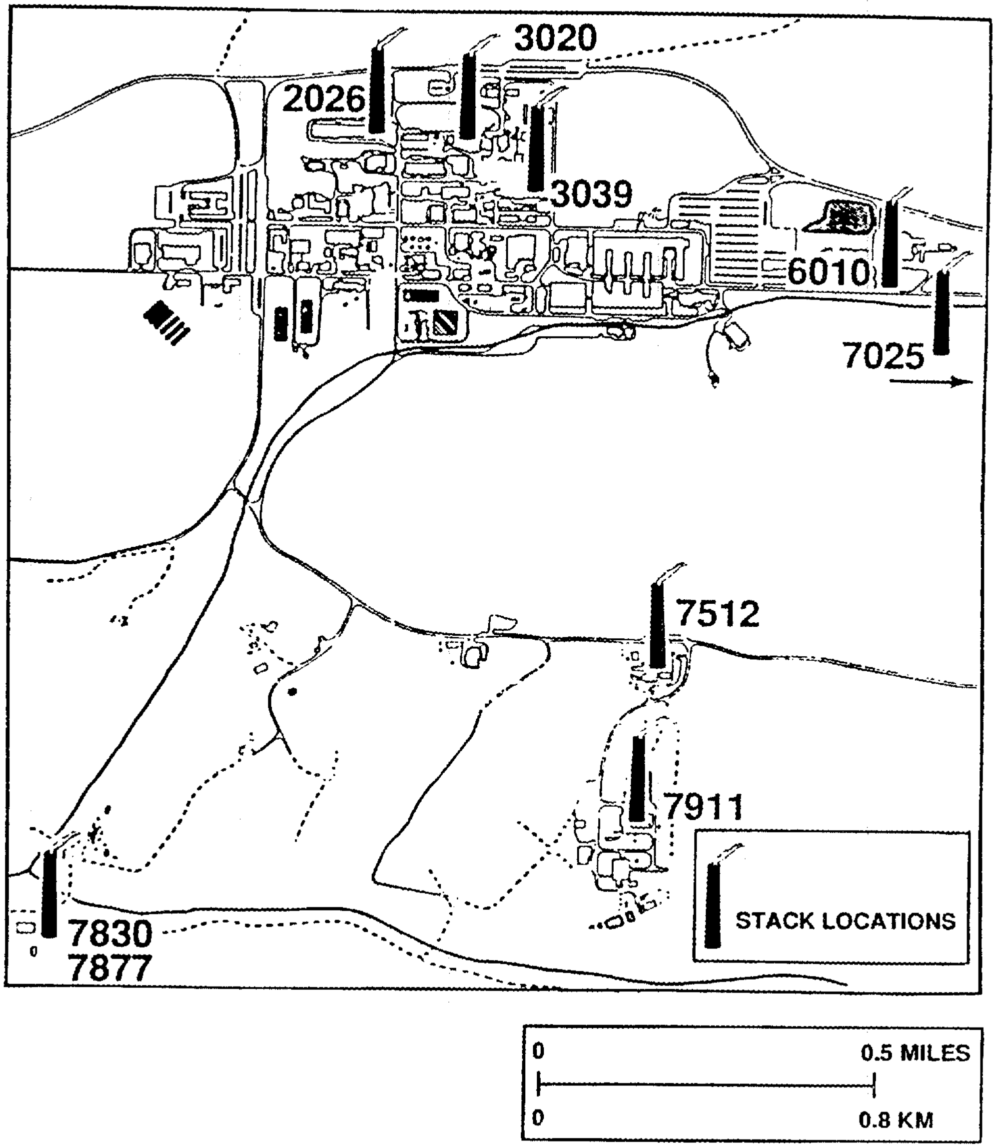

Fig. 1. Location map of major stacks (emission points) at ORNL.

2.1.2 Procedures and Results

The current convention for data read at the instrument detection limit is to treat it 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 associated with performing calculations on "less than" (<) values.

Emission of gross alpha, gross beta, or a specific radionuclide is calculated from the laboratory-measured activity in the sample and a conversion factor for flow. On upgraded systems in which sample flow totalizers have been installed, measured activity values are multiplied by a conversion factor that is the ratio of the total stack or duct discharge for the sampling period divided by the total sample flow during the period. For the older sampling systems at Stacks 2026, 3020, and 7512, the conversion factor consists of the average stack discharge rate divided by the average sampling rate.

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

Sums of weekly emission values for particular radionuclides are tested for statistical significance using the laboratory counting uncertainty associated with each measured activity. If the 95% lower bound calculated from the variance of the sum is greater than zero, then the sum is determined to be significantly different from zero. The variance used in the test is based only on the counting uncertainty; it does not include uncertainty due to the sampling process.

Table 1 presents the airborne radionuclide emissions for the second quarter, listing total emission for each isotope and the percent of the total contributed by each stack. The percent values are based on summed emissions for the quarter from each stack. In the table, percents derived from sums that were determined to be significantly different from zero are marked with an asterisk.

During this quarter, the radioactive airborne emissions from the Laboratory consisted primarily of H-3, Pb-212, I-131, I-133, and I-135. Most of the H-3 originated at Stack 3039-3, the Isotope Solid State Ventilation System (92%, 30 x 10^{12} Bq). The other large amount came from Stack 7025 at the Tritium Target Fabrication Facility (8%, 2.6 x 10^{12} Bq).

Virtually all of the total I-131 (1.4 x 10^8 Bq), I-133 (2.0 x 10^8 Bq), and I-135 (1.8 x 10^8 Bq) was emitted from Stack 7911 in the Melton Valley Complex. No other stack emitted more than about one percent of the total iodine emissions.

Table 1. ORNL airborne radionuclide emissions, April-June 1990

	Percent contribution by stack[a,b]							
Isotope	2026	3020	3039	7025	7830	7911	7512	Total Emission (10^6 Bq)
Au-194			99*			0.88*		0.37
Be-7			100*					0.015
Co-60			100*			<0.0001		1.5
Cs-137	58*	2.6	40*			<0.0001		0.22
H-3			92*	8.0*		0.0028*		33,000,000
I-131	0.0035	<0.0001	1.1*		<0.0001	99*	0.0040	140
I-132						100*		26
I-133	<0.0001	0.0019	0.43*		0.00036*	100*	<0.0001	200
I-135	0.0049	0.0026	<0.0001		<0.0001	100*	<0.0001	180
La-140						100*		0.010
Os-191			100*					46
Pb-212	8.4*	14*	61*		0.084*	17*	0.25*	600
Te-132						100*		0.022
Gross alpha	67*	11*	21*		0.10*	0.80*	0.80*	0.15
Gross beta	16*	2.0*	79*		0.59*	2.3*	0.19*	3.5

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[a] Total percentages that exceed 100 are due to rounding.

[b] The values marked with an asterisk (*) are statistically determined to be significantly different from zero. Note that the variance used in the significance test is based only on the laboratory counting uncertainty, and does not include uncertainty due to the sampling process.

About half of the total Pb-212 reported for the quarter came from Stack 3039-2 (2.9 x 10^8 bq). Stack 7911 contributed 17% (0.99 x 10^8 Bq), Stack 3020 accounted for 14% (0.84 x 10^8 Bq), and Stacks 2026 and 3039-1 each had about 8% (0.50 x 10^8 Bq and 0.45 x 10^8 Bq) of the total.

Virtually all of the reported Os-191 was released at Stack 3039-4 (99%, 0.45 x 10^8 Bq). The remainder (0.28 x 10^6 Bq) was released at Stack 3039-2.

The same procedures and conventions used in calculating emissions based on the weekly samples are used for the quarterly composite sample. The only exception occurs in the determination of statistical significance. Because the emission value for a long-lived radionuclide in the composite is based on a single measured activity, the 95% lower bound is calculated from the uncertainty associated with that measurement. The 95% lower bound for the summed weekly emissions is calculated from the variance of the sum.

Table 2 presents the airborne emissions of long-lived radionuclides detected in the composite of particulate filters for the first quarter of 1990. Following the same form as Table 1, it lists total emission for each radionuclide and the percent of the total contributed by each stack. In Table 2, the percent values are calculated using only those emissions that are significantly different from zero. No test for statistical significance is applied to the Uranium emissions, which are based on laboratory measurements for which no uncertainty values are available.

The largest percentages of long-lived radionuclides were contributed by the ducts at Stack 3039 and by Stack 2026. The largest emission was Os-191, with 16 x 10^6 Bq, all from Stacks 3039-4 (16 x 10^6 Bq) and 3039-3 (0.01 x 10^6 Bq). The next largest, 0.28 x 10^6 Bq of Cs-137, came mostly from Stack 2026 (75%, 0.21 x 10^6 Bq) and Stack 3039 (19%, 0.05 x 10^6 Bq). Stack 3039-4 contributed 0.04 x 10^6 Bq of the Cs-137 emission. The four ducts at Stack 3039 also accounted for most (96%) of the total emission of Be-7 (0.11 x 10^6 Bq), with 0.03 x 10^6 from 3039-1, 0.01 x 10^6 from 3039-2, 0.02 x 10^6 from 3039-3, and 0.04 x 10^6 from 3039-4.

2.1.3 Trends

During the second quarter, tritium emissions were significantly higher than those reported for the preceding quarter and slightly lower than those for the fourth quarter of 1989. The total H-3 for this quarter was 33 x 10^{12} Bq, compared with 4.1 x 10^{12} Bq for first quarter and 39 x 10^{12} Bq for fourth quarter of 1989. Emissions from the largest source, Stack 3039-3, were higher by more than a factor of sixty, up from 0.48 x 10^{12} Bq in the first quarter to 30 x 10^{12} Bq in this quarter. Tritium emissions from the stack in this quarter were up by about a factor of five from levels in 1989. Emissions of tritium from Stack 7025 (2.6 x 10^{12} Bq) continue to decline, down by about 20% from first quarter 1990 (3.3 x 10^{12} Bq), and far below the fourth quarter 1989 emission (31 x 10^{12} Bq). Further reductions in emissions from Stack 7025 are expected as production work is ending at the facility.

Table 2. ORNL airborne emissions of long-lived radionuclides, January-March 1990

	Percent contribution by stack[a,b]					
Isotope	2026	3020	3039	7830	7911	Total Emission (10^6 Bq)
Be-7			96	3.9		0.11
Co-60	15	18	56	0.75	10	0.0084
Cs-134	100					0.0024
Cs-137	75	4.4	19	0.41	1.6	0.28
Eu-155	100					0.0044
I-131			100			0.013
Os-191			100			16
Pu-238	86	13	0.69	0.019		0.0023
Pu-239	86	14	0.46	0.0066		0.0073
Th-228	95	3.6	1.6	0.027	0.33	0.0034
Th-230	16	30	37	0.92	16	0.00012
Th-232	15	33	37	1.2	13	0.000097
Total-Sr	59	8.4	31	0.12	2.2	0.095
U	13	45	29	1.3	12	0.00028

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[a] Percentages are calculated using only those emissions that are significantly different from zero. No significance test was applied to emission values for Uranium, which are based on measurements for which no associated uncertainty is available.

[b] Total percentages that exceed 100 are due to rounding.

Iodine levels were, in general, similar to those reported for the last two quarters. The only significant source, Stack 7911, showed no change for I-133 (2.0×10^8 Bq). I-131 at the stack decreased by 12% from 1.6×10^8 Bq to 1.4×10^8 Bq; I-135 emissions there increased from 1.4×10^8 Bq to 1.8×10^8 Bq. The usual small sources of iodine showed only minor fluctuations in iodine levels as compared with the previous several quarters.

Total emissions of Pb-212 show a small decrease this quarter, down from 7.2×10^8 Bq in the first quarter to 6.0×10^8 Bq in the second quarter. The decrease is due to marked declines from Stacks 3020 and 2026. The declines were partially offset by a marked increase at 3039-2, returning to a more typical emission of 2.9×10^8 Bq, and by a slight increase at Stack 7911, from 0.84×10^8 Bq to 0.99×10^8 Bq, but still in its normal range.

Total Os-191 emission for this quarter was 46×10^6 Bq, down from 2.2×10^9 Bq in the first quarter, and down from 4.3×10^9 Bq in fourth quarter 1989. As in the past, virtually all of the Os-191 was detected at Stack 3039-4.

2.2 AMBIENT AIR

Martha M. Stevens

2.2.1 Program Description

Most gaseous wastes from ORNL are released to the atmosphere in stack emissions. Radioactivity may be present in gaseous waste streams as a solid (particulates), as an adsorbable gas (e.g., iodine), or as a nonadsorbable species (noble gas). At ORNL, gaseous wastes that may contain radioactivity are processed to reduce the radioactivity to acceptable levels before the wastes are discharged to the atmosphere. As described in Sect. 2.1, airborne emissions are monitored as they leave the stacks. In addition, radioactivity in the atmosphere is continuously monitored at 18 stations placed around ORNL, the Oak Ridge Reservation (ORR), and the surrounding area. The ambient air monitoring stations are categorized into three groups according to their geographical locations:

1. The ORNL perimeter air monitoring (PAM) network consists of stations 3, 7, 9, 20, 21, and 22. These six stations, located at or near the ORNL boundary as shown in Fig. 2, provide data used to assess the impact of operations at ORNL on ambient air.

2. The ORR PAM network consists of stations 23, 33, 34, and 40 through 46, also shown in Fig. 2. The reservation PAM stations, located at or near the ORR boundary, provide data on effects from operations on the reservation.

3. The remote air monitoring (RAM) network consists of stations 52 and 58. These stations, located within a 120-km radius of ORNL outside the ORR boundary, as shown in Fig. 3, provide reference data from areas not expected to be affected by operations on the ORR.

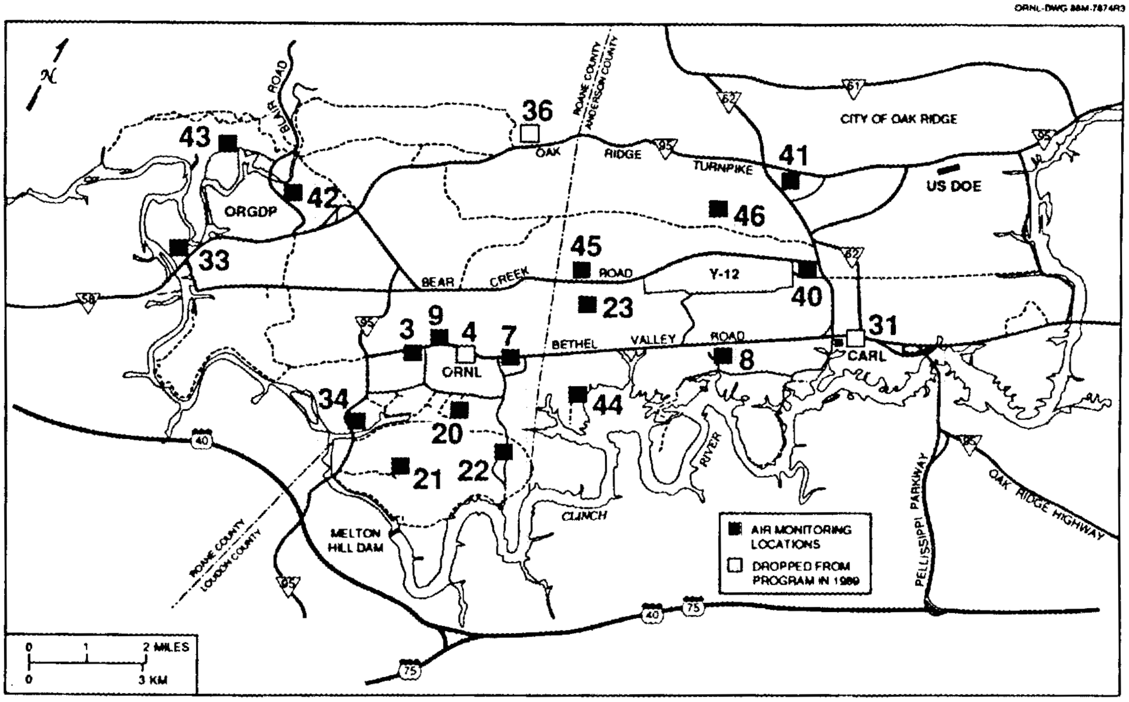

Fig. 2. Location map of ORR and ORNL PAM stations.

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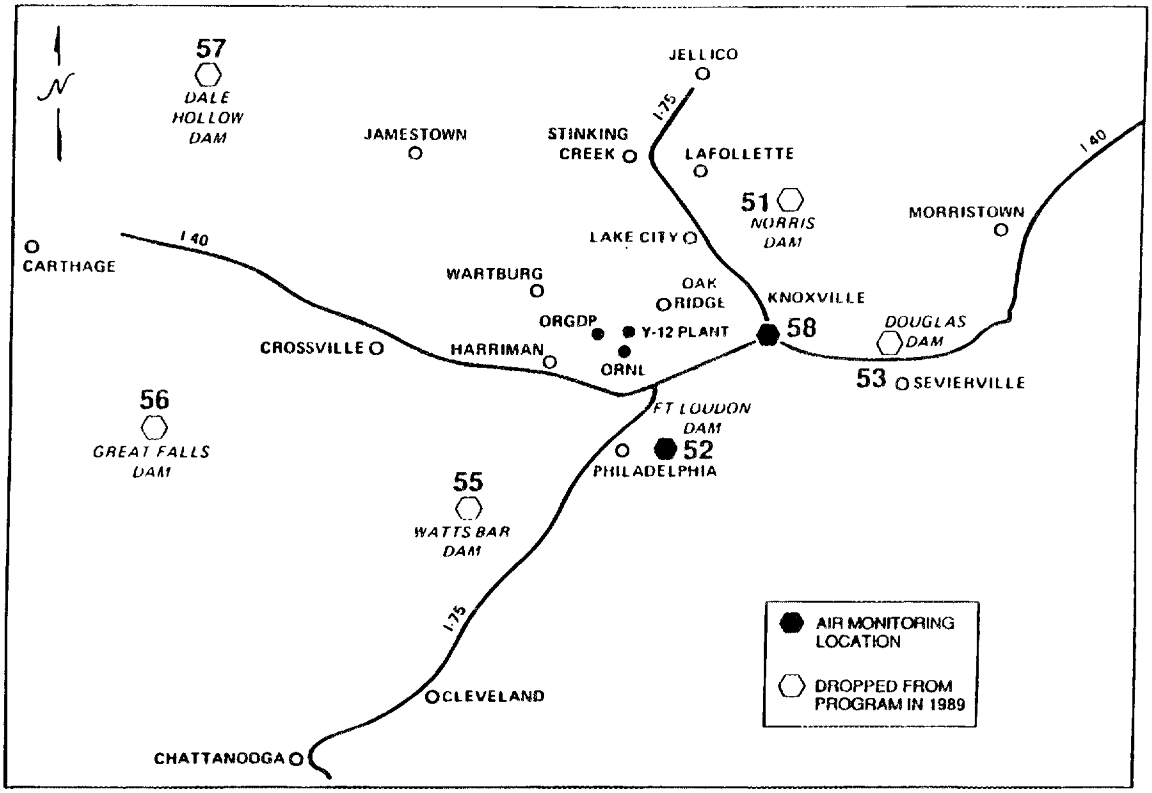

Fig. 3. Location map of RAM stations.

All ORNL and most ORR PAM stations have real-time monitors for five radiation parameters, including gross alpha, gross beta, iodine, gross gamma, and noble gas. The primary purpose of the monitoring system is to determine whether radiation levels on the 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. Reservation PAM stations 33, 34, and 40 through 45 perform real-time monitoring, and station 46 is currently being equipped for real-time monitoring.

Sampling of ambient air occurs at all 18 stations. Airborne radioactive particulates are collected by pumping a continuous flow of air through a paper filter. Then, at most stations, the air flows through a cartridge packed with activated charcoal to collect adsorbable gases. The filter papers are collected and analyzed biweekly for gross alpha and gross beta activity. The filter papers are analyzed 4 days after collection to minimize artifacts from short-lived radionuclides and again after 8 days for comparability with similar data in the airborne emissions program. (A departure from normal analysis procedures during second quarter 1990 is described in the results section.) The charcoal cartridge samples are collected biweekly and analyzed within 24 hrs for I-131. The beginning and ending dates, total time on and off, and flow values are recorded when a sample medium is mounted or removed. The total volume of air that flowed through the sampler during the sampling period is obtained from a flow totalizer installed at each station. The concentration of radionuclides in the sampled air is calculated by dividing the total activity in the sample by the total volume of air sampled.

In addition, the particulate filters are composited annually and analyzed for specific radionuclides of uranium, thorium, and plutonium and for total strontium. The composite provides a larger sample volume and allows more precise measurement of activity. Annual analysis is valid because the isotopes of interest are all long-lived. Results from analyses of composites prepared at the end of the fourth quarter of 1989 were summarized in the report for that quarter. The next summary of specific isotopes will appear in the report for the fourth quarter 1990.

Monthly samples for atmospheric tritium are routinely collected from air monitoring station 3, at the west end of ORNL, and from station 8, located east of ORNL. At these stations, atmospheric tritium in the form of water vapor is removed from the air in silica gel. In the analytical laboratory, the silica gel is heated in a distillation flask to remove the moisture, and the distillate is counted in a liquid scintillation counter. The concentration of tritium in the air is calculated by dividing the total activity in the sample by the total volume of air sampled.

2.2.2 Results

Concentrations of gross alpha, gross beta, atmospheric I-131, and atmospheric tritium for second quarter 1990 are summarized in Tables 3-6. In the laboratory, instrument background levels are subtracted from the measured value, sometimes resulting in a negative number. Negative concentration values in the tables represent activities below the instrument background level.

Table 3. Gross alpha activity at ambient air stations, April-June 1990

Station	Number of samples	Concentration (10^{-8} Bq/L)			
		Maximum	Minimum	Mean[a]	Standard error of mean
		ORNL PAM Stations[b]			
3	7	300	9.3	89 *	37
7	7	270	5.9	76 *	34
9	7	250	2.3	87 *	30
20	7	270	5.2	96 *	36
21	5	160	12	54	26
22	7	510	5.5	160 *	64
ORNL Summary	40	510	2.3	95 *	16
		ORR PAM Stations[b]			
23	6	200	3.2	70 *	29
33	7	230	6.6	88 *	30
34	6	370	7.6	130 *	53
40	6	240	44	120 *	36
41	7	170	2.5	65 *	21
42	7	240	3.4	92 *	30
43	6	170	4.3	71 *	25
44	7	270	4.3	84 *	33
45	7	200	4.6	79 *	27
46	6	290	5.5	110 *	45
ORR Summary	65	370	2.5	90 *	10

Table 3. (continued)

Station	Number of samples	Concentration (10^{-8} Bq/L)			
		Maximum	Minimum	Mean[a]	Standard error of mean
Remote Stations[c]					
52	6	260	4.7	77	40
58	1	15	15	15 *	
Remote Summary	7	260	4.7	69 *	35
Overall Summary	112	510	2.3	91 *	8.5

[a] Means marked with an asterisk (*) are statistically determined to be significantly different from zero.

[b] Locations of ORNL and ORR perimeter stations are shown in Fig. 2.

[c] Locations of remote stations are shown in Fig. 3.

Note: The magnitude of the values presented is discussed in Sect. 2.2.2.

Table 4. Gross beta activity at ambient air stations, April-June 1990

Station	Number of samples	Concentration (10^{-8} Bq/L) Maximum	Minimum	Mean[a]	Standard error of mean
		ORNL PAM Stations[b]			
3	7	660	100	240 *	72
7	7	600	100	230 *	65
9	7	550	71	230 *	58
20	7	580	100	260 *	65
21	5	340	110	170 *	43
22	7	960	93	340 *	110
ORNL Summary	40	960	71	250 *	30
		ORR PAM Stations[b]			
23	6	420	110	190 *	47
33	7	450	110	220 *	49
34	6	730	90	280 *	95
40	6	440	140	260 *	53
41	7	370	93	190 *	38
42	7	500	100	230 *	51
43	6	340	96	190 *	39
44	7	490	100	200 *	51
45	7	440	96	230 *	46
46	6	620	110	270 *	78
ORR Summary	65	730	90	230 *	17

Table 4. (continued)

Station	Number of samples	Concentration (10^{-8} Bq/L) Maximum	Minimum	Mean[a]	Standard error of mean
		Remote Stations[c]			
52	6	590	110	220 *	74
58	1	100	100	100 *	
Remote Summary	7	590	100	210 *	65
Overall Summary	112	960	71	230 *	15

[a] Means marked with an asterisk (*) are statistically determined to be significantly different from zero.

[b] Locations of ORNL and ORR perimeter stations are shown in Fig. 2.

[c] Locations of remote stations are shown in Fig. 3.

Note: The magnitude of the values presented is discussed in Sect. 2.2.2.

Table 5. I-131 concentrations at ambient air stations, April-June 1990

Station	Number of samples	Concentration (10^{-8} Bq/L) Maximum	Minimum	Mean[a]	Standard error of mean	Percent of DCG[b]
		ORNL PAM Stations[c]				
3	7	30	-20	4.1	6.3	< 0.01
7	7	8.7	-6.6	1.3	2.0	< 0.01
9	7	7.1	-3.6	2.2	1.4	< 0.01
20	7	14	-6.8	4.8	3.1	< 0.01
21	5	25	-5.2	7.7	5.7	< 0.01
22	7	21	-22	0.28	5.1	< 0.01
ORNL Summary	40	30	-22	3.2 *	1.7	< 0.01
		ORR PAM Stations[c]				
23	6	3.0	-6.9	-1.2	1.8	< 0.01
34	6	32	-4.6	6.1	5.5	< 0.01
40	6	29	-3.4	6.7	5.0	< 0.01
41	7	6.9	-7.6	-1.0	1.9	< 0.01
44	7	14	-15	-0.14	3.3	< 0.01
45	7	6.9	-45	-7.1	7.4	< 0.01
46	6	27	-7.4	4.6	5.1	< 0.01
ORR Summary	45	32	-45	0.88	1.8	< 0.01
Overall Summary	85	32	-45	2.0 *	1.2	< 0.01

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[a] Means marked with an asterisk (*) are statistically determined to be significantly different from zero.

[b] Percent of DCG = Mean/DCG * 100. The derived concentration guide (DCG) for I-131 is 1.5 x 10^{-2} Bq/L.

[c] Locations of ORNL and ORR perimeter stations are shown in Fig. 2.

Table 6. Tritium concentrations at ambient air stations, April-June 1990

Station[a]	Number of samples	Concentration (10^{-4} Bq/L)				
		Maximum	Minimum	Mean[b]	Standard error of mean	Percent of DCG[c]
3	2	4.0	3.6	3.8 *	0.20	0.010
8	3	6.2	0.099	2.6	1.8	0.0071
Overall Summary	5	6.2	0.099	3.1 *	1.1	0.0084

---

[a] Station locations are shown in Fig. 2.

[b] Means marked with an asterisk (*) are statistically determined to be significantly different from zero.

[c] Percent of DCG = Mean/DCG * 100. The derived concentration guide (DCG) for tritium is 3.7 Bq/L. The concentration guide assumes that 50% of the tritium is absorbed through the skin.

Average concentration values for gross alpha, gross beta, I-131, and tritium are tested for statistical significance using a calculated variance that includes variation from the sampling process and from the laboratory counting process. If the 95% lower bound calculated from the variance of the mean is greater than zero, then the mean is determined to be significantly different from zero. In the tables, averages that were determined to be significantly different from zero are marked with an asterisk.

Summary data for gross alpha activity detected at stations in the three air monitoring networks are presented in Table 3. Summary data for gross beta activity are given in Table 4. In normal procedures, laboratory analysis of the particulate filters occurs 4 days after collection to allow decay of naturally occurring short-lived radionuclides. The measurements can then provide a more realistic view of the impact on ambient air from facility operations. However, in this quarter, concomitant with a change in laboratories, analysis of the filters was performed within 24 hrs of collection. As a result, all values for gross alpha and gross beta activity are well above normal and cannot be used as an indicator of actual effects on the air. The concentrations shown in Tables 3 and 4 of this report are based on the 24-hr measurements. To make the data useful for other reports and for comparisons, a method to adjust the measured activities to include expected decay is being investigated. The adjustment would be based on results from time-staged analyses that have been performed previously.

A summary of atmospheric I-131 concentrations in the second quarter is presented in Table 5. No average concentration values for I-131 at individual stations were determined to be significantly different from zero, and all average values are reported as less than 0.01 percent of the derived concentration guide (DCG). The maximum value over the ORNL and ORR networks, 32×10^{-8} Bq/L, reported for ORR station 34 near White Oak Dam, is only 0.002 percent of the DCG for I-131. The highest average concentration, 7.7×10^{-8} Bq/L, occurred at ORNL station 21, south of the facility. The average concentration of atmospheric I-131 from the ORNL network was 3.2×10^{-8} Bq/L, and from the ORR network, 0.88×10^{-8} Bq/L.

Concentrations of atmospheric tritium for the period are summarized in Table 6. The average concentration value for station 3 (3.8×10^{-4} Bq/L) is 0.01% of the DCG for tritium. Station 8 shows an average concentration of 2.6×10^{-4} Bq/L.

2.2.3 Trends

The revised sampling schedule continues to provide better data. Fewer negative concentration values occur now that filter papers are collected and analyzed biweekly, rather than weekly. The two-week sampling period doubles the sample volume and increases the activity sufficiently to discriminate it from analytical background.

Because of the change in holding time before laboratory analysis of particulate filter samples during this quarter, summary data for gross alpha and gross beta for this quarter cannot be directly compared with those from preceding quarters.

Atmospheric I-131 concentrations at ORNL stations are higher than those from the previous three quarters and similar to those reported in early 1989. ORNL network average concentrations, beginning with first quarter 1989, have been 2.1×10^{-8}, 3.7×10^{-8}, 0.39×10^{-8}, -0.91×10^{-8}, 0.10×10^{-8}, and 3.2×10^{-8} Bq/L. Average concentrations of atmospheric I-131 at all stations continue to be less than 0.01% of the DCG.

The average tritium concentration for the second quarter 1990 (3.1×10^{-4} Bq/L) continues the decline from the concentrations reported for first quarter 1990 (4.8×10^{-4} Bq/L) and for fourth quarter 1989 (11×10^{-4} Bq/L). Longer range comparisons cannot be made because of problems in determining the total volume of air sampled at stations 3 and 8 during the first three quarters of 1989.

2.3 EXTERNAL GAMMA RADIATION

Anita E. Osborne-Lee

2.3.1 Program Description

External gamma radiation measurements (exposure rates) are recorded on a near real-time data acquisition system at ORNL and reservation perimeter air monitoring stations. The location of these PAMs are shown in Figure 2. The readings are averaged at 10-minute intervals and stored in a database on the host computer. From these data, hourly averages are computed and also stored in a database. Readings are marked as invalid by the system if less than 75% of the data are available for the computation of the average as well as if the data are out of a predefined range. If a station has been marked off poll, there will be no readings returned to the data acquisition system for inclusion in the databases.

2.3.2 Procedures and Results

The valid hourly readings for the quarter are queried from the data acquisition system database and processed by a statistical program to produce a table of valid hourly measurements. Table 7 summarizes these measurements for the second quarter of 1990. The equivalent dose rate is calculated using the average reading for each station during the quarter.

Table 7 shows a maximum reading of 3500 nC/gk/h at reservation PAM station 8 for the quarter. This is the largest of eight hourly average spikes on June 21, 1990 that were picked up by the monitor. An investigations to determine the cause of the elevated readings is underway.

2.3.3 Trends

Typical values for cities in the United States are usually between 1.5 and 4.2 nC/kg/h (nanocoulomb per kilogram per hour) according to the recent issues of EPA Environmental Radiation Data. The median value for cities in the contiguous United States for the first three quarters of 1989 was 2.4 nC/kg/h. The last value given for Knoxville (July - September 1989) was 2.4 nC/kg/h. All of the values given in Table 7 except stations 4 and 8 are close to the range of background values as given above. Readings at station 4 have been historically higher than the norm. These are believed to be due to its location near the Process Waste Treatment Plant.

Table 7. External gamma radiation measurements at ORNL and reservation perimeter air monitoring stations, April - June 1990

Location	Number of Samples[b]	Exposure rate(nC/kg/h)[a]				Equivalent Dose (μSv/h)
		Max	Min	Av	Standard error[c]	
ORNL PAM Stations[d]						
03	126	0.43	0.14	0.22	0.0048	0.0086
04	1654	35	21	28	0.057	1.1
07	412	2.2	0.28	1.3	0.027	0.051
20	1570	2.8	2.0	2.1	0.0020	0.083
Network summary	3762	35	0.14	14	0.22	0.52
Reservation PAM Stations[d]						
08	181	3500	1.7	22	19	0.84
31	325	4.5	1.8	2.0	0.0091	0.077
33	1259	2.5	0.015	1.6	0.016	0.062
34	792	2.7	1.8	2.0	0.0049	0.079
36	48	1.9	1.8	1.8	0.0057	0.071
40	387	2.6	1.9	2.1	0.0037	0.082
41	1025	1.6	1.4	1.4	0.00086	0.055
42	504	5.6	0.58	1.8	0.011	0.071
43	550	2.4	1.7	1.8	0.0035	0.071
44	1667	2.3	1.5	1.6	0.0016	0.062
45	193	2.3	1.6	1.8	0.0077	0.071
Network summary	6931	3500	0.015	2.2	0.50	0.087

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[a] Nanocoulomb per kilogram per hour

[b] 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.

[c] Standard deviation of the mean.

[d] See Fig. 2.

3.0 WATER

The ORNL site is drained by two main streams, White Oak Creek (WOC) and Melton Branch. With the exception of two small discharges from the 7600 area 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. 4). WOC continues through a gap in Chestnut Ridge into Melton Valley where it is joined by Melton Branch, which drains Melton Valley. Water quality in these streams is affected primarily by wastewater discharges and by groundwater transport of contaminants from land disposal of wastes. WOC empties into White Oak Lake (WOL) which is controlled by White Oak Dam (WOD), and is the last sampling point before effluents leave the ORNL site. The majority of the drainage or liquid effluent from ORNL flows into the Clinch River by way of WOC. The Clinch River flows southwest from Virginia to its mouth near Kingston, Tennessee, where it joins with the Tennessee River. Process effluents discharged to these streams are handled in a number of ways which include: treatment [Process Waste Treatment Plant (PWTP), Coal Yard Runoff] 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 WAG 1 and WAG 6. Samples are analyzed for radionuclides and nonradioactive chemicals.

3.1 SURFACE WATER

Dennis A. Wolf

3.1.2 Program Description

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, Melton Branch (MB). WOD, located above the mouth of WOC, forms WOL and serves as a point for monitoring flow and discharges of contaminants from the ORNL site.

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 8.

Changes in the sampling procedures were implemented during this quarter. Effective in March, X09A [High Flux Isotope Reactor (HFIR) Ponds and Transuranium (TRU) Ponds], X06A (190 Ponds, 1500 Area and 2000 Area), 3518 and PWTP effluents were redirected to the Nonradiological Waste Water Treatment Facility (NonRad). However, PWTP effluents continue to be monitored as they flow into the NonRad facility. The results section contains data summaries of samples collected from each location.

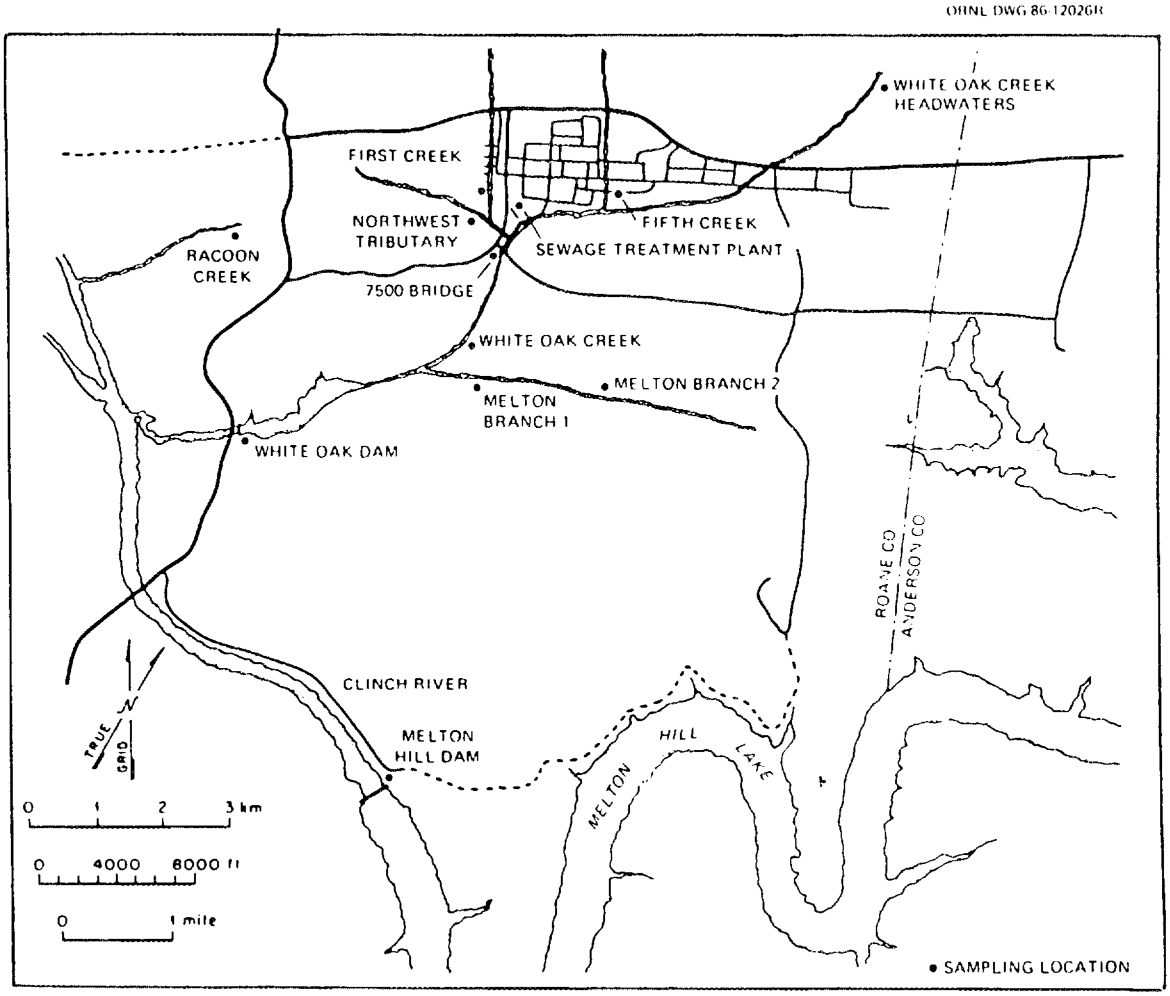

Fig. 4. Location map of ORNL streams and sampling stations.

Table 8. Summary of collection and analysis frequencies of surface, pond, and effluent water samples

Station	Parameter	Collection Frequency	Analysis Type	Frequency
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, MB2, WOC	Gamma scan, total Sr[a], H-3	Weekly	Flow Proportional	Monthly
First Creek, Fifth Creek, Raccoon Creek	Gamma scan, total Sr[a]	Weekly	Grab	Monthly
Gallaher	H-3, gamma scan, gross alpha, gross beta, total U, total Sr[a], Pu-238, Pu-239	Weekly	Time proportional	Quarterly
Kingston	H-3, gamma scan, gross alpha, gross beta, total U, total Sr[a], Pu-238, Pu-239	Weekly	Grab	Quarterly
Melton Hill Dam	Gamma scan, gross alpha[b], gross beta[c]	Weekly	Flow Proportional	Monthly
NonRad	H-3, gamma scan, gross alpha,gross beta, total Sr[a]	Weekly	Flow Proportional	Monthly
NWT	Gamma scan, total Sr[a]	Weekly	Flow Proportional	Monthly
WOC Headwaters	Gamma scan, gross alpha[b], gross beta[c]	Weekly	Flow Proportional	Monthly
WOD	Gamma scan, gross alpha, gross beta	Weekly	Flow Proportional	Weekly
WOD	H-3, total Sr[a]	Weekly	Flow Proportional	Monthly

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[a] Total radioactive Sr (Sr-89 + Sr-90).

[b] If gross alpha >1 Bq/L then analyze for Am-241, Cm-244, Pu-238, Pu-239, Th-228, Th-230, Th-233, U-234, U-235, and U-238.

[c] If gross beta >30 Bq/L then analyze for total radioactive strontium.

A one-tailed test of significance is used to determine whether a radionuclide concentration is significantly greater than zero. If the concentration is statistically significant, the concentration is followed by an asterisk in the tables. Whenever a concentration is not significantly greater than zero, no further summaries derived from that concentration, e.g., percentage of the Derived Concentration Guide or discharge, are presented. All tests are performed at the 5% significance level.

When there is a single observation, the normal approximation is used to approximate the distribution of net activity concentration. The estimated counting uncertainty, which is based upon Poisson statistics and treated as known for the purpose of this test, is used to derive an estimate of the variance. When there are multiple observations, a one-sided t-test is used to test whether an average concentration is greater than zero. The mean is compared to its standard error using the t-distribution with n-1 degrees of freedom, where n is the number of observations used to calculate the mean. Note that two different types of tests are performed. In the first case the test is whether a particular observed concentration exceeds zero, whereas in the second case a test of whether the assumed constant population mean (not an individual concentration) exceeds zero. In the first case the variance estimate pertains only to the counting process, whereas in the second case the variance estimate pertains to the combined sampling and counting processes.

3.1.3 Results

Treated water samples are collected weekly at the Kingston and Oak Ridge K-25 Site (ORGDP, Gallaher) potable water treatments plants (Fig. 5) and are analyzed quarterly. Table 9 contains the concentrations measured at these stations during this quarter of 1990. At Gallaher, gross beta, Pu-239, total radioactive Sr and H-3 were significantly greater than zero; total radioactive Sr, gross beta and H-3 were no greater than 25% of the respective EPA drinking water standards. The Pu-239 concentration is less than 0.1% of the gross alpha drinking water standard. At Kingston, total radioactive Sr and H-3 were significantly greater than zero but less than 5% of the drinking water standards. No test of significance was possible for the single total uranium measurement (concentration not determined from counting) at each site, but the concentrations at Gallaher and Kingston are less than 0.2% of the gross alpha standard.

Melton Hill Dam and WOC headwater, two locations above ORNL discharge points, serve as references for other water sampling locations at the ORNL site. Water samples are collected there and from six streams: WOC, MB, First Creek, Fifth Creek, Northwest Tributary, and Raccoon Creek (Fig. 4). Summary statistics for each radionuclide at each surface water sampling location are given in Table 10. Included in this table are data summaries for 3544 effluents. (Station PWTP is no longer a site for NPDES monitoring and is therefore not included in the summaries for those sites.)

DOE Order 5400.5, Chapter III, requires comparison of annual average radionuclide concentrations with the derived concentration guide (DCG) values. According to the 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

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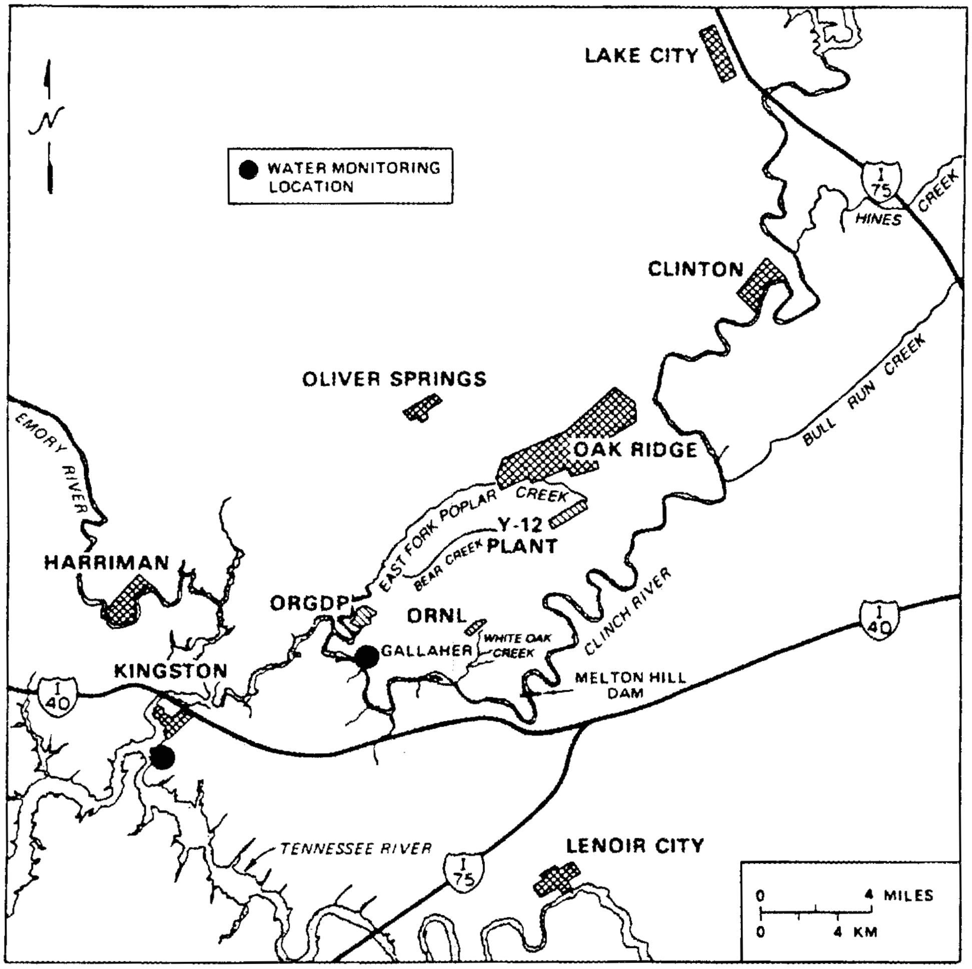

Fig. 5. Location map of Kingston and Gallaher sampling points.

Table 9. Summary of radionuclide concentrations in water off-site ORNL, April-June 1990

Radionuclide	Concentration[a] (Bq/L)	Drinking Water Standard[b] (DWS) (Bq/L)	Percentage of DWS[c]
	Gallaher[d]		
Co-60	0.010	e	e
Cs-137	0.0050	e	e
Gross alpha	-0.030	0.56	e
Gross beta	0.38*	1.5	25
Pu-238	0.00017	e	e
Pu-239	0.00049*	e	e
Total Sr[f]	0.046*	0.30	16
Total U[g]	0.00059	e	e
H-3	27*	740	3.6
	Kingston[d]		
Co-60	-0.0010	e	e
Cs-137	0.0070	e	e
Gross alpha	0.051	0.56	e
Gross beta	-0.10	1.5	e
Pu-238	-0.00029	e	e
Pu-239	-0.000010	e	e
Total Sr[f]	0.013*	0.30	4.4
Total U[g]	0.00029	e	e
H-3	13*	740	1.7

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[a] Concentrations significantly greater than zero are identified by an *.

[b] National Primary Drinking Water Standard. From 40 CFR 141, as amended. Values for gross beta and total Sr are based upon the Sr-90 limit.

[c] Concentration as a percentage of the DWS.

[d] See Fig. 5.

[e] Not applicable.

[f] Total radioactive Sr (Sr-89 + Sr-90).

[g] No test for significance is possible.

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 10.

At the two reference sites Melton Hill Dam and WOC headwater, only the average Co-60 concentration at WOC headwater (0.90 Bq/L, 0.47% of the DCG) was significantly greater than zero. Average Cs-137 concentration at PWTP (60 Bq/L) was 54% of the DCG. The concentration of gross beta (53 Bq/L) is likely due to the Cs-137. Average total radioactive Sr concentration at First Creek (9.2 Bq/L) was 25% of the DCG for Sr-90. Otherwise, all average concentrations at First Creek, Fifth Creek, Northwest Tributary, Raccoon Creek, MB2, 7500 bridge and 3544 were no greater than 5.3% of the respective DCGs.

Locations that are sampled for nonradioactive chemicals under the requirements of the NPDES permit (see Sect. 3.2) are also sampled for radionuclides (Fig. 6). Parameters analyzed and the frequency of analysis are given in Table 8. Table 11 contains a summary of the concentrations for each of these locations during this quarter. The average concentration is expressed as a percentage of the DCG (when one exists) in the last column of this table.

No parameter average concentration exceeded 63% of its DCG. Average total radioactive Sr (23 Bq/L) and H-3 (1,800 Bq/L) at MB1 were 63% and 59% of the respective DCGs.

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 12. Clinch River flows are regulated by a series of TVA dams, one of which is Melton Hill Dam. The flow in Melton Branch is usually about one-third that in WOC. The ratio of WOC flow to Clinch River flow is also reported in Table 12. 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 170 to 570.

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 H-3 and total Sr 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 13 - 15). In addition, weekly flow-proportional samples were obtained at WOD and analyzed (for radionuclides other than H-3 and total Sr) 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.

Table 10. Radionuclide concentrations in surface waters around ORNL,[a] April-June 1990

Radionuclide	Number of Samples	Concentration (Bq/L) Max	Min	Av[b]	Standard error[c]	Derived Concentration Guide (DCG)[d]	Percentage of DCG[e]
				Melton Hill Dam			
Co-60	3	0.20	-0.40	-0.20	0.20	190	f
Cs-137	3	1.7	-1.4	-0.033	0.91	110	f
Gross alpha	3	-0.010	-0.060	-0.030	0.015	f	f
Gross beta	3	0.90	-0.90	0.10	0.53	f	f
				White Oak Creek Headwaters			
Co-60	3	1.4	0.40	0.90*	0.29	190	0.47
Cs-137	3	2.1	-0.60	0.77	0.78	110	f
Gross alpha	3	0.37	0.020	0.14	0.11	f	f
Gross beta	3	0.60	-0.40	0.033	0.30	f	f
				7500 Bridge			
Co-60	3	0.50	-0.60	0.033	0.33	190	f
Cs-137	3	6.8	0.20	4.0	2.0	110	f
Total Sr[g]	3	2.7	1.6	2.0*	0.37	37	5.3
H-3	3	110	81	97*	8.5	74,000	0.13
				First Creek			
Co-60	3	0.60	-1.0	-0.10	0.47	190	f
Cs-137	3	2.2	-0.40	0.73	0.77	110	f
Total Sr[g]	3	14	5.6	9.2*	2.5	37	25
				Fifth Creek			
Co-60	3	0.80	-1.4	-0.30	0.64	190	f
Cs-137	3	1.1	-0.90	0.10	0.58	110	f
Total Sr[g]	3	1.4	1.2	1.3*	0.058	37	3.5

Table 10. (continued)

Radionuclide	Number of Samples	Concentration (Bq/L) Max	Min	Av[b]	Standard error[c]	Derived Concentration Guide (DCG)[d]	Percentage of DCG[e]
				Melton Branch 2			
Co-60	3	1.2	-0.20	0.53	0.41	190	f
Cs-137	3	1.7	-1.4	0.23	0.90	110	f
Total Sr[g]	3	0.11	0.010	0.070	0.031	37	f
H-3	3	180	50	100	40	74,000	f
				Northwest Tributary			
Co-60	3	1.3	0.40	0.83*	0.26	190	0.44
Cs-137	3	2.7	0.10	1.4	0.75	110	f
Total Sr[g]	3	2.2	1.4	1.8*	0.23	37	4.8
				Process Waste Treatment Plant			
Co-60	3	3.8	2.4	3.1*	0.41	190	1.6
Cs-137	3	73	51	60*	6.8	110	54
Gross alpha	3	3.3	1.6	2.2*	0.54	f	f
Gross beta	3	77	29	53*	14	f	f
Total Sr[g]	3	1.2	0.81	0.95*	0.12	37	2.6
				Raccoon Creek			
Co-60	3	0.70	-1.3	-0.067	0.62	190	f
Cs-137	3	1.9	-1.8	0.10	1.1	110	f
Total Sr[g]	3	1.4	0.59	0.99*	0.23	37	2.7

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[a] Locations are shown in Fig. 4.

[b] Mean concentrations significantly greater than zero are identified by an *.

[c] Standard error of the mean.

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

[e] Mean concentration as a percentage of the derived concentration guide (DCG), calculated only when a DCG exists and mean concentration is significantly greater than zero.

[f] Not applicable.

[g] Total radioactive Sr (Sr-89 + Sr-90).

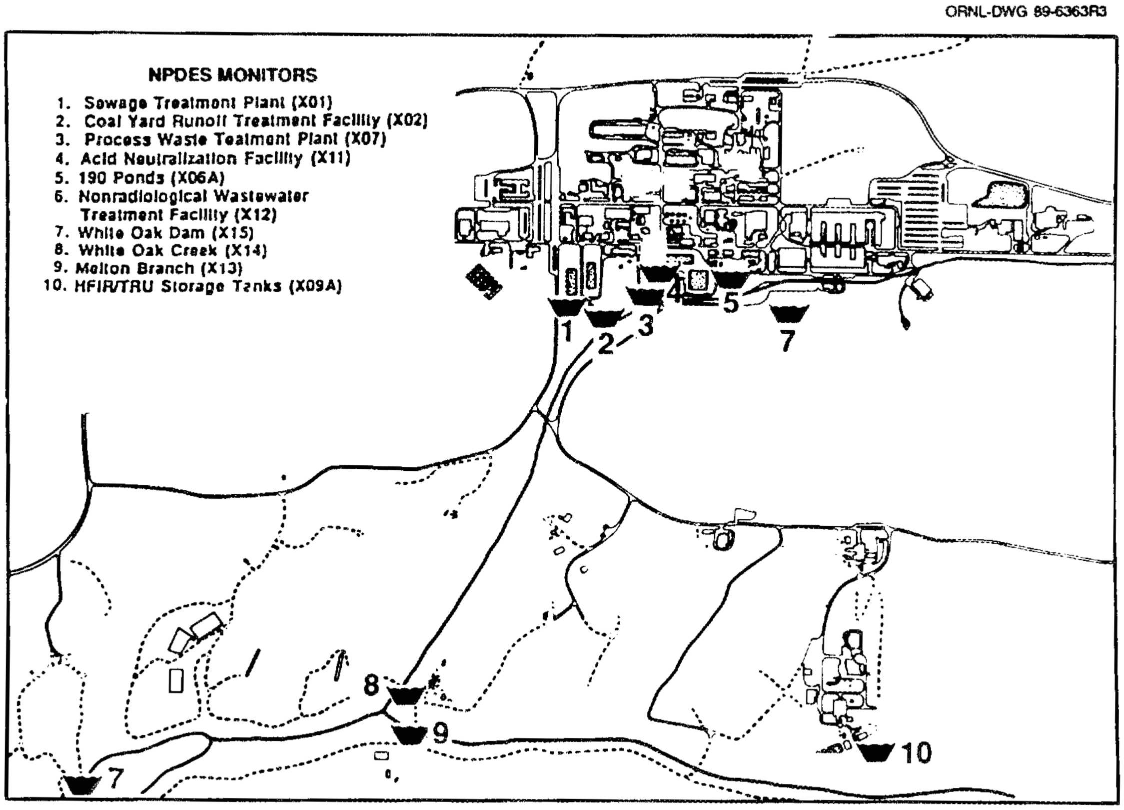

Fig. 6. Location map of ORNL NPDES and radioactivity sampling locations.

Table 11. Radionuclide concentrations at ORNL NPDES locations,[a] April-June 1990

Radionuclide	Number of Samples	Concentration (Bq/L) Max	Min	Av[b]	Standard error[c]	Derived Concentration Guide (DCG)[d]	Percentage of DCG[e]
				Sewage Treatment Plant (X01)			
Co-60	3	-0.10	-0.50	-0.27	0.12	190	f
Cs-137	3	2.0	0.60	1.1	0.44	110	f
Gross beta	3	9.1	6.2	7.6*	0.84	f	f
Total Sr[g]	3	4.6	2.6	3.7*	0.59	37	10
				Non-Radioactive Process Waste Treatment Facility (X12)			
Co-60	3	2.0	-2.0	-0.23	1.2	190	f
Cs-137	3	29	22	25*	2.2	110	22
Gross alpha	3	0.81	0.30	0.53*	0.15	f	f
Gross beta	3	30	9.1	22*	6.7	f	f
Total Sr[g]	3	0.50	0.43	0.47*	0.020	37	1.3
H-3	3	1,100	520	810*	170	74,000	1.1
				Melton Branch 1 (X13)			
Co-60	3	0.90	0.30	0.60*	0.17	190	0.32
Cs-137	3	1.8	-0.50	0.70	0.67	110	f
Total Sr[g]	3	34	13	23*	6.1	37	63
H-3	3	59,000	33,000	44,000*	7,900	74,000	59
				White Oak Creek (X14)			
Co-60	3	0.30	-0.90	-0.33	0.35	190	f
Cs-137	3	4.2	1.7	3.1*	0.74	110	2.8
Total Sr[g]	3	5.6	2.8	4.5*	0.85	37	12
H-3	3	2,000	1,300	1,800*	230	74,000	2.4

Table 11. (continued)

		Concentration (Bq/L)					
Radionuclide	Number of Samples	Max	Min	Av[b]	Standard error[c]	Derived Concentration Guide (DCG)[d]	Percentage of DCG[e]
			White Oak Dam (X15)				
Co-60	13	2.3	-0.40	0.47*	0.18	190	0.25
Cs-137	13	2.8	0.29	1.2*	0.21	110	1.1
Gross alpha	13	0.44	0.10	0.29*	0.032	f	f
Gross beta	13	22	1.0	15*	1.7	f	f
Total Sr[g]	3	11	5.9	8.1*	1.5	37	22
H-3	3	11,000	6,600	8,200*	1,400	74,000	11

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[a] Locations are shown in Fig. 6.

[b] Mean concentrations significantly greater than zero are identified by an *.

[c] Standard error of the mean.

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

[e] Mean concentration as a percentage of the derived concentration guide (DCG), calculated only when a DCG exists and mean concentration is significantly greater than zero.

[f] Not applicable.

[g] Total radioactive Sr (Sr-89 + Sr-90).

Table 12. Stream[a] flows, April-June 1990

Month	Melton Branch 1	White Oak Creek[b]	White Oak Dam[c]	Clinch River	Average Ratio[d]
	Flow (10^9L)				
April	0.13	0.59	0.76	130	170
May	0.56	1.3	1.9	300	260
June	0.098	0.54	0.62	340	570

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[a] See Fig. 4.

[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.

Table 13. Radionuclide concentrations and releases at ORNL,[a] April 1990

Radionuclide	Flow (10^6L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	Concentration Guide (DCG)[d] (Bq/L)	Percentage of DCG[e]
Melton Branch 1 (03/28-04/25)					
Co-60	120	[g]	0.30	190	[g]
Cs-137	120	[g]	0.80	110	[g]
Total Sr[f]	120	0.39	34*	37	92
H-3	120	680	59,000*	74,000	80
Sewage Treatment Plant (03/28-04/30)					
Co-60	24	[g]	-0.20	190	[g]
Cs-137	24	[g]	0.80	110	[g]
Gross beta	24	0.018	7.4*	[g]	[g]
Total Sr[f]	24	0.0098	4.0*	37	11
White Oak Creek (03/28-04/25)					
Co-60	560	[g]	-0.90	190	[g]
Cs-137	560	[g]	1.7	110	[g]
Total Sr[f]	560	0.28	5.0*	37	14
H-3	560	110	2,000*	74,000	2.7
White Oak Dam[h] (04/01-05/01)					
Co-60	760	0.019	0.25*	190	0.13
Cs-137	760	0.080	1.1*	110	0.96
Gross alpha	760	0.026	0.35*	[g]	[g]
Gross beta	760	1.5	19*	[g]	[g]
White Oak Dam (03/28-04/25)					
Total Sr[f]	710	0.79	11*	37	30
H-3	710	790	11,000*	74,000	15

---

[a] Locations are shown in Fig. 4.

[b] Discharges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

[c] Concentrations signficantly greater than zero are identified by an *

[d] Derived concentration guide for ingestion of water. From DOE Order 5400.5.

[e] Mean concentration as a percentage of the DCG.

[f] Total radioactive Sr (Sr-89 + Sr-90).

[g] Not applicable.

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

Table 14. Radionuclide concentrations and releases at ORNL,[a] May 1990

Radionuclide	Flow (10^6L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	Concentration Guide (DCG)[d] (Bq/L)	Percentage of DCG[e]
Melton Branch 1 (04/25-05/30)					
Co-60	580	[g]	0.60	190	[g]
Cs-137	580	[g]	-0.50	110	[g]
Total Sr[f]	580	1.3	23*	37	62
H-3	580	1,900	33,000*	74,000	45
Sewage Treatment Plant (04/30-05/30)					
Co-60	26	[g]	-0.50	190	[g]
Cs-137	26	[g]	0.60	110	[g]
Gross beta	26	0.024	9.1*	[g]	[g]
Total Sr[f]	26	0.012	4.6*	37	12
White Oak Creek (04/25-05/30)					
Co-60	1,400	[g]	0.30	190	[g]
Cs-137	1,400	0.48	3.4*	110	3.1
Total Sr[f]	1,400	0.78	5.6*	37	15
H-3	1,400	280	2,000*	74,000	2.7
White Oak Dam[h] (05/01-06/01)					
Co-60	1,900	0.067	0.35*	190	0.19
Cs-137	1,900	0.18	0.95*	110	0.87
Gross alpha	1,900	0.039	0.21*	[g]	[g]
Gross beta	1,900	2.5	13*	[g]	[g]
White Oak Dam (04/25-05/30)					
Total Sr[f]	2,000	1.5	7.4*	37	20
H-3	2,000	1,400	7,000*	74,000	9.5

---

[a] Locations are shown in Fig. 4.

[b] Discharges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

[c] Concentrations signficantly greater than zero are identified by an *

[d] Derived concentration guide for ingestion of water. From DOE Order 5400.5

[e] Mean concentration as a percentage of the DCG

[f] Total radioactive Sr (Sr-89 + Sr-90).

[g] Not applicable.

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

Table 15. Radionuclide concentrations and releases at ORNL,[a] June 1990

Radionuclide	Flow (10^6L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	Concentration Guide (DCG)[d] (Bq/L)	Percentage of DCG[e]
Melton Branch 1 (05/30-06/27)					
Co-60	95	[g]	0.90	190	[g]
Cs-137	95	0.017	1.8*	110	1.6
Total Sr[f]	95	0.12	13*	37	35
H-3	95	370	39,000*	74,000	53
Sewage Treatment Plant (05/30-06/29)					
Co-60	25	[g]	-0.10	190	[g]
Cs-137	25	0.0051	2.0*	110	1.8
Gross beta	25	0.016	6.2*	[g]	[g]
Total Sr[f]	25	0.0066	2.6*	37	7.0
White Oak Creek (05/30-06/27)					
Co-60	520	[g]	-0.40	190	[g]
Cs-137	520	0.22	4.2*	110	3.8
Total Sr[f]	520	0.14	2.8*	37	7.6
H-3	520	67	1,300*	74,000	1.8
White Oak Dam[h] (06/01-07/01)					
Co-60	620	0.048	0.77*	190	0.41
Cs-137	620	0.061	0.98*	110	0.89
Gross alpha	620	0.017	0.27*	[g]	[g]
Gross beta	620	0.71	11*	[g]	[g]
White Oak Dam (05/30-06/27)					
Total Sr[f]	610	0.36	5.9*	37	16
H-3	610	400	6,600*	74,000	8.9

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[a] Locations are shown in Fig. 4.

[b] Discharges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

[c] Concentrations signficantly greater than zero are identified by an *

[d] Derived concentration guide for ingestion of water. From DOE Order 5400.5

[e] Mean concentration as a percentage of the DCG

[f] Total radioactive Sr (Sr-89 + Sr-90).

[g] Not applicable.

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

Each average flow-weighted concentration was compared with an existing DCG. Co-60 and Cs-137 concentrations did not exceed 3.8% of the DCGs during this quarter. At MB1 total radioactive Sr concentrations decreased from 92% of the Sr-90 DCG in April to 35% of the DCG in June. H-3 concentrations there ranged from 80% of the DCG down to 45% of the DCG. Total radioactive Sr and H-3 concentrations ranged respectively from 7% to 30% and 1.8% to 15% of the DCG at the other locations where they were measured.

3.1.3 Trends

Radionuclide concentrations obtained during this quarter were compared with historical concentrations to assess trends. For the off-site stations Gallaher and Kingston, the concentrations have been fairly stable historically. The significant concentrations observed during this quarter are all lower than the two-year maxima with exception of Pu-239 at Gallaher (0.0049 Bq/L, 0.089% of total alpha drinking water standard). All radionuclide concentrations reported this quarter for MB1, WOC and WOD are lower than past two-year maxima with the exception of total radioactive Sr at MB1 and Co-60 at WOD.

Total radioactive Sr concentration at MB1 during April 1990 (34 Bq/L, 63% of the DCG for Sr-90) is significantly higher than the previous two-year maximum (24 Bq/L) obtained in December of 1989. Concentrations at MB1 appear to have been increasing slightly over the past two years; however concentrations decreased in May and June (23 Bq/L and 13 Bq/L, respectively). There is evidence of seasonality in total radioactive Sr at these three stations, a tendency for higher values in the winter and spring and lower values in the summer and fall.

A WOD Co-60 concentration obtained in June 1990 (2.3 Bq/L, 1.2% of the DCG) exceeded the previous maximum value (1.0 Bq/L) observed in March of 1989. When the value is compared to its counting uncertainty, it is not significantly greater than 1 Bq/L.

H-3 concentration at MB1 appear to be decreasing with time, whereas the levels at WOC and WOD have been fairly constant since the fall of 1989. Prior to then there was a clear seasonal trend at WOD with higher values in the winter and spring and lower values in the summer and fall.

Co-60 and Cs-137 concentrations appear to be reasonably stable over time at MB1, WOC, and WOD.

Total radioactive Sr concentrations in First Creek have decreased since 1988 (27 Bq/L average concentration in 1988 to 11 Bq/L in 1989) and exhibit a seasonal pattern with higher concentrations in the fall relative to the spring.

3.2 REFERENCE SURFACE WATERS

Michael R. Powell

3.2.1 Program Description

Monthly surface water samples are collected at two sampling locations for the purpose of determining background contamination levels before the influence of

ORNL. One sampling location is the Melton Hill Dam above ORNL's discharge point into the Clinch river (Fig. 4). The other sample location is White Oak Creek headwaters, above the point where ORNL discharges to White Oak Creek (Fig. 4). Analyses were performed to detect classical, inorganic, and organic pollutants in the water. Classical pollutants are those indicated by Conductivity, Temperature, Turbidity, pH, Total Dissolved Solids, Suspended Solids, and Oil and Grease. Inorganic parameters are those indicated by metal and anion analysis. The presence of organic pollutants are based on the Total Organic Carbon (TOC) analysis. If significant amounts of TOC are detected, a more complete organic analysis is performed.

The inorganics, oil and grease, and dissolved solids were collected flow-proportionally by a sampling station at each location. All other samples are grab samples taken once per month.

3.2.2 Results

The results for the inorganic, organic, and classical pollutants are found in Table 16. The column "percent DWL" is included to show the average concentration as a percentage of the National Primary or Secondary Drinking Water Regulation level, where available. There were no high levels of organic compounds detected by the TOC analysis at either location, as indicated by the average value of 1.6 mg/L. Most inorganic compounds were also below the National Primary and Secondary Drinking Water regulation levels. Arsenic, cadmium, iron, lead, magnesium and selenium all show high percentage DWL. 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 428% of the National Secondary Drinking Water Limit, which is 0.05 mg/L. The average concentration of manganese at WOC was 84% of the drinking water limit. The average concentration of iron at Melton Hill Dam was 337% of the National Secondary Drinking Water Limit, and at WOC this figure was 114%. Similarly, arsenic, selenium, and cadmium all show high values for DWL. Because the limit of detection is high for many of these metals, it is not possible to accurately determine if the DWL has been exceeded. Future program improvements will address this problem by replacing these analyses with analytical methods of greater sensitivity.

Many of the inorganic analytical results show a wide range of detection limits. This results from a dilution that must be made to some of the water samples. When a given sample contains an element in a concentration that is higher than the Inductively Coupled Plasma (ICP) equipment can accurately measure, this compound can cause a spectral interference with other elements. The sample must then be diluted to bring the interfering element into a range that the equipment can accurately measure. The resulting analytical values from the ICP process must be adjusted by the dilutions factor. This dilution factor must also be applied to the detection limit value for each element.

3.2.3 Trends

Current trends in the concentration of pollutants found at these reference locations are assessed by comparing the maximum and average values for the quarter, to the historic concentrations of these pollutants at the same locations for the last 2 years. In this quarter Total Dissolved Solids (TDS),

Table 16. Surface Water Analyses at Reference Locations, April-June 1990

Parameter	Number of Samples	Concentration (mg/L) Max	Min	Av	Standard Error	Percent[a] DWL
		Melton Hill Dam[b]				
Aluminum-total	3	2.6	0.21	1.2	0.72	
Antimony-total	3	0.078	<0.050	<0.059	0.0093	
Arsenic-total	3	<0.050	<0.050	<0.050	0	<100
Barium-total	3	0.051	0.025	0.036	0.0079	3.5
Beryllium-total	3	<0.00030	<0.00020	<0.00023	0.000033	
Boron-total	3	<0.080	<0.080	<0.080	0	
Cadmium-total	3	<0.0070	<0.0050	<0.0057	0.00067	<56
Calcium-total	3	40	35	37	1.5	
Chromium-total	3	0.0065	0.0040	0.0053	0.00072	10
Cobalt-total	3	<0.0040	<0.0040	<0.0040	0	
Copper-total	3	0.016	0.0078	0.012	0.0024	1.1
Dissolved solids-total	3	480	140	260	110	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Iron-total	3	2.1	0.27	1.0	0.56	337
Lead-total	3	<0.050	<0.050	<0.050	0	<100
Lithium-total	3	<15	<15	<15	0	
Magnesium-total	3	10	8.3	9.0	0.51	
Manganese-total	3	0.49	0.043	0.21	0.14	428
Molybdenum-total	3	<0.040	<0.040	<0.040	0	
Nickel-total	3	<0.0090	<0.0050	<0.0063	0.0013	
Nitrate	3	<5.0	<5.0	<5.0	0	<50
Oil and grease	3	69	<2.0	<24	22	
Organic carbon-total	3	3.1	1.8	2.3	0.39	
Phosphorus-total	3	<0.30	<0.30	<0.30	0	
Selenium-total	3	<0.050	<0.040	<0.047	0.0033	<466
Silicon-total	3	5.9	2.5	4.0	1.0	
Silver-total	3	<0.0050	<0.0050	<0.0050	0	<10
Sodium-total	3	<5.0	<5.0	<5.0	0	
Strontium-total	3	0.091	0.073	0.081	0.0053	
Sulfate (as SO4)	3	25	17	20	2.5	8.0
Suspended solids-total	3	73	24	42	16	
Tin-total	3	<0.050	<0.050	<0.050	0	
Titanium-total	3	0.053	<0.020	<0.032	0.010	
Vanadium-total	3	0.0042	<0.0020	<0.0034	0.00070	
Zinc-total	3	0.019	<0.0050	<0.0099	0.0046	<0.19
Zirconium-total	3	<0.020	<0.020	<0.020	0	
Conductivity, mS/cm	3	1.5	0.50	1.1	0.31	

Table 16. (continued)

Parameter	Number of Samples	Concentration (mg/L) Max	Min	Av	Standard Error	Percent[a] DWL
Oxygen-dissolved	3	13	7.3	9.6	1.6	
Temperature, °C	3	20	12	17	2.4	
Turbidity, JTU	3	42	3.0	26	12	
pH, standard units	3	8.2	7.4	7.8	0.23	
		White Oak Creek[b]				
Aluminum-total	3	0.31	0.072	0.17	0.072	
Antimony-total	3	0.074	<0.050	<0.058	0.0080	
Arsenic-total	3	<0.050	<0.050	<0.050	0	<100
Barium-total	3	0.054	0.033	0.045	0.0063	4.5
Beryllium-total	3	<0.00030	<0.00020	<0.00023	0.000033	
Boron-total	3	<0.080	<0.080	<0.080	0	
Cadmium-total	3	<0.0070	<0.0050	<0.0057	0.00067	<56
Calcium-total	3	22	19	20	1.0	
Chromium-total	3	0.0054	<0.0040	<0.0047	0.00041	<9.3
Cobalt-total	3	<0.0040	<0.0040	<0.0040	0	
Copper-total	3	0.0052	<0.0050	<0.0051	0.000067	<0.50
Dissolved solids-total	3	110	90	100	7.2	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Iron-total	3	0.76	0.10	0.34	0.21	114
Lead-total	3	<0.050	<0.050	<0.050	0	<100
Lithium-total	3	<15	<15	<15	0	
Magnesium-total	3	11	8.2	9.6	0.81	
Manganese-total	3	0.084	0.0061	0.042	0.023	84
Molybdenum-total	3	<0.040	<0.040	<0.040	0	
Nickel-total	3	<0.0090	<0.0050	<0.0063	0.0013	
Nitrate	3	<5.0	<1.0	<3.7	1.3	<36
Oil and grease	3	<2.0	<2.0	<2.0	0	
Organic carbon-total	3	1.1	0.70	0.87	0.12	
Phosphorus-total	3	<0.30	<0.30	<0.30	0	
Selenium-total	3	<0.050	<0.040	<0.047	0.0033	<466
Silicon-total	3	3.7	3.4	3.6	0.088	
Silver-total	3	<0.0050	<0.0050	<0.0050	0	<10
Sodium-total	3	<5.0	<5.0	<5.0	0	
Strontium-total	3	0.024	0.021	0.022	0.00088	
Sulfate (as SO4)	3	<5.0	<5.0	<5.0	0	<2.0
Suspended solids-total	3	12	<5.0	<8.0	2.1	

Table 16. (continued)

Parameter	Number of Samples	Concentration (mg/L) Max	Min	Av	Standard Error	Percent[a] DWL
Tin-total	3	<0.050	<0.050	<0.050	0	
Titanium-total	3	<0.020	<0.020	<0.020	0	
Vanadium-total	3	0.0046	<0.0020	<0.0029	0.00087	
Zinc-total	3	<0.0050	<0.0050	<0.0050	0	<0.10
Zirconium-total	3	<0.020	<0.020	<0.020	0	
Conductivity, mS/cm	3	1.6	0.30	1.2	0.43	
Oxygen-dissolved	3	12	9.6	10	0.83	
Temperature, °C	3	18	11	14	2.0	
Turbidity, JTU	3	35	13	21	7.2	
pH, standard units	3	7.3	7.0	7.2	0.088	

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

[b] See Fig 4.

and Oil and Grease values have exceeded the 2-year average and maximum at Melton Hill Dam. The maximum values for these two parameters are significantly greater than past maximum values. The average value for the TDS is more than twice the past average values, while the average value for Oil and Grease is a higher less than value than past average Oil and Grease values. The average value for the Antimony and conductivity have exceeded the 2 year maximum value at the White Oak Creek reference location. However, average values for these parameters remain near the 2 year average.

3.3 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REQUIREMENTS

Pamela Y. Goldberg and Charles K. Valentine

3.3.1 Program Description and Results

ORNL's current NPDES permit requires that point-source outfalls be sampled prior to their discharge into receiving waters or before mixing with any other wastewater stream. The Nonradiological Wastewater Treatment Plant (NRWTP) began operating in March 1990. The 190 Ponds (X06A), Process Waste Treatment Plant (X07), HFIR Ponds (X09A), and Acid Neutralization Facility (X11) discharges were rerouted to the NRWTP in February 1990. In addition, there are ambient sampling points that are located in the streams as reference points or for additional information. Equipment Cleaning Facility (VC7002) has been under investigation for some time. Effluent discharge from that facility was discontinued on March 8, 1990, pending resolution of the problem.

Quarterly summary statistics for the second quarter of 1990 are given for each sampling location in Tables 17 through 26. Monitoring of the 190 Ponds (X06A), Process Waste Treatment Plant (X07), HFIR Ponds (X09A), and Acid Neutralization Facility (X11) are no longer required because those discharges are now treated at the NRWTP. The maximun value for total toxic organics at the NRWTP (X12) reflected a prefix of B, which represents the fact that total toxic organics were found in the blank. The maximum value for total PCBs at the Melton Branch (X13), White Oak Creek (X14), and White Oak Dam (X15) stations reflected a prefix of B (Tables 20-22), which represents the fact that PCB-total (Total PCBs) were found in blank.

Data collected for the NPDES permit are also summarized monthly for reporting to DOE and the state of Tennessee. These summaries are submitted to DOE in the Monthly Discharge Monitoring Reports and are available upon request. Noncompliances are provided in Tables 27 and 28. A brief summary of the noncompliances follows.

3.3.2 Noncompliances

3.3.2.1 April 1990

There were no exceedences for the month of April.

3.3.2.2 May 1990

The NPDES Permit limit excursions at the ORNL Sewage Treatment Plant (Outfall X01) are attributed to a single event that occurred on May 2, 1990. The Sewage Treatment Plant experienced an upset that resulted in effluent from the clarifier passing directly into the chlorine contact chamber before discharge to White Oak Creek. The upset was precipitated by high rainfall that occurred

Table 17. NPDES discharge point X01[a], April-June 1990

Parameter	Number of samples	Concentration (mg/L)			
		Max	Min	Av	Standard error[b]
Ammonia (as N)	39	0.53	0.010	0.14	0.022
Biochemical oxygen demand	39	<5.0	<5.0	<5.0	0
Bromodichloromethane	3	<0.0050	~0.0020	~0.0040	0.0010
Chlorine-total residual	39	0.43	<0.010	<0.16	0.018
Copper-total	3	0.0091	<0.0050	<0.0074	0.0012
Cyanide-total	3	<0.0020	<0.0020	<0.0020	0
Downstream pH, standard units	13	8.2	7.2	NA[c]	NA
Fecal coliform, col/100 mL[d]	41	400	<1.0	<13	9.7
Flow, Mgd	63	0.37	0.12	0.22	0.0058
Mercury-total	3	<0.00005	<0.00005	<0.00005	0
Oil and grease	40	630	<2.0	<25	17
Oxygen-dissolved	63	13	6.3	9.4	0.21
pH, standard units	13	8.4	7.0	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	87	<5.0	<8.2	2.3
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Zinc-total	3	0.079	0.056	0.065	0.0071

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[a] See Fig. 6.

[b] Standard error of the mean.

[c] NA = not applicable.

[d] Geometric mean.

Table 18. NPDES discharge point X02,[a] April-June 1990

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Arsenic-total	13	0.13	<0.050	<0.056	0.0062
Cadmium-total	13	<0.0070	<0.0050	<0.0056	0.00027
Chromium-total	13	0.015	<0.0040	<0.0088	0.0011
Copper-total	13	0.25	0.0062	0.032	0.018
Downstream pH, standard units	63	8.4	7.2	NA[c]	NA
Flow, Mgd	63	0.055	0	0.018	0.0022
Iron-total	13	0.96	0.058	0.32	0.077
Lead-total	13	<0.050	<0.030	<0.045	0.0024
Manganese-total	13	0.056	0.011	0.031	0.0041
Nickel-total	13	<0.0090	<0.0050	<0.0062	0.00053
Oil and grease	13	2.0	<2.0	<2.0	0
pH, standard units	63	8.4	6.6	NA	NA
Selenium-total	13	<0.050	<0.040	<0.047	0.0013
Silver-total	13	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO4)	3	1700	1600	1700	33
Suspended solids-total	13	60	<5.0	<15	3.9
Temperature, °C	63	29	11	21	0.54
Zinc-total	13	0.039	<0.0050	<0.021	0.0028

[a] See Fig. 6.
[b] Standard error of the mean.
[c] NA = not applicable.

Table 19. NPDES discharge point X12,[a] April-June 1990

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
1,1-Dichloroethane	13	<0.0050	<0.0050	<0.0050	0
Arsenic-total	13	<0.050	<0.050	<0.050	0
Benzene	13	<0.0050	<0.0050	<0.0050	0
Biochemical oxygen demand	13	<5.0	<5.0	<5.0	0
Bromodichloromethane	13	<0.0050	<0.0050	<0.0050	0
Cadmium-total	13	<0.0070	<0.0050	<0.0055	0.00024
Chlorobenzene	13	<0.0050	<0.0050	<0.0050	0
Chloroform	13	<0.0050	~0.00080	~0.0044	0.00043
Chromium-total	13	0.0063	<0.0040	<0.0044	0.00021
Copper-total	13	0.23	<0.0050	<0.025	0.017
Cyanide-total	13	<0.0020	<0.0020	<0.0020	0
Downstream pH, standard units	62	8.4	7.4	NA[c]	NA
Flow, Mgd	63	0.58	0.31	0.43	0.0074
Fluoride-total	13	1.3	1.0	1.0	0.023
Iron-total	13	0.12	<0.010	<0.041	0.0083
Lead-total	13	<0.050	<0.030	<0.045	0.0024
Mercury-total	13	0.00008	<0.00005	<0.000052	0.0000023
Methylene chloride	13	<0.0050	~0.00040	~0.0040	0.00052
Nickel-total	13	<0.0090	<0.0050	<0.0059	0.00049
Nitrate	13	6.1	<5.0	<5.1	0.085
Oil and grease	13	2.0	<2.0	<2.0	0
pH, standard units	[d]	6.5	8.7	NA	NA
Phosphorus-total	13	0.50	<0.30	<0.34	0.018
Recoverable phenolics-total	13	<0.0010	<0.0010	<0.0010	0
Selenium-total	13	<0.050	<0.040	<0.048	0.0012
Silver-total	13	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO_4)	13	130	94	110	3.9
Suspended solids-total	13	<5.0	<5.0	<5.0	0
Temperature, °C	62	26	15	21	0.36
Tetrachloroethene	13	<0.0050	<0.0050	<0.0050	0
Total toxic organics[e]	13	B0.24	<0.010	<0.060	0.023
Trichloroethene	13	<0.0050	<0.0050	<0.0050	0
Zinc-total	13	0.032	0.0062	0.021	0.0021

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[a] See Fig. 6.

[b] Standard error of the mean.

[c] NA = not applicable.

[d] pH monitoring is continuous.

[e] B means that the maximum value for the total toxic organics were found in the blank.

Table 20. NPDES discharge point X13,[a] April-June 1990

		Concentration (mg/L)			
Parameter	Number of samples	Max	Min	Av	Standard error[b]
Aluminum-total	3	0.39	0.13	0.28	0.079
Ammonia (as N)	3	0.060	0.040	0.050	0.0058
Arsenic-total	3	<0.050	<0.050	<0.050	0
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium-total	3	<0.0020	<0.0020	<0.0020	0
Chlorine-total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.0050	<0.0050	<0.0050	0
Chromium-total	3	0.0088	0.0050	0.0072	0.0011
Conductivity, mS/cm	3	2.2	0.78	1.7	0.46
Copper-total	3	0.013	0.0075	0.011	0.0016
Dissolved solids-total	3	350	190	270	48
Flow, Mgd	63	48	0.45	2.3	0.81
Fluoride-total	3	1.4	<1.0	<1.1	0.13
Iron-total	3	0.35	0.31	0.33	0.012
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.12	0.075	0.092	0.014
Mercury-total	3	<0.00005	<0.00005	<0.00005	0
Nickel-total	3	<0.0050	<0.0050	<0.0050	0
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	250	<2.0	<21	19
Organic carbon-total	3	3.1	2.0	2.4	0.35
Oxygen-dissolved	13	15	6.5	9.9	0.62
PCB-total[d]	3	B0.0046	<0.00050	<0.0024	0.0012
pH, standard units	3	8.8	8.1	NA[c]	NA
Phosphorus-total	3	1.2	<0.30	<0.73	0.26
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	150	17	82	38
Suspended solids-total	3	5.0	<5.0	<5.0	0
Temperature, °C	16	24	9.5	19	1.0
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU[e]	3	110	90	99	5.8
Zinc-total	3	0.042	0.0063	0.020	0.011

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[a] See Fig. 6.

[b] Standard error of the mean.

[c] NA = not applicable.

[d] B = PCB-total found in blank.

[e] Measured in Jackson Turbidity Units.

Table 21. NPDES discharge point X14,[a] April-June 1990

		Concentration (mg/L)			
Parameter	Number of samples	Max	Min	Av	Standard error[b]
Aluminum-total	3	0.17	0.12	0.15	0.015
Ammonia (as N)	3	0.060	0.040	0.047	0.0067
Arsenic-total	3	<0.050	<0.050	<0.050	0
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium-total	3	<0.0020	<0.0020	<0.0020	0
Chlorine-total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.0050	~0.0030	~0.0043	0.00067
Chromium-total	3	0.0087	0.0042	0.0060	0.0014
Conductivity, mS/cm	3	1.7	0.74	1.3	0.29
Copper-total	3	0.0067	<0.0050	<0.0056	0.00054
Dissolved solids-total	3	210	170	180	11
Flow, Mgd	63	52	3.0	7.1	0.90
Fluoride-total	3	1.0	1.0	1.0	0
Iron-total	3	0.16	0.12	0.14	0.012
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.018	0.013	0.015	0.0017
Mercury-total	3	<0.00005	<0.00005	<0.00005	0
Nickel-total	3	<0.0050	<0.0050	<0.0050	0
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	2.0	<2.0	<2.0	0
Organic carbon-total	3	1.8	1.5	1.7	0.088
Oxygen-dissolved	13	13	7.5	10	0.46
PCB-total[d]	3	B0.012	<0.00050	<0.0048	0.0036
pH, standard units	3	8.5	8.1	NA[c]	NA
Phosphorus-total	3	0.50	<0.30	<0.37	0.067
Recoverable phenolics-total	3	<0.0010	<0.0010	<0.0010	0
Silver-total	3	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO_4)	3	33	24	28	2.6
Suspended solids-total	3	<5.0	<5.0	<5.0	0
Temperature, °C	16	24	12	19	0.82
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU[e]	3	67	22	50	14
Zinc-total	3	0.027	0.012	0.017	0.0048

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[a] See Fig. 6.
[b] Standard error of the mean.
[c] NA = not applicable.
[d] B = PCB-total found in blank.
[e] Measured in Jackson Turbidity Units.

Table 22. NPDES discharge point X15,[a] April-June 1990

Parameter	Number of samples	Concentration (mg/L)			
		Max	Min	Av	Standard error[b]
Aluminum-total	3	0.65	0.47	0.54	0.056
Ammonia (as N)	3	0.14	0.070	0.10	0.021
Arsenic-total	3	<0.050	<0.050	<0.050	0
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium-total	3	<0.0020	<0.0020	<0.0020	0
Chlorine-total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.0050	~0.0010	~0.0037	0.0013
Chromium-total	3	0.015	0.011	0.013	0.0012
Conductivity, mS/cm	3	1.9	0.72	1.5	0.39
Copper-total	3	0.0060	<0.0050	<0.0053	0.00033
Dissolved solids-total	3	210	190	190	6.1
Flow, Mgd	63	100	3.3	9.6	1.7
Fluoride-total	3	1.0	1.0	1.0	0
Iron-total	3	0.71	0.46	0.63	0.083
Lead-total	3	0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.16	0.087	0.12	0.022
Mercury-total	3	<0.00005	<0.00005	<0.00005	0
Nickel-total	3	<0.0050	<0.0050	<0.0050	0
Nitrate	3	5.0	<5.0	<5.0	0
Oil and grease	13	34	<2.0	<5.2	2.5
Organic carbon-total	3	5.6	2.4	3.6	0.99
Oxygen-dissolved	13	14	5.1	10	0.59
PCB-total[d]	3	B0.0069	<0.00050	<0.0031	0.0019
pH, standard units	3	8.8	8.0	NA[c]	NA
Phosphorus-total	3	0.50	<0.30	<0.37	0.067
Silver-total	3	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO_4)	3	46	27	37	5.5
Suspended solids-total	3	19	9.0	13	3.0
Temperature, °C	16	29	16	21	0.89
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU[e]	3	100	90	94	3.1
Zinc-total	3	0.021	0.0079	0.014	0.0038

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[a] See Fig. 6.

[b] Standard error of the mean.

[c] NA = not applicable.

[d] B = PCB-total found in blank.

[e] Measured in Jackson Turbidity Units.

Table 23. NPDES cooling towers,[a] April-June 1990

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Chlorine-total residual	11	0.18	<0.010	<0.044	0.018
Chromium-total	11	0.071	<0.0040	<0.015	0.0062
Copper-total	11	0.42	<0.0050	<0.087	0.037
Downstream pH, standard units	10	8.3	7.9	NA[c]	NA
Flow, Mgd	11	0.18	0.0026	0.023	0.016
pH, standard units	11	8.9	7.9	NA	NA
Temperature, °C	11	36	9.4	22	2.7
Zinc-total	11	0.95	0.20	0.47	0.080

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[a] ORNL.

[b] Standard error of the mean.

[c] NA = not applicable.

Table 24. NPDES miscellaneous outfalls, April-June 1990

	Concentration (mg/L)	
Parameter	EF7002[a]	SP2519[b]
Flow, Mgd	NO DISHCARGE	0.00012
pH, standard units	NO DISHCARGE	9.0
Temperature, °C	NO DISHCARGE	24

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

[b] Central Steam Plant, Building 2519.

Table 25. NPDES discharge point category II outfalls,[a] April-June 1990

Parameter	Number of samples	Concentration (mg/L)			
		Max	Min	Av	Standard error[b]
Downstream pH, standard units	41	8.9	7.0	NA[c]	NA
Flow, Mgd	41	0.058	0.00010	0.012	0.0021
Gross beta, Bq/L	41	5.8	0.010	0.71[d]	0.19
Oil and grease	40	31	<2.0	<4.4	1.1
pH, standard units	41	8.9	6.8	NA	NA
Suspended solids-total	41	400	<5.0	<34	11
Temperature, °C	41	40	17	24	0.79

[a] ORNL.
[b] Standard error of the mean.
[c] NA = not applicable.
[d] Average is statistically significantly different that zero.

Table 26. NPDES discharge point category III outfalls,[a] April-June 1990

Parameter	Number of samples	Concentration (mg/L)			
		Max	Min	Av	Standard error[b]
Flow, Mgd	20	0.35	0.00030	0.044	0.019
pH, standard units	20	8.3	6.7	NA[c]	NA

[a] ORNL.

[b] Standard error of the mean.

[c] NA = not applicable.

Table 27. NPDES noncompliances, May 1990

Permit Location	Limit Violated	Limit			Value
Sewage Treatment Plant	Oil and grease	15	mg/L	daily max	630
	Oil and grease	13.1	kg/d	daily max	673
	Oil and grease	10	mg/L	monthly max	44
	Oil and grease	8.7	kg/d	monthly max	46
	Total suspended solids	45	mg/L	daily max	87
	Total suspended solids	39.2	kg/d	daily max	93

Table 28. NPDES noncompliances, June 1990

Permit Location	Limit Violated (daily max)	Limit (mg/L) (daily max)	Value
Category II - Outfall 207	Oil and grease	15	27
Outfall 208	Total suspended Solids	50	395
Outfall 209	Total suspended Solids	50	105
Outfall 213	Total suspended Solids	50	205
Outfall 215	Total suspended Solids	50	175
Outfall 230	Oil and grease	15	28
Outfall 231	Oil and grease	15	31
Outfall 233	Total suspended Solids	50	66
Outfall 242	Total suspended Solids	50	106
Outfall 268	Oil and grease	15	*
Outfall 281	Temperature	30.5	34.9
Outfall 283	Downstream pH	8.5	8.9
Coal Yard Runoff Facility	Total suspended Solids	50	60
Cooling Tower CS7902	Temperature	38	**

* Bottle was broken in the Analytical Chemistry Laboratory.

** Downstream temperature readings were conducted, but no samples were collected.

on May 1; the resulting heavy throughput necessitated early backwashing of the STP's filters, and during the backwash cycle some material from the clarifier passed around the filters. The incident resulted in exceedence of daily-maximum limits for TSS and oil and grease, and the concentrations caused calculated monthly average and mass load limits to be exceeded as well. Sewage Treatment Plant supervisory personnel have modified operating procedures to guard against a recurrence of the situation. In addition, an alarm system to signal high clarifier sludge-blanket level is being procured.

One additional NPDES excursion occurred on May 31, 1990 at the Building 4509 compressor house when approximately 200 gallons of 6% ethylene glycol solution were accidently released to a storm drain following maintenance work on a chiller system. Although this incident is not a violation of any NPDES numeric limit, it does represent an accidental unpermitted discharge and therefore is technically an NPDES excursion. Downstream surveys of White Oak Creek following the release showed no evidence of environmental detriment.

3.3.2.3 June 1990

The exceedences of total suspended solids (TSS) and oil and grease (O&G) at Category II Outfalls (parking lot drains, roof drains, storage area drains) in various areas of ORNL were attributed to the conveyance of residual dust, dirt, and vehicle grease and oil drippings from streets and parking lots during storm events. Because these outfalls are mostly precipitation-dependent, they are monitored during or immediately following storm events. ORNL has requested NPDES Permit modification to more realistically address storm water runoff. Corrective measure alternatives are also being evaluated for the event that permit modification does not receive regulatory approval.

Based on the effluent pH, Outfall 283 does not seem to be the cause for the high downstream pH value. The limits for downstream pH are imposed by the Tennessee Department of Health and Environment (TDHE), not by the NPDES permit.

No operational upset or unusual condition was found at the time of the TSS exceedence at the Coal Yard Runoff Treatment Facility (CYRTF). The exceedence was attributed to an abundance of algae that was noted in the discharge basin at the CYRTF. This is a normal late-summer condition in this basin.

The temperature limit exceedence at the CS7902 cooling tower was based on an exceedence of Tennessee water quality criteria for temperature in the receiving stream at the point where CS7902 discharges blowdown to the stream. A few dead fish and invertebrates were found at the site, apparently the result of the excessive water temperature. CS7902 operators have revised operating procedures to manually control the release of blowdown; apparently this has remedied the problem.

3.4 POLYCHLORINATED BIPHENYL (PCB) IN THE AQUATIC ENVIRONMENT

Michael R. Powell

3.4.1 Program Description

Water samples were collected from various locations along WOC, MB, Northwest

Tributary (NWT) and the Clinch River (CR) to determine PCB concentrations in these areas (Fig. 7). A total of 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 April through July, 1990. This was done to comply with the Clean Water Act (CWA) and is an integral part of ORNL's NPDES activities. Water samples are being analyzed quarterly for aroclors 1016, 1221, 1232, 1242, 1248, 1254 and 1260. The Environmental Protection Agency (EPA) acute criteria for the protection of fish and aquatic life is 2.0 μg/L for PCB.

Sediment samples are collected from the same locations as water samples and are analyzed for the same aroclors as water semiannually. Two samples per site were taken for sediment during January through July, 1990. Sediment samples are analyzed in addition to water because PCB's are relatively insoluble in water and tend to accumulate in stream sediments. There are currently no regulatory guidelines for PCB concentrations in stream sediment.

Water samples were taken by the manual grab method and placed in amber glass containers. The samples were cooled to 4°C; the water samples can be held for a maximum of 7 days before extraction. The samples were analyzed by a gas chromatographic procedure and measured by electron capture detector. 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.

3.4.2 Results

The concentrations of PCB in water during April through July 1990 were below the analytical quantitation limit at all sampling sites. Analyses were performed for seven aroclors of PCB; all were below the quantitation limit. The quantitation limit for PCB aroclors 1016, 1221, 1232, 1242, and 1248 is 0.5 μg/L. The quantitation limit for PCB aroclors 1254 and 1260 is 1.0 μg/L. Sediment results are shown in Table 29. Seven locations had results above detection limits for PCB in sediment. On White Oak Creek station WOC6 had a maximum concentration of 2000 μg/L for aroclor-1254 and 640 μg/L for aroclor-1260. Location WOC 10 had a maximum concentration of 490 μg/L for aroclor-1254 and 270 μg/L for aroclor-1242. Location WOD 13 had a maximum value of 240 μg/L for aroclor-1016 and WOC 14 had a maximum concentration of 300 μg/L for aroclor-1242. On the Clinch River location CR 9 had a maximum value of 230 μg/L for aroclor-1242. Melton branch has a maximum concentration of 270 μg/L for aroclor-1242 at location MB 7.

3.4.3 Trends

Current trends in the concentration of PCB found at theses sites are assessed by comparing the current maximum and average values to the historic concentration of PCB at the same locations for the last 2 years. All current values for water samples remain within the distribution of maximum and average values for the last 2 years. Sediment samples have a number of positive values for PCB concentrations for the sampling period. Most of these samples exceed the two year high for PCB determinations at the same site, but are only slightly above detection limits. Additional data will be necessary to determine if they represent significant increases in the PCB

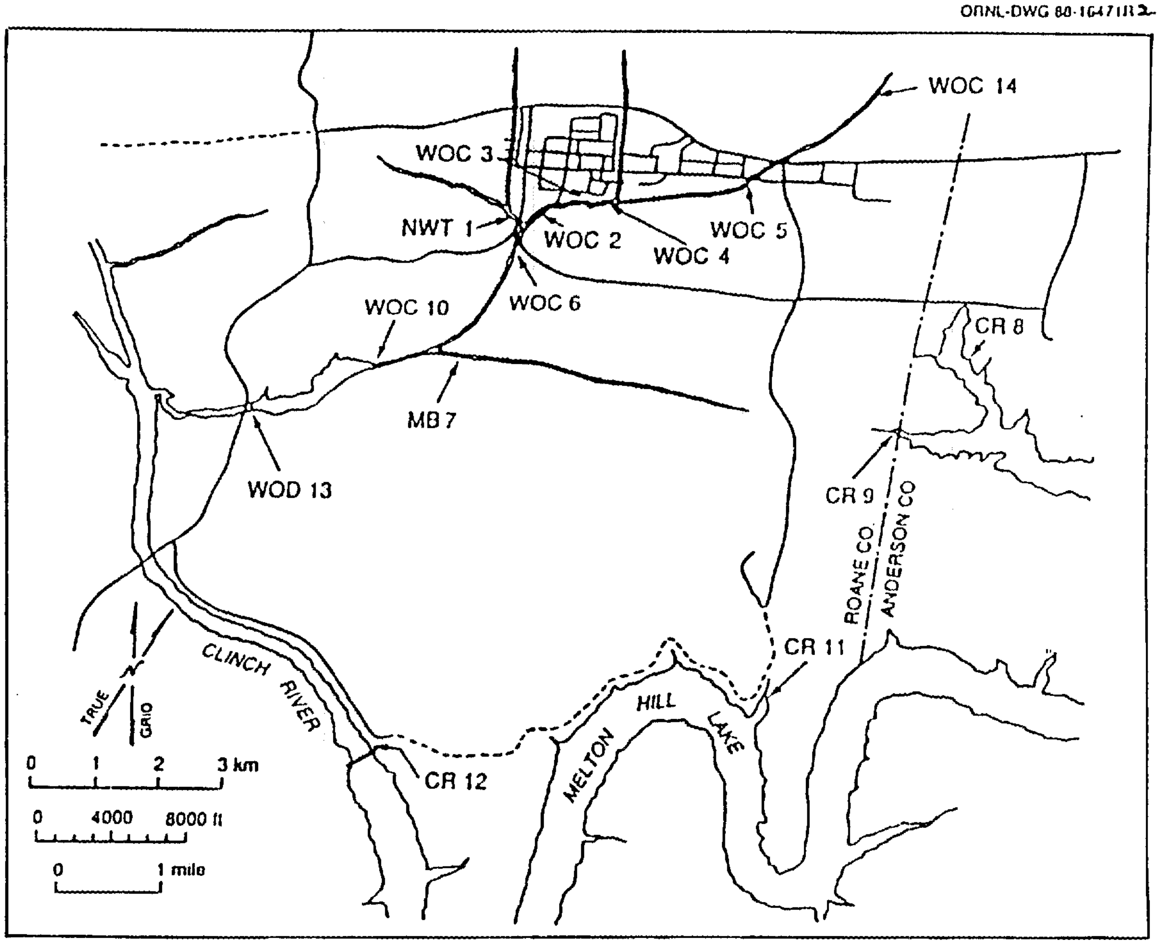

Fig. 7. Location map of PCB sampling points.

Table 29. PCB concentrations in sediment, July 1990

Location[a]	Analysis	Number	Concentration (μg/Kg)			Standard error[b]
			Max	Min	Av	
WOC 6	Aroclor-1016	2	<250	<190	<220	29
	HP LaserJet Series II J FontJFONT2.PRS			Aroclor-1242		2
<250	210 <230	18				
	Aroclor-1248	2	<250	<190	<220	29
	Aroclor-1254	2	2000	1200	1600	387
	Aroclor-1260	2	640	480	560	82
WOC 10	Aroclor-1016	2	<220	<200	<210	10
	Aroclor-1221	2	<220	<200	<210	10
	Aroclor-1232	2	<220	<200	<210	10
	Aroclor-1242	2	270	<220	<250	25
	Aroclor-1248	2	<220	<200	<210	10
	Aroclor-1254	2	490	~400	~440	46
	Aroclor-1260	2	~180	~120	~150	30
WOD 13	Aroclor-1016	2	240	<110	<180	61
	Aroclor-1221	2	<110	<110	<110	1.9
	Aroclor-1232	2	<110	<110	<110	1.9
	Aroclor-1242	2	<110	~21	~65	44
	Aroclor-1248	2	<110	<110	<110	1.9
	Aroclor-1254	2	<230	~64	~150	80
	Aroclor-1260	2	<230	<220	<220	3.0
WOC 14	Aroclor-1016	2	<260	<220	<240	16
	Aroclor-1221	2	<260	<220	<240	16
	Aroclor-1232	2	<260	<220	<240	16
	Aroclor-1242	2	300	~120	~210	87
	Aroclor-1248	2	<260	<220	<240	16
	Aroclor-1254	2	~210	~89	~150	58
	Aroclor-1260	2	<510	<450	<480	32
MB 7	Aroclor-1016	2	<210	<130	<170	40
	Aroclor-1221	2	<210	<130	<170	40
	Aroclor-1232	2	<210	<130	<170	40
	Aroclor-1242	2	270	~28	~150	119
	Aroclor-1248	2	<210	<130	<170	40
	Aroclor-1254	2	<410	<250	<330	81
	Aroclor-1260	2	<410	<250	<330	81

Table 29. (continued)

Location[a]	Analysis	Number	Concentration (µg/Kg)			Standard Error[b]
			Max	Min	Av	
CR 8	Aroclor-1016	2	<140	<87	<110	27
	Aroclor-1221	2	<140	<87	<110	27
	Aroclor-1232	2	<140	<87	<110	27
	Aroclor-1242	2	250	~78	~160	85
	Aroclor-1248	2	<140	<87	<110	27
	Aroclor-1254	2	<280	~29	~160	127
	Aroclor-1260	2	<280	<180	<230	54
CR 9	Aroclor-1016	2	<180	<160	<170	9.8
	Aroclor-1221	2	<180	<160	<170	9.8
	Aroclor-1232	2	<180	<160	<170	9.8
	Aroclor-1242	2	230	~140	~190	43
	Aroclor-1248	2	<180	<160	<170	9.8
	Aroclor-1254	2	~180	~44	~110	66
	Aroclor-1260	2	<360	<320	<340	19
CR 11	Aroclor-1016	2	<130	<84	<110	24
	Aroclor-1221	2	<130	<84	<110	24
	Aroclor-1232	2	<130	<84	<110	24
	Aroclor-1242	2	<130	~26	~79	52
	Aroclor-1248	2	<130	<84	<110	24
	Aroclor-1254	2	<260	<170	<220	48
	Aroclor-1260	2	<260	<170	<220	48
CR 12	Aroclor-1016	2	<110	<110	<110	3.1
	Aroclor-1221	2	<110	<110	<110	3.1
	Aroclor-1232	2	<110	<110	<110	3.1
	Aroclor-1242	2	~76	~22	~49	26
	Aroclor-1248	2	<110	<110	<110	3.1
	Aroclor-1254	2	<220	~56	~140	79
	Aroclor-1260	2	<230	<220	<220	6.3

[a] See Fig. 7.

[b] Standard deviation of the mean.

concentrations. The highest concentration was at WOC 6 for aroclor-1254. This location has exhibited high PCB concentrations in past sampling periods and remains within the distribution of past high and average values.

3.5 MERCURY IN THE AQUATIC ENVIRONMENT

Michael R. Powell

3.5.1 Program Description

Samples of surface water and stream sediment in the Bethel and Melton valleys are analyzed for mercury content. These analyses are done in compliance with the Clean Water Act and ORNL's National Pollutant Discharge Elimination System (NPDES) permit. The primary purpose of this effort is to identify, locate, and minimize all sources of mercury contamination in ORNL discharge to the aquatic environment.

In previous years, before stringent regulations came into effect, some contaminants reached various streams, primarily as the result of accidental spills or leakages. The majority of the mercury spills occurred from 1954 through 1963, during a period when ORNL was involved with OREX and METALLEX separation processes. Most of this activity was in and around buildings 4501, 4505, and 3592 (Fig. 8). These processes are no longer in operation at ORNL. During the time of operation, an unknown number of mercury spills took place. The spills were cleaned up; however, quantities of mercury escaped and reached the surrounding environment. The sampling locations have been placed in areas surrounding known mercury spills. Sampling locations have also been placed near outfalls from building areas with a past history of mercury concern and outfalls from storage areas spill areas, road, and parking lot drains. Additional sampling locations have been placed downstream from the outfalls and drains to determine the extent to which any mercury is being transported in the surface water and sediment. The surface water sampling locations are shown on Figs. 8 and 9. Many of the sediment locations are not currently shown on the map. These include: 1STUNW and NWTU1S, both of which are near the confluence of First Creek and Northwest Tributary: MB2UWE, which is located at the Melton Branch Middle Stream Sampling Site; MBUWOC and WOCD1S, which is located near the confluence of White Oak Creek and First Creek; WOCHWS, which is located at the White Oak Creek Headwaters sampling site; and WOCU5T, which is located near the confluence of White Oak Creek and Fifth Creek.

A total of 249 surface water samples and 41 sediment samples were taken from 89 surface water locations and 12 sediment locations (Fig. 8 and 9). The surface water samples were collected by the manual grab method and placed in 1-L polyethylene bottles with polyethylene caps. The sediment samples were also collected by manual grab and placed in glass containers. The samples were analyzed for total mercury content by manual cold vapor atomic absorption.

3.5.2 Results

Table 30 shows the maximum, minimum, and average concentrations in surface water for the period of January through July 1990. The standard error of the mean is also included. The proposed Tennessee Water Quality Standard (TWQ)

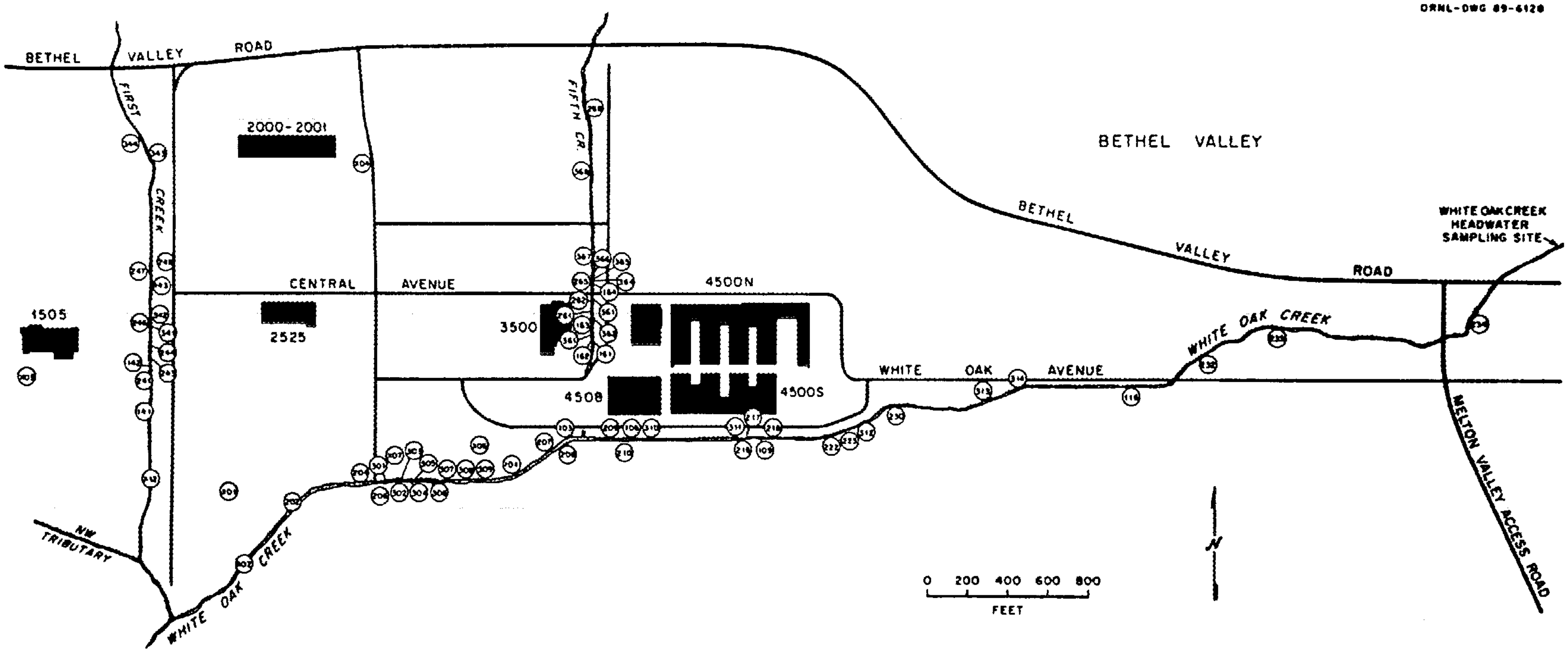

Fig. 8. Location map of mercury sampling points around ORNL in Bethel Valley.

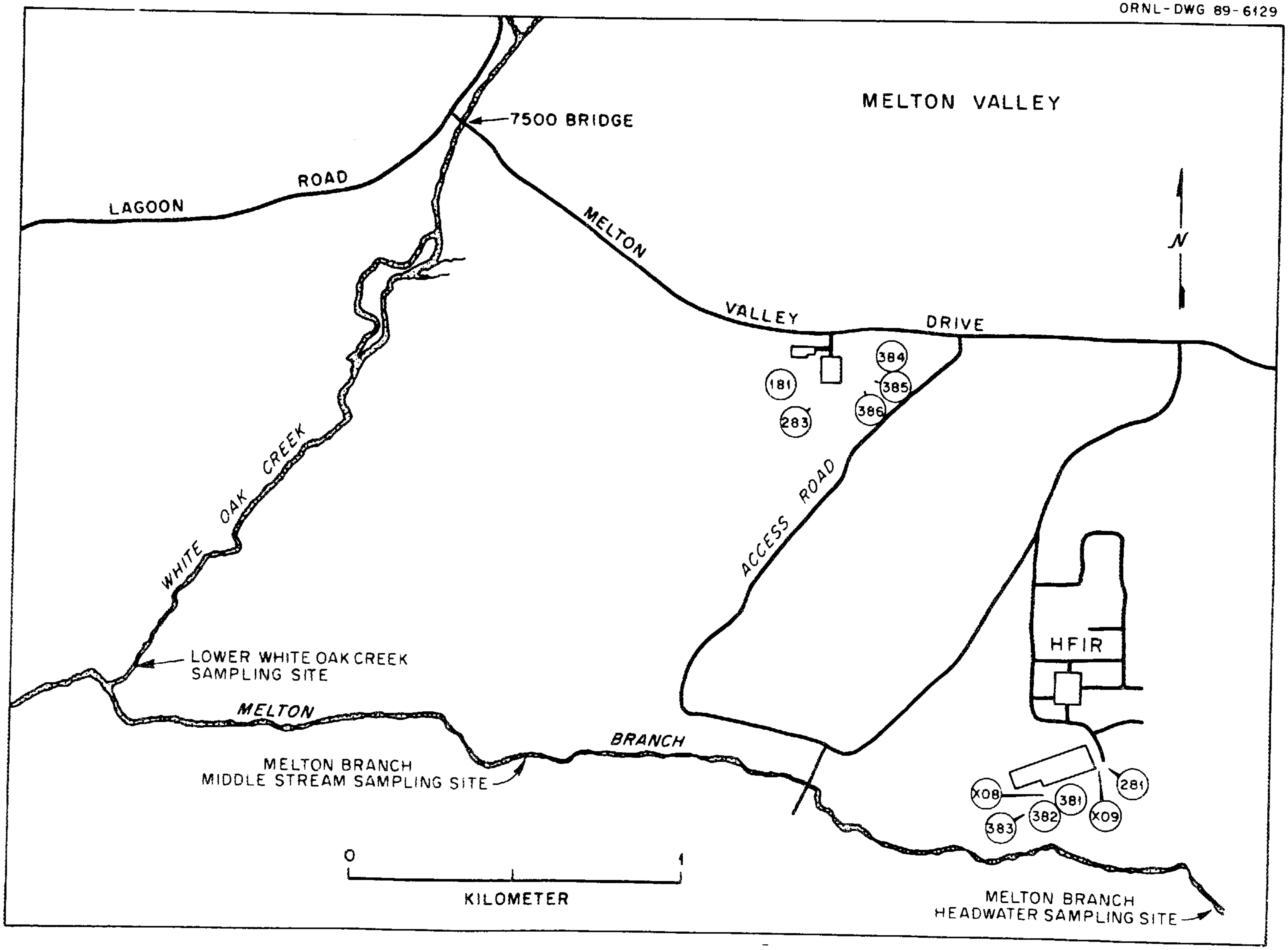

Fig. 9. Location map of mercury sampling points in Melton Valley.

Table 30. Mercury concentrations in ORNL area surface water[a], January-July 1990

Station	Number of Samples	Concentration (μg/L) Max	Min	Av	Standard Error	Percent TWQ[b]
			First Creek			
141	3	<0.050	<0.050	<0.050	0	<2.1
142	3	<0.050	<0.050	<0.050	0	<2.1
143	3	<0.050	<0.050	<0.050	0	<2.1
241	3	<0.050	<0.050	<0.050	0	<2.1
243	3	<0.050	<0.050	<0.050	0	<2.1
244	3	<0.050	<0.050	<0.050	0	<2.1
246	3	<0.050	<0.050	<0.050	0	<2.1
247	3	<0.050	<0.050	<0.050	0	<2.1
248	3	<0.050	<0.050	<0.050	0	<2.1
341	3	0.49	0.46	0.47	0.010	20
342	3	<0.050	<0.050	<0.050	0	<2.1
343	3	<0.050	<0.050	<0.050	0	<2.1
344	3	<0.050	<0.050	<0.050	0	<2.1
X12	3	<0.050	<0.050	<0.050	0	<2.1
Stream summary	42	0.49	0.050	0.080	0.017	3.3
			Fifth Creek			
161	3	<0.050	<0.050	<0.050	0	<2.1
162	3	0.10	<0.050	<0.070	0.015	<2.9
163	3	0.060	<0.050	<0.053	0.0033	<2.2
164	3	<0.050	<0.050	<0.050	0	<2.1
261	3	0.14	0.080	0.11	0.017	4.6
262	3	<0.050	<0.050	<0.050	0	<2.1
265	3	<0.050	<0.050	<0.050	0	<2.1
268	3	<0.050	<0.050	<0.050	0	<2.1
361	3	<0.050	<0.050	<0.050	0	<2.1
362	3	0.18	<0.050	<0.093	0.043	<3.9
363	3	0.53	0.47	0.50	0.018	21
364	3	<0.050	<0.050	<0.050	0	<2.1
365	3	<0.050	<0.050	<0.050	0	<2.1
366	3	<0.050	<0.050	<0.050	0	<2.1
367	3	1.3	1.2	1.3	0.048	54
368	3	<0.050	<0.050	<0.050	0	<2.1
Stream summary	48	1.3	0.050	0.16	0.045	6.8

Table 30. (continued)

Station	Number of Samples	Concentration (µg/L) Max	Min	Av	Standard Error	Percent TWQ[b]
		Melton Branch				
281	3	<0.050	<0.050	<0.050	0	<2.1
283	3	<0.050	<0.050	<0.050	0	<2.1
381	3	<0.050	<0.050	<0.050	0	<2.1
382	3	<0.050	<0.050	<0.050	0	<2.1
383	3	<0.050	<0.050	<0.050	0	<2.1
384	3	<0.050	<0.050	<0.050	0	<2.1
HDWTR	3	<0.050	<0.050	<0.050	0	<2.1
MBS	3	<0.050	<0.050	<0.050	0	<2.1
MHD	3	<0.050	<0.050	<0.050	0	<2.1
Stream summary	27	0.050	0.050	0.050	0	2.1
		White Oak Creek				
101	3	<0.050	<0.050	<0.050	0	<2.1
103	3	0.11	0.080	0.093	0.0088	3.9
106	3	<0.050	<0.050	<0.050	0	<2.1
109	3	0.050	0.050	0.050	0	2.1
116	3	<0.050	<0.050	<0.050	0	<2.1
202	3	<0.050	<0.050	<0.050	0	<2.1
204	3	<0.050	<0.050	<0.050	0	<2.1
206	3	<0.050	<0.050	<0.050	0	<2.1
207	3	<0.050	<0.050	<0.050	0	<2.1
208	3	0.54	0.14	0.27	0.13	11
209	3	<0.050	<0.050	<0.050	0	<2.1
210	3	<0.050	<0.050	<0.050	0	<2.1
216	3	<0.050	<0.050	<0.050	0	<2.1
217	3	<0.050	<0.050	<0.050	0	<2.1
218	3	<0.050	<0.050	<0.050	0	<2.1
222	3	<0.050	<0.050	<0.050	0	<2.1
223	3	<0.050	<0.050	<0.050	0	<2.1
230	3	<0.050	<0.050	<0.050	0	<2.1
232	3	<0.050	<0.050	<0.050	0	<2.1
233	3	<0.050	<0.050	<0.050	0	<2.1
234	3	<0.050	<0.050	<0.050	0	<2.1

Table 30. (continued)

Station	Number of Samples	Concentration (μg/L) Max	Min	Av	Standard Error	Percent TWQ[c]
			White Oak Creek (continued)			
301	3	<0.050	<0.050	<0.050	0	<2.1
302	3	<0.050	<0.050	<0.050	0	<2.1
303	3	<0.050	<0.050	<0.050	0	<2.1
304	3	<0.050	<0.050	<0.050	0	<2.1
305	3	<0.050	<0.050	<0.050	0	<2.1
306	3	<0.050	<0.050	<0.050	0	<2.1
307	3	<0.050	<0.050	<0.050	0	<2.1
308	3	<0.050	<0.050	<0.050	0	<2.1
309	3	<0.050	<0.050	<0.050	0	<2.1
310	3	<0.050	<0.050	<0.050	0	<2.1
311	3	<0.050	<0.050	<0.050	0	<2.1
312	3	<0.050	<0.050	<0.050	0	<2.1
313	3	<0.050	<0.050	<0.050	0	<2.1
314	3	<0.050	<0.050	<0.050	0	<2.1
7500	3	<0.050	<0.050	<0.050	0	<2.1
FLUME	3	<0.050	<0.050	<0.050	0	<2.1
HDW	3	<0.050	<0.050	<0.050	0	<2.1
LSC	3	<0.050	<0.050	<0.050	0	<2.1
WOD	3	<0.050	<0.050	<0.050	0	<2.1
X01	3	<0.050	<0.050	<0.050	0	<2.1
X02	3	<0.050	<0.050	<0.050	0	<2.1
X03	3	<0.050	<0.050	<0.050	0	<2.1
X12	3	<0.050	<0.050	<0.050	0	<2.1
Stream summary	132	0.54	0.050	0.056	0.0039	2.3
Overall summary	249	1.3	0.050	0.080	0.0097	3.3

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[a] See Figs. 8 and 9.

[b] Average concentration as a percentage of Tennessee Water Quality Standards for the protection of fish and aquatic life (2.4 Ug/L).

for the protection of fish and aquatic life is 2.4 ug/L (ppb) for the acute criteria. The percentage TWQ column shows the average value as a percentage of this limit for each sampling location. The highest average values reported during this period were at locations 367, 363, 341 and 208. Sampling locations 367 and 363, near building 3500 on Fifth creek, had an average concentration of 1.3 ug/L and 0.50 ug/L, respectively, which is 54% and 21%of the TWQ standard. Sampling location 341, near the Environmental Sciences Division, had an average concentration of 0.47 ug/L, which is 20% of the TWQ standard. Sample 208, near the High Temperature Materials Laboratory (HTML) and Fifth Creek on White Oak Creek, had an average concentration of 0.27 ug/L, which is 11% of the TWQ standard.

Table 31 shows the maximum, minimum, and average concentrations in sediment from the period of January through July of 1990. The standard error of the mean is also included. There is no established state or EPA standard for mercury in sediment. The highest average values reported during this period were at the locations 2615TH and 3625TH. Sampling location 2615TH had an average concentration of 1300 ug/g, which is higher than the other sediment samples during this time period. This location is downstream from the 3675TH water sampling point. Sampling location 3625TH had an average concentration of 33 ug/g. This sampling location is upstream of the 3675TH water sampling point and also shows relatively higher levels of mercury than other sampling locations during this period.

3.5.3 Trends

Current trends in the concentration of mercury found at these locations are assessed by comparing the maximum and average values for the period to the historic concentration of mercury at the same locations for the last 2 years. In the current period water samples have shown high average and maximum concentrations at locations 208, 341, 363 and 367. Locations 208 and 341 have exceeded the highest maximum and average values recorded during the last 2 years. Location 341 has remained under the 2 year maximum value but has exceeded the 2 year average value. Location 367 has remained below both the 2 year maximum and average values. Sediment samples at all locations, except MBUWOC,WOCDMB, and WOCUMB, have remained below the highest maximum and average values for the last 2 years. These samples, from White Oak Creek, have shown increases in both the maximum and average values when compared to past data.

3.6 GROUNDWATER

Dennis A. Wolf

3.6.1 Program Description

Groundwater in Solid Waste Storage Area (SWSA) 6 is monitored to comply with Tennessee's Hazardous Waste Management Rule 1200-1-11-.05(6)(a)4.(iv).

SWSA 6 is one of three Solid Waste Management Units (SWMUs) that make up waste area grouping (WAG) 6. WAG 6 is located about 1.5 km southwest of the ORNL main site (Fig. 10). Besides SWSA 6, WAG 6 is made up of the Emergency Waste Basin and the Explosives Detonation Trench. SWSA 6 was opened for limited disposal in 1969, began full-scale operation in 1973, and still receives radioactive wastes. In the course of its operation, SWSA 6 has received a

Table 31. Mercury concentrations in ORNL stream sediment[a], January-July 1990

		Concentration (µ2yg/g)			
Station	Number of Samples	Max	Min	Av	Standard Error
		First Creek			
1STUNW	3	0.61	0.56	0.58	0.015
NWTU1S	3	0.045	0.041	0.042	0.0013
Stream summary	6	0.61	0.041	0.31	0.12
		Fifth Creek			
2615TH	3	2000	590	1300	420
3625TH	3	51	8.3	33	13
362BOX	2	5.9	3.8	4.9	1.1
Stream summary	8	2000	3.8	480	260
		Melton Branch			
MB2UWE	3	0.027	0.023	0.025	0.0012
MBHWSS	3	0.021	0.018	0.019	0.00088
Stream summary	6	0.027	0.018	0.022	0.0015
		White Oak Creek			
309WOC	3	1.8	0.61	1.0	0.38
MBUWOC	3	0.037	0.028	0.033	0.0027
WOCD1S	3	1.5	0.49	0.83	0.32
WOCDMB	3	0.85	0.82	0.84	0.0070
WOCHWS	3	0.046	0.037	0.040	0.0030
WOCU5T	3	7.2	0.80	3.0	2.1
WOCUMB	3	0.75	0.43	0.55	0.10
Stream summary	21	7.2	0.028	0.90	0.33
Overall summary	41	2000	0.018	95	57

[a] See Fig. 8.

ORNL-DWG 88-17137

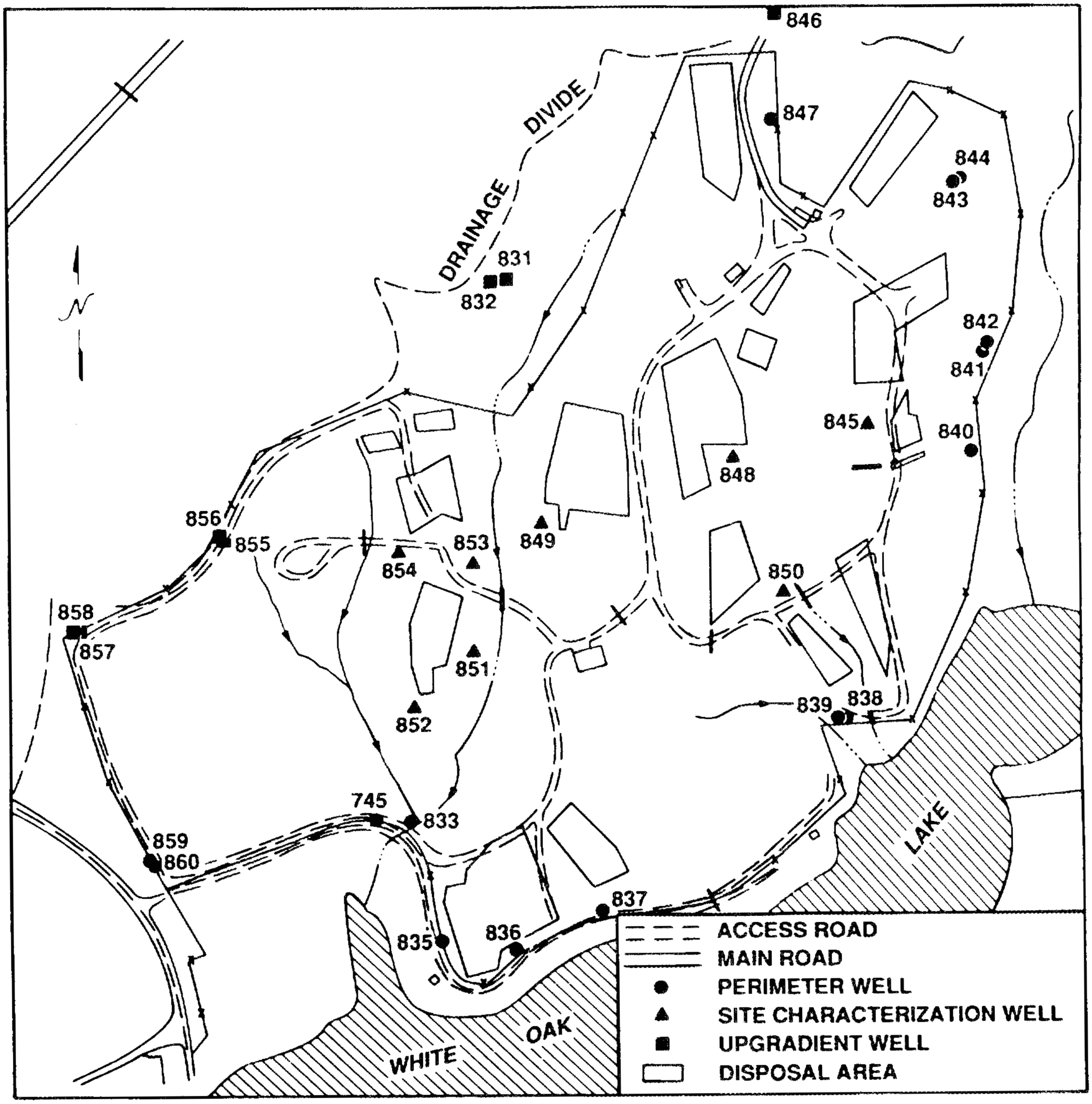

Fig. 10. Location map of ORNL waste area groupings.

broad spectrum of low-level waste (LLW) materials. The basin has not been used since its construction was completed in 1962. The Explosives Detonation Trench is used for explosive and shock-sensitive chemicals requiring disposal.

The wells at SWSA 6 are divided into three types: (1) upgradient wells, which are intended to provide reference information; (2) perimeter wells, which are intended to serve as down-gradient boundary wells; and (3) internal site-characterization wells, which provide information about conditions within the site. The SWSA 6 data reported here pertain only to the up-gradient and perimeter wells.

References to regulatory limits or guidelines used for comparison in the following tables are given in Table 32 in order of precedence.

3.6.2 Results

The first groundwater samples taken at SWSA 6 during 1990 were obtained during May and June. Analyte summaries in Table 33 are those for detected analytes. The observed minimum and maximum for the sampling period, a regulatory limit and reference, the minimum detection limit of the undetected values, and the ratio of number of detected values to total number of samples. A prefix of "U" means that the value is undetected; a blank prefix corresponds to a detected value. The tentatively identified compounds listed were obtained from the sample from well 835.

Table 34 contains the list of wells and analytes where a regulatory limit was exceeded at either a perimeter or up-gradient well. An "E" prefix means that the sample level exceeds the calibration range and is estimated. (Normally, when a value exceeds the calibration range, the sample is reanalyzed. This was not possible for the single sample where this occurred.)

Several analytes listed in Table 33 were detected below the quantitation limit: acetone, carbon disulfide, methylene chloride and toluene. All are laboratory contaminants; carbon disulfide is not as common as the others. The values associated with these analytes are of the approximate concentration and frequency as those found in laboratory blanks; and, as such, they are suspected of being low level sample contamination.

An estimated acetone value of 0.003 mg/L, prefix "JB," was obtained from the trip blank associated with well 835. As stated in the previous paragraph, it is believed that detection is an artifact of the analytical technique.

All radionuclide values are corrected for background, which explains the negative values in the Table 33. No radionuclide minimum detection limits are reported. The presence or absence of a radionuclide was determined by comparing the corrected value to its uncertainty. A value exceeding twice its estimated standard error was declared different from 0 and considered a detected value.

Several observed analyte values exceeded regulatory limits. The occurrences were for pH (low in wells 835-837, 857 and 859, high in well 858), H-3 (tritium) (wells 838, 841-844, 847), carbon tetrachloride (well 842), and trichloroethene (well 842).

Table 32. Sources for regulatory limits given in order of precedence

Regulation Reference Number	Reference
1	State of Tennessee Hazardous Waster Regulations TN 1200-1-11-05, Appendix 05/B.
2	Safe Drinking Water Act - National Primary Drinking Water Regulations, 40 CFR 141, as amended.
3	DOE Order 5400.5, February 8, 1990. Chapter III, Derived Concentration Guides for Air and Water. 4% of DCG used to convert DOE 100 mrem/yr dose to 4 mrem/yr dose.
4	Safe Drinking Water Act - National Secondary Drinking Water Regulations, 40 CFR 143, as amended.

Table 33. Analyte summary statistics for Solid Waste Storage Area (SWSA) 6 wells

Analyte Group=Field Measurements

Analyte	Prefix	Min Value	Prefix	Max Value	Regulatory Limit and Reference	Min Detection Limit	Detected/N
Conductivity (mS/cm)		0.010		0.80		.	22/22
pH (Std)		5.2		9.1	(6.5, 8.5) 4	.	22/22
Temperature (Deg C)		12		16		.	22/22

Analyte Group=Other

Analyte	Prefix	Min Value	Prefix	Max Value	Regulatory Limit and Reference	Min Detection Limit	Detected/N
Alkalinity (as CaCO3) (mg/L)		4.5		460		.	20/20
Alkalinity-unfiltered (as CaCO3) (mg/L)		3.8		480		.	22/22

Analyte Group=Radionuclides

Analyte	Prefix	Min Value	Prefix	Max Value	Regulatory Limit and Reference	Min Detection Limit	Detected/N
Co-60 (Bq/L)	U	-0.50		4.1	7.6 3	.	3/22
Cs-137 (Bq/L)	U	-0.14	U	0.20	4.4 3	.	0/22
Gross alpha (Bq/L)	U	-0.19		0.45	0.55 1	.	6/22
Sr-89 + Sr-90 (Bq/L)	U	-0.13		0.19	1.4 3	.	1/22
H-3 (Bq/L)	U	-8.0		12000	740 2	.	14/22

Table 33 (continued)

-- Analyte Group=Volatile Organics --

Analyte	Prefix	Min Value	Prefix	Max Value	Regulatory Limit and Reference	Min Detection Limit	Detected/N
1,1,1-Trichloroethane (mg/L)	U	0.0050	U	0.0050	0.20 2	0.0050	0/22
1,1,2,2-Tetrachloroethane (mg/L)	U	0.0050	U	0.0050		0.0050	0/22
1,1,2-Trichloroethane (mg/L)	U	0.0050	U	0.0050		0.0050	0/22
1,1-Dichloroethane (mg/L)		0.0030		0.0050		0.0050	1/22
1,1-Dichloroethene (mg/L)	U	0.0050	U	0.0050	0.0070 2	0.0050	0/22
1,2-Dichloroethane (mg/L)	U	0.0050	U	0.0050	0.0050 2	0.0050	0/22
1,2-Dichloroethene (mg/L)	U	0.0050		0.0090		0.0050	2/22
1,2-Dichloropropane (mg/L)	U	0.0050	U	0.0050		0.0050	0/22
2-Butanone (mg/L)	U	0.010	U	0.010		0.010	0/22
2-Hexanone (mg/L)	U	0.010	U	0.010		0.010	0/22
4-Methyl-2-pentanone (mg/L)	U	0.010	U	0.010		0.010	0/22
Acetone (mg/L)		0.0030		0.010		0.010	1/22
Benzene (mg/L)	U	0.0050	U	0.0050	0.0050 2	0.0050	0/22
Bromodichloromethane (mg/L)	U	0.0050	U	0.0050		0.0050	0/22
Bromoform (mg/L)	U	0.0050	U	0.0050	0.10 1	0.0050	0/22
Bromomethane (mg/L)	U	0.010	U	0.010		0.010	0/22
Carbon disulfide (mg/L)		0.0010		0.0050		0.0050	1/22

Table 33 (continued)

-- Analyte Group=Volatile Organics --

Analyte	Prefix	Min Value	Prefix	Max Value	Regulatory Limit and Reference	Min Detection Limit	Detected/N
Carbon tetrachloride (mg/L)	U	0.0050		0.073	0.0050 2	0.0050	1/22
Chlorobenzene (mg/L)	U	0.0050	U	0.0050		0.0050	0/22
Chloroethane (mg/L)	U	0.010	U	0.010		0.010	0/22
Chloroform (mg/L)		0.0010		0.061	0.10 1	0.0050	4/22
Chloromethane (mg/L)	U	0.010	U	0.010		0.010	0/22
cis-1,3-Dichloropropene (mg/L)	U	0.0050	U	0.0050		0.0050	0/22
Dibromochloromethane (mg/L)	U	0.0050	U	0.0050	0.10 1	0.0050	0/22
Ethylbenzene (mg/L)	U	0.0050	U	0.0050		0.0050	0/22
Methylene chloride (mg/L)		0.0010		0.0050		0.0050	4/22
Styrene (mg/L)	U	0.0050	U	0.0050		0.0050	0/22
Tetrachloroethene (mg/L)		0.0010		0.0050		0.0050	2/22
Toluene (mg/L)		0.0010		0.0050		0.0050	14/22
trans-1,3-Dichloropropene (mg/L)	U	0.0050	U	0.0050		0.0050	0/22
Trichloroethene (mg/L)		0.0020		0.32	0.0050 2	0.0050	3/22
Vinyl acetate (mg/L)	U	0.010	U	0.010		0.010	0/22
Vinyl chloride (mg/L)	U	0.010	U	0.010	0.0020 2	0.010	0/22
Xylene-total (mg/L)	U	0.0050	U	0.0050		0.0050	0/22

-- Analyte Group=Tent. Ident. Compounds --

Analyte	Prefix	Min Value	Prefix	Max Value	Regulatory Limit and Reference	Min Detection Limit	Detected/N
ETHYLETHER-3.03 (UG/L)		58		58		.	1/1
UNKNOWN-10.9 (UG/L)		9.0		9.0		.	1/1

Table 34. List of SWSA 6 wells and analytes where a regulatory standard is exceeded

Well	Analyte (units)	Prefix	Value	Regulatory Limit and Reference	
	Perimeter Wells				
835	pH (Std)		5.2	(6.5, 8.5)	4
836	pH (Std)		5.9	(6.5, 8.5)	4
837	pH (Std)		5.2	(6.5, 8.5)	4
838	H-3 (Bq/L)		920	740	2
841	H-3 (Bq/L)		5300	740	2
842	H-3 (Bq/L)		6800	740	2
"	Carbon tetrachloride (mg/L)		0.073	0.0050	2
"	Trichloroethene (mg/L)	E	0.32	0.0050	2
843	H-3 (Bq/L)		12000	740	2
844	H-3 (Bq/L)		2000	740	2
847	H-3 (Bq/L)		2700	740	2
859	pH (Std)		5.2	(6.5, 8.5)	4
	Upgradient Wells				
857	pH (Std)		5.9	(6.5, 8.5)	4
858	pH (Std)		9.1	(6.5, 8.5)	4

3.6.3 Trends

Except for the pH (9.1 at well 858) and alkalinity (460 at well 843), all analyte values were within the range of values obtained for the RCRA groundwater quality assessment. The results presented in Table 34 are consistent with the findings during the groundwater assessment with the exception of the elevated H-3 in well 838 (920 Bq/L) which is significantly larger than the regulatory limit and larger than the maximum observed value obtained during the assessment.

4. METEOROLOGICAL PROCESSES

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

4.1 WIND

Anita E. Osborne-Lee

4.1.1 Program Description

The ORNL wind tower network consists of towers A and B, each with sensors mounted at 10 and 30 meters, and tower C with sensors mounted at 10, 30, and 100 meters. Locations of these towers are shown in Fig. 11. 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-minute averages using a procedure that avoids the unrealistically low windspeed values obtained when appreciable winds of nearly opposite direction are vector averaged in the conventional way. This alternative averaging procedure involves calculating a unit vector to represent the direction of each one-minute wind velocity, finding the vector average of those unit vectors, scaling that average to a unit vector, and multiplying the result by the mean (scalar) windspeed. A similar calculation is used to convert the 15-minute averages into hourly averages. The 15-minute averages are retained for one day and the hourly averages are stored for at least one year and eventually archived.

4.1.2 Results

The hourly averages are used to generate wind roses (Figs. 12-18) for the quarter. Examination of these 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.

4.1.3 Trends

An examination of the wind roses generated for the previous quarters have shown a consistency in results. This is due primarily to the static locations of the meteorological towers and the virtually unchanging topology of the land. These findings are consistent with expectations.

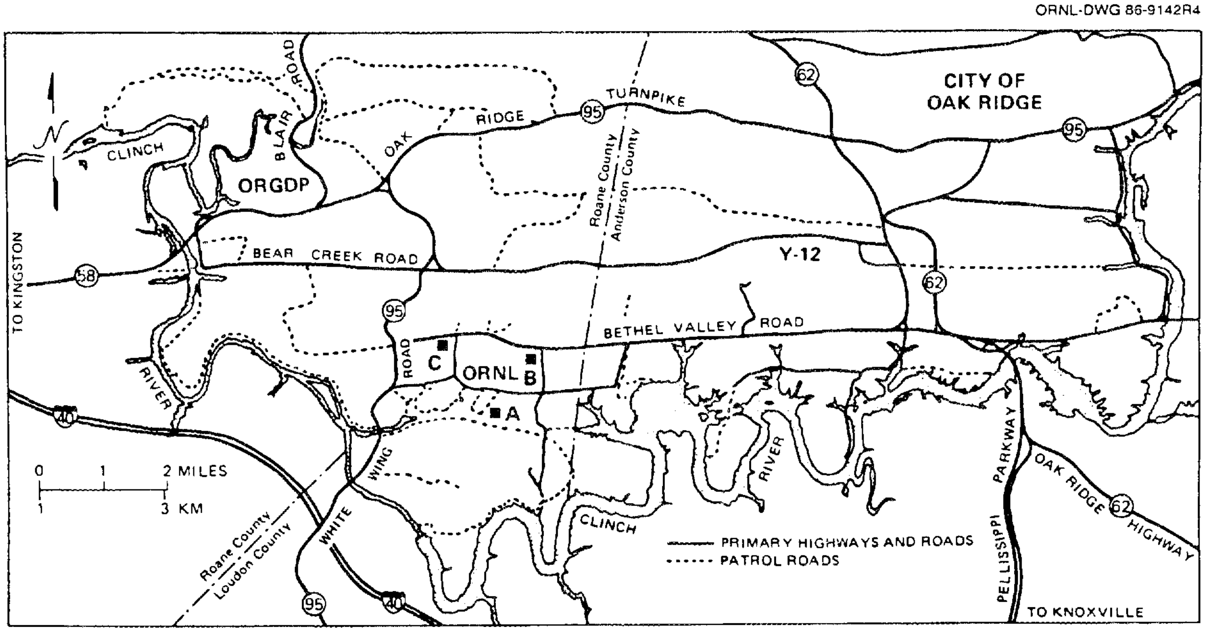

Fig. 11. Location map of meteorological towers at ORNL.

with 97.6% of possible data
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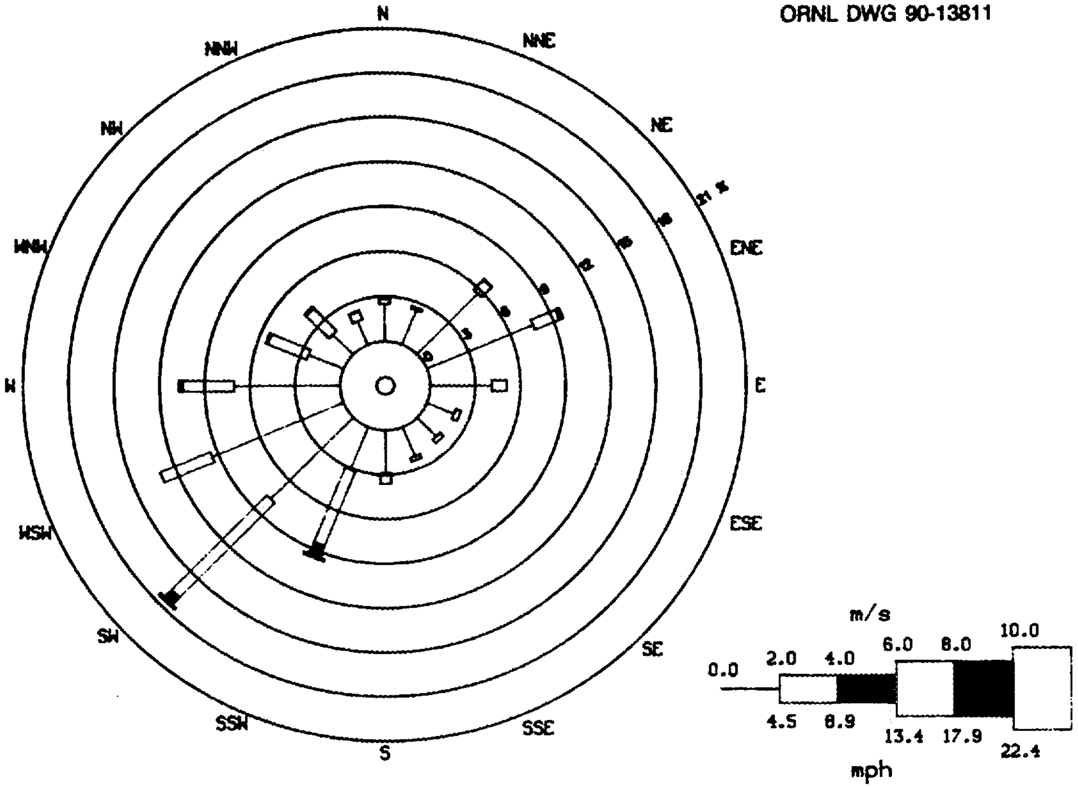

Fig. 12. Wind rose at 10-m level of meteorological tower A, April-June 1990

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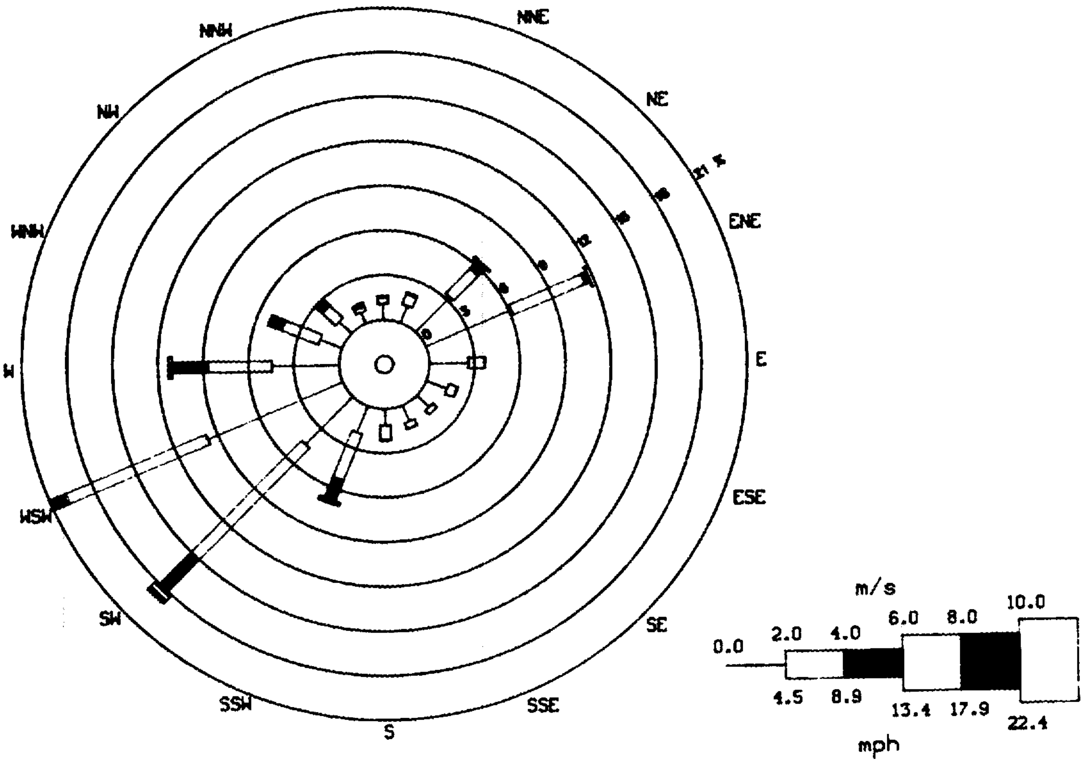

Fig. 13. Wind rose at 30-m level of meteorological tower A, April-June 1990

with 96.0% of possible data
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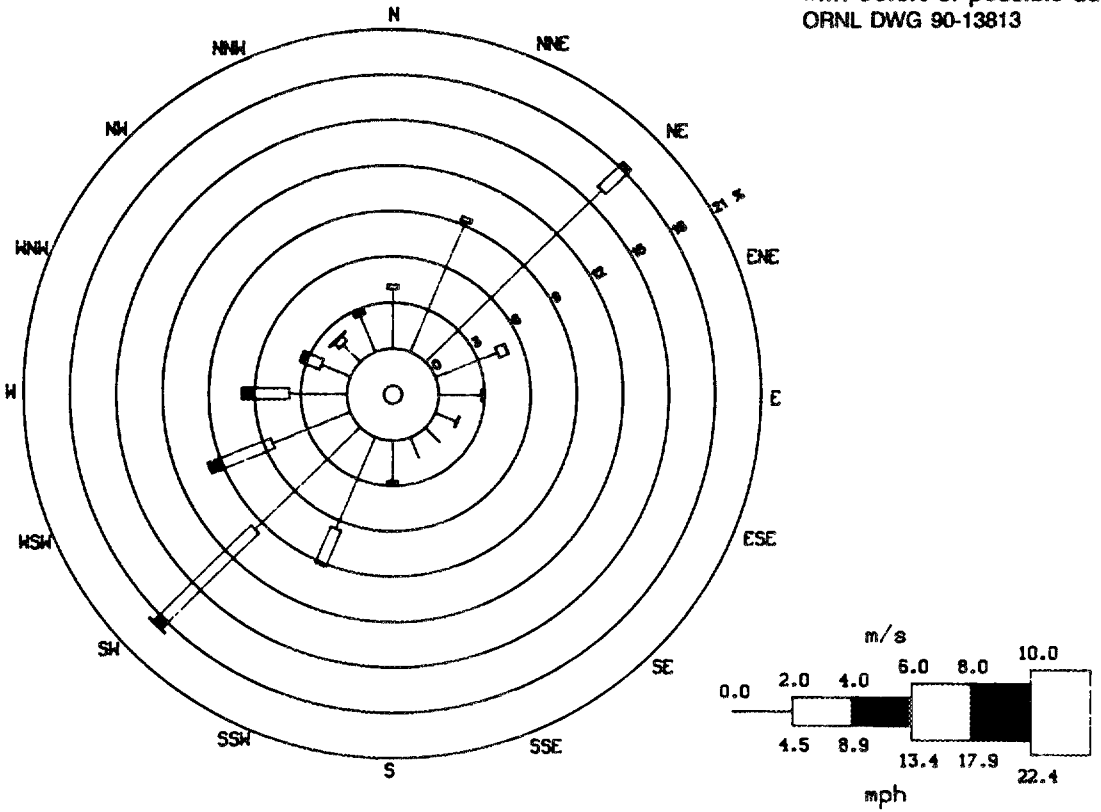

Fig. 14. Wind rose at 10-m level of meteorological tower B, April-June 1990

with 93.9% of possible data
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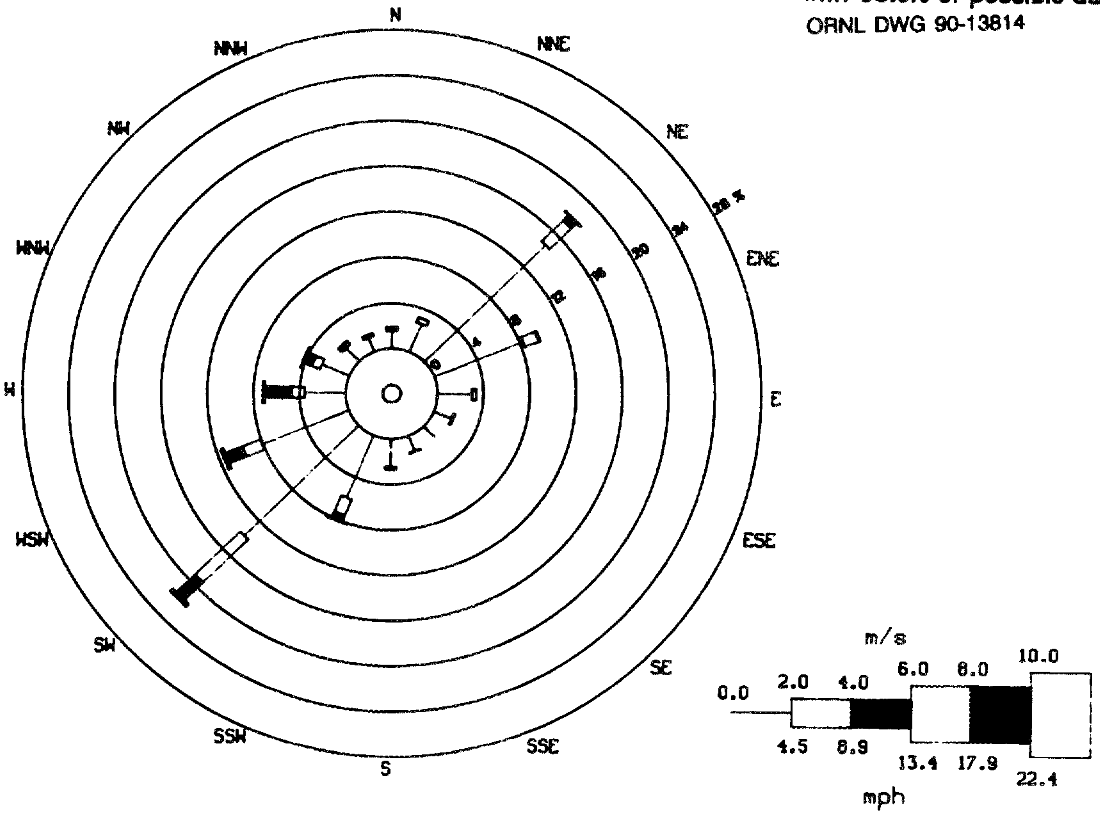

Fig. 15. Wind rose at 30-m level of meteorological tower B, April-June 1990

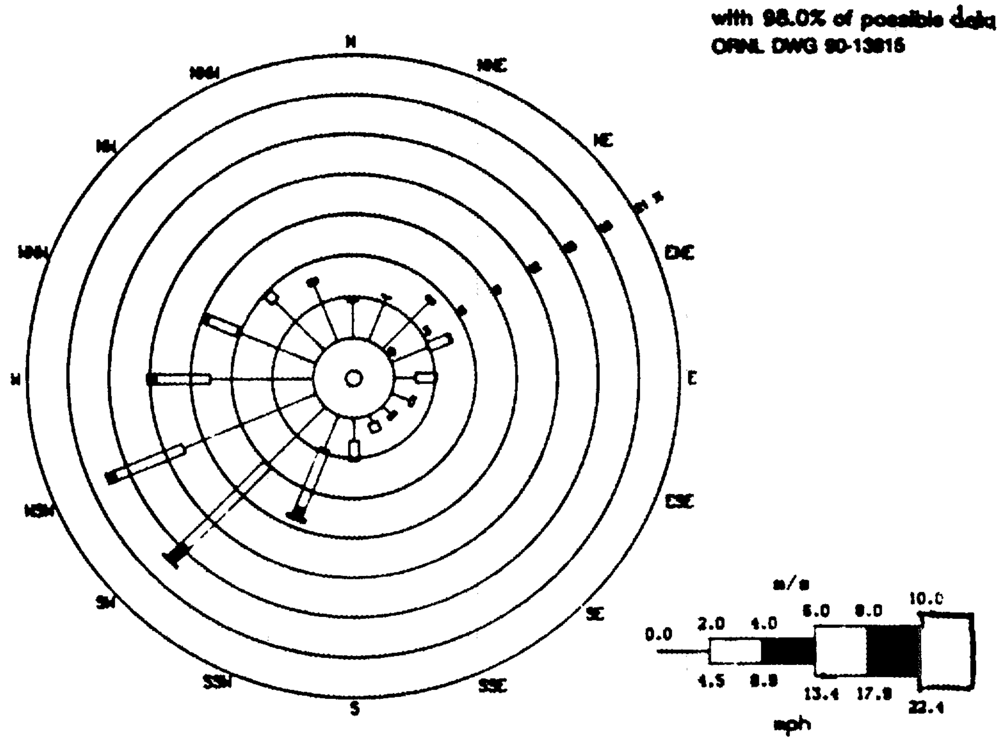

Fig. 16. Wind rose at 10-m level of meteorological tower C, April-June 1990

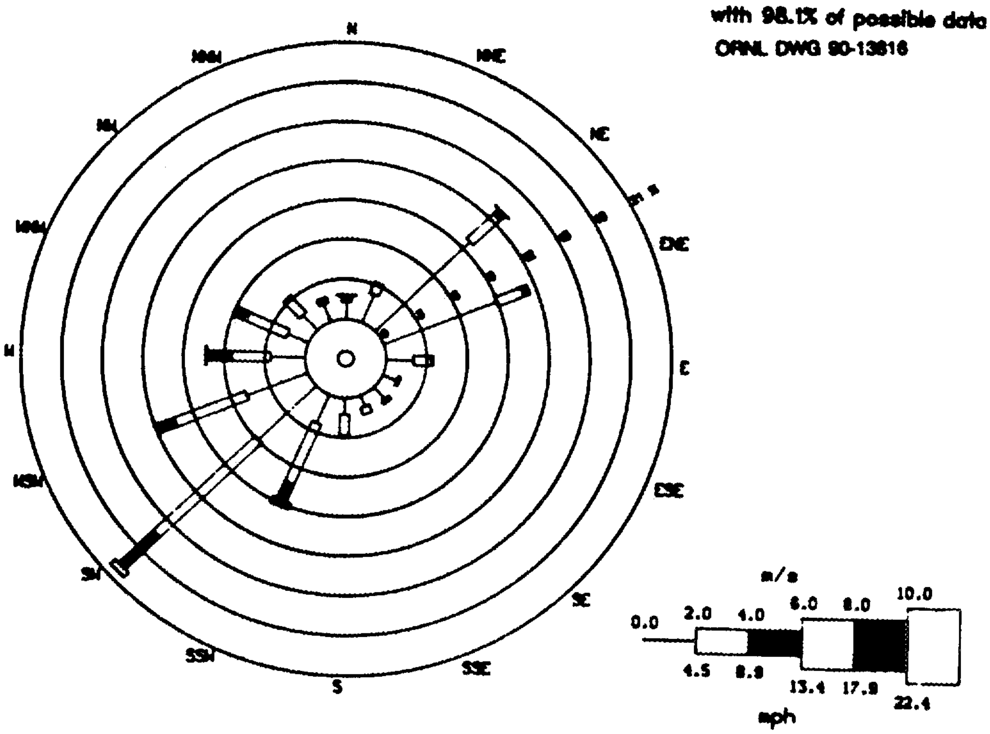

Fig. 17. Wind rose at 30-m level of meteorological tower C, April-June 1990

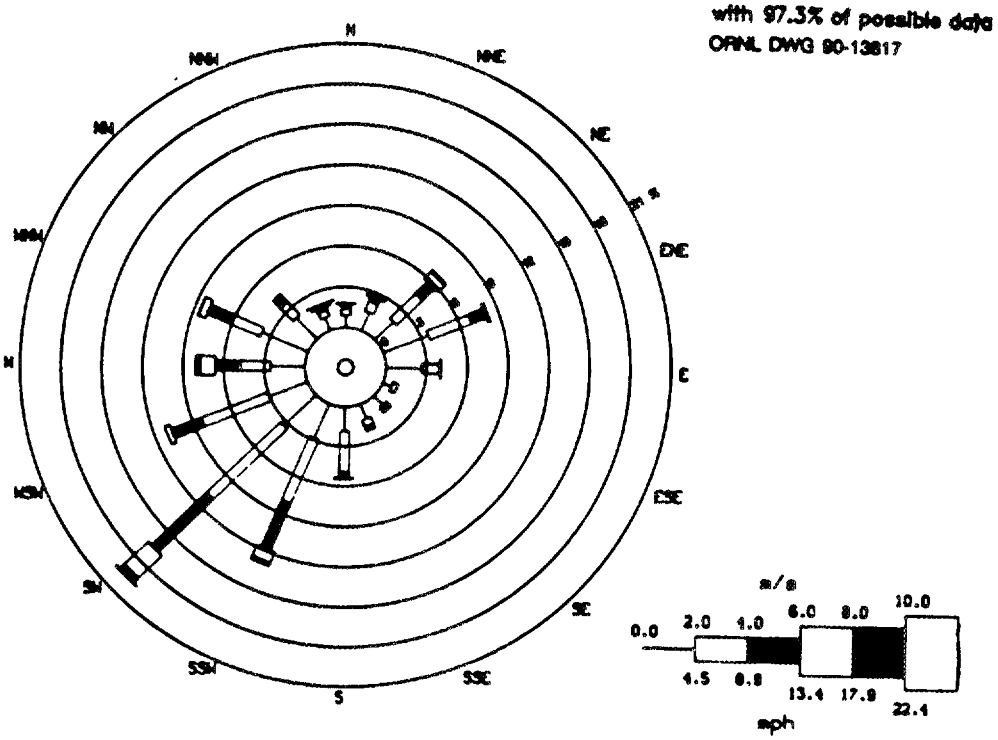
with 97.3% of possible data
ORNL DWG 90-13817

Fig. 18. Wind rose at 100-m level of meteorological tower C, April-June 1990

5. BIOLOGICAL MONITORING

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

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

5.1 Milk

Michael R. Powell

5.1.1 Program Description

Raw milk from five locations, including one dairy, within a radius of 80 km of Oak Ridge is monitored for I-131 and total radioactive strontium. Samples are collected each month from the stations located near the Oak Ridge area (Fig. 19). Samples are analyzed for I-131 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 I-131 and Sr in milk samples, and net activity concentrations are summarized. No milk was availble for the months of May and June for this quarter from station 8.

5.1.2 Results

Concentrations of total radioactive strontium are shown in Table 35. The estimated overall average concentration of total radioactive strontium at the stations in the immediate Oak Ridge area was 0.098 Bq/L, which is significantly greater than zero. Values of I-131 for the first quarter were often less than instrument background, as is indicated by negative values in Table 36. The estimated overall average concentration of I-131 at the stations in the immediate Oak Ridge area was -0.00077 Bq/L, which is not significantly greater than zero.

Dose was calculated for a station when the average value obtained was statistically greater than zero. The measured average concentrations of total radioactive Sr (assuming 100% Sr-90) and I-131 in milk were used to calculate the potential 50-year committed effective dose equivalents given in Tables 36 and 37. This calculation is based on the assumption that 1 L/day of milk is ingested at these concentrations for 365 days. Doses resulting from ingestion of milk were less than 1% of DOE's guideline of 1000 uSv.

5.1.3 Trends

Current trends in the I-131 and Sr concentration are assessed by comparing the maximum and average values for the quarter to the historic concentrations of these isotopes in milk for the last 2 years. In the current quarter I-131

ORNL DWG 85-9421R6

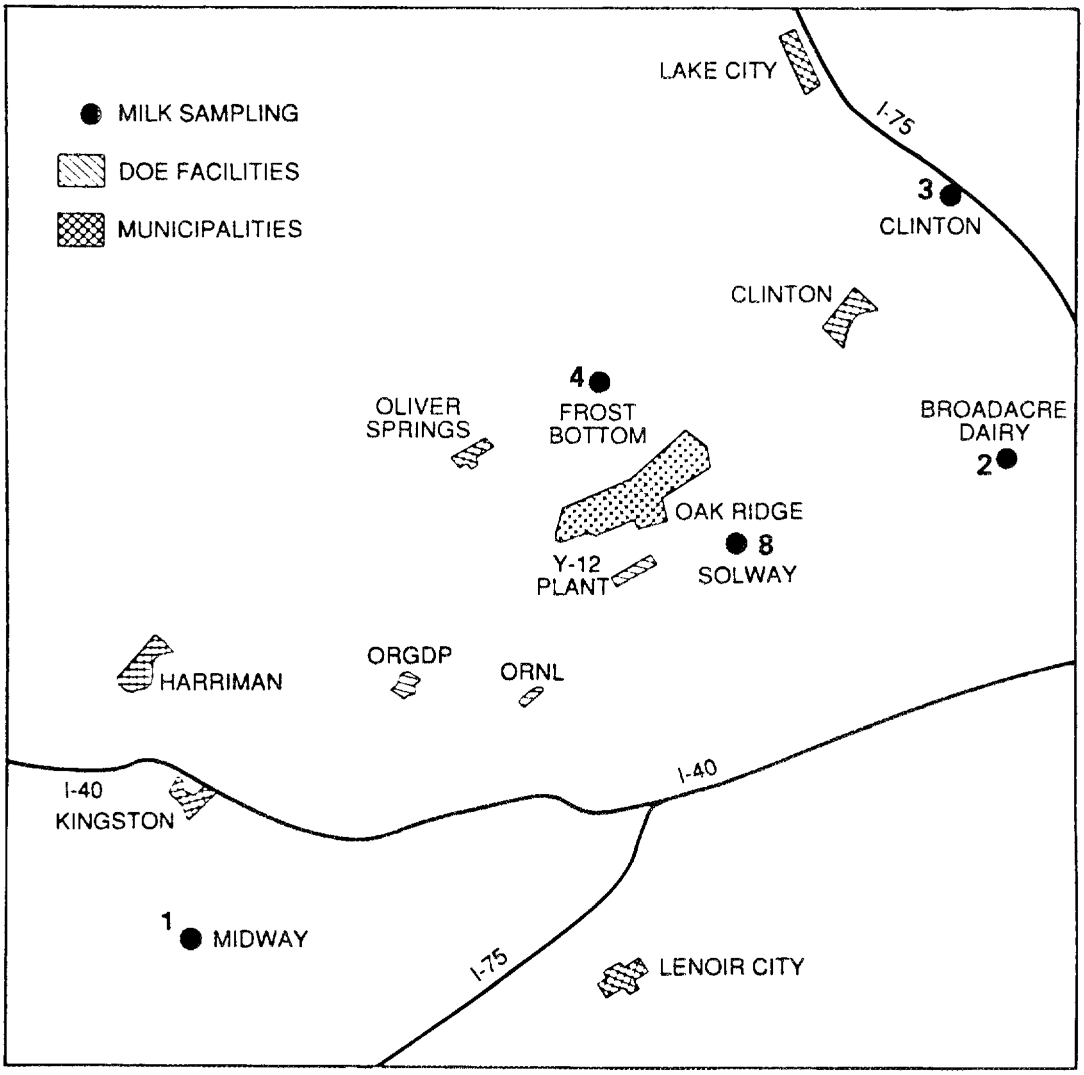

Fig. 19. Location map of milk-sampling stations near the Oak Ridge facilities.

Table 35. Concentrations of Sr in milk and calculated doses,[a] April-June 1990

Station	Number of Samples	Concentration (Bq/L) Max	Min	Av[b]	Standard error[c]	Dose (μSv)[d]
		Immediate environs[e]				
1	3	0.090	0.012	0.056	0.023	.
2	3	0.11	0.013	0.068	0.029	.
3	3	0.070	0.050	0.061*	0.0058	0.78
4	3	0.20	0.14	0.17*	0.017	2.2
8	1	0.21	0.21	0.21*	.	2.7
Network Summary	13	0.21	0.012	0.098*	0.018	1.3

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

[b] Average value marked with an asterisk (*) indicates significantly greater than zero.

[c] Standard error of mean.

[d] Potential 50-year committed effective dose equivalents from drinking 365 L of milk per year using average radionuclide concentrations at each location. Dose is estimated for stations whose average value is statistically greater than zero.

[e] See Figure 19.

Table 36. Concentrations of I-131 in milk and calculated doses,[a] April-June 1990

Station	Number of Samples	Concentration (Bq/L) Max	Min	Av[b]	Standard error[c]	Dose (μSv)[d]
		Immediate environs[e]				
1	3	0.050	-0.090	-0.017	0.041	.
2	3	0.010	-0.010	0.0033	0.0067	.
3	3	0.020	-0.020	0.0067	0.013	.
4	3	0.020	-0.040	-0.0033	0.019	.
8	1	0.020	0.020	0.020	.	.
Network Summary	13	0.050	-0.090	-0.00077	0.0097	.

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

[b] Average value marked with an asterisk (*) indicates significantly greater than zero.

[c] Standard error of mean.

[d] Potential 50-year committed effective dose equivalents from drinking 365 L of milk per year using average radionuclide concentrations at each location. Dose is estimated for stations whose average value is statistically greater than zero.

[e] See Figure 19.

concentrations are below the average values for the last two years and are not significantly greater than zero. Sr values at stations 1 and 2 are also not significantly greater than zero. These stations maxima and average values are below the respective maxima and average values for the last two years. Estimated Sr activities are significantly greater than zero at stations 3, 4, and 8. The maximum and the average value for Sr at these stations is below the two year maximum for both 3 and 4. Station 8 is slightly above the two year maximum for total strontium.

5.2 FISH

Michael R. Powell

5.2.1 Program Description

Bluegill from three Clinch River locations are collected for tissue analyses of radionuclides, mercury, and PCBs (Fig. 20). Sampling is performed semiannually. The last sampling was reported in the fourth quarter of 1989. Sampling locations include the following Clinch River kilometers (CRK): (1) 40.0, which is above Melton Hill dam and most of the Oak Ridge DOE facility outfalls which serves as a background location; (2) 33.33, which is ORNL's discharge point from White Oak Creek to the Clinch River; and (3) 8.0, which is downstream from both ORNL and the Oak Ridge K-25 Site (ORGDP).

The primary radionuclides of concern at ORNL, because of fish consumption, are total radioactive Sr and Cs-137. These two result in the highest dose to humans from ingestion of fish. Composite samples are ashed and analyzed by gamma spectroscopy and radiochemical techniques for the radionuclide that contribute most of the potential radionuclide dose to humans. Radionuclide concentrations are determined on three composites of 6 to 10 fish per sampling period. Mercury and PCB concentrations are measured in six individual fish from each sampling location. Scales, head, and entrails are removed from each fish before samples are obtained. Mercury is measured by digestion of the fish tissue and determination of the mercury by a cold vapor AA technique. PCBs are determined by extraction of the PCB from the fish tissue and determination of PCB by gas chromatography.

5.2.2 Results

Average mercury concentrations ranges from a low of 0.043 ug/g to a high of 0.19 ug/g of wet weight. These concentrations represent 4.3 to 19% of the Food and Drug Administration (FDA) action level for mercury in fish. Concentrations of mercury in fish are shown in Table 37.

Average concentrations of PCBs in fish during this period were all less than detection limits. Average concentrations of PCBs were less than 5% of the FDA's tolerance level of 2.0 ug/g wet weight for fish. Concentrations of PCBs are shown in Table 38.

Average radionuclides found in bluegill were highest for Cs-137 with a range of 0.85 to 6.3 Bq/kg wet weight. Total radioactive Sr ranged from 0.13 to 0.92 Bq/kg, and Co-60 ranged from 0.036 to 0.069 Bq/kg. Average radionuclide values that were statistically determined to be greater than zero were found at CRK 33.3 and CRK 40.0. No guidelines currently exist for radionuclides

ORNL-DWG 86-8811R5

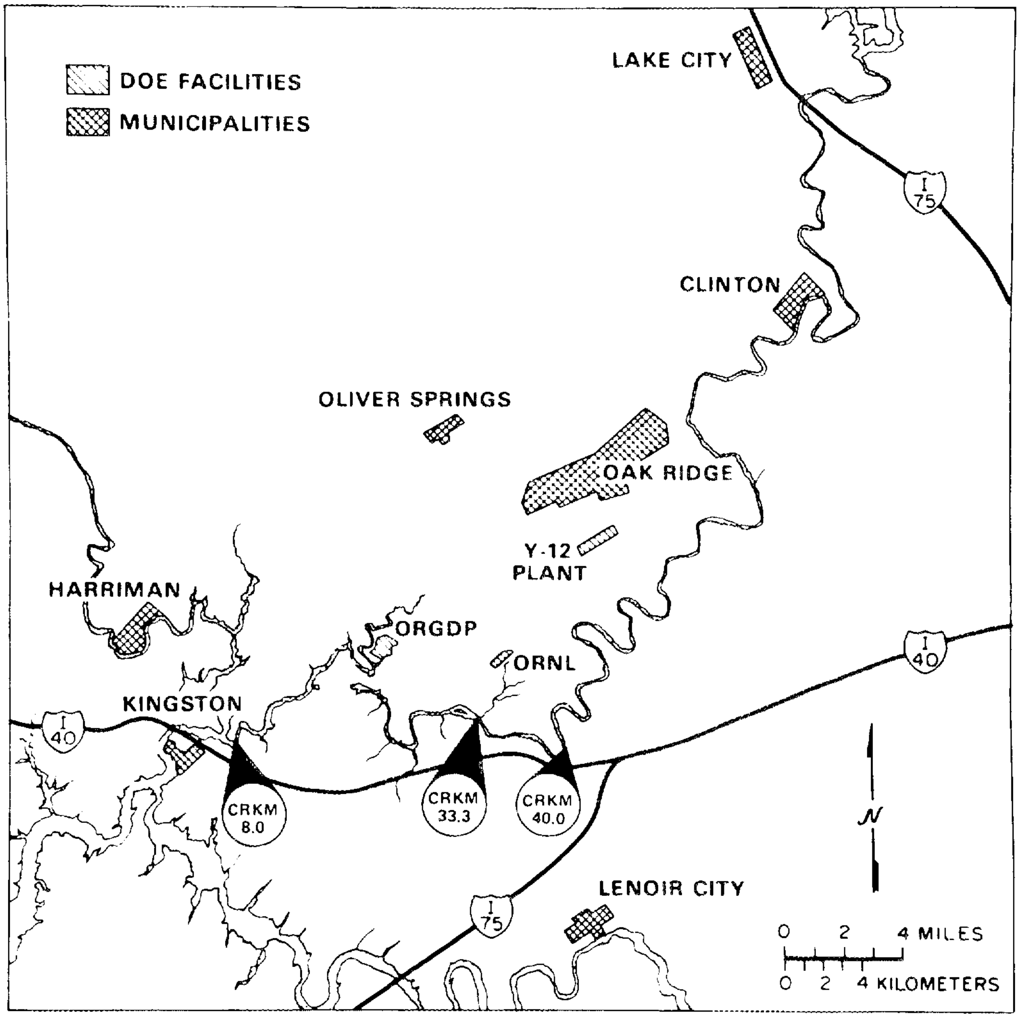

Fig. 20. Location map of fish-sampling points along the Clinch River.

Table 37. Mercury concentrations in Clinch River Bluegill, January-July 1990

Location[a]	No. of Fish Sampled	Concentration (μg/g wet wt) Max	Min	Av	Standard Error	Percentage of FDA Level[b]
CRK 8.0	6	0.46	0.082	0.19	0.056	19
CRK 33.3	6	0.17	0.044	0.10	0.018	10
CRK 40.0	6	0.055	0.025	0.043	0.0053	4.3

---

[a] See Figure 20.

[b] Percent of Food and Drug Administration action level of mercury in fish (1.0 μg/g) for the average concentration.

Table 38. PCB concentrations in Clinch River Bluegill, January-July 1990

Location[a]	PCB Type	No. of Fish Sampled	Concentration (μg/g wet wt)				Percent of FDA Limit[b]
			Max	Min	Av	Standard Error	
CRK 8.0	1254	6	0.010	<0.010	<0.010	0	<0.50
	1260	6	0.050	<0.010	<0.020	0.0068	<1.0
CRK 33.3	1254	6	0.010	<0.010	<0.010	0	<0.50
	1260	6	0.18	<0.010	<0.050	0.028	<2.5
CRK 40.0	1254	6	0.010	<0.010	<0.010	0	<0.50
	1260	6	0.030	<0.010	<0.017	0.0033	<0.83

[a] See Figure 20.

[b] Percent of Food and Drug Administration action level of PCB in fish (2.0 μg/g) for the average concentration.

in fish. Concentrations and summary statistics are presented in Table 39.

5.2.3 Trends

Current trends in the concentration of mercury, PCBs, and radionuclides are assessed by comparing the maximum and average values for the current period to the historic concentrations of these contaminates in fish for the last two years. In the current period the concentration of mercury in fish has exceeded the 2 year maximum and average concentration at CRK 8.0. Locations CRK 33.3 and CRK 40.0 have exceeded the 2 year average concentration. These values remain very close to past values and will require additional data to determine if they are significant. Location CRK 33.3 has shown a slight increase in both average and maximum concentrations for PCBs over the past 2 year maximum and average. This increase was due to one sample with a result of 0.18 ug/g aroclor-1260. All other PCB concentrations remain at the same level as the past two years. Radionuclides in fish have exceeded the 2 year maximum and average at CRK 33.3 and CRK 40.0 for Cs-137. In addition, CRK 8.0 and CRK 33.0 have exceeded the 2 year maximum and average concentrations for total Sr. These values also remain near past values and will require more data to determine if they are significant.

Table 39. Radionuclide concentrations in Clinch River bluegill, January-July 1990

Location[a]	Radionuclide	Number of Samples[b]	Concentration (Bq/kg wet wt) Max	Min	Av[c]	Standard error[d]
CRK 8.0	Co-60	3	0.087	0.011	0.037	0.025
	Cs-137	3	2.9	0.67	2.2	0.75
	Total radioactive Sr[e]	3	2.5	-0.013	0.92	0.81
CRK 33.3	Co-60	3	0.080	0.051	0.069*	0.0093
	Cs-137	3	10	4.2	6.3*	1.9
	Total radioactive Sr[e]	3	1.2	0.37	0.69	0.27
CRK 40.0	Co-60	3	0.043	0.023	0.036*	0.0066
	Cs-137	3	2.0	0.28	0.85	0.56
	Total radioactive Sr[e]	3	0.20	0.054	0.13*	0.042
Network Summary	Co-60	9	0.087	0.011	0.047*	0.0096
	Cs-137	9	10	0.28	3.1*	1.0
	Total radioactive Sr[e]	9	2.5	-0.013	0.58*	0.27

[a] See Fig. 20.

[b] A sample is a composite of 6 to 10 fish.

[c] Average value marked with an asterisk (*) indicates significantly greater than zero.

[d] Standard error of mean.

[e] Total radioactive Sr (Sr-89 + Sr-90)

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