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MARTIN MARIETTA

Environmental Surveillance Data Report for the Fourth Quarter of 1990

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B. M. Horwedel
R. S. Loffman
A. E. Osborne-Lee
M. R. Powell
M. M. Stevens
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MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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CONTENTS

LIST OF ACRONYMS

Bq	becquerel
CAA	Clean Air Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
CYRTF	Coal Yard Runoff Treatment Facility
DCG	derived concentration guide
DOE	Department of Energy
DWL	Drinking water limit
DWS	Drinking Water Standard
EPA	U.S. Environmental Protection Agency
ICP	inductively coupled plasma
MB	Melton Branch
MHD	Melton Hill Dam
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NRWTF	Nonradiological Wastewater Treatment Facility
NWT	Northwest tributary
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge reservation
PAM	perimeter air monitoring
PCB	polychlorinated biphenyl
PWTP	Process Waste Treatment Facility
RAM	remote air monitoring
RCRA	Resource Conservation and Recovery Act
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
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 who produced each section is identified 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 continue to increase and were the highest that they have been in the previous five quarters. The Isotope Solid-State Ventilation System (3039-3) is the major airborne source of tritium. Iodines from Melton Valley (7911 Stack) returned from last quarter's high value to normal levels for the year. Other airborne emissions were consistent with recent monitoring results.

Ambient air sampling around ORNL and the reservation showed that I-131 continues to be at concentrations of less than 0.01% of the derived concentration guide (DCG) for this isotope. Tritium concentrations near the 3039 stack were elevated, with the maximum value being 0.18% of the DCG. These data are consistent with the trend in airborne emissions.

Surface Water

Cesium-137 concentrations at White Oak Dam were elevated this quarter to 2.7% of the DCG. This isotope is particle reactive; elevated concentrations during the quarter are associated with heavy rainfall and sediment transport. Tritium and strontium concentrations at the dam were at 8.2% and 19% of their DCGs for the quarter respectively. These values are typical for this location, suggesting that their concentrations are not greatly affected by rainfall. All of the other radionuclides that were evaluated at the dam were at 1% or less of their DCGs. The concentration of total radioactive strontium at Melton Branch is consistent with the previous quarter. This concentration had risen consistently for four quarters prior to the last two quarters.

The National Pollutant Discharge Elimination System compliance ratio for this quarter was 98% due to 20 noncompliances. Seven of the violations resulted from unpermitted discharges and oil sheens. Five of the violations resulted from high oil and grease values at category outfalls. Four violations were associated with the Coal Yard Runoff Treatment Facility, and four violations were associated with the Sewage Treatment Plant. Mercury and polychlorinated biphenyl (PCB) monitoring was conducted for water and sediments in accordance with the NPDES permit. These data are consistent with previous results.

Groundwater

Groundwater perimeter wells for WAG 1 and WAG 5 were sampled during this quarter. Data are generally consistent with data from previous sampling events. The water level of one of the upgradient wells in WAG 1 is lower than a perimeter monitoring well in the vicinity. The choice of upgradient wells for WAG 1 should be revisited.

Biological Monitoring

Iodine in milk was not detected at any of the five sampling stations during the quarter. Total radioactive strontium in milk was detected at one of the stations. The concentrations were less than 1% of the respective DCGs.

Fish collected at three locations in the Clinch River showed mercury and PCB concentrations that are consistent with the last two years' data. The Cs-137 results were equivalent to the two year maxima at the river location near White Oak Creek. Cobalt-60 levels were equivalent to the two-year maxima near White Oak Creek and at Melton Hill Dam. All of these data are well below Food and Drug Administration action levels and dose limits, respectively.

1. INTRODUCTION

The Environmental Surveillance and Protection Section within the Office of Environmental and Health Protection 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 DOE directives and to provide a continuity of data on environmental media at unregulated locations. The major legislation affecting the environmental program that assessed off-site impacts at the DOE facilities includes the Clean Water Act, the Clean Air Act, the Resource Conservation and Recovery Act, and the Superfund Amendments and Reauthorization Act. In November of 1988, DOE finalized Order 5400.1, "General Environmental Protection Program," that establishes the requirements, authorities, and responsibilities for DOE operations for ensuring compliance with applicable federal, state, and local environmental protection laws and regulations. This order sets forth the requirements for both radiological and nonradiological monitoring. DOE's 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 Order 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.

Monthly or quarterly summaries are presented in this report for each media sampled. All data are rounded to two significant digits. 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. The SE is based upon 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 one 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 strontium 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. Results that include the negative values can be evaluated statistically without incurring the difficulties associated with performing calculations on "less than" (<) values. Radiation measurements are reported in units of becquerel (Bq). A Bq is a Systeme Internationale (SI) unit equivalent to one disintegration per second.

Single measurement values and multiple value summaries are tested for their difference from zero using the t statistic and a one-tailed test at a confidence limit of 95%. Occasionally, the result will be declared as different from zero by the statistical test when in fact it is not. The frequency of this error is directly related to the confidence limit of the test. Since the specified confidence limit for the test is 95%, there is 5% chance of being incorrect. This is a commonly used confidence limit that represents a compromise between incorrectly determining that a value is significant and incorrectly determining that a value is not significant.

The lower confidence limit for a single radioactivity measurement is computed by multiplying the counting standard deviation by 1.645 (t value for a one-tailed test at a 95% level of confidence). If the sample result minus the lower confidence limit is equal to or less than zero, the result is said to be not significantly different from zero. If the sample result minus the lower confidence limit is greater than zero, the result is said to be significantly greater than zero.

Multiple value summaries are of two types: averages and sums. Averages are tested for a significant difference from zero using the standard error of the mean and the appropriate t value with n-1 degrees of freedom. The counting uncertainty is intrinsically incorporated in the estimate of sample variance. Consequently, the estimate of uncertainty for an average of radioactivity measurements is propagated across the measurement uncertainty, sampling variability, and population variability. Sums are tested for a significant difference from zero using only the measurement uncertainties. The lower bound is computed by multiplying the square root of the summed counting variances by the one-tailed t value of 1.645. Estimates of sampling and population variability for sums are not presently available; thus, these errors cannot be propagated.

Presentations of radioactivity data throughout the report follow the convention of flagging data which are statistically significant with an asterisk. Data that are not significantly different from zero are presented without a flag.

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), has authority and responsibility for enforcing the regulations associated with the CAA. The regulatory criteria for CAA are promulgated in Title 40 Code of Federal Regulations (CFR) Parts 50-80. In particular, 40 CFR 61 establishes the National Emission Standards for Hazardous Air Pollutants (NESHAP). Authority for nonradioactive air pollutants in Tennessee has been delegated by EPA to the state. DOE orders are enforced at the local level through the Oak Ridge National Laboratory (ORNL) Directorate for Environmental, Safety, and Health Compliance. Airborne emissions are addressed in DOE Orders 5400.1 and 5400.5 and in Regulatory Guide 5400.6.

ORNL has monitoring requirements for radioactive emissions only. These are NESHAP standards based on calculated annual dose to off-site individuals. 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 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 ORNL 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 - Isotopes/Solid State Ventilation System Duct 4 - 3025 and 3026 Areas Cell Ventilation Systems
7025	Tritium Target Fabrication Facility
7830	Melton Valley Storage Tank 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 presently 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.

Sampling media are collected and evaluated weekly. 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 spectrometry. 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 an activity above the analytical instrument and sample background, the value is reported. Typically, there are thirteen data values for gross alpha, gross beta, I-131, and I-133. In a particular quarter, some isotopes may be represented by fewer than thirteen 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. Laboratory analyses identify and measure the activity level of specific 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.

Noble gas data are presented in the annual site environmental report for the Oak Ridge reservation (ORR). A summary of yearly emissions of I-125 and I-129 by month is presented in the environmental surveillance data report for the fourth quarter.

2.1.2 Procedures and Results

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

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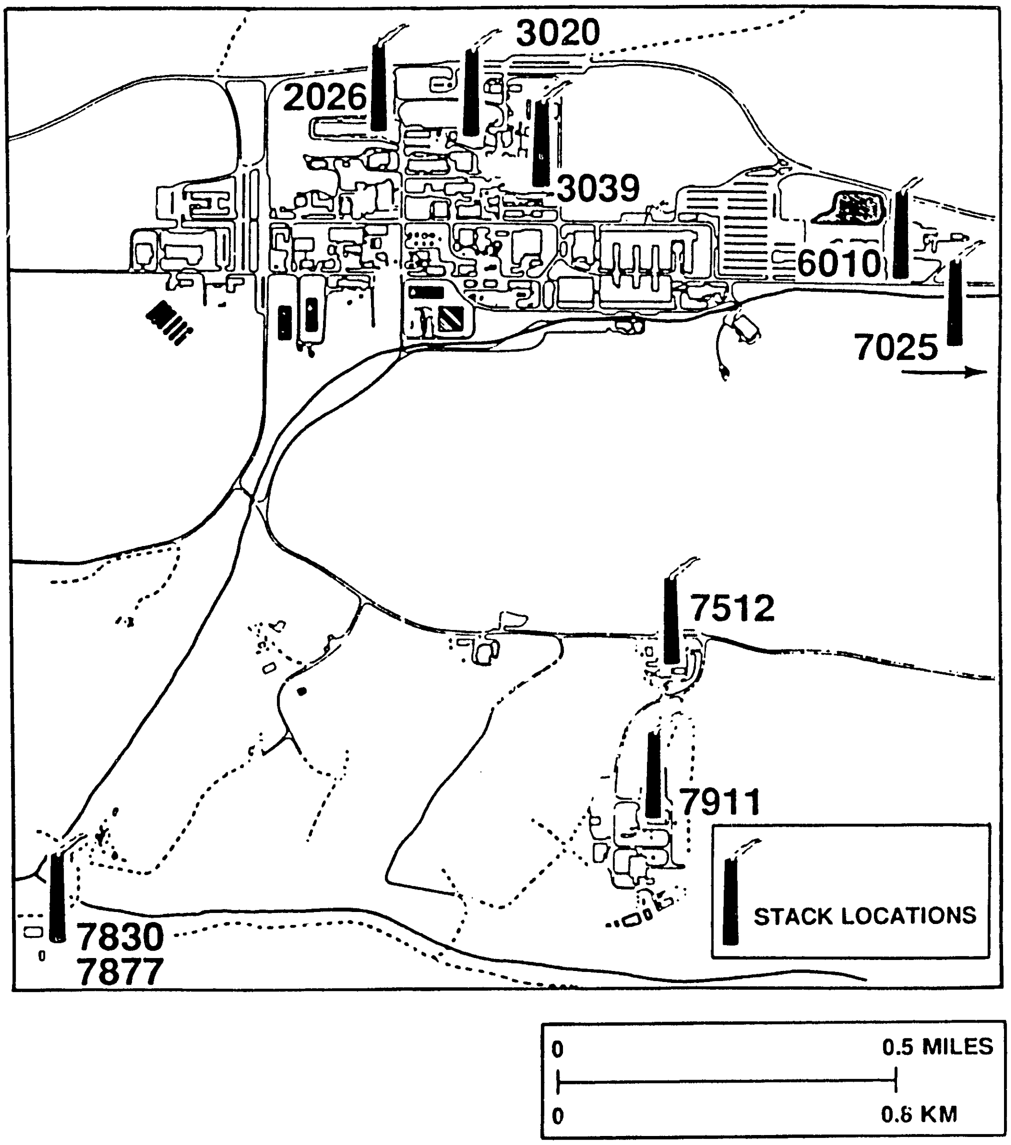

Fig. 1. Location map of major stacks (emission points) at ORNL.

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 presented units of 10^6 Becquerel (Bq). Data reporting conventions are provided in the report introduction. 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. Extrapolating across isotopes is not valid because the uncertainty for each isotope is unique.

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, 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 fourth 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 ORNL consisted primarily of H-3, Pb-212, I-135, I-133, and I-131. Of the total H-3, 97% came from Stack 3039, with most originating in Duct 3 from the Isotopes/Solid State ventilation system. Less than 3% (3.3×10^{12} Bq) was detected at Stack 7025, the Tritium Target Fabrication Facility, where monitoring continues following the shutdown of the production facility in third quarter 1990.

Virtually all of the total I-135 (1.2×10^8 Bq), I-133 (1.1×10^8 Bq), and I-131 (0.94×10^8 Bq) was emitted from Stack 7911 in the Melton Valley Complex. Contributions from other stacks were all well under 1% of the total iodine emissions. The largest part of the total Pb-212 reported for the quarter came from Station 3039-2 (4.9×10^8 Bq). Stack 7911 contributed 1.1×10^8 Bq and Stack 3020 accounted for 0.65×10^8 Bq of Pb-212. All of the reported Os-191 (0.99×10^6 Bq) was detected at Station 3039-4, the 3025 and 3026 areas cell ventilation system. The total emission of 3.0×10^6 Bq of Co-60 reported for the quarter was released at Station 3039-3.

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 single measurement. For the summed weekly emissions, the 95% lower bound is calculated from the variance of the sum.

Table 1. Airborne emissions of radionuclides from ORNL, October-December 1990

	Percent contribution by stack[a,b]							
Radionuclide	2026	3020	3039	7025	7830	7911	7512	Total Emission (10^6 Bq)
Au-194			100*					0.091
Co-60			100*					3.0
Cs-137		8.3*	91*		0.0091*	0.88*		1.8
H-3			97*	2.9*		0.069*		110,000,000
I-131	0.28*	0.0031	0.11		0.00055	100*	<0.0001	94
I-133	<0.0001	<0.0001	0.0086		0.00069	100*	0.00063	110
I-135	0.025	<0.0001	0.0024		0.0020	100*	<0.0001	120
Os-191			100*					0.99
Pb-212	6.0*	8.0*	72*		0.15*	14*	0.013*	810
Gross alpha	56*	8.8*	29*		0.54*	2.4*	3.2*	0.20
Gross beta	0.71*	0.72*	98*		0.017*	0.50*	0.028*	24

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

[b] Values marked with an asterisk represent emissions statistically determined to be significantly different from zero. Note that the variance used in the significance test is based only on the uncertainty associated with laboratory counting and does not include uncertainty due to the sampling process.

Table 2 presents the airborne emissions of long-lived radionuclides detected in the composite of particulate filters collected during the third 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 Stacks 2026, 3020, and 3039. The largest emission was Cs-137, with 0.27 x 10^6 Bq, mostly from Stack 2026 (0.15 x 10^6 Bq), with smaller amounts from Stacks 3039 and 3020. The next largest emission was 0.14 x 10^6 Bq of total Sr, which came from Stack 3020 (0.08 x 10^6 Bq), Stack 3039 (0.038 x 10^6 Bq), and Stack 2026 (0.02 x 10^6 Bq). The four ducts at Stack 3039 accounted for virtually all of the total emission of Be-7 (0.098 x 10^6 Bq).

Airborne emissions of I-125 and I-129 during 1990 are reported by stack in Table 3. For each stack, emissions are listed by month and then summarized in maximum, minimum, and average values over the year. Omissions in the table indicate that the isotopes were not detected in samples taken in those months. The total emission of I-125 and I-129 from all sampled stacks was 0.87 x 10^6 Bq. The largest single contributor was the Isotopes/Solid State ventilation system, monitored at Station 3039-3, with a 1990 emission of 0.35 x 10^6 Bq. The monthly emission values were tested for statistical significance using the variance calculated from laboratory counting uncertainty. Only three monthly emissions of I-125 and I-129 were significantly different from zero, an emission of 0.15 x 10^6 Bq reported for Station 3039-3 in March, and two smaller emissions from Stack 7830 in March and April.

2.1.3 Trends

During the fourth quarter, tritium emissions were again higher than those reported for preceding quarters. The total H-3 for this quarter was 110 x 10^{12} Bq, compared with 87 x 10^{12} Bq for third quarter and 33 x 10^{12} Bq for second quarter. Emissions from the largest source, Station 3039-3, increased from 78 x 10^{12} Bq in the third quarter to more than 100 x 10^{12} Bq in this quarter. Some portion of the increase is expected; it is attributable to improvements in the tritium sampling systems.

Iodine levels were reduced from the higher levels reported for last quarter. The only significant source, Stack 7911, returned to lower levels for all three iodine isotopes. Fourth-quarter emissions of iodine at the stack were lower than those of any other quarter in 1990.

Table 2. Particulate airborne emissions of long-lived radionuclides from ORNL, October-December 1990

Radionuclide	Percent contribution by stack[a]					Total Emission (10^6 Bq)
	2026	3020	3039	7830	7911	
Be-7			92	2.2		0.098
Co-60		15	75	1.5		0.0066
Cs-134	100					0.00074
Cs-137	54	18	25	2.6	0.26	0.27
Eu-154		100				0.0022
Pu-238	69	30				0.0011
Pu-239	58	39	3.2			0.0047
Th-228	75	20	3.1	0.12	1.4	0.0010
Th-230	35	25	23	1.6	16	0.000099
Th-232	17		42	1.1	18	0.000068
Total Sr	15	56	27	0.24	1.4	0.14
Total U	9.1	42	38	0.85	10	0.00025

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

Note: Percentages are shown only for 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.

Table 3. Airborne emissions of I-125 and I-129 from ORNL, 1990

MONTH	Emission (10^6 Bq) by station[a]									Total Emission
	2026	3020	3039-1	3039-2	3039-3	3039-4	7512	7830	7911	
Jan	0.0053	0.0091	0.0084	0.00092	0.0078	0.0089	0.0017	0.00057	0.0029	0.046
Feb	0.0042	0.0091	0.0070	0.00080	0.036	0.0074	0.0017	0.00043	0.0021	0.069
Mar	0.0042	0.011	0.0095	0.0011	0.15*	0.0098	0.0017	0.064*	0.0029	0.25
Apr	0.0053	0.0091	0.0096	0.0012	0.084	0.011	0.0017	0.0085*	0.0030	0.13
May	-0.0084	0.057	0.022	0.0061	0.0034	0.083	-0.0026	0.0013	0.0044	0.17
Jun	0.0084	0.0068	0.011	0.0012	0.0073	0.010	0.0017	0.00017	0.0037	0.050
Jul	0.0053	0.0091	0.012	0.0015	0.0086	0.019	0.0022	0.00022	0.0048	0.063
Aug	0.0042	0.0091	0.0094	0.0012	0.0072	0.011	0.0017	0.00023	0.0032	0.047
Sep	0.0021	0.0046	0.0026	0.00026	0.0017	0.0022	0.00087	0.000069	0.00088	0.015
Nov			0.13	0.0065	0.067	-0.024		0.000034	0.0075	0.19
Total	0.031	0.12	0.22	0.021	0.373	0.14	0.011	0.076	0.035	1.0
Maximum	0.0084	0.057	0.13	0.0065	0.15	0.083	0.0022	0.064	0.0075	
Minimum	-0.0084	0.0046	0.0026	0.00026	0.0017	-0.024	-0.0026	0.000034	0.00088	
Mean	0.0034	0.014	0.022	0.0021	0.037	0.014	0.0012	0.0076	0.0035	
Std err[b]	0.0016	0.0054	0.012	0.00071	0.016	0.0085	0.00049	0.0063	0.00056	

[a] Emissions marked with an asterisk were statistically determined to be significantly different from zero. Note that the variance used in the significance test is based only on the uncertainty associated with laboratory counting and does not include uncertainty due to the sampling process.

[b] The standard error shown in the summary statistics is the error of the mean.

Total emissions of Pb-212 also showed a decrease this quarter, down from 970 x 10^6 Bq in the third quarter to 810 x 10^6 Bq in fourth quarter. Station 3039-2 showed an emission of 490 x 10^6 Bq, down from 660 x 10^6 Bq in third quarter, but still elevated from the more typical emission of 290 x 10^6 Bq of second quarter. The general decrease was partially offset by an increase at Stack 7911, from 54 x 10^6 Bq to a more typical 110 x 10^6 Bq.

Total Os-191 emissions continued to decline, from 2.2 x 10^9 Bq in first quarter to 46 x 10^6 in second quarter, to 3.0 x 10^6 in third, and 0.99 x 10^6 in fourth quarter. Emissions of Co-60, mostly from the ducts at 3039, doubled, up from 1.4 x 10^6 and 1.5 x 10^6 Bq in preceding quarters to 3.0 x 10^6 Bq in fourth quarter.

2.2 AMBIENT AIR

Martha M. Stevens

2.2.1 Program Description

Most gaseous wastes from ORNL are released to the atmosphere from stacks. Radioactivity may be present in gaseous waste streams as a solid (particulates), 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 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 40-46, 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.

All ORNL stations and reservation stations 33, 34, and 40 through 46 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.

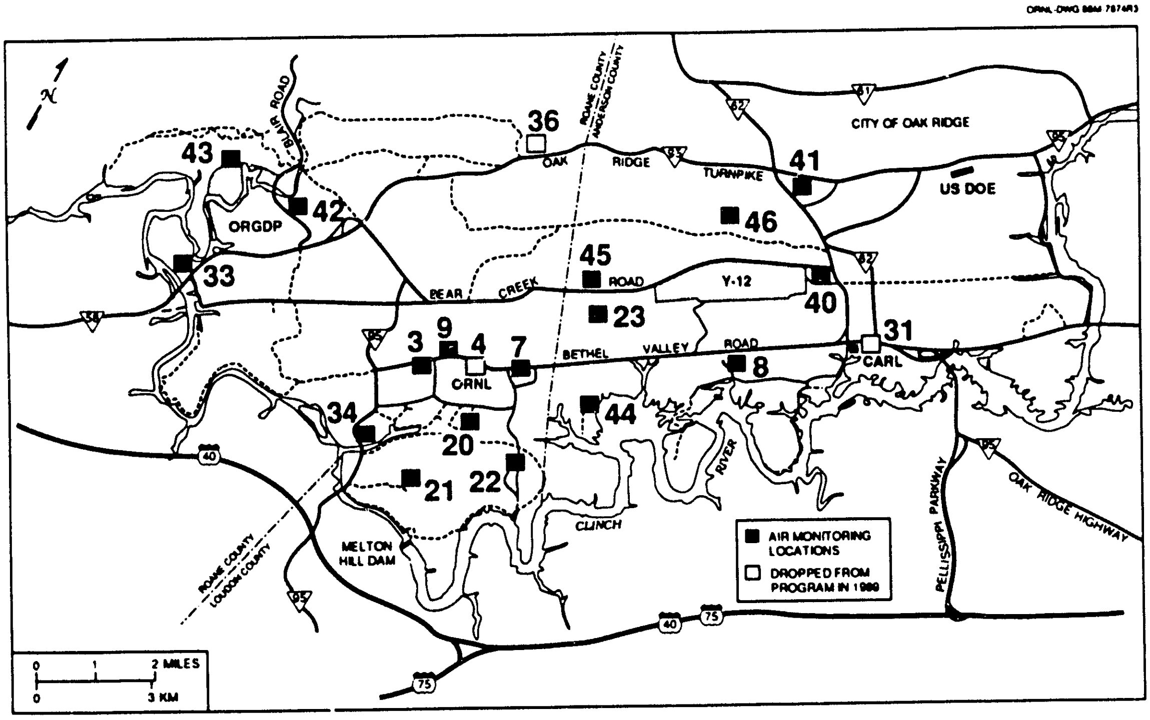

Fig. 2. Location map of ORR and ORNL PAM stations.

ORNL DWG 87 7047R3

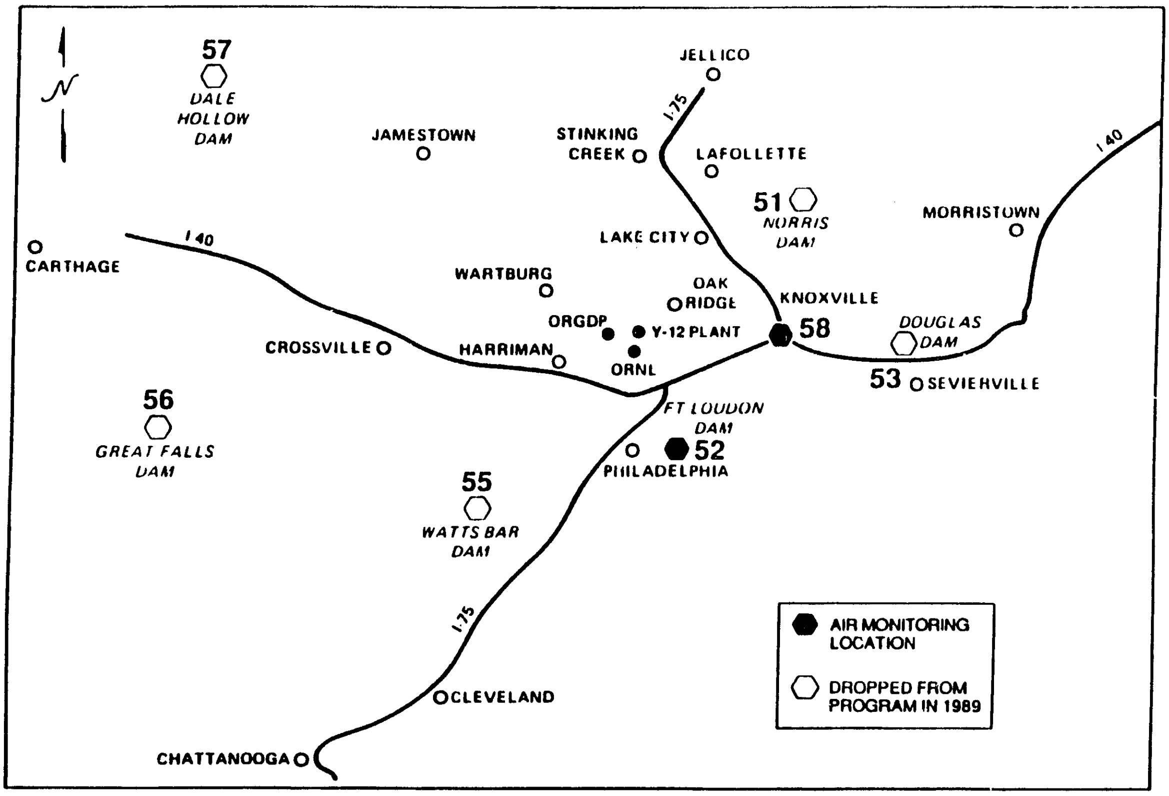

Fig. 3. Location map of RAM stations.

Ambient air is sampled continually 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 paper filters are collected and analyzed biweekly for gross alpha and gross beta activity. The particulate filters are analyzed four days after collection to minimize artifacts from short-lived radionuclides, and again after eight days for comparability with similar data in the airborne emissions program. The charcoal cartridge samples are collected concurrently with the particulate filters and analyzed within 24 h for adsorbed radioactive gases by gamma spectrometry. Iodine-131 is reported for each sample. Other radionuclides on the charcoal are opportunistically captured; they are reported only when present above instrument and sample background. The date, time, and flow value are recorded each time 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 to the biweekly analysis, 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. Concentrations of specific isotopes detected in the 1990 composites are presented in Table 7 of this report.

Monthly samples for atmospheric tritium are 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 Procedures and Results

Concentrations of gross alpha and gross beta for the fourth quarter of 1990 are presented in Tables 4 and 5. Concentrations of atmospheric I-131 and atmospheric tritium for fourth quarter are summarized in Tables 6 and 7. Data reporting conventions, including negative numbers, are addressed in the report introduction.

Summary data for gross alpha activity detected at stations in the three air monitoring networks in the fourth quarter are presented in Table 4. Average concentration values from all but two stations in the ORNL and ORR networks were statistically determined to be significantly different from zero. In December, ORNL station 21 and ORR station 40 each had one sample with a relatively high laboratory measurement of gross alpha. Because the associated

Table 4. Gross alpha activity at ambient air stations, October-December 1990

Station	Number of samples	Concentration (10^{-8} Bq/L) Maximum	 Minimum	 Mean[a]	 Standard error of mean
		ORNL PAM Stations[b]			
3	1	8.8	8.8	8.8 *	
7	4	27	7.6	14 *	4.6
9	6	17	4.7	8.3 *	1.8
20	5	11	6.4	8.3 *	0.78
21	2	59	4.2	32	27
22	1	13	13	13 *	
Summary	19	59	4.2	12 *	2.9
		ORR PAM Stations[b]			
23	5	10	-0.41	6.4 *	1.9
33	7	26	2.5	9.5 *	3.0
34	1	23	23	23 *	
40	6	53	1.2	15	7.9
41	6	18	2.4	11 *	2.6
42	4	20	6.9	11 *	2.8
43	6	30	2.2	11 *	4.4
44	5	20	3.4	8.9 *	3.1
45	7	35	6.1	15 *	3.6
46	5	16	3.4	8.7 *	2.5
Summary	52	53	-0.41	11 *	1.3
		RAM Stations[c]			
52	4	46	-0.51	23	9.8
58	3	24	7.9	13	5.4
Summary	7	46	-0.51	19 *	5.9
Overall Summary	78	59	-0.51	12 *	1.2

[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.

Table 5. Gross beta activity at ambient air stations, October-December 1990

Station	Number of samples	Concentration (10^{-8} Bq/L) Maximum	Minimum	Mean[a]	Standard error of mean
		ORNL PAM Stations[b]			
3	1	170	170	170 *	
7	4	200	72	140 *	30
9	6	140	71	99 *	11
20	5	160	59	110 *	18
21	2	110	39	73	34
22	1	150	150	150 *	
Summary	19	200	39	110 *	10
		ORR PAM Stations[b]			
23	5	170	62	95 *	20
33	7	200	77	140 *	19
34	1	52	52	52 *	
40	6	130	62	90 *	11
41	6	130	54	94 *	11
42	4	150	72	110 *	18
43	6	150	61	110 *	12
44	5	140	62	100 *	15
45	7	140	68	110 *	12
46	5	150	67	120 *	13
Summary	52	200	52	110 *	5.0
		RAM Stations[c]			
52	4	270	55	120	52
58	3	140	74	110 *	20
Summary	7	270	55	120 *	29
Overall Summary	78	270	39	110 *	4.8

[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.

Table 6. Atmospheric I-131 concentration at ambient air stations, October-December 1990

		Concentration (10^{-8} Bq/L)				
Station	Number of samples	Maximum	Minimum	Mean[a]	Standard error of mean	Percent of DCG[b]
		ORNL PAM Stations[c]				
3	1	2.4	2.4	2.4		
7	4	20	-3.2	3.3	5.7	
9	6	10	-4.0	1.8	2.0	
20	5	3.5	-17	-4.1	3.8	
21	2	3.8	1.4	2.6	1.2	
22	1	9.0	9.0	9.0		
Summary	19	20	-17	1.1	1.7	
		ORR PAM Stations[c]				
23	5	5.6	-4.1	1.9	1.6	
34	1	-27	-27	-27		
40	6	9.0	-2.8	2.6	1.7	
41	6	10	-6.0	0.96	2.3	
44	5	7.3	-7.7	-1.0	2.7	
45	7	9.1	-13	0.65	2.9	
46	5	13	-16	0.069	4.8	
Summary	35	13	-27	0.11	1.3	
Overall Summary	54	20	-27	0.44	1.0	

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

[b] Percent of derived concentration guide (DCG) = Mean/DCG x 100. The DCG for I-131 is 1.5×10^{-2} Bq/L. This value is reported only for means that are statistically significant.

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

Table 7. Atmospheric tritium concentration at ambient air stations, October-December 1990

		Concentration (10^{-4} Bq/L)				
Station[a]	Number of samples	Maximum	Minimum	Mean[b]	Standard error of mean	Percent of DCG[c]
3	4	68	1.5	30	15	
8	3	9.2	3.8	6.3 *	1.6	0.017
Overall Summary	7	68	1.5	20 *	9.4	0.054

[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 x 100. The DCG for tritium is 3.7 Bq/L. The concentration guide assumes that 50% of the tritium is absorbed through the skin. This value is reported only for means that are statistically significant.

uncertainties were also high, the calculated concentrations were not considered statistically significant. In the ORNL network, at station 21, the maximum concentration was 59 x 10^{-8} Bq/L; at station 40 in the ORR network, the maximum concentration was 53 x 10^{-8} Bq/L. Due in large part to the same high value, ORNL station 21 also showed the highest station average in all three networks. The remote network had the highest network average, but the individual station averages were not statistically significant.

Summary data for gross beta activity are given in Table 5. All average concentration values are marked as significantly different from zero except for the averages computed for ORNL station 21 and remote station 52. In the ORNL network, the maximum gross beta concentration, 200 x 10^{-8} Bq/L, occurred at station 7. The maximum concentration reported in the ORR network, also 200 x 10^{-8} Bq/L, occurred at station 33. The highest station averages in the three networks were reported from ORNL station 3, with 170 x 10^{-8} Bq/L from one sample, and from ORNL station 22, with 150 x 10^{-8} Bq/L. There was no statistical difference among the network averages in the fourth quarter.

A summary of atmospheric I-131 concentrations in the fourth quarter is presented in Table 6. No average concentration values for I-131 were determined to be significantly different from zero. The maximum concentration over the ORNL and ORR networks, 20 x 10^{-8} Bq/L, reported for ORNL station 7, is only 0.001% of the DCG for I-131. The highest average concentration, 9 x 10^{-8} Bq/L, occurred at ORNL station 22.

Concentrations of atmospheric tritium for the period are summarized in Table 7. Station 8 shows an average concentration of 6.3 x 10^{-4} Bq/L, which is 0.017% of the DCG. The unusually high mean at station 3 results from two high measurements in December; the average is not statistically significant, but the individual values are different from zero. The highest value from station 3 is 0.18% of the DCG.

In 1990, composites of particulate filters were prepared and analyzed at the end of the first quarter and again after the fourth quarter. Results of the analyses were combined for annual reporting, and concentrations of specific radionuclides at some individual stations and in the networks are listed in Table 8.

2.2.3 Trends

Compared with summary results from the previous six quarters, concentrations of gross alpha and, to a lesser extent, of gross beta, showed a general increase in the third and fourth quarters of 1990. The increase is attributed to improvements made in the sampling equipment in late spring and early summer. In similar comparisons, concentrations of I-131 showed little difference or were slightly lower.

Tritium concentrations at station 3 were elevated for the quarter with the highest value of 68 x 10^{-4} Bq/L being nominally ten times the typical concentration for this location. These results are consistent with the effluent monitoring data for 3039-3 which is the major airborne tritium source.

Table 8. Concentrations of specific radionuclides, 1990

	Concentration[a] (10^{-10} Bq/L)					
Analysis	Station 34[b]	Percentage DCG[c]	Station 40[b]	Percentage DCG[c]	Station 41[b]	Percentage DCG[c]
Co-60	25*	<0.01	7.1	<0.01	7.8	<0.01
Cs-137	0.87	<0.01	8.6*	<0.01	8.9*	<0.01
Pu-238	0.52*	<0.01	0.16	<0.01	0.45	<0.01
Pu-239	-0.50	<0.01	-0.35	<0.01	-0.63	<0.01
Th-228	8.7*	0.058	7.5*	0.051	5.8*	0.039
Th-230	1.5*	0.010	2.0*	0.013	2.1*	0.014
Th-232	1.3*	0.048	1.1*	0.042	1.6*	0.063
Total Sr[d]	26*	<0.01	21*	<0.01	9.5	<0.01
U-234	1.8*	<0.01	39*	0.12	12*	0.037
U-235	0.41*	<0.01	1.4*	<0.01	0.67*	<0.01
U-238	0.96*	<0.01	4.4*	0.012	1.8*	<0.01

	Concentration[a] (10^{-10} Bq/L)					
Analysis	Station 45[b]	Percentage DCG[c]	Station 46[b]	Percentage DCG[c]	ORNL PAMS[b]	Percentage DCG[c]
Co-60	4.4	<0.01	-2.4	<0.01	4.5	<0.01
Cs-137	-1.9	<0.01	10*	<0.01	11*	<0.01
Pu-238	0.12	<0.01	0.86	<0.01	0.18*	<0.01
Pu-239	0.068	<0.01	-0.47	<0.01	-0.099	<0.01
Th-228	6.4*	0.043	9.1*	0.062	2.6*	0.017
Th-230	1.8*	0.012	2.0*	0.014	1.5*	0.010
Th-232	1.3*	0.049	1.9*	0.075	1.2*	0.048
Total Sr[d]	-5.2	<0.01	1.3	<0.01	-0.55	<0.01
U-234	23*	0.068	23*	0.069	2.9*	<0.01
U-235	1.0*	<0.01	1.5*	<0.01	0.10*	<0.01
U-238	4.4*	0.012	4.3*	0.012	0.85*	<0.01

Table 8 (continued)

Analysis	Concentration[a] (10^{-10} Bq/L) ORR PAMS[b]	Percentage DCG[c]	RAMS[b]	Percentage DCG[c]
Co-60	-0.56	<0.01	7.6	<0.01
Cs-137	-0.22	<0.01	0.42	<0.01
Pu-238	0.033	<0.01	0.61*	<0.01
Pu-239	-0.081	<0.01	0.063	<0.01
Th-228	2.8*	0.019	6.7*	0.045
Th-230	1.4*	<0.01	1.9*	0.013
Th-232	1.7*	0.066	2.3*	0.087
Total Sr[d]	5.9*	<0.01	16*	<0.01
U-234	3.4*	0.010	1.5*	<0.01
U-235	0.26*	<0.01	0.34*	<0.01
U-238	0.89*	<0.01	0.91*	<0.01

[a] Concentrations marked with an asterisk (*) are statistically determined to be significantly greater than zero. See Figs 2 and 3.

[b] Percent DCG = concentration * 100 /derived concentration guide (DCG). The DCG for Co-60 is 3.0 x 10^{-3} Bq/L; Cs-137 is 1.5 x 10^{-2} Bq/L; Pu-238 is 1.5 x 10^{-6} Bq/L; Pu-239 is 1.5 x 10^{-6} Bq/L; Th-228 is 1.5 x 10^{-6} Bq/L; Th-230 is 1.9 x 10^{-6} Bq/L; Th-232 is 3.7 x 10^{-7} Bq/L; Total strontium is 3.3 x 10^{-4} Bq/L; U-234 is 3.3 x 10^{-6} Bq/L; U-235 is 3.7 x 10^{-6} Bq/L; and U-238 is 3.7 x 10^{-6} Bq/L.

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

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 locations of these PAMs are shown in Fig. 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 9 summarizes these measurements for the fourth quarter of 1990. The equivalent dose rate is calculated using the average reading for each station during the quarter.

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 9 except stations 4 and 46 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 9. External gamma radiation measurements at ORNL and reservation perimeter air monitoring stations, October - December 1990

		Exposure rate(nC/kg/h)[a]				
Location	Percentage of Samples[b]	Max	Min	Av[c]	Standard error[d]	Equivalent Dose (uSv/h)
			ORNL PAM Stations[e]			
03	0.012	2.4	1.9	2.0 *	0.022	0.076
04	0.98	28	8.8	24 *	0.080	0.95
07	0.63	2.2	1.4	1.7 *	0.0057	0.066
20	0.98	3.1	2.1	2.4 *	0.0028	0.091
Network summary	0.65	28	1.4	11 *	0.15	0.41
			Reservation PAM Stations[e]			
08	0.65	2.7	1.8	1.9 *	0.0029	0.074
31	0.027	2.1	2.0	2.1 *	0.0028	0.080
33	0.62	2.8	1.6	2.0 *	0.0035	0.077
34	0.81	3.1	1.9	2.2 *	0.0035	0.085
40	0.28	2.9	2.0	2.1 *	0.0039	0.082
41	0.58	1.5	1.4	1.4 *	0.00071	0.054
42	0.98	2.6	1.6	1.8 *	0.0025	0.071
43	0.32	2.8	1.6	1.9 *	0.0054	0.072
44	0.98	2.5	1.6	1.8 *	0.0021	0.070
45	0.26	2.6	1.6	1.8 *	0.0048	0.071
46	0.89	30	2.0	2.5 *	0.023	0.097
Network summary	0.58	30	1.4	2.0 *	0.0042	0.076

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[a] Nanocoulomb per kilogram per hour.

[b] Real-time readings were collected at all stations at 10-min intervals. The percent number of samples indicate the total number of valid hourly averages during the quarter divided by total possible.

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

[d] Standard deviation of the mean.

[e] See Fig. 2.

3.0 WATER

The ORNL site is located in the 17 km^2 White Oak Creek (WOC) watershed, with the exception of two small effluent points in the 7600 area that discharge directly into Melton Hill Lake. A sketch of the watershed and sampling station locations is shown in Fig. 4. The major tributary to WOC is Melton Branch (MB). Upper WOC drains Bethel Valley in the vicinity of ORNL, receiving inputs from Fifth Creek, First Creek, and Northwest Tributary (NWT) prior to crossing the gap in Haw Ridge and flowing Southwest to White Oak Lake (WOL). Melton Branch drains Melton Valley and joins WOC less than a kilometer from WOL. The present final point of control for the watershed is at White Oak Dam (WOD), which is the structure that forms WOL. The lake is about 1 km long and less than 0.2 km wide. The purpose of the lake is to serve as a settling basin and catchment in the event of contaminant releases from the ORNL facility. The receiving water for the watershed is Watts Bar Lake of the Clinch River (CR).

Water quality in these streams is affected primarily by effluent discharges, surface runoff, subsurface storm flow, and groundwater transport of contaminants from historically disposed wastes. The average flow for the watershed is 14 CFS (9 MGD), of which 1 CFS (0.67 MGD) is attributed to the major National Pollutant Elimination System (NPDES) effluent points, and 3 CFS (2 MGD) is attributed to cooling towers and blowdown. The base flow during drought is estimated to 1.75 CFS (1.14 MGD).

Surveillance of the water environment consists of the collection of ambient surface water, effluent and sediment samples required under the NPDES permit, and groundwater from Waste Area Groups (WAGs) 1, 5, 7 and 6. Samples are analyzed for radionuclides and nonradioactive chemicals.

3.1 Surface Water

Dennis A. Wolf

3.1.1 Program Description

Water 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 10.

3.1.2 Procedures and Results

Treated water samples are collected weekly at the Kingston and Gallaher potable water treatment plants (Fig. 5) and are analyzed quarterly. Table 11 contains the concentrations measured at these stations during this quarter. At Gallaher, gross beta and H-3 were significantly greater than zero but were no greater than 7% of their respective EPA drinking water standards. At Kingston, H-3, gross alpha and gross beta were significantly greater than zero but less than 6% of the drinking water standards. No test of significance

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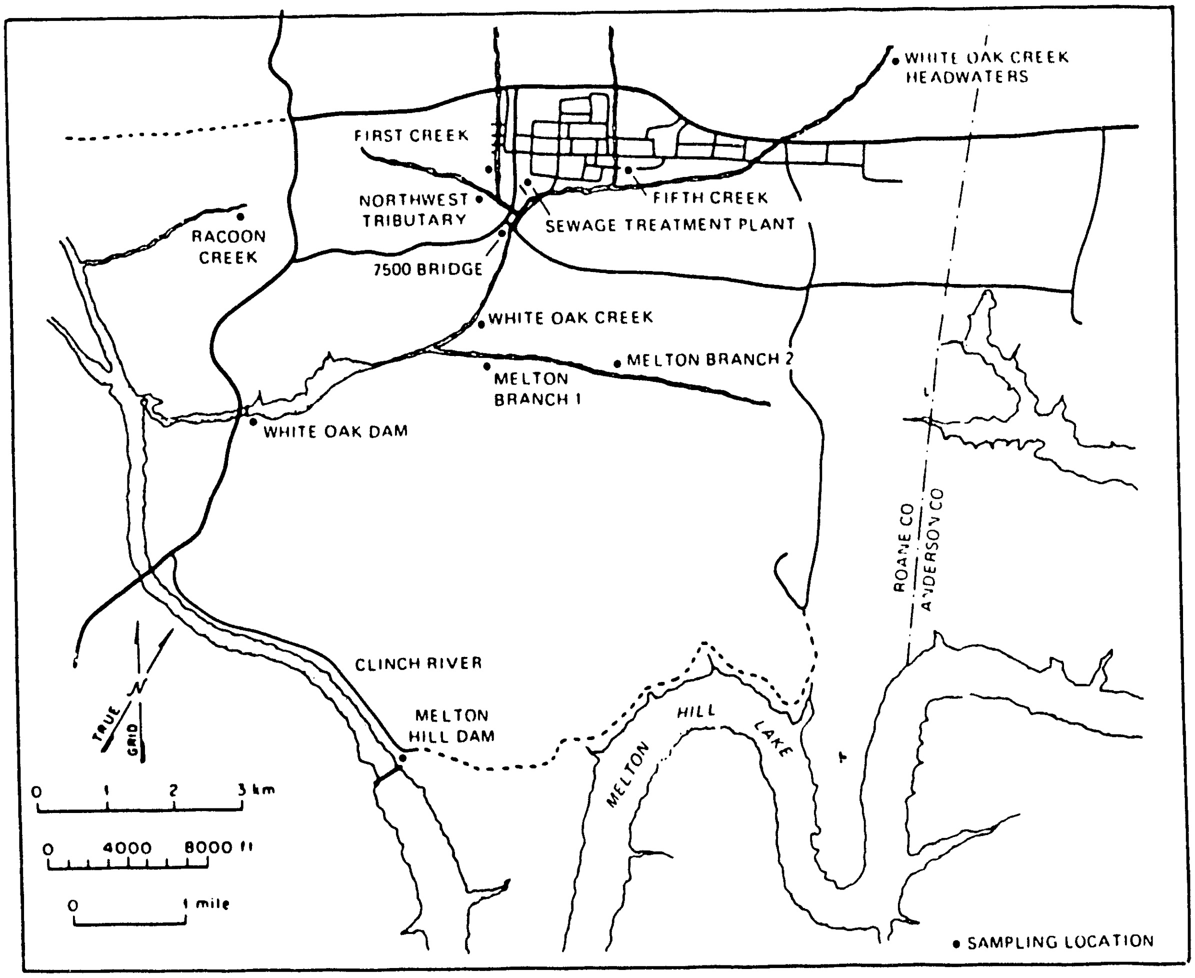

Fig. 4. Location map of ORNL streams and sampling stations.

Table 10. Summary of collection and analysis frequencies of surface, pond, and effluent water samples

Station	Parameter	Collection Frequency	Sample Type	Analysis Frequency
Sewage Treatment Plant	Gamma scan, gross beta, 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 (MHD)	Gamma scan, gross alpha[b], gross beta[c]	Weekly	Flow Proportional	Monthly
Nonrad Wastewater Treatment Fac.	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 strontium (Sr-89 + Sr-90).

[b] If gross alpha >1 Bq/L, 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, analyze for total radioactive strontium.

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.

Derived concentration guides are estimates of the rate of exposure to a given radioisotope via one exposure pathway that would result in a dose of 100 mrem (1 mSv) per year to "reference man," as defined by the International Commission of Radiation Protection Publication 23. These values have been published in draft 10 CFR 834 and are used here as a means of standardized comparison for effluent points with different isotope signatures. The calculation of percent DCG does not imply that effluent points or ambient water sampling stations at ORNL are sources of drinking water.

The sum of DCG percentages for each of the effluent points and ambient water stations is less than 100%. In the event that a sum ever exceeds 100%, an analysis of the best available technology to reduce the signature would be conducted as specified in 10 CFR 834.

Melton Hill Dam and WOC headwaters, two locations above ORNL discharge points, serve as references for other water sampling locations at the ORNL site. Water samples are collected there and from six streams: WOC, MB, First Creek, Fifth Creek, NWT, and Raccoon Creek (Fig. 4). Summary statistics for each radionuclide at each surface water sampling location are given in Table 12.

Gross alpha concentration at MHD was significantly greater than zero (0.090 Bq/L). No radionuclide concentrations were significantly greater than zero at WOC headwaters during this quarter.

Average total radioactive strontium concentration at First Creek (14 Bq/L) was 37% of the DCG for Sr-90. Otherwise, all average concentrations at First Creek, Fifth Creek, NWT, Raccoon Creek, MB2, and 7500 bridge were no greater than 6.4% 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 10. Table 13 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 at the NPDES points exceeded 34% of its DCG. Average total radioactive strontium (13 Bq/L) and H-3 (24,000 Bq/L) at MB1 are 34% and 32% of the respective DCGs. Average Cs-137 (28 Bq/L) at the Nonradiological Wastewater Treatment Facility is 25% of the DCG and total radioactive Sr (7.1 Bq/L) at WOD is 19% of the DCG. All other concentrations were no greater than 10% of the DCGs.

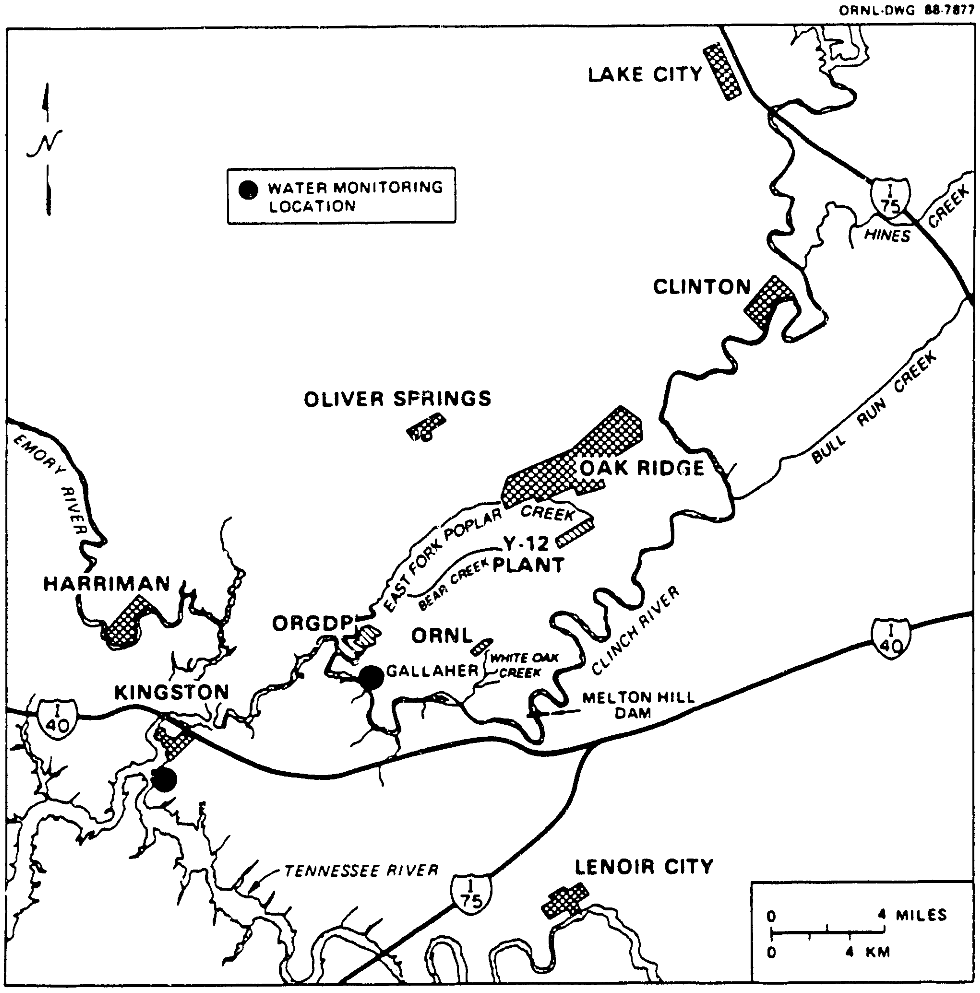

Fig. 5. Location map of Kingston and Gallaher sampling points.

Table 11. Summary of radionuclide concentrations in water off-site ORNL, October-December 1990

Radionuclide	Concentration[a] (Bq/L)	Drinking Water Standard[b] (DWS) (Bq/L)	Percentage of DWS[c]
Gallaher[d]			
Co-60	0.0050	*e*	*e*
Cs-137	0.011	*e*	*e*
Gross alpha	0.0040	0.56	*e*
Gross beta	0.10*	1.5	6.8
Pu-238	0.00020	*e*	*e*
Pu-239	0.00030	*e*	*e*
Total Sr[f]	0.026	0.30	*e*
Total U[g]	0.00099	*e*	*e*
H-3	17*	740	2.3
Kingston[d]			
Co-60	0.0040	*e*	*e*
Cs-137	0.0090	*e*	*e*
Gross alpha	0.010*	0.56	1.8
Gross beta	0.082*	1.5	5.5
Pu-238	-0.00010	*e*	*e*
Pu-239	0.0010	*e*	*e*
Total Sr[f]	0.0080	0.30	*e*
Total U[g]	0.00017	*e*	*e*
H-3	6.8*	740	0.92

[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 strontium 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 strontium (Sr-89 + Sr-90).

[g] No test for significance is possible.

Table 12. Radionuclide concentrations in surface waters around ORNL,[a] October-December 1990

Radionuclide	Number of Samples	Concentration (Bq/L)					Percentage of DCG[e]
		Max	Min	Av[b]	Standard error[c]	Derived Concentration Guide (DCG)[d]	
				Melton Hill Dam			
Co-60	3	1.3	-1.4	-0.063	0.78	190	*f*
Cs-137	3	0.50	-0.050	0.18	0.16	110	*f*
Gross alpha	3	0.12	0.030	0.090*	0.030	*f*	*f*
Gross beta	3	0.34	-0.30	0.093	0.20	*f*	*f*
				White Oak Creek Headwaters			
Co-60	3	0.40	-1.1	-0.22	0.45	190	*f*
Cs-137	3	0.40	-0.90	-0.19	0.38	110	*f*
Gross alpha	3	0.13	0.030	0.080	0.029	*f*	*f*
Gross beta	3	0.34	-0.20	0.10	0.16	*f*	*f*
				7500 Bridge			
Co-60	3	0.11	-0.30	-0.097	0.12	190	*f*
Cs-137	3	6.4	3.5	5.1*	0.85	110	4.6
Total Sr[g]	3	3.4	1.7	2.4*	0.52	37	6.4
H-3	3	130	110	120*	5.8	74,000	0.16
				First Creek			
Co-60	3	0.50	-0.10	0.14	0.18	190	*f*
Cs-137	3	1.0	-1.0	0.037	0.58	110	*f*
Total Sr[g]	3	17	8.8	14*	2.5	37	37
				Fifth Creek			
Co-60	3	0.060	-0.90	-0.38	0.28	190	*f*
Cs-137	3	0.80	0.018	0.37	0.23	110	*f*
Total Sr[g]	3	2.1	1.2	1.6*	0.27	37	4.2
				Melton Branch 2			
Co-60	3	0.22	-1.7	-0.89	0.58	190	*f*
Cs-137	3	0.030	-0.30	-0.12	0.096	110	*f*
Total Sr[g]	3	0.10	0.010	0.055	0.026	37	*f*
H-3	2	200	80	140	60	74,000	*f*

Table 12. (continued)

Radionuclide	Number of Samples	Concentration (Bq/L) Max	Min	Av[b]	Standard error[c]	Derived Concentration Guide (DCG)[d]	Percentage of DCG[e]
Northwest Tributary							
Co-60	3	1.7	0.010	1.0	0.52	190	*f*
Cs-137	3	0.20	-0.60	-0.16	0.23	110	*f*
Total Sr[g]	3	1.5	1.4	1.5*	0.033	37	4.0
Raccoon Creek							
Co-60	3	2.1	0.020	1.2	0.61	190	*f*
Cs-137	3	0.70	0.10	0.30	0.20	110	*f*
Total Sr[g]	3	1.9	0.69	1.2*	0.38	37	3.1

[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] DCG for ingestion of water. From DOE Order 5400.5.

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

[f] Not applicable.

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

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 CR (as measured at MHD) are given in Table 14. Clinch River flows are regulated by a series of Tennessee Valley Authority dams, one of which is MHD. The flow in Melton Branch is usually less than one-third that in WOC. The ratio of WOC flow measured at WOD to CR flow is also reported in Table 14. 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 CR from WOC. The ratio for the quarter ranged from 190 to 540.

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. A flow weighted composite is made and analyzed monthly. The discharge for the period is calculated as the product of the flow-weighted concentration and the total flow for the sampling period (Tables 15-17). In addition, weekly flow-proportional samples were obtained at WOD and analyzed, for radionuclides other than H-3 and total strontium, at weekly intervals. The average concentration during the calendar month was calculated as a weighted sum of all concentrations obtained for sampling periods overlapping the calendar month. The weights were proportional to the calendar period total flow attributable to the sampling periods. This average concentration was multiplied by the calendar month total flow to arrive at the discharge.

Each average flow-weighted concentration was compared with an existing DCG. Co-60 and Cs-137 concentrations did not exceed 2.3% of the DCGs during this quarter, except at WOC and WOD during December. At the end of December, a large amount of rainfall stirred the sediments and resuspended amounts of Cs-137, resulting in an average monthly concentrations of approximately double those usually seen at WOD and about 15 times those normally seen at WOC. At MB1 total radioactive strontium concentrations ranged from 25% of the Sr-90 DCG to 43% of the DCG. Tritium concentrations there ranged from 15% of the DCG to 47% of the DCG. Total radioactive strontium and H-3 concentrations ranged respectively from 8.9% to 25% and 2.6% to 11% 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.

Cesium-137 concentrations at WOC during December were approximately 15 times the concentrations usually observed there. This was due to increased water levels stirring up contaminated sediments during an extended period of heavy rains. As a result, Cs-137 concentrations observed at WOD were elevated during that month. During the last week in December, the observed concentration of Cs-137 at WOD was about seven times that usually observed

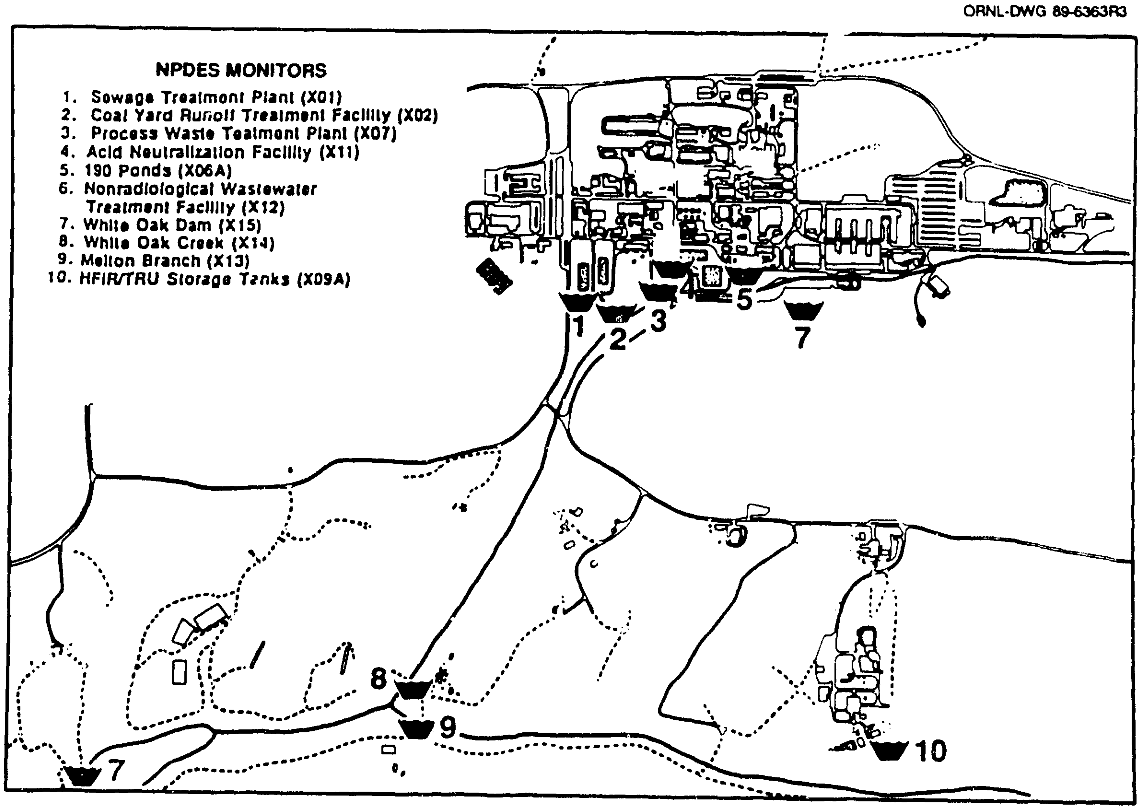

Fig. 6. Location map of ORNL NPDES and radioactivity sampling locations.

Table 13. Radionuclide concentrations at ORNL NPDES locations,[a] October-December 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	0.70	0.13	0.34	0.18	190	*f*
Cs-137	3	0.50	-1.0	-0.11	0.45	110	*f*
Gross beta	3	19	5.6	10	4.5	*f*	*f*
Total Sr[g]	3	10	2.3	4.9	2.5	37	*f*
Nonradioactive Process Waste Treatment Facility (X12)							
Co-60	3	2.9	0.39	1.5	0.73	190	*f*
Cs-137	3	33	22	28*	3.2	110	25
Gross alpha	3	0.98	0.20	0.54	0.23	*f*	*f*
Gross beta	3	27	19	23*	2.3	*f*	*f*
Total Sr[g]	3	1.2	0.38	0.89*	0.26	37	2.4
H-3	3	1,000	850	930*	44	74,000	1.3
Melton Branch 1 (X13)							
Co-60	3	1.9	-0.60	0.30	0.80	190	*f*
Cs-137	3	1.1	-0.40	0.53	0.47	110	*f*
Total Sr[g]	3	16	9.1	13*	2.0	37	34
H-3	3	35,000	11,000	24,000*	7,000	74,000	32
White Oak Creek (X14)							
Co-60	3	1.2	-2.2	-0.34	0.99	190	*f*
Cs-137	3	33	1.4	12	10	110	*f*
Total Sr[g]	3	9.1	3.3	5.3	1.9	37	*f*
H-3	3	3,000	1,900	2,600*	350	74,000	3.5

Table 13 (continued).

Radionuclide	Number of Samples	Concentration (Bq/L) Max	Min	Av[b]	Standard error[c]	Derived Concentration Guide (DCG)[d]	Percentage of DCG[e]
White Oak Dam (X15)							
Co-60	13	0.54	0.050	0.33*	0.038	190	0.17
Cs-137	13	14	0.31	3.0*	1.0	110	2.7
Gross alpha	13	0.42	0.065	0.26*	0.030	*f*	*f*
Gross beta	13	29	2.7	16*	1.8	*f*	*f*
Total Sr[g]	3	8.3	6.1	7.1*	0.64	37	19
H-3	3	7,900	5,100	6,000*	930	74,000	8.2

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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 5400.5.

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

[f] Not applicable.

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

Table 14. Stream[a] flows, October-December 1990

Month	Flow (10^9 L) Melton Branch 1	White Oak Creek[b]	White Oak Dam[c]	Clinch River	Average Ratio[d]
October	0.10	0.57	0.66	210	320
November	0.077	0.47	0.54	270	540
December	0.91	2.0	2.4	420	190

[a] See Fig. 4.

[b] WOC at confluence of MB.

[c] WOC at WOD.

[d] Flow ratios CR: WOC at WOD are calculated daily and averaged for the month.

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

Radionuclide	Flow (10^6 L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	Concentration Guide (DCG)[d] (Bq/L)	Percentage of DCG[e]
Melton Branch 1 (09/26-10/31)					
Co-60	120	*g*	-0.60	190	*g*
Cs-137	120	*g*	-0.40	110	*g*
Total Sr[f]	120	0.15	13*	37	35
H-3	120	290	25,000*	74,000	34
Sewage Treatment Plant (09/26-10/31)					
Co-60	27	*g*	0.20	190	*g*
Cs-137	27	*g*	0.50	110	*g*
Gross beta	27	0.015	5.6*	*g*	*g*
Total Sr[f]	27	0.0069	2.5*	37	6.8
White Oak Creek (09/26-10/31)					
Co-60	630	*g*	1.2	190	*g*
Cs-137	630	0.13	2.1*	110	1.9
Total Sr[f]	630	0.21	3.3*	37	8.9
H-3	630	120	1,900*	74,000	2.6
White Oak Dam[h] (10/01-11/01)					
Co-60	660	0.023	0.34*	190	0.18
Cs-137	660	0.17	2.6*	110	2.3
Gross alpha	660	0.018	0.27*	*g*	*g*
Gross beta	660	0.91	14*	*g*	*g*
White Oak Dam (09/26-10/31)					
Total Sr[f]	720	0.60	8.3*	37	22
H-3	720	370	5,100*	74,000	6.9

[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 significantly greater than zero are identified by an *.

[d] DCG for ingestion of water. From DOE Order 5400.5

[f] Total radioactive strontium (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 16. Radionuclide concentrations and releases at ORNL,[a] November 1990

Radionuclide	Flow (10^6 L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	Concentration Guide (DCG)[d] (Bq/L)	Percentage of DCG[e]
Melton Branch 1 (10/31-11/28)					
Co-60	68	[g]	-0.40	190	[g]
Cs-137	68	[g]	0.90	110	[g]
Total Sr[f]	68	0.11	16*	37	43
H-3	68	240	35,000*	74,000	47
Sewage Treatment Plant (10/31-11/30)					
Co-60	21	[g]	0.70	190	[g]
Cs-137	21	[g]	-1.0	110	[g]
Gross beta	21	0.012	5.6*	[g]	[g]
Total Sr[f]	21	0.0048	2.3*	37	6.2
White Oak Creek (10/31-11/28)					
Co-60	430	[g]	-2.2	190	[g]
Cs-137	430	0.060	1.4*	110	1.3
Total Sr[f]	430	0.16	3.6*	37	9.7
H-3	430	130	2,900*	74,000	3.9
White Oak Dam[h] (11/01-12/01)					
Co-60	540	0.018	0.33*	190	0.18
Cs-137	540	0.11	2.1*	110	1.9
Gross alpha	540	0.016	0.30*	[g]	[g]
Gross beta	540	0.94	17*	[g]	[g]
White Oak Dam (10/31-11/28)					
Total Sr[f]	490	0.30	6.1*	37	16
H-3	490	390	7,900*	74,000	11

[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 significantly greater than zero are identified by an *.

[d] DCG for ingestion of water. From DOE Order 5400.5

[f] Total radioactive strontium (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 17. Radionuclide concentrations and releases at ORNL,[a] December 1990.

Radionuclide	Flow (10^6 L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	Concentration Guide (DCG)[d] (Bq/L)	Percentage of DCG[e]
			Melton Branch 1 (11/28-12/28)		
Co-60	660	0.13	1.9*	190	1.0
Cs-137	660	0.073	1.1*	110	1.0
Total Sr[f]	660	0.60	9.1*	37	25
H-3	660	730	11,000*	74,000	15
			Sewage Treatment Plant (11/30-12/31)		
Co-60	28	*g*	0.13	190	*g*
Cs-137	28	*g*	0.16	110	*g*
Gross beta	28	0.052	19*	*g*	*g*
Total Sr[f]	28	0.028	10*	37	27
			White Oak Creek (11/28-12/28)		
Co-60	1,500	*g*	-0.010	190	*g*
Cs-137	1,500	5.0	33*	110	30
Total Sr[f]	1,500	1.4	9.1*	37	25
H-3	1,500	450	3,000*	74,000	4.1
			White Oak Dam[h] (12/01-01/01)		
Co-60	2,400	0.083	0.34*	190	0.18
Cs-137	2,400	2.0	8.4*	110	7.6
Gross alpha	2,400	0.050	0.21*	*g*	*g*
Gross beta	2,400	3.9	16*	*g*	*g*
			White Oak Dam (11/28-12/27)		
Total Sr[f]	1,700	1.2	6.9*	37	19
H-3	1,700	850	5,100*	74,000	6.9

[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] DCG for ingestion of water. From DOE Order 5400.5

[f] Total radioactive strontium (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.

observed there. All other radionuclide concentrations reported this quarter for MB1, WOC and WOD are lower than past two-year maxima.

Total radioactive strontium concentrations at MB1 appear to have been increasing slightly over the past two years; however, concentrations were fairly constant during this quarter. There is evidence of seasonality in total radioactive strontium at these three stations, a tendency for higher values in the winter and spring and lower values in the summer and fall.

Tritium concentrations 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 that time, there was a clear seasonal trend at WOD with higher values in the winter and spring and lower values in the summer and fall.

Cobalt-60 and Cs-137 concentrations appear to be reasonably stable over time at MB1, WOC, and WOD except for the December anomalies described earlier.

Total radioactive strontium concentrations in First Creek have decreased since 1988 (27 Bq/L average concentration in 1988 to around 11 Bq/L in 1990) 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 MHD above ORNL's discharge point into the CR (Fig. 4). The other sample location is WOC headwaters above the point where ORNL discharges to WOC (Fig. 4). Analyses were performed to detect classical, inorganic, and organic pollutants in the water. Classical pollutants are indicated by conductivity, temperature, turbidity, pH, total dissolved solids, suspended solids, and oil and grease (O&G). Inorganic parameters are indicated by metal and anion analysis. The presence of organic pollutants is based on the total organic carbon (TOC) analysis. If significant amounts of TOC are detected, a more complete organic analysis is performed.

The inorganics, O&G, 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 18. The column "percent DWL" is included to show the average concentration as a percentage of the National Primary or Secondary Drinking Water Regulation level (DWL) 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 1.5 mg/L. Most inorganic compounds were also below the National Primary and Secondary Drinking Water regulation levels

Table 18. Surface water analyses at reference locations, October-December 1990

		Concentration (mg/L)				
Parameter	Number of Samples	Max	Min	Av	Standard Error	Percent[a] DWL
Melton Hill Dam[b]						
Aluminum-total	3	0.61	<0.050	<0.42	0.19	
Antimony-total	3	<0.050	<0.050	<0.050	0	
Arsenic-total	3	<0.010	<0.010	<0.010	0	<20
Barium-total	3	0.038	<0.0010	<0.023	0.011	<2.3
Beryllium-total	3	<0.0003	<0.0003	<0.0003	0	
Boron-total	3	<0.080	<0.080	<0.080	0	
Cadmium-total	3	<0.0050	<0.0050	<0.0050	0	<50
Calcium-total	3	40	36	38	1.2	
Chromium-total	3	0.0072	0.0045	0.0055	0.00085	11
Cobalt-total	3	<0.0040	<0.0040	<0.0040	0	
Copper-total	3	0.015	<0.0070	<0.0097	0.0027	<0.96
Dissolved solids-total	3	160	130	140	10	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Iron-total	3	0.79	<0.050	<0.52	0.23	<172
Lead-total	3	<0.050	<0.050	<0.050	0	<100
Lithium-total	3	<15	<15	<15	0	
Magnesium-total	3	11	9.8	10	0.37	
Manganese-total	3	0.56	0.0060	0.19	0.18	384
Molybdenum-total	3	<0.040	<0.040	<0.040	0	
Nickel-total	3	<0.0040	<0.0040	<0.0040	0	
Nitrate	3	<5.0	<5.0	<5.0	0	<50
Oil and grease	3	2.0	<2.0	<2.0	0	
Organic carbon-total	3	1.9	1.7	1.8	0.058	
Phosphorus-total	3	1.8	<0.30	<0.80	0.50	
Selenium-total	3	0.0050	<0.0050	<0.0050	0	<50
Silicon-total	3	3.7	2.3	3.0	0.41	
Silver-total	3	<0.0050	<0.0050	<0.0050	0	<10
Sodium-total	3	5.5	<5.0	<5.2	0.17	
Strontium-total	3	0.096	0.095	0.096	0.00033	
Sulfate (as SO4)	3	24	18	20	2.0	8.0
Suspended solids-total	3	22	<5.0	<15	5.0	
Tin-total	3	<0.050	<0.050	<0.050	0	
Titanium-total	3	<0.020	<0.020	<0.020	0	
Vanadium-total	3	<0.0020	<0.0020	<0.0020	0	
Zinc-total	3	0.020	<0.0050	<0.010	0.0049	<0.20
Zirconium-total	3	<0.020	<0.020	<0.020	0	

Table 18. (continued)

Parameter	Number of Samples	Concentration (mg/L)				
		Max	Min	Av	Standard Error	Percent[a] DWL
Conductivity, mS/cm	3	1.7	0.10	0.66	0.52	
Oxygen-dissolved	3	11	7.0	9.2	1.1	
Temperature, oC	3	23	12	17	3.2	
Turbidity, JTU	3	170	7.0	62	54	
pH, standard units	3	7.9	7.2	7.6	0.22	
White Oak Creek[b]						
Aluminum-total	3	0.77	<0.050	<0.30	0.23	
Antimony-total	3	<0.050	<0.050	<0.050	0	
Arsenic-total	3	<0.010	<0.010	<0.010	0	<20
Barium-total	3	0.085	<0.0010	<0.056	0.027	<5.5
Beryllium-total	3	<0.0003	<0.0003	<0.0003	0	
Boron-total	3	<0.080	<0.080	<0.080	0	
Cadmium-total	3	<0.0050	<0.0050	<0.0050	0	<50
Calcium-total	3	31	19	26	3.6	
Chromium-total	3	0.0070	<0.0040	<0.0059	0.00097	<11
Cobalt-total	3	<0.0040	<0.0040	<0.0040	0	
Copper-total	3	0.011	<0.0070	<0.0083	0.0013	<0.83
Dissolved solids-total	3	160	84	130	22	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Iron-total	3	0.90	0.12	0.43	0.24	142
Lead-total	3	<0.050	<0.050	<0.050	0	<100
Lithium-total	3	<15	<15	<15	0	
Magnesium-total	3	14	8.3	12	1.9	
Manganese-total	3	0.17	<0.010	<0.11	0.049	<212
Molybdenum-total	3	<0.040	<0.040	<0.040	0	
Nickel-total	3	<0.0040	<0.0040	<0.0040	0	
Nitrate	3	<5.0	<5.0	<5.0	0	<50
Oil and grease	3	<2.0	<2.0	<2.0	0	
Organic carbon-total	3	1.3	0.80	1.1	0.15	
Phosphorus-total	3	<0.30	<0.30	<0.30	0	
Selenium-total	3	<0.0050	<0.0050	<0.0050	0	<50
Silicon-total	3	4.3	3.5	3.8	0.27	
Silver-total	3	<0.0050	<0.0050	<0.0050	0	<10
Sodium-total	3	<5.0	<5.0	<5.0	0	
Strontium-total	3	0.034	0.022	0.030	0.0038	
Sulfate (as SO4)	3	<5.0	<5.0	<5.0	0	<2.0
Suspended solids-total	3	27	<5.0	<16	6.4	

Table 18. (continued)

		Concentration (mg/L)				
Parameter	Number of Samples	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	<0.0020	<0.0020	<0.0020	0	
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	1.7	0.060	0.75	0.49	
Oxygen-dissolved	3	12	6.7	9.8	1.6	
Temperature, oC	3	20	8.6	13	3.9	
Turbidity, JTU	3	170	15	79	48	
pH, standard units	3	8.0	7.5	7.7	0.15	

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

[b] See Fig 4.

(DWL). Exceptions to this were iron and manganese. The concentration of iron at these reference locations has been consistently high for all sampling periods. The average concentration of iron at MHD was <172% of the National Secondary Drinking Water Limit, and at WOC this figure was 142%. The average concentration of manganese was 384% at MHD and <212% at WOC. The other parameters for which DWL limits exist were <100% of the applicable DWL guide.

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 dilution 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 average values for the quarter, to the historic concentrations of these pollutants at the same locations for the last two years. In the current quarter, turbidity has exceeded the highest average value recorded for MHD and WOC. All other parameters are below previously recorded average values.

3.3 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REQUIREMENTS

Pamela Y. Goldberg and Charles K. Valentine, Jr.

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. There are ambient sampling points that are located in the streams as reference points or for additional information. Effluent discharge from the Vehicle Cleaning Facility (VC7002) was discontinued on March 8, 1990, pending resolution of the investigation.

Quarterly summary statistics for the fourth quarter of 1990 are given for each sampling location in Tables 19 through 29. The minimum value for methylene chloride at the Nonradiological Wastewater Treatment Plant (X12) reflects a prefix of JB, which represents the fact that methylene chloride was estimated and found in the 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 30 through 32. A brief summary of the noncompliances follows.

3.3.2 Noncompliances

3.3.2.1 October 1990

3.3.2.1.1 Exceedences of NPDES Permit Limits

On October 4, 1990 during rainfall the storm water runoff being conveyed through Outfall 234 was noted by ORNL personnel to place a visible sheen on the surface of the discharge ditch which receives this effluent. Because the ditch enters the receiving stream of WOC in a wooded area and in a turbulent fashion, it could not be discerned that a sheen was placed on the receiving stream itself. However, the appearance of the Outfall 234 effluent is considered to warrant reporting as an NPDES exceedence. Outfall 234 conveys storm water runoff from the ORNL 7000 Area, which includes ORNL vehicle maintenance, refueling, and materials receiving and storage areas. The 7000 area was inspected at length as soon as the sheen was discovered. However, no discrete source of oil discharge to storm drains was found. Therefore, the sheen was attributed to accumulated O&G being conveyed from the overall 7000 Area by storm water runoff.

3.3.2.1.2 Inappropriate and/or Unpermitted Discharges

On October 2, 1990, ORNL personnel noted evidence of waste concrete and/or wash water having been disposed of at a storm drain catch basin for Outfall 302. Although the estimated quantity disposed was small (around 2 gal) and no discernable effect was noted in the receiving stream, this is considered an exceedence of permit conditions in terms of inappropriate or unpermitted discharge. ORNL personnel were unable to locate the individual(s) responsible for the discharge. Workers at ORNL construction areas where concrete was being used on October 2 were reminded that discharges of any waste materials to storm drains, including waste concrete or concrete washwater, are Clean Water Act violations and are prohibited.

On October 6, 1990, a whitish discoloration was noted in WOC that was traced back to Outfall 227 which conveys storm drainage and building sump drainage from around Building 5500, the High Voltage Accelerator Laboratory. Further investigation revealed that wastewater from janitorial work (floor wax stripping) inside Building 5500 had been disposed of in a janitor's sink that was then dye-tested and found to be inappropriately piped to drain into the storm sewer system. In August 1990, a facility-wide memorandum was issued at ORNL requesting all available information on potentially inappropriate drain system tie-ins and requiring that usage of any sinks, etc., that do not drain to an appropriate wastewater treatment facility be discontinued immediately upon discovery. Accordingly, the janitor's sink in Building 5500 was taken out of service on October 6 until its drain is reconfigured to discharge into the sanitary sewer system.

During a recent environmental audit, three facilities were discovered at ORNL that discharged wastewater either into ORNL receiving streams or onto the ground surface near receiving streams that are not listed on the NPDES permit. These are discussed below:

Table 19. NPDES discharge point X01[a], October-December 1990

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Ammonia (as N)	39	3.6	0.010	0.21	0.11
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	0.28	0.10	0.17	0.0083
Copper-total	3	0.010	<0.0070	<0.0080	0.0010
Cyanide-total	3	<0.0020	<0.0020	<0.0020	0
Downstream pH, standard units	13	8.0	7.2	NA[c]	NA
Fecal coliform, col/100 mL[d]	39	>600	<1.0	<28	18
Flow, Mgd	62	0.49	0.10	0.21	0.0074
Mercury-total	3	0.00010	<0.00005	<0.000067	0.000017
Oil and grease	39	24	<2.0	<2.6	0.56
Oxygen-dissolved	62	18	4.5	8.5	0.24
pH, standard units	13	7.7	7.2	NA	NA
Recoverable phenolics-total	3	<0.0010	<0.0010	<0.0010	0
Silver-total	3	<0.0050	<0.0050	<0.0050	0
Suspended solids-total	39	11	<5.0	<5.4	0.22
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Zinc-total	3	0.054	0.0091	0.038	0.015

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

Table 20. NPDES discharge point X02,[a] October-December 1990

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Arsenic-total	13	0.071	<0.050	<0.055	0.0025
Cadmium-total	13	<0.0050	<0.0050	<0.0050	0
Chromium-total	13	0.017	0.0087	0.012	0.00064
Copper-total	13	0.015	<0.0070	<0.0098	0.00073
Downstream pH, standard units	62	8.2	7.0	NA[c]	NA
Flow, Mgd	62	0.070	0	0.0098	0.0019
Iron-total	13	1.3	<0.050	<0.27	0.093
Lead-total	13	<0.050	<0.050	<0.050	0
Manganese-total	13	0.23	0.0044	0.074	0.018
Nickel-total	13	0.014	<0.0040	<0.0070	0.00097
Oil and grease	13	<2.0	<2.0	<2.0	0
pH, standard units	62	11	6.7	NA	NA
Selenium-total	13	0.14	0.040	0.078	0.0088
Silver-total	13	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO_4)	3	1600	19	980	490
Suspended solids-total	13	27	<5.0	<9.2	2.1
Temperature, °C	62	24	5.2	14	0.63
Zinc-total	13	0.035	<0.0050	<0.014	0.0025

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

Table 21. NPDES discharge point X12,[a] October-December 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	<0.0050	<0.0050	<0.0050	0
Chlorobenzene	13	<0.0050	<0.0050	<0.0050	0
Chloroform	13	<0.0050	~0.0010	~0.0042	0.00045
Chromium-total	13	0.018	<0.0040	<0.0059	0.0011
Copper-total	13	0.021	<0.0070	<0.0091	0.0011
Cyanide-total	13	0.0020	0.0010	0.0019	0.000077
Downstream pH, standard units	62	8.2	7.2	NA[c]	NA
Flow, Mgd	62	0.62	0.24	0.43	0.0090
Fluoride-total	13	<5.0	<1.0	<1.7	0.41
Iron-total	13	<0.050	<0.050	<0.050	0
Lead-total	13	<0.050	<0.050	<0.050	0
Mercury-total	13	0.00020	<0.00005	<0.000068	0.000013
Methylene chloride[d]	13	<0.0050	JB0.0010	~0.0044	0.00042
Nickel-total	13	0.0091	<0.0040	<0.0045	0.00041
Nitrate	13	7.0	1.2	5.0	0.36
Oil and grease	13	2.0	<2.0	<2.0	0
pH, standard units	[e]	8.8	6.9	NA	NA
Phosphorus-total	13	1.0	0.20	0.44	0.059
Recoverable phenolics-total	13	<0.0010	<0.0010	<0.0010	0
Selenium-total	13	<0.050	<0.050	<0.050	0
Silver-total	13	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO_4)	13	440	98	170	26
Suspended solids-total	13	<5.0	<5.0	<5.0	0
Temperature, °C	62	25	13	19	0.39
Tetrachloroethene	13	<0.0050	<0.0050	<0.0050	0
Total toxic organics	13	<0.010	<0.010	<0.010	0
Trichloroethene	13	<0.0050	<0.0050	<0.0050	0
Zinc-total	13	0.097	<0.0050	<0.033	0.0076

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[a] See Fig. 6.

[b] Standard error of the mean.

[c] NA = not applicable.

[d] JB means that the minimum value of methylene chloride was estimated and found in the blank.

[e] pH monitoring is continuous.

Table 22. NPDES discharge point X13,[a] October-December 1990

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Aluminum-total	3	0.10	<0.050	<0.067	0.017
Ammonia (as N)	3	0.050	0.020	0.030	0.010
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	0.010	0.0073	0.0088	0.00079
Conductivity, mS/cm	3	2.4	1.8	2.1	0.17
Copper-total	3	0.010	<0.0070	<0.0080	0.0010
Dissolved solids-total	3	530	330	450	61
Flow, Mgd	62	39	0.35	2.4	0.75
Fluoride-total	3	3.0	1.6	2.1	0.45
Iron-total	3	0.31	0.14	0.22	0.050
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.13	0.064	0.10	0.021
Mercury-total	3	0.00010	<0.00005	<0.000067	0.000017
Nickel-total	3	<0.0040	<0.0040	<0.0040	0
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	10	<2.0	<3.0	0.70
Organic carbon-total	3	3.7	3.1	3.4	0.17
Oxygen-dissolved	13	19	7.2	9.8	0.85
PCB-total	3	<0.0020	<0.0020	<0.0020	0
pH, standard units	3	7.6	7.4	NA[c]	NA
Phosphorus-total	3	1.7	0.51	0.94	0.38
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	1900	140	750	580
Suspended solids-total	3	11	<5.0	<7.0	2.0
Temperature, °C	16	22	6.1	14	1.1
Trichloroethene	3	<0.0050	~0.0020	~0.0040	0.0010
Turbidity, JTU[d]	3	35	5.0	20	8.7
Zinc-total	3	0.017	0.0081	0.012	0.0026

[a] See Fig. 6.
[b] Standard error of the mean.
[c] NA = not applicable.
[d] Measured in Jackson turbidity uUnits.

Table 23. NPDES discharge point X14,[a] October-December 1990

		Concentration (mg/L)			
Parameter	Number of samples	Max	Min	Av	Standard error[b]
Aluminum-total	3	0.55	0.16	0.35	0.11
Ammonia (as N)	3	0.040	0.010	0.030	0.010
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	~0.0040	0.00058
Chromium-total	3	0.0054	0.0044	0.0051	0.00033
Conductivity, mS/cm	3	1.7	0.90	1.4	0.25
Copper-total	3	0.014	<0.0070	<0.0093	0.0023
Dissolved solids-total	3	240	180	210	19
Flow, Mgd	62	62	3.2	7.6	1.3
Fluoride-total	3	1.2	<1.0	<1.1	0.067
Iron-total	3	0.70	0.24	0.50	0.14
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.091	0.046	0.066	0.013
Mercury-total	3	0.00022	<0.00005	<0.00011	0.000057
Nickel-total	3	<0.0040	<0.0040	<0.0040	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	2.2	1.6	1.9	0.17
Oxygen-dissolved	13	20	7.1	10	0.92
PCB-total	3	<0.0020	<0.0020	<0.0020	0
pH, standard units	3	7.9	7.7	NA[c]	NA
Phosphorus-total	3	1.4	0.40	0.77	0.32
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	39	22	30	4.9
Suspended solids-total	3	34	5.0	21	8.5
Temperature, °C	16	23	9.1	16	0.88
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU[d]	3	55	4.0	23	16
Zinc-total	3	0.050	0.028	0.040	0.0064

[a] See Fig. 6.

[b] Standard error of the mean.

[c] NA = not applicable.

[d] Measured in Jackson turbidity units.

Table 24. NPDES discharge point X15,[a] October-December 1990

Parameter	Number of samples	Concentration (mg/L)			
		Max	Min	Av	Standard error[b]
Aluminum-total	3	0.56	<0.050	<0.32	0.15
Ammonia (as N)	3	0.13	0.020	0.060	0.035
Arsenic-total	4	<0.050	<0.010	<0.020	0.010
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	0.018	0.0044	0.012	0.0040
Conductivity, mS/cm	3	1.8	1.0	1.5	0.25
Copper-total	3	0.018	<0.0070	<0.011	0.0037
Dissolved solids-total	3	260	220	240	13
Flow, Mgd	62	67	3.5	9.2	1.5
Fluoride-total	3	1.0	<1.0	<1.0	0
Iron-total	3	0.86	<0.050	<0.51	0.24
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	6	0.13	<0.0010	<0.075	0.023
Mercury-total	3	0.00006	<0.00005	<0.000053	3.3E-6
Nickel-total	3	<0.0040	<0.0040	<0.0040	0
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	53	<2.0	<6.8	4.0
Organic carbon-total	3	3.5	2.1	2.9	0.43
Oxygen-dissolved	13	21	7.6	9.2	0.97
PCB-total	3	<0.0020	<0.0020	<0.0020	0
pH, standard units	3	7.6	7.4	NA[c]	NA
Phosphorus-total	3	0.60	0.30	0.49	0.094
Silver-total	3	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO_4)	3	67	36	54	9.3
Suspended solids-total	3	27	<5.0	<14	6.6
Temperature, °C	16	22	7.3	14	1.0
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Turbidity, JTU[d]	3	60	9.0	28	16
Zinc-total	3	0.074	0.011	0.039	0.019

[a] See Fig. 6.
[b] Standard error of the mean.
[c] NA - not applicable.
[d] Measured in Jackson turbidity units.

Table 25. NPDES cooling towers,[a] October-December 1990

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Chlorine-total residual	9	0.16	<0.010	<0.027	0.017
Chromium-total	8	0.020	0.0054	0.012	0.0017
Copper-total	8	0.052	<0.0070	<0.019	0.0055
Downstream pH, standard units	8	8.2	7.0	NA[c]	NA
Flow, Mgd	8	0.19	0.0042	0.053	0.029
pH, standard units	8	8.5	7.4	NA	NA
Temperature, °C	8	33	12	23	2.0
Zinc-total	8	0.30	0.061	0.19	0.033

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

Table 26. NPDES miscellaneous outfalls, October-December 1990

Parameter	Concentration (mg/L) EF7002[a]	SP2519[b]
Flow, Mgd	NO DISCHARGE	0.000094
pH, standard units	NO DISCHARGE	8.8
Temperature, °C	NO DISCHARGE	20

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

Table 27. NPDES discharge point category I outfalls,[a] October-December 1990

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
pH, standard units	1	7.3	7.3	NA[c]	NA
Suspended solids-total	1	48	48	48	
Temperature, °C	1	12	12	12	

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

Table 28. NPDES discharge point category II outfalls,[a] October-December 1990

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Downstream pH, standard units	43	8.3	7.2	NA[c]	NA
Flow, Mgd	43	0.17	0.00013	0.030	0.0067
Gross beta, Bq/L	43	12	-0.12	0.70[d]	0.30
Oil and grease	43	120	<2.0	<8.8	3.2
pH, standard units	43	9.0	7.2	NA	NA
Suspended solids-total	43	35	<5.0	<8.3	1.1
Temperature, °C	43	41	14	20	0.96

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

Table 29. NPDES discharge point category III outfalls,[a] October-December 1990

Parameter	Number of samples	Concentration (mg/L) Max	Min	Av	Standard error[b]
Flow, Mgd	14	0.17	0.00072	0.041	0.016
pH, standard units	14	8.2	7.4	NA[c]	NA

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

Table 30. NPDES noncompliances, October 1990

During the period of October 1-31, 1990, ORNL experienced seven noncompliances. The noncompliances that occurred were not NPDES permit limit exceedences but rather the result of inappropriate and/or unpermitted discharges. Please reference the NPDES text section for explanations on the October noncompliances.

Table 31. NPDES noncompliances, November 1990

Permit Location	Limit Violated	Limit			Value
Sewage Treatment Plant (X01)	Oil and grease	15	mg/L	daily max	24
	Oil and grease	13.1	kg/D	daily max	15.5
	Fecal Coliform	5000	mg/L	daily max	> 600[a]
Category II Outfall 209	Oil and grease	15	mg/L	daily max	42
Category II Outfall 226	Oil and grease	15	mg/L	daily max	56
Category II Outfall 231	Oil and grease	15	mg/L	daily max	26
Category II Outfall 264	Oil and grease	15	mg/L	daily max	44
Category II Outfall 268	Oil and grease	15	mg/L	daily max	117

[a] See text in Sect. 3.3.2.2 for discussion.

Table 32. NPDES noncompliances, December 1990

Permit Location	Limit Violated	Limit			Value
Sewage Treatment Plant (X01)	Dissolved Oxygen	6.0	mg/L	daily min	4.5
Coal Yard Runoff Facility (X02)	Iron	1.0	mg/L	daily max	1.3
	pH	9.0	SU	daily max	10.8
	pH	9.0	SU	daily max	11.0
	pH	9.0	SU	daily max	9.1

On October 24, 1990, it was discovered that backwash water from sand filters and charcoal filters used to filter well water and potable water for use in Building 1504 Aquatics Lab aquaria are discharged to NWT via the storm drain system. These discharges are currently being characterized. Applications requesting that these be added to the ORNL NPDES permit will be submitted to the Tennessee Department of Health and Environment (TDHE) as soon as possible.

On October 26, 1990, it was discovered that wastewater from rinsing soil from plant samples was discharged to the ground surface adjacent to the Building 1506 Plant Sciences Laboratory. This practice has been discontinued pending development of a filtration system for this wastewater discharge.

On October 27, 1990, it was discovered that an oil separator associated with the 901 Electrical Substation north of ORNL was discharging storm water runoff to the ground surface approximately 75 yards east of Fifth Creek. Because the facility is the responsibility of K-25 Utilities, K-25 personnel have plugged the discharge point, restoring the proper function of the separator. When the separator is again discharging properly, the discharge will be characterized and an application requesting that this discharge be added to the ORNL NPDES permit will be submitted to TDHE as soon as possible.

On October 28, 1990, a leaking plug in an abandoned drain pipeline resulted in a release of heating oil estimated at up to one quart to the ORNL storm drain system. A portion of the oil reached WOC, temporarily placing a slight sheen on a portion of the creek. Oil-absorbent booms were placed in the storm drainage ditch and in WOC, capturing the released oil. The leaking drain plug was repaired immediately, and the floor drain inlet through which the release occurred was sealed with a solid cover.

3.3.2.2 November 1990

The O&G exceedence that occurred at the STP on November 19, 1990, was investigated, but no clear cause was determined. No upsets or unusual operating conditions were present at or around the time of the exceedence, and no additional O&G exceedences occurred at the STP after that date.

The fecal coliform exceedence was only a technical exceedence in that the analytical method did not provide adequate information for a determination of compliance to be made. There is no evidence that noncompliance effluent was actually discharged in that instance. A memorandum was issued to the analytical laboratory staff confirming the analytical requirements for determining compliance with the STP fecal coliform discharge limit on December 6, 1990.

The O&G exceedences that were noted at several Category II outfall (parking lot, roof, storage area, and cooling water) drains were attributed to storm water conveyance of residual O&G from the areas that are drained by these particular outfalls. With the exception of Outfall 268, which drains a gravel parking area, most of the areas involved are paved with asphalt.

3.3.2.3 December 1990

The dissolved oxygen exceedence that occurred at the STP on December 27, 1990, is attributed to heavy rainfall in the days preceding that date, which resulted in flood conditions in the area where the STP discharges to WOC. The flood conditions combined with heavy influent loading placed on the STP by the rain event resulted in temporary upset which temporarily impaired the effectiveness of that facility. The low dissolved oxygen level appears to have been a short-lived condition, and no further NPDES exceedences have been recorded at the STP since December 27.

The pH and iron limit exceedences that occurred at the Coal Yard Runoff Treatment Facility (CYRTF) on December 26, 27, and 28, 1990, are also attributed to the flood conditions that were experienced in that time frame. The CYRTF area was flooded and the treatment capabilities of that facility were temporarily impaired. Routine operation of the facility was restored after December 28 and no additional NPDES exceedences have been recorded at the CYRTF since that date.

3.4 POLYCHLORINATED BIPHENYL IN THE AQUATIC ENVIRONMENT

Michael R. Powell

3.4.1 Program Description

Water samples were collected from various locations along WOC, MB, NWT and the 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 October through December, 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 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 semiannually for the same aroclors as water. Two samples per site were taken for sediment during October through December 1990. Sediment samples are analyzed in addition to water because PCBs are relatively insoluble in water and tend to accumulate in stream sediments. There are currently no regulatory guidelines for PCB concentrations in stream sediment.

Sediment samples are also analyzed for TOC as indicators of the amounts of organic containing compounds being accumulated by the soil. Sediment samples, in addition to trapping organic contaminates, contain natural quantities of organic compounds. Results of TOC analyses are therefore compared to background concentrations to determine the presence of additional organic contamination. Results of TOC are then compared to the PCB analyses as confirmation of the presence of PCB in the sediment samples.

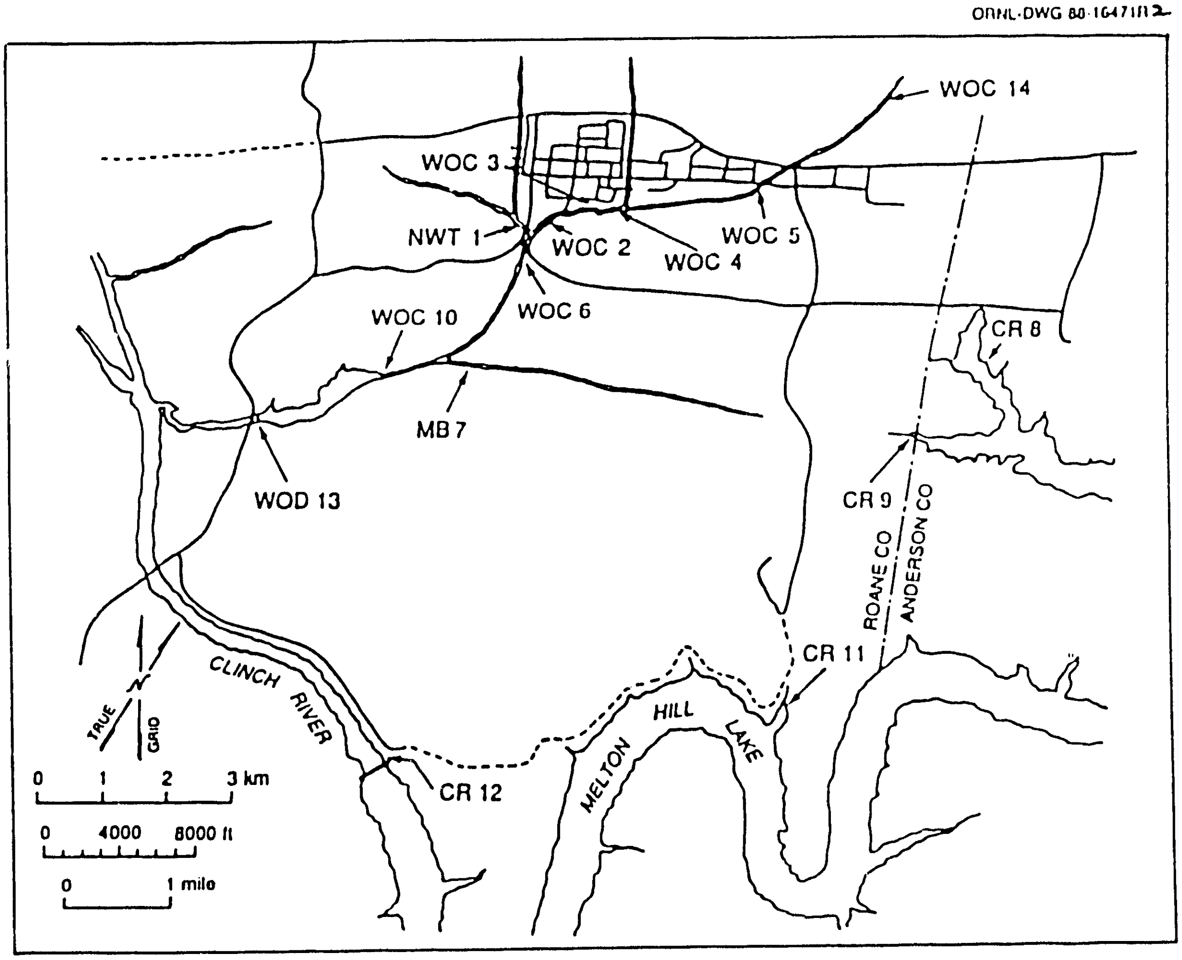

Fig. 7. Location map of PCB sampling points.

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 seven 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 October through December 1990 were below the analytical quantitation limit at all sampling sites. Analyses were performed for seven aroclors of PCB. The quantitation limit for PCB aroclors 1016, 1221, 1232, 1242, and 1248 is 0.5 μg/L in water and 1.0 μg/L for PCB aroclors 1254 and 1260. Sediment results are shown in Table 33. Quantitation limits vary for sediment samples. One location had results above detection limits for PCB in sediment. On WOC, station WOC6 had a maximum concentration of 390 μg/L for aroclor-1260. This location represents the area of maximum sediment deposition and collectively represents all potential releases. All other sediment samples were below detection limits.

3.4.3 Trends

Current trends in the concentration of PCB found at these sites are assessed by comparing the current average values to the historic concentration of PCB at the same locations for the last two years. All current average values for water and sediment samples remain below the highest average values for the last two years.

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 CWA and ORNL's 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

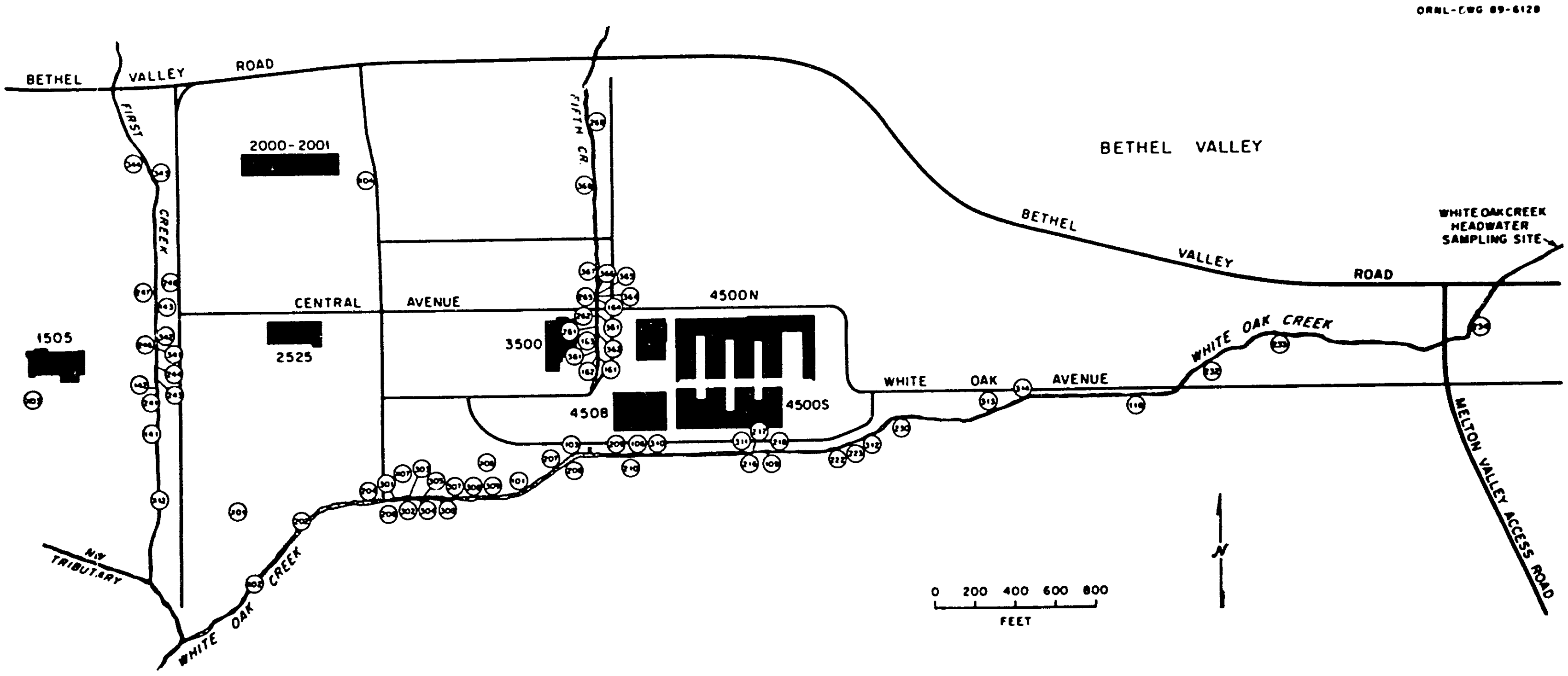

Fig. 8. Location map of mercury sampling points around ORNL in Bethel Valley.

Table 33. PCB concentrations in sediment, December 1990

Location[a]	Analysis	Number	Concentration (μg/Kg) Max	Min	Av	Standard Error[b]
WOC 6	Aroclor-1016	2	<110	<100	<100	4.0
	Aroclor-1221	2	<110	<100	<100	4.0
	Aroclor-1232	2	<110	<100	<100	4.0
	Aroclor-1242	2	<110	<100	<100	4.0
	Aroclor-1248	2	<110	<100	<100	4.0
	Aroclor-1254	2	<220	<200	<210	8.0
	Aroclor-1260	2	390	~130	~260	131
WOC 10	Aroclor-1016	2	<89	<89	<89	0
	Aroclor-1221	2	<89	<89	<89	0
	Aroclor-1232	2	<89	<89	<89	0
	Aroclor-1242	2	<89	<89	<89	0
	Aroclor-1248	2	<89	<89	<89	0
	Aroclor-1254	2	<89	<89	<89	0
	Aroclor-1260	2	<180	<180	<180	0
WOD 13	Aroclor-1016	2	<81	<81	<81	0
	Aroclor-1221	2	<81	<81	<81	0
	Aroclor-1232	2	<81	<81	<81	0
	Aroclor-1242	2	<81	<81	<81	0
	Aroclor-1248	2	<81	<81	<81	0
	Aroclor-1254	2	<160	<160	<160	0
	Aroclor-1260	2	<160	<160	<160	0
WOC 14	Aroclor-1016	2	<130	<130	<130	0
	Aroclor-1221	2	<130	<130	<130	0
	Aroclor-1232	2	<130	<130	<130	0
	Aroclor-1242	2	<130	<130	<130	0
	Aroclor-1248	2	<130	<130	<130	0
	Aroclor-1254	2	<250	<250	<250	0
	Aroclor-1260	2	<250	<250	<250	0
MB 7	Aroclor-1016	2	<100	<100	<100	0
	Aroclor-1221	2	<100	<100	<100	0
	Aroclor-1232	2	<100	<100	<100	0
	Aroclor-1242	2	<100	<100	<100	0
	Aroclor-1248	2	<100	<100	<100	0
	Aroclor-1254	2	<200	<200	<200	0
	Aroclor-1260	2	<200	<200	<200	0

Table 33. (continued)

Location[a]	Analysis	Number	Concentration (μg/Kg) Max	Min	Av	Standard Error[b]
CR 8	Aroclor-1016	2	<80	<80	<80	0
	Aroclor-1221	2	<80	<80	<80	0
	Aroclor-1232	2	<80	<80	<80	0
	Aroclor-1242	2	<80	<80	<80	0
	Aroclor-1248	2	<80	<80	<80	0
	Aroclor-1254	2	<80	<80	<80	0
	Aroclor-1260	2	<160	<160	<160	0
CR 9	Aroclor-1016	2	<83	<80	<82	1.5
	Aroclor-1221	2	<83	<80	<82	1.5
	Aroclor-1232	2	<83	<80	<82	1.5
	Aroclor-1242	2	<83	<80	<82	1.5
	Aroclor-1248	2	<83	<80	<82	1.5
	Aroclor-1254	2	<83	<80	<82	1.5
	Aroclor-1260	2	<170	<160	<160	3.5
CR 11	Aroclor-1016	2	<81	<80	<81	0.50
	Aroclor-1221	2	<81	<80	<81	0.50
	Aroclor-1232	2	<81	<80	<81	0.50
	Aroclor-1242	2	<81	<80	<81	0.50
	Aroclor-1248	2	<81	<80	<81	0.50
	Aroclor-1254	2	<160	<160	<160	1.0
	Aroclor-1260	2	<160	<160	<160	1.0
CR 12	Aroclor-1016	2	<89	<81	<85	4.0
	Aroclor-1221	2	<89	<81	<85	4.0
	Aroclor-1232	2	<89	<81	<85	4.0
	Aroclor-1242	2	<89	<81	<85	4.0
	Aroclor-1248	2	<89	<81	<85	4.0
	Aroclor-1254	2	<180	<160	<170	8.0
	Aroclor-1260	2	<180	<160	<170	8.0

[a] See Fig. 7.
[b] Standard error of the mean.

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 NWT; MB2UWE, which is located at the Melton Branch middle stream sampling site; MBUWOC and WOCD1S, which are located near the confluence of WOC and First Creek; WOCHWS, which is located at the WOC headwaters sampling site; and WOCU5T, which is located near the confluence of WOC and Fifth Creek.

A total of 258 surface water samples and 39 sediment samples were taken from 86 surface water locations and 13 sediment locations (Figs. 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 34 shows the maximum, minimum, and average concentrations in surface water for the period of July through December 1990. The standard error of the mean is also included. The proposed Tennessee Water Quality (TWQ) Standard for the protection of fish and aquatic life is 2.4 μg/L (ppb) for the acute criteria. The percentage TWQ column shows the average value as a percentage of this limit for each sampling location. The highest maximum values reported during this period were at locations 103, 208 and 7500. Sample 103, on WOC, had an average value of 0.15 μg/L, which is 6.1% of the TWQ standard. Sample 208, near the HTML and Fifth creek on WOC, had an average concentration of 0.11 μg/L, which is 4.4% of the TWQ standard. Sample 7500, on WOC, had an average value of <0.080 μg/L, which is <3.3% of the TWQ standard.

Table 35 shows the maximum, minimum, and average concentrations in sediment from the period of July through December of 1990. The standard error of the mean is also included. There is no established state or EPA standard for mercury in sediment. The current period had no detectable concentrations of mercury in sediment.

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 two years. In the current period, water and sediment samples have remained below the past two-year maximum and average values. Water results remain close to past values obtained at the same sampling sites. Some sediment results are much below historic values at some of the sampling points. This sudden drop

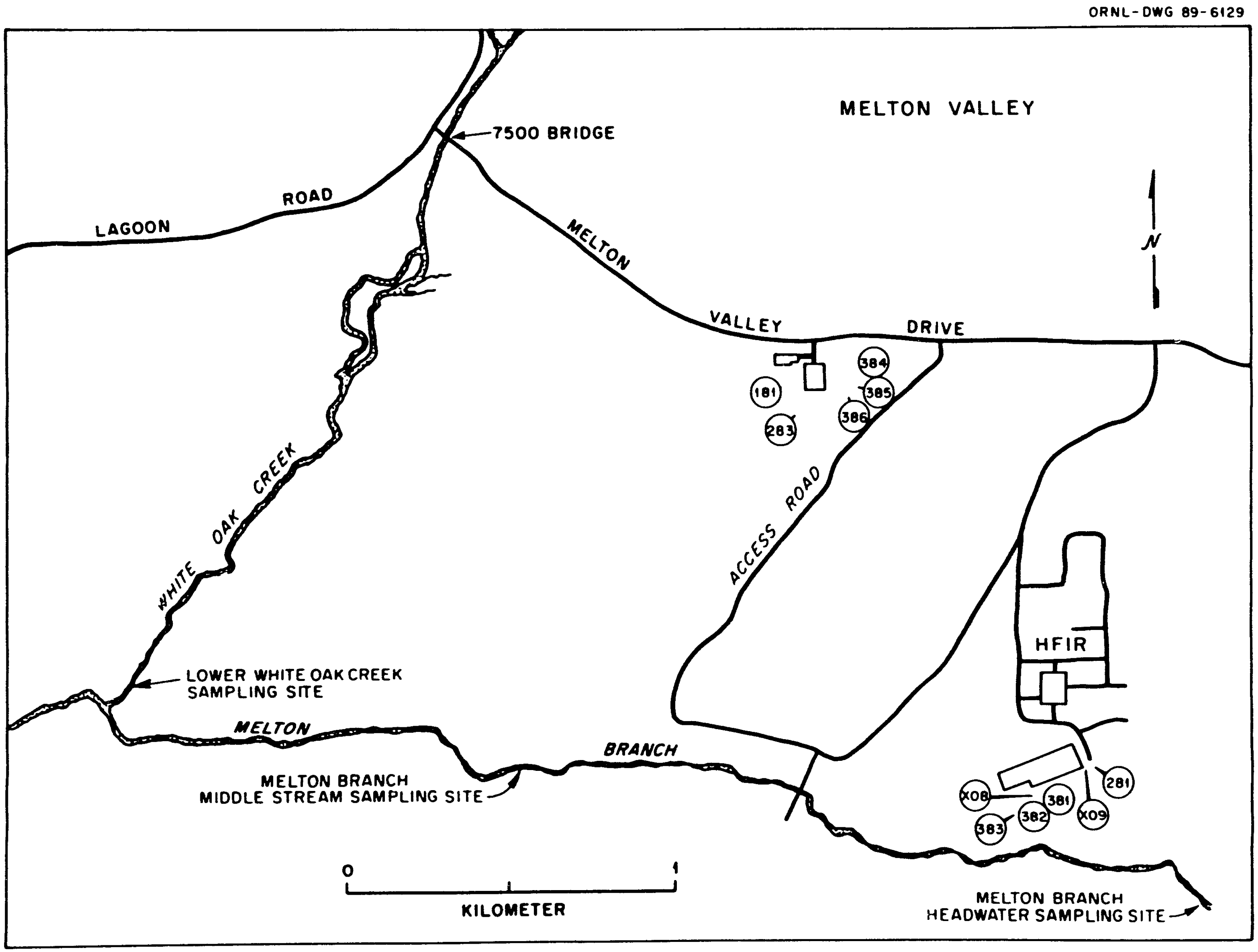

Fig. 9. Location map of mercury sampling points in Melton Valley.

Table 34. Mercury concentrations in ORNL area surface water[a], July-December 1990

Station	No. of Samples	Concentration (μg/L) Max	Min	Av	Standard[b] error	Percent[c] TWQ
		First Creek				
141	3	<0.050	<0.050	<0.050	0	<2.1
142	3	0.050	<0.050	<0.050	0	<2.1
143	3	<0.050	<0.050	<0.050	0	<2.1
241	3	<0.050	<0.050	<0.050	0	<2.1
243	3	0.050	0.050	0.050	0	2.1
244	3	0.050	0.050	0.050	0	2.1
246	3	0.050	<0.050	<0.050	0	<2.1
247	3	<0.050	<0.050	<0.050	0	<2.1
248	3	<0.050	<0.050	<0.050	0	<2.1
341	3	0.060	<0.050	<0.053	0.0033	<2.2
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	0.060	<0.050	<0.050	0.00024	<2.1
		Fifth Creek				
161	3	<0.050	<0.050	<0.050	0	<2.1
162	3	<0.050	<0.050	<0.050	0	<2.1
163	3	<0.050	<0.050	<0.050	0	<2.1
164	3	<0.050	<0.050	<0.050	0	<2.1
261	3	<0.050	<0.050	<0.050	0	<2.1
262	3	<0.050	<0.050	<0.050	0	<2.1
265	3	<0.050	<0.050	<0.050	0	<2.1
268	3	<0.050	<0.050	<0.050	0	<2.1
361	3	<0.050	<0.050	<0.050	0	<2.1
362	3	<0.050	<0.050	<0.050	0	<2.1
363	3	<0.050	<0.050	<0.050	0	<2.1
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	<0.050	<0.050	<0.050	0	<2.1
368	3	<0.050	<0.050	<0.050	0	<2.1
Stream summary	48	<0.050	<0.050	<0.050	0	<2.1

Table 34. (Continued)

Station	No. of Samples	Concentration (μg/L) Max	Min	Av	Standard[b] error	Percent[c] TWQ
		Melton Branch				
181	3	<0.050	<0.050	<0.050	0	<2.1
281	3	<0.050	<0.050	<0.050	0	<2.1
283	3	<0.050	<0.050	<0.050	0	<2.1
381	3	<0.050	<0.050	<0.050	0	<2.1
382	3	<0.050	<0.050	<0.050	0	<2.1
383	3	<0.050	<0.050	<0.050	0	<2.1
384	3	<0.050	<0.050	<0.050	0	<2.1
385	3	0.060	<0.050	<0.053	0.0033	<2.2
386	3	<0.050	<0.050	<0.050	0	<2.1
HDWTR	3	<0.050	<0.050	<0.050	0	<2.1
MBS	3	<0.050	<0.050	<0.050	0	<2.1
MHD	3	<0.050	<0.050	<0.050	0	<2.1
Stream summary	36	0.060	<0.050	<0.050	0.00028	<2.1
		White Oak Creek				
101	3	<0.050	<0.050	<0.050	0	<2.1
103	3	0.15	0.14	0.15	0.0033	6.1
106	3	0.050	0.050	0.050	0	2.1
109	3	<0.050	<0.050	<0.050	0	<2.1
116	3	<0.050	<0.050	<0.050	0	<2.1
202	3	0.050	<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	0.070	0.060	0.067	0.0033	2.8
208	3	0.11	0.10	0.11	0.0033	4.4
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

Table 34. (Continued)

Station	No. of Samples	Concentration (μg/L) Max	Min	Av	Standard[b] error	Percent[c] TWQ
		White Oak Creek (continued from previous page)				
234	3	<0.050	<0.050	<0.050	0	<2.1
301	3	<0.050	<0.050	<0.050	0	<2.1
302	3	<0.050	<0.050	<0.050	0	<2.1
303	3	<0.050	<0.050	<0.050	0	<2.1
304	3	<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	0.11	<0.050	<0.080	0.017	<3.3
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	0.060	0.050	0.053	0.0033	2.2
Stream summary	132	0.15	<0.050	<0.055	0.0015	<2.3
Overall summary	258	0.15	<0.050	<0.052	0.0027	<2.4

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[a] See Figs. 8 and 9.

[b] Standard error of the mean.

[c] Average concentration as a percentage of TWQ Standards for the protection of fish and aquatic life (2.4 μg/L).

Table 35. Mercury concentrations in ORNL stream sediment[a], December 1990

Station	Number of Samples	Concentration (μg/g) Max	 Min	 Av	Standard error[b]
		First Creek			
1STUNW	3	<0.51	<0.40	<0.44	0.035
NWTU1S	3	<0.38	<0.37	<0.37	0.0033
Stream summary	6	<0.51	<0.37	<0.41	0.022
		Fifth Creek			
2615TH	3	<0.47	<0.40	<0.42	0.023
3625TH	3	<0.47	<0.43	<0.45	0.012
Stream summary	6	<0.47	<0.40	<0.44	0.013
		Melton Branch			
MB2UWE	3	<0.50	<0.39	<0.44	0.032
MBHWSS	3	<0.51	<0.38	<0.45	0.038
Stream summary	6	<0.51	<0.38	<0.45	0.022
		White Oak Creek			
309WOC	3	<0.44	<0.43	<0.44	0.0033
WOCD1S	3	<0.45	<0.35	<0.39	0.031
WOCDMB	3	<0.45	<0.39	<0.42	0.017
WOCDWO	3	<0.41	<0.39	<0.40	0.0067
WOCHWS	3	<0.48	<0.42	<0.45	0.018
WOCU5T	3	<0.53	<0.38	<0.46	0.044
WOCUMB	3	<0.43	<0.38	<0.40	0.015
Stream summary	21	<0.53	<0.35	<0.42	0.0093
Overall summary	39	<0.53	<0.35	<0.43	0.0070

[a] See Fig. 8

[b] Standard error of the mean.

in mercury concentrations in sediment is thought to be connected to a change in the preparation method of the analytical technique. Investigation of this anomaly is currently under way and will be addressed in future reports.

3.6 GROUNDWATER

Regis S. Loffman and Dennis A. Wolf

Groundwater at ORNL is monitored to comply with 3004(U) of the Resource Conservation and Recovery Act (RCRA) and to meet data needs for remediation activities. Because of the large number of solid waste management units (SWMU) sites at ORNL located close to one another and the proven hydrologic inter-connections between many of these units, individual monitoring and assessment was shown to be impractical. Therefore, the concept of waste area groupings (WAGs) has been developed to evaluate potential sources of releases to the environment. A WAG is a group of multiple sites that are geographically contiguous and/or hydrologically defined areas, and each WAG contains small, distinct drainage areas within which similar contaminants may have been introduced.

Groundwater quality monitoring wells at ORNL are designated as up-gradient perimeter or down-gradient perimeter depending on their location relative to the general direction of groundwater flow. Up-gradient wells are located to provide groundwater samples that are not expected to be affected by possible leakage from the site. Down-gradient wells are positioned along the perimeter of the site to detect possible groundwater contaminant migration from the site.

Table 36 contains a listing of all of the analyses conducted on groundwater at ORNL in 1990. Not all parameters were quanitifed for each sample; however, Table 36 in conjunction with the sampling plan synopsis provided for each WAG can be used to determine the respective specific analyte lists.

3.6.1 WAG 1

3.6.1.1 Program Description

The sites at WAG 1 are currently remedial action sites regulated under RCRA 3004(u). ORNL previously sampled WAG 1 during 1988 and 1989 and has plans to continue sampling on a semiannual schedule.

WAG 1 consists of an area covering much of the ORNL main plant site (Figs. 10-14). It contains many types of SWMUs listed by EPA in the definition of a SWMU (tanks, ponds, waste water treatment facilities, leak sites, spill sites, landfills). A listing of the type and number of sites within WAG 1 is given in Table 37.

Parameters measured consisted of the toxic compound list for organics; metals by atomic absorption for As, Hg, K, Se, Se, and Tl; metals by ICP; anions (bromide, chloride, fluoride, nitrate, phosphate, and sulfate); total organic halides; total organic carbon; total dissolved solids; total suspended solids; alkalinity; total sulfide; total cyanide; total kjeldahl nitrogen; radionuclides (H-3, total radioactive Sr, gamma emitting isotopes, gross alpha, and gross beta); and field parameters (pH, specific conductance, and temperature).

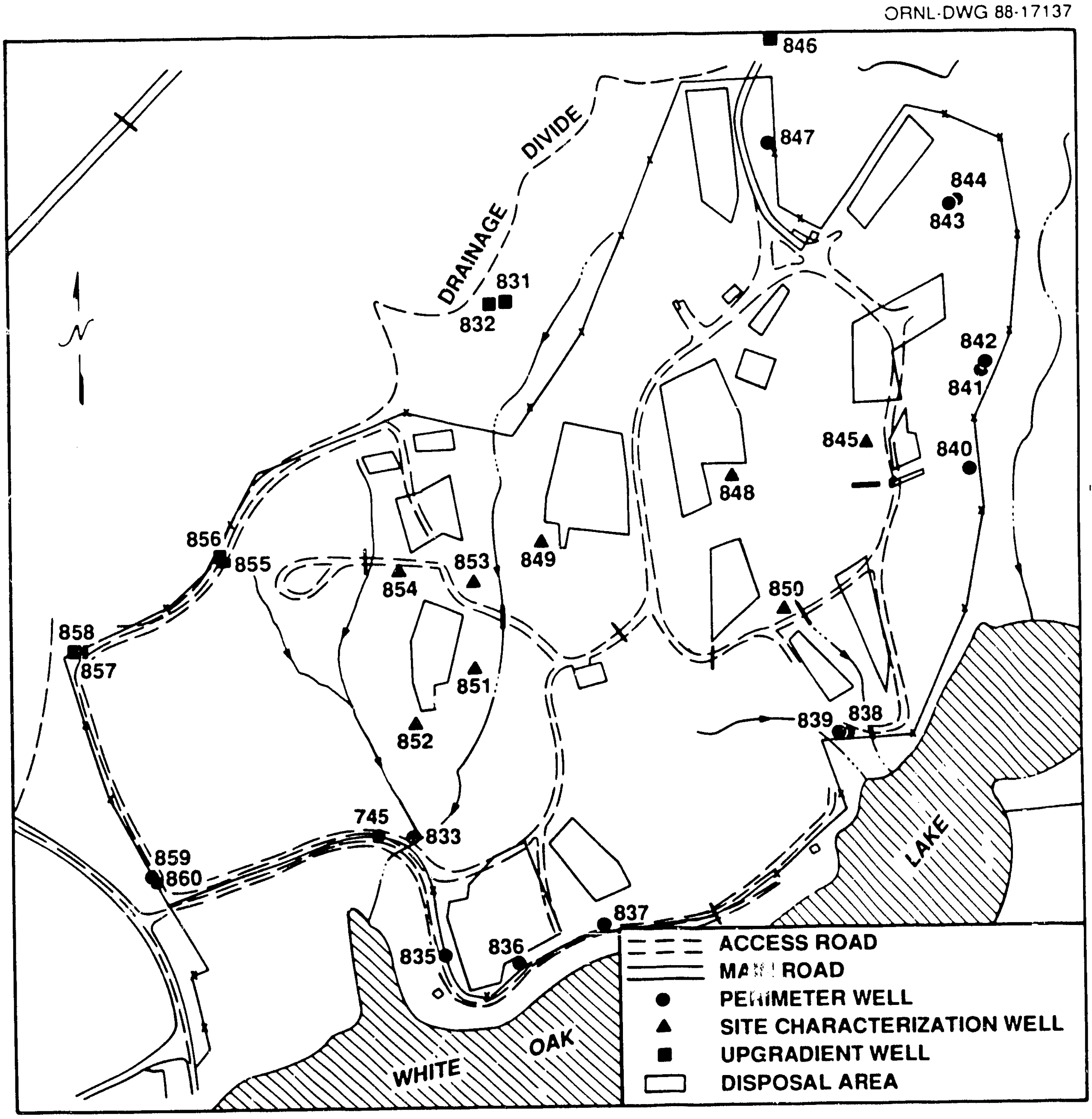

Fig. 10. Location map of ORNL waste area groupings.

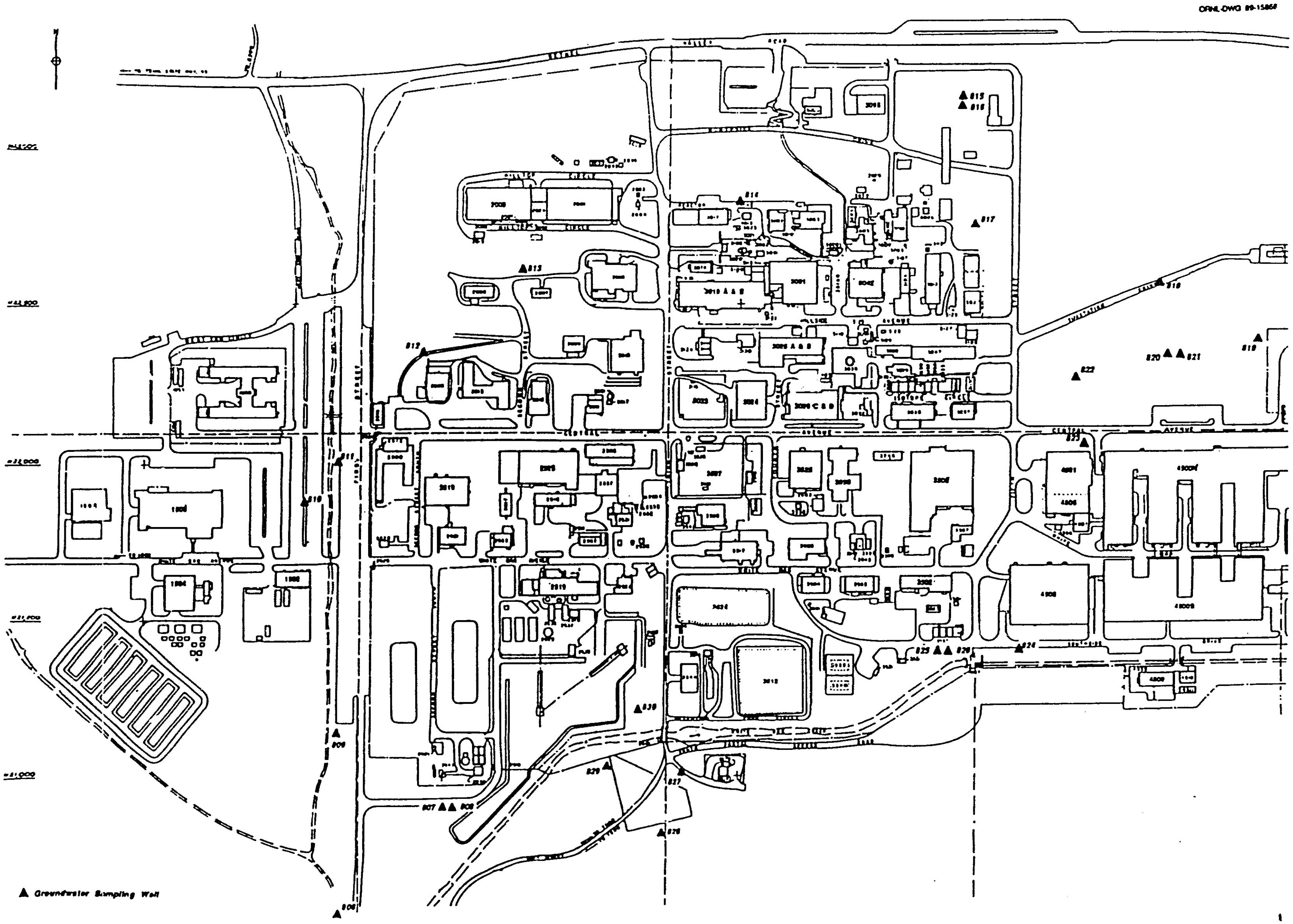

Fig. 11. Location map of WAG 1.

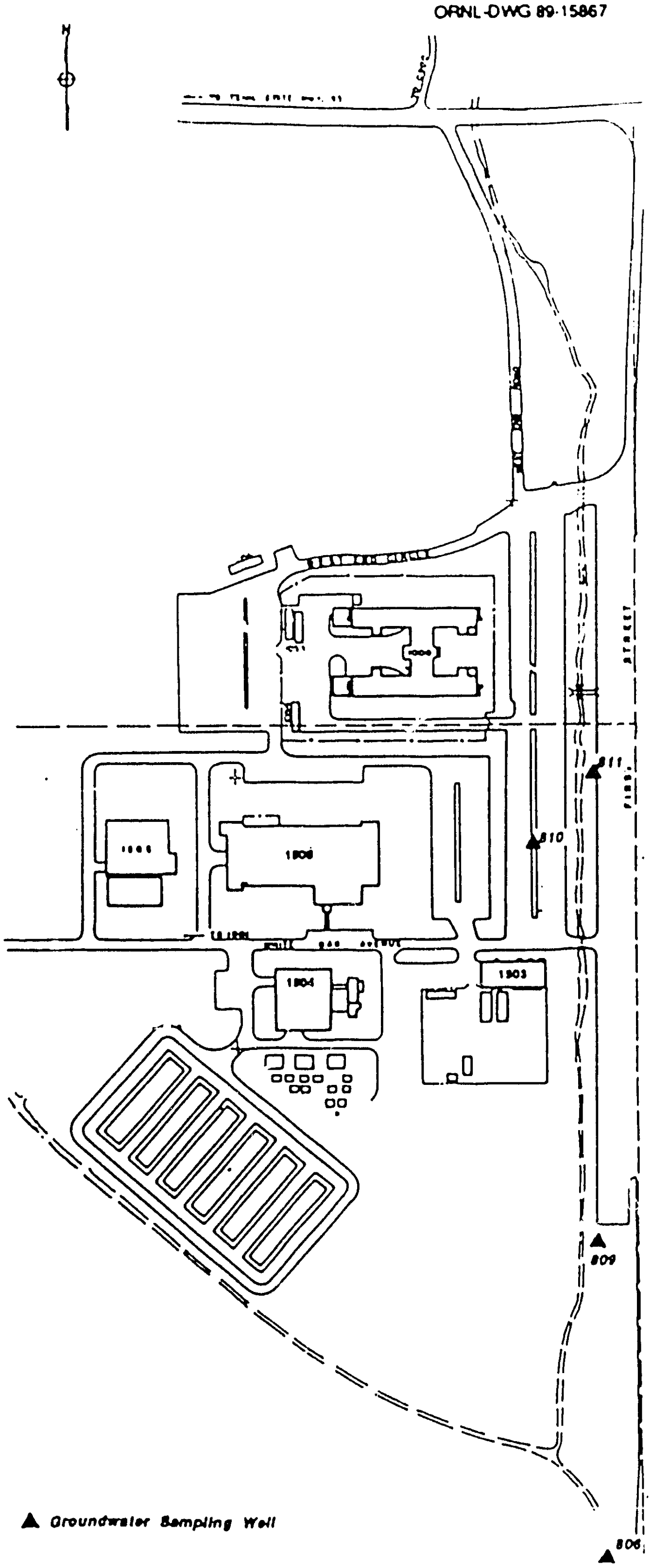

Fig. 12. Location map of wells in the 1000 area of WAG 1.

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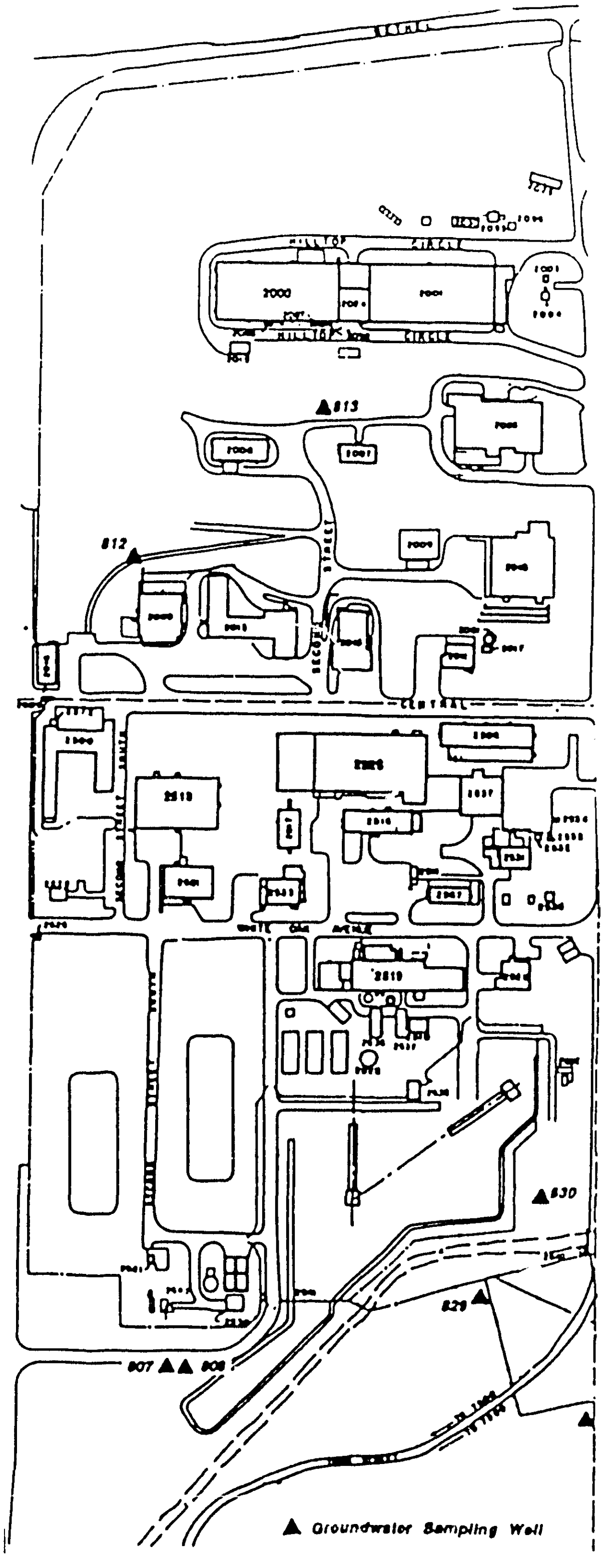

Fig. 13. Location map of wells in the 2000 area of WAG 1.

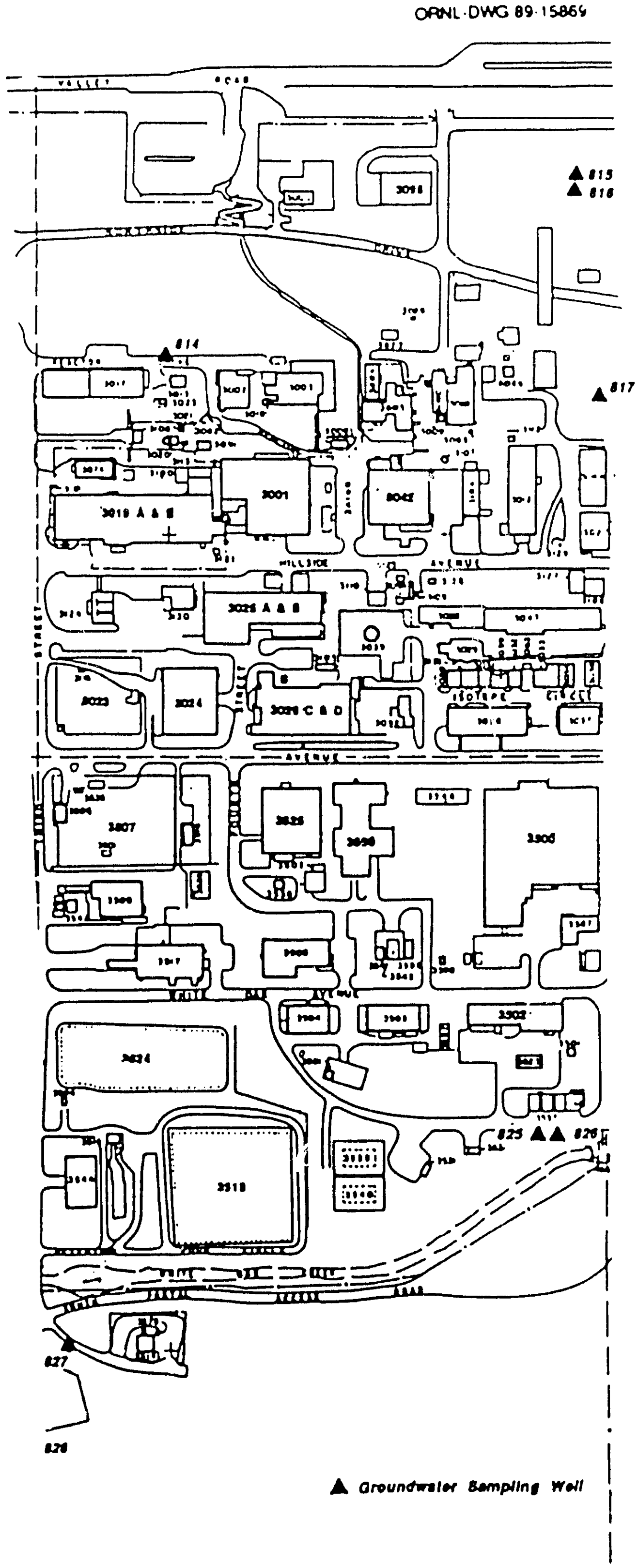

Fig. 14. Location map of wells in the 3000 area of WAG 1.

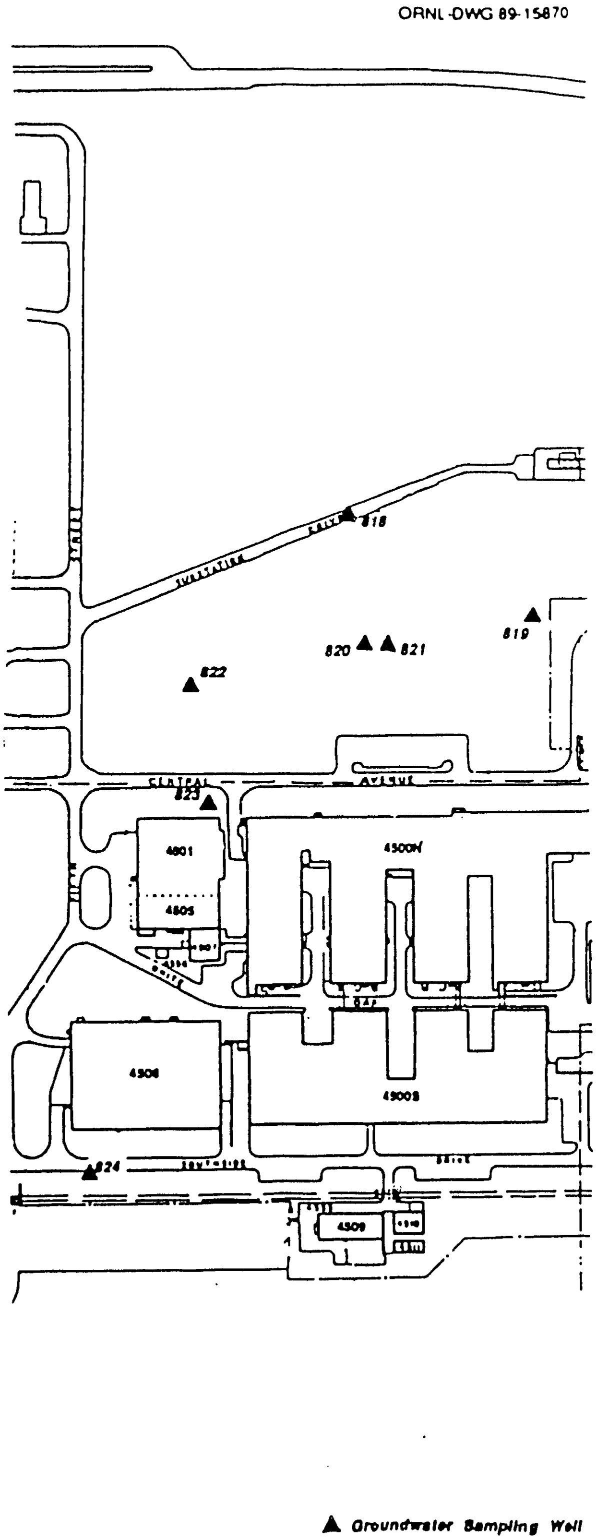

Fig. 15. Location map of wells in the 4000 area of WAG 1.

Table 36. Analytes sought in groundwater at ORNL in 1990

Analyte
Field Measurements
Conductivity
Temperature
Turbidity
pH
Anions
Bromide
Chloride
Fluoride
Nitrate
Phosphate
Sulfate (as SO4)
Miscellaneous
Alkalinity (as CaCO3)
Carbon, total organic
Cyanide, total
Halides, total organic
Nitrogen, total Kjeldahl
Solids, total dissolved
Solids, total suspended
Sulfide, total
AA Metals
Antimony, total
Arsenic, total
Barium, total
Cadmium, total
Chromium, total
Lead, total
Mercury, total
Selenium, total
Silver, total
Thallium, total

Analyte
ICP Metals
Aluminum, total
Antimony, total
Arsenic, total
Barium, total
Beryllium, total
Boron, total
Cadmium, total
Calcium, total
Chromium, total
Cobalt, total
Copper, total
Iron, total
Lead, total
Lithium, total
Magnesium, total
Manganese, total
Molybdenum, total
Nickel, total
Phosphorus, total
Potassium
Selenium, total
Silicon, total
Silver, total
Sodium, total
Strontium, total
Thorium, total
Tin, total
Titanium, total
Vanadium, total
Zinc, total
Zirconium, total

Table 36. (continued)

Analyte
Radionuclides
Co-60
Cs-137
Gross alpha
Gross beta
H-3
Pu-238
Pu-239
Sr-89 + Sr-90
Tc-99
U-234
U-235
U-238
Uranium, total
Volatile Organics
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2-Dichloroethane
1,2-Dichloroethene
1,2-Dichloropropane
2-Butanone
2-Hexanone
4-Methyl-2-pentanone
Acetone
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
Dibromochloromethane
Ethylbenzene
Methylene chloride
Styrene
Tetrachloroethene
Toluene
Volatile Organics (continued)
Trichloroethene
Vinyl acetate
Vinyl chloride
Xylene, total
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Base/Neutral/Acid Extractable Organics
1,2,4-Trichlorobenzene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
2-Chloronaphthalene
2-Chlorophenol
2-Methylnaphthalene
2-Methylphenol
2-Nitroaniline
2-Nitrophenol
3,3'-Dichlorobenzidine
3-Nitroaniline
4,6-Dinitro-2-methylphenol
4-Bromophenylphenyl ether
4-Chloro-3-methylphenol
4-Chloroaniline
4-Chlorophenylphenyl ether
4-Methylphenol
4-Nitroaniline
4-Nitrophenol
Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene

Table 36. (continued)

Analyte

Base/Neutral/Acid Extractable Organics
(continnued)
- Benzo(ghi)perylene
- Benzo(k)fluoranthene
- Benzoic acid
- Benzyl alcohol
- Benzyl butyl phthalate
- Bis(2-chloroethoxy) methane
- Bis(2-chloroethyl) ether
- Bis(2-chloroisopropyl) ether
- Bis(2-ethylhexyl) phthalate
- Chrysene
- Di-n-butylphthalate
- Di-n-octylphthalate
- Dibenzo(a,h)anthracene
- Dibenzofuran
- Diethyl phthalate
- Dimethyl phthalate
- Fluoranthene
- Fluorene
- Hexachlorobenzene
- Hexachlorobutadiene
- Hexachlorocyclopentadiene
- Hexachloroethane
- Indeno(1,2,3-cd)pyrene
- Isophorone
- N-Nitrosodi-n-propylamine
- N-Nitrosodiphenylamine
- Naphthalene
- Nitrobenzene
- Pentachlorophenol
- Phenanthrene
- Phenol
- Pyrene

Analyte

Pesticides
- 4,4'-DDD
- 4,4'-DDE
- 4,4'-DDT
- Aldrin
- Aroclor-1016
- Aroclor-1221
- Aroclor-1232
- Aroclor-1242
- Aroclor-1248
- Aroclor-1254
- Aroclor-1260
- Aroclor-1262
- Aroclor-1268
- Alpha chlordane
- Gamma chlordane
- Dieldrin
- Endosulfan I
- Endosulfan II
- Endosulfan sulfate
- Endrin
- Endrin ketone
- Heptachlor
- Heptachlor epoxide
- Isodrin
- Kepone
- Methoxychlor
- Toxaphene
- alpha-BHC
- beta-BHC
- delta-BHC
- gamma-BHC (Lindane)

Table 37. Listing of WAG 1 sites by type

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

3.6.1.2 Results

Perimeter wells at WAG 1 were sampled once during 1990, between September 7 and October 4. A summary of the analytical results by well type, (i.e., up-gradient and down-gradient) is presented in Table 38.

The sampling plan that is specified under Program Description was followed; the environmental restoration contractor requested additional sampling and data for aroclors-1262 and -1268, isodrin, and kepone from 17 of the 26 wells. The mercury sample for well 809 was lost in the laboratory.

The reference wells that have been identified for WAG 1, (814, 818, 819), are located in the northern sections of the 3000 and 4000 areas. Well 814 had a water level during the sampling period that was lower than well 815, a perimeter well in the same vicinity. Based upon this information, the specification of reference wells for the WAG should be revisited. A preliminary review of these data indicate that topography in the 3000 and 4000 area has a minor impact upon the groundwater elevations.

Nominal amounts of organics were detected at wells located in the southern 1000 area, northern and southern 2000 area, southern 3000 area, and the northern 4000 area. Most of the values are in the 10 to 20 μg/L range and are probably spurious results. Well 810, in the lower 1000 area, had 220 μg/L of Di-N-Octylphthalate; this value is an order of magnitude higher than previous results for this analyte at any well in WAG 1.

Elevated levels of radioactivity were detected in the upper 2000 area, lower 2000 area, and the lower 3000 area. The upper 2000 area showed gross alpha activity, radioactive strontium and gross beta activity. In accordance with the sampling and analysis plan, if the gross alpha result exceeds 0.5 Bq/L (15 pCi/L), sequential isotopic analysis is conducted to determine the source of the activity. Well 812, located in the northern section of the 2000 area, had gross alpha activity of 11 Bq/L in the filtered and 6.1 Bq/L in the unfiltered samples. This activity is attributed to uranium isotopes, with U-234 being the major contributor. Plutonium isotopes were also quantified but not found in concentrations significantly above zero. The gross beta activity is equivalent to the strontium activity plus the activity of the yttrium daughter. The lower 2000 area shows tritium concentrations of around 1000 Bq/l; this signature has been decreasing since the initial value of 2000 Bq/L in December 1988. The lower 3000 area showed elevated strontium activity and the consequent gross beta signature.

No exceedences of the EPA primary drinking water limits were noted in any of the up-gradient wells.

One set of duplicate samples was taken for WAG 1 (well 810). Table 39 presents an analysis of duplicate samples by providing relative percent difference (RPD) calculations. The analytical results for the duplicates was compared with the analytical results for the samples. Relative percent difference is 100 times the absolute value of the difference between the sample and duplicate values divided by the average of the two values. The RPD was calculated for the analytes which were detected in both samples. Analytes which were estimated or undetected

Table 38. Constituents in WAG 1 groundwater at ORNL from sampling period of September 7, 1990 - October 4, 1990

Analyte	N Det./ N Total	Values above the detection limit			Reference value[c]	N values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
Down-Gradient Well Type						
Anions -- Unfiltered						
Chloride (mg/L)	23/23	89	1.3	22*	250	0[3]
Fluoride (mg/L)	23/23	3.3	0.20	0.59*	4.0	0[2]
Nitrate (mg/L)	4/23	9.8	1.6	4.7*	10	0[2]
Sulfate (as SO4) (mg/L)	20/23	170	5.3	45*	200	0[3]
Base/neutral/acid Extractable Organics -- Unfiltered						
Bis(2-ethylhexyl) phthalate (μg/L)	4/23	41	J 7.0	22*	*e*	[*e*]
Di-n-octylphthalate (μg/L)	2/23	220	10	120	*e*	[*e*]
Diethyl phthalate (μg/L)	7/23	B 23	JB 2.0	7.4*	*e*	[*e*]
Field Measurements -- Unfiltered						
Conductivity (mS/cm)	23/23	0.92	0.027	0.48*	*e*	[*e*]
Temperature (°C)	23/23	26	15	19*	31	0[1]
pH (standard units)	23/23	9.2	6.5	7.4*	(6.5, 8.5)	2[3]
Metals -- Filtered						
Aluminum, total (mg/L)	1/23	0.13	0.13	0.13	*e*	[*e*]
Arsenic, total (mg/L)	1/23	0.064	0.064	0.064	0.050	1[2]
Barium, total (mg/L)	23/23	0.31	0.0030	0.11*	1.0	0[2]
Boron, total (mg/L)	8/23	1.1	0.088	0.41*	*e*	[*e*]
Cadmium, total (mg/L)	1/23	0.0071	0.0071	0.0071	0.010	0[1]
Calcium, total (mg/L)	23/23	180	1.0	88*	*e*	[*e*]
Chromium, total (mg/L)	20/23	0.012	0.0053	0.0089*	0.050	0[1]
Iron, total (mg/L)	14/23	15	0.057	2.8*	0.30	6[3]
Magnesium, total (mg/L)	23/23	31	0.46	18*	*e*	[*e*]

Table 38. (continued)

Analyte	N Det./ N Total	Values above the detection limit Max[a]	Min[a]	Average[b]	Reference value[c]	N values exceeding reference [ref][d]
Metals -- Filtered (continued)						
Manganese, total (mg/L)	15/23	7.6	0.0081	1.4*	0.050	10[3]
Nickel, total (mg/L)	7/23	0.010	0.0042	0.0063*	0.10	0[1]
Potassium (mg/L)	23/23	6.3	1.0	2.0*	*e*	[*e*]
Silicon, total (mg/L)	23/23	7.7	2.8	5.5*	*e*	[*e*]
Silver, total (mg/L)	1/23	0.0052	0.0052	0.0052	0.050	0[1]
Sodium, total (mg/L)	17/23	300	6.3	53*	*e*	[*e*]
Strontium, total (mg/L)	23/23	2.6	0.076	0.62*	*e*	[*e*]
Zinc, total (mg/L)	20/23	0.052	0.0052	0.013*	5.0	0[1]
Metals -- Unfiltered						
Aluminum, total (mg/L)	8/23	2.1	0.081	0.75*	*e*	[*e*]
Arsenic, total (mg/L)	2/23	0.074	0.065	0.070*	0.050	2[2]
Barium, total (mg/L)	23/23	0.30	0.0033	0.11*	1.0	0[2]
Boron, total (mg/L)	8/23	1.1	0.088	0.40*	*e*	[*e*]
Calcium total (mg/L)	23/23	170	2.1	88*	*e*	[*e*]
Chromium, total (mg/L)	20/23	0.059	0.0066	0.012*	0.050	1[1]
Copper, total (mg/L)	2/23	0.011	0.0098	0.010*	1.0	0[1]
Iron, total (mg/L)	20/23	17	0.086	2.4*	0.30	14[3]
Magnesium, total (mg/L)	23/23	32	0.49	18*	*e*	[*e*]
Manganese, total (mg/L)	19/23	6.9	0.0012	1.1*	0.050	11[3]
Mercury, total (mg/L)	1/22	*e*	*e*	*e*	0.00020	0[1]
Nickel, total (mg/L)	8/23	0.021	0.0041	0.0089*	0.10	0[1]
Potassium (mg/L)	23/23	6.0	1.0	2.1*	*e*	[*e*]
Silicon, total (mg/L)	23/23	8.9	2.8	5.8*	*e*	[*e*]
Sodium, total (mg/L)	17/23	280	6.0	52*	*e*	[*e*]
Strontium, total (mg/L)	23/23	2.5	0.072	0.61*	*e*	[*e*]
Vanadium, total (mg/L)	1/23	0.0040	0.0040	0.0040	*e*	[*e*]
Zinc, total (mg/L)	22/23	0.034	0.0062	0.014*	5.0	0[1]

Table 38. (continued)

Analyte	N Det./ N Total	Values above the detection limit			Reference value^c	N values exceeding reference [ref]^d
		Max^a	Min^a	Average^b		
Others -- Filtered						
Alkalinity (mg/L)	23/23	480	170	310*	*e*	[*e*]
Solids, total dissolved (mg/L)	23/23	740	230	420*	500	7[1]
Others -- Unfiltered						
Alkalinity-unfiltered (mg/L)	23/23	480	170	300*	*e*	[*e*]
Carbon, total organic (mg/L)	23/23	3.1	0.55	1.3*	*e*	[*e*]
Halides, total organic (μg/L)	15/23	29	5.5	11*	*e*	[*e*]
Nitrogen, total Kjeldahl (mg/L)	14/23	3.6	0.30	1.1*	*e*	[*e*]
Solids, total suspended (mg/L)	15/23	46	5.0	18*	*e*	[*e*]
Sulfide, total (mg/L)	1/23	1.1	1.1	1.1	*e*	[*e*]
Pesticides -- Unfiltered						
Aroclor-1254 (μg/L)	1/23	J 0.26	J 0.26	0.26	*e*	[*e*]
Endosulfan sulfate (μg/L)	2/23	J 0.026	J 0.019	0.023*	*e*	[*e*]
Heptachlor epoxide (μg/L)	4/23	J 0.040	J 0.014	0.028*	*e*	[*e*]
Radionuclides -- Filtered						
Co-60 (Bq/L)	4/23	0.32	0.15	0.23*	7.4	0[4]
Cs-137 (Bq/L)	1/23	0.18	0.18	0.18	4.4	0[4]
Gross alpha (Bq/L)	18/23	11	0.043	0.78	0.56	1[2]
Gross beta (Bq/L)	21/23	600	0.064	30	1.9	3[2]
H-3 (Bq/L)	19/23	1,000	29	170*	740	1[2]
Sr-89 + Sr-90 (Bq/L)	5/6	300	0.54	62	0.30	5[2]
U-234 (Bq/L)	1/1	8.1	8.1	8.1	0.74	1[4]
U-235 (Bq/L)	1/1	0.12	0.12	0.12	0.89	0[4]
U-238 (Bq/L)	1/1	0.26	0.26	0.26	0.89	0[4]
U-Total (g/L)	1/1	0.000022	0.000022	0.000022	*e*	[*e*]

Table 38. (continued)

Analyte	N Det./ N Total	Values above the detection limit			Reference value[c]	N values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
Radionuclides -- Unfiltered						
Co-60 (Bq/L)	2/23	0.27	0.21	0.24*	7.4	0[4]
Cs-137 (Bq/L)	1/23	0.26	0.26	0.26	4.4	0[4]
Gross alpha (Bq/L)	17/23	6.1	0.044	0.53	0.56	1[2]
Gross beta (Bq/L)	22/23	440	0.20	21	1.9	3[2]
H-3 (Bq/L)	16/23	1,100	30	210*	740	1[2]
Sr-89 + Sr-90 (Bq/L)	5/5	280	0.32	58	0.30	5[2]
U-234 (Bq/L)	1/1	7.4	7.4	7.4	0.74	1[4]
U-235 (Bq/L)	1/1	0.12	0.12	0.12	0.89	0[4]
U-238 (Bq/L)	1/1	0.25	0.25	0.25	0.89	0[4]
U-Total (g/L)	1/1	0.000022	0.000022	0.000022	*e*	[*e*]
Tentatively Identified Compounds -- Unfiltered						
1,13-Tetradecadiene-28.92 (μg/L)	4/4	B 220	B 130	160*	*e*	[*e*]
Hexane-20.1 (μg/L)	1/1	JB 16	JB 16	16	*e*	[*e*]
Hexane-20.12 (μg/L)	2/2	JB 15	JB 15	15	*e*	[*e*]
Hexane-20.14 (μg/L)	1/1	JB 14	JB 14	14	*e*	[*e*]
Hexane-20.24 (μg/L)	1/1	JB 14	JB 14	14	*e*	[*e*]
Hexane-20.25 (μg/L)	3/3	JB 17	JB 3.0	12	*e*	[*e*]
Hexane-20.26 (μg/L)	1/1	JB 14	JB 14	14	*e*	[*e*]
Hexane-20.37 (μg/L)	1/1	JB 17	JB 17	17	*e*	[*e*]
Hexane-20.38 (μg/L)	1/1	JB 15	JB 15	15	*e*	[*e*]
Hexane-20.39 (μg/L)	2/2	JB 15	JB 15	15	*e*	[*e*]
Unknown-11.68 (μg/L)	1/1	J 17	J 17	17	*e*	[*e*]
Unknown-11.9 (μg/L)	1/1	J 14	J 14	14	*e*	[*e*]
Unknown-34.06 (μg/L)	1/1	J 15	J 15	15	*e*	[*e*]
Unknown-7.77 (μg/L)	1/1	J 7.0	J 7.0	7.0	*e*	[*e*]
Unknown-8.87 (μg/L)	1/1	J 16	J 16	16	*e*	[*e*]
Unknown-8.97 (μg/L)	2/2	B 11	J 10	11*	*e*	[*e*]
Unknownphthalate-34.06 (μg/L)	1/1	J 27	J 27	27	*e*	[*e*]

Table 38. (continued)

Analyte	N Det./ N Total	Values above the detection limit			Reference value[c]	N values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
Volatile Organics -- Unfiltered						
1,2-Dichloroethene (μg/L)	1/23	21	21	21	*e*	[*e*]
Benzene (μg/L)	1/23	J 2.0	J 2.0	2.0	*e*	[*e*]
Chloroform (μg/L)	1/23	15	15	15	100	0[2]
Methylene chloride (μg/L)	10/23	J 3.0	JB 1.0	1.4*	*e*	[*e*]
Trichloroethene (μg/L)	1/23	6.0	6.0	6.0	*e*	[*e*]
Vinyl chloride (μg/L)	1/23	18	18	18	*e*	[*e*]
Up-Gradient Well Type						
Anions -- Unfiltered						
Chloride (mg/L)	3/3	15	3.0	7.7	250	0[3]
Fluoride (mg/L)	3/3	0.70	0.30	0.47*	4.0	0[2]
Nitrate (mg/L)	2/3	6.7	1.8	4.3	10	0[2]
Sulfate (as SO4) (mg/L)	3/3	28	24	26*	200	0[3]
Field Measurements -- Unfiltered						
Conductivity (mS/cm)	3/3	0.39	0.26	0.32*	*e*	[*e*]
Temperature (°C)	3/3	15	15	15*	31	0[1]
pH (standard units)	3/3	7.7	7.0	7.3*	(6.5, 8.5)	0[3]
Metals -- Filtered						
Barium, total (mg/L)	3/3	0.22	0.018	0.14	1.0	0[2]
Calcium, total (mg/L)	3/3	110	92	100*	*e*	[*e*]
Chromium, total (mg/L)	3/3	0.0094	0.0048	0.0074*	0.050	0[1]
Iron, total (mg/L)	2/3	3.4	0.060	1.7	0.30	1[3]
Magnesium, total (mg/L)	3/3	27	6.7	17*	*e*	[*e*]
Manganese, total (mg/L)	2/3	1.5	0.0024	0.75	0.050	1[3]
Nickel, total (mg/L)	1/3	0.0043	0.0043	0.0043	0.10	0[1]

Table 38. (continued)

Analyte	N. Det./ N. Samps.	Max Val.[a]	Min Val.[a]	Avg. of vals. > det. lim.[b]	Ref. val.[c]	N. of vals. exceeding ref. [ref][d]
Metals -- Filtered (continued)						
Potassium (mg/L)	3/3	1.9	0.70	1.1	*e*	[*e*]
Silicon, total (mg/L)	3/3	5.3	3.1	4.4*	*e*	[*e*]
Sodium, total (mg/L)	1/3	11	11	11	*e*	[*e*]
Strontium, total (mg/L)	3/3	1.0	0.15	0.66	*e*	[*e*]
Zinc, total (mg/L)	3/3	0.012	0.010	0.011*	5.0	0[1]
Metals -- Unfiltered						
Barium, total (mg/L)	3/3	0.22	0.015	0.14	1.0	0[2]
Calcium, total (mg/L)	3/3	99	92	96*	*e*	[*e*]
Chromium, total (mg/L)	3/3	0.0096	0.0050	0.0078*	0.050	0[1]
Iron, total (mg/L)	2/3	6.4	0.12	3.3	0.30	1[3]
Magnesium, total (mg/L)	3/3	27	6.3	17	*e*	[*e*]
Manganese, total (mg/L)	2/3	1.5	0.0019	0.75	0.050	1[3]
Nickel, total (mg/L)	1/3	0.0043	0.0043	0.0043	0.10	0[1]
Potassium (mg/L)	3/3	1.8	0.68	1.1*	*e*	[*e*]
Silicon, total (mg/L)	3/3	5.3	2.9	4.4*	*e*	[*e*]
Sodium, total (mg/L)	1/3	11	11	11	*e*	[*e*]
Strontium, total (mg/L)	3/3	1.0	0.14	0.65	*e*	[*e*]
Zinc, total (mg/L)	3/3	0.021	0.0095	0.014*	5.0	0[1]
Others -- Filtered						
Alkalinity (mg/L)	3/3	330	240	270*	*e*	[*e*]
Solids, total dissolved (mg/L)	3/3	390	300	350*	500	0[1]
Others -- Unfiltered						
Alkalinity-unfiltered (mg/L)	3/3	330	240	270*	*e*	[*e*]
Carbon, total organic (mg/L)	3/3	1.3	0.60	0.95*	*e*	[*e*]
Halides, total organic (μg/L)	1/3	6.0	6.0	6.0	*e*	[*e*]
Nitrogen, total Kjeldahl (mg/L)	2/3	0.40	0.30	0.35*	*e*	[*e*]
Sulfide, total (mg/L)	1/3	1.0	1.0	1.0	*e*	[*e*]

Table 38. (continued)

Analyte	N. Det./ N. Samps.	Max Val.[a]	Min Val.[a]	Avg. of vals. > det. lim.[b]	Ref. val.[c]	N. of vals. exceeding ref. [ref][d]
Radionuclides -- Filtered						
Gross alpha (Bq/L)	2/3	0.050	0.047	0.049*	0.56	0[2]
Gross beta (Bq/L)	3/3	0.19	0.093	0.14*	1.9	0[2]
H-3 (Bq/L)	3/3	160	84	130*	740	0[2]
Radionuclides -- Unfiltered						
Cs-137 (Bq/L)	1/3	0.22	0.22	0.22	4.4	0[4]
Gross alpha (Bq/L)	2/3	0.053	0.024	0.039	0.56	0[2]
Gross beta (Bq/L)	3/3	0.36	0.18	0.27*	1.9	0[2]
H-3 (Bq/L)	3/3	150	83	120*	740	0[2]
Tentatively Identified Compounds -- Unfiltered						
Ethanol-6.4 (μg/L)	1/1	J 66	J 66	66	*e*	[*e*]
Hexane-20.38 (μg/L)	3/3	JB 14	JB 5.0	11*	*e*	[*e*]
Sulfur-28.63 (μg/L)	1/1	J 21	J 21	21	*e*	[*e*]
Unknown-15.3 (μg/L)	1/1	J 6.0	J 6.0	6.0	*e*	[*e*]
Volatile Organics -- Unfiltered						
Methylene chloride (μg/L)	2/3	J 3.0	JB 2.0	2.5	*e*	[*e*]

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[a] Prefixes U, J and B mean that the value was undetected, estimated, or found in the laboratory blank, respectively.

[b] An asterisk (*) follows a mean that is significantly greater than zero.

[c] Tennessee or federal reference limit or guideline, if one exists.

[d] The source of the reference limit is enclosed within brackets.

[e] Not applicable.

1 Rules of TDHE, Bureau of Environment, Division of Water Pollution Control, Chapter 1200-4-3, General Water Quality Cirteria, February 1987.

2 40 CFR (7-1-1989 Edition) Part 141 - National Primary Drinking Water Regulations, Subpart B, Maximum Contaminant Levels.

3 40 CFR (7-1-1989 Edition) Part 143 - National Secondary Drinking Water Regulations.

4 DOE Order 5400.5, February 8, 1990. Chapter III, Derived Concentration Guides for Air and Water.

Table 39. Duplicate sample evaluation using calculated relative percent difference in WAG 1 groundwater at ORNL during the first sampling period of 1990, September 7 - October 4

Analyte	Sample	Duplicate	RPD[a]
Anions -- Unfiltered			
Chloride (mg/L)	36	37	2.7
Fluoride (mg/L)	0.30	0.30	0
Sulfate (as SO4) (mg/L)	42	46	9.1
Base/neutral/acid Extractable Organics -- Unfiltered			
Bis(2-ethylhexyl) phthalate (µg/L)	24	U 11	b
Di-n-octylphthalate (µg/L)	220	U 11	b
Metals -- Filtered			
Barium, total (mg/L)	0.13	0.13	0
Calcium, total (mg/L)	94	97	3.1
Chromium, total (mg/L)	0.0094	0.0092	2.2
Iron, total (mg/L)	0.059	U 0.050	b
Magnesium, total (mg/L)	30	30	0
Manganese, total (mg/L)	0.14	0.13	7.4
Nickel, total (mg/L)	0.0050	U 0.0040	b
Potassium (mg/L)	1.4	1.4	2.2
Silicon, total (mg/L)	5.9	6.1	3.3
Sodium, total (mg/L)	8.0	8.0	0
Strontium, total (mg/L)	0.25	0.25	0
Metals -- Unfiltered			
Aluminum, total (mg/L)	0.18	0.15	18
Barium, total (mg/L)	0.087	0.089	2.3
Calcium, total (mg/L)	100	110	9.5
Chromium, total (mg/L)	0.0093	0.0090	3.3
Iron, total (mg/L)	0.38	0.48	23
Magnesium, total (mg/L)	21	22	4.7
Manganese, total (mg/L)	0.11	0.10	9.5
Potassium (mg/L)	1.3	1.4	5.3
Silicon, total (mg/L)	5.9	6.1	3.3
Sodium, total (mg/L)	12	11	8.7
Strontium, total (mg/L)	0.22	0.23	4.4
Zinc, total (mg/L)	0.0079	0.0092	15
Others -- Filtered			
Alkalinity (mg/L)	430	290	39
Solids, total dissolved (mg/L)	290	460	46
Others -- Unfiltered			
Alkalinity-unfiltered (mg/L)	290	290	0
Carbon, total organic (mg/L)	0.95	0.95	0
Halides, total organic (µg/L)	6.5	6.5	0
Solids, total suspended (mg/L)	19	16	17

Table 39. (continued)

Analyte	Sample	Duplicate	RPD[a]
Radionuclides -- Filtered			
Gross alpha (Bq/L)	0.28	0.32	13
Gross beta (Bq/L)	0.65	0.82	23
H-3 (Bq/L)	120	92	26
Radionuclides -- Unfiltered			
Gross alpha (Bq/L)	0.044	0.062	34
Gross beta (Bq/L)	0.35	0.19	59
H-3 (Bq/L)	110	98	12
Volatile Organics -- Unfiltered			
Methylene chloride (μg/L)	JB 1.0	U 5.0	b

[a] Where both values are estimated or undetected (prefix J, U, or JB), RPD is not calculated and the analyte is omitted from this report.

[b] Where one or more values are estimated or undetected (prefix J, U, or JB), RPD is not calculated.

Table 40. Field blank evaluation in WAG 1 groundwater at ORNL from September 7 - October 4, 1990

Analyte	Value
Detected Analytes	
Metals -- Filtered	
Aluminum, total (mg/L)	0.10
Calcium, total (mg/L)	0.053
Nickel, total (mg/L)	0.0048
Potassium (mg/L)	0.030
Zinc, total (mg/L)	0.020
Metals -- Unfiltered	
Aluminum, total (mg/L)	0.24
Calcium, total (mg/L)	0.23
Magnesium, total (mg/L)	0.040
Potassium (mg/L)	0.020
Strontium, total (mg/L)	0.0085
Zinc, total (mg/L)	0.014
Others -- Filtered	
Alkalinity (mg/L)	5.0
Others -- Unfiltered	
Alkalinity-unfiltered (mg/L)	5.0
Radionuclides -- Filtered	
Gross alpha (Bq/L)	0.12
Gross beta (Bq/L)	0.20
Radionuclides -- Unfiltered	
Gross alpha (Bq/L)	0.14
Gross beta (Bq/L)	0.16
Volatile Organics -- Unfiltered	
Methylene chloride (μg/L)	J 1.0

for one of the two samples (duplicate or sample) have a footnote indicating that RPD was not calculated. Analytes which were estimated or undetected for both of the two samples (duplicate and sample) are not included in the table. The table contains the analyte, the sample and duplicate values, and the RPD where calculated.

One set of field blanks accompanied the sampling team when they sampled one well (well 820). Table 40 presents the values for the field blank analyses. Tables 41, 42, and 43 provide information about the trip blanks which were prepared by Bechtel. The first table (Table 41) presents each well for which analytes were detected in the trip blank and comparative data. The comparative data are the values for the detected analytes in the trip blanks and the values for their corresponding sample. The second table (Table 42) provides a listing of the wells for which no analytes were detected in the trip blanks. Table 43 provides a listing of the tentatively identified compounds which were detected in the trip blanks.

3.6.2 WAG 5

3.6.2.1 Program Description

The sites at WAG 5 are currently remedial action sites regulated under RCRA 3004(u), which does not specify sampling schedules. ORNL sampled the sites once during 1990 and has plans to sample on a semiannual schedule.

WAG 5 is located directly south of the ORNL main plant (Fig. 15). This WAG contains 25 sites, 13 of which are tanks used to store low-level waste (LLW) prior to disposal by the hydrofracture process. WAG 5 also includes the surface facilities constructed in support of both the Old and New Hydrofracture facilities. The largest land areas in WAG 5 are devoted to Solid Waste Storage Area (SWSA) 5 and the Transuranium (TRU) Waste Storage Area. The remaining SWMUs are support facilities for ORNL's hydrofracture operations, two LLW leak/spill sites, and an impoundment in SWSA 5 used to dewater sludge from the original Process Waste Treatment Plant (PWTP) (3518). At present, LLW tanks are being used to store evaporator concentrates pending a decision regarding ultimate disposal of these wastes.

SWSA 5 was used to dispose of solid LLW generated at ORNL from 1959 to 1973. During the period 1959 to 1963, the burial ground served as the Southeastern Regional Burial Ground for the Atomic Energy Commission. At the time SWSA 5 burial operations were initiated, a portion of the site [approximately 4 ha (10 acres)] was set aside for the retrievable storage of TRU wastes.

The WAG 5 boundary includes the old and new hydrofracture installations. Because MB flows between the old and new hydrofracture facilities, there is a separate boundary for the New Hydrofracture Facility.

Parameters measured included selected atomic absorption metals (As, Ba, Cd, Cr, Pb, Hg, Se and Ag), inductively coupled argon plasma (ICP) metals, total fluorometric uranium, anions (chloride, fluoride, nitrate and sulfate), total organic halides, total organic carbon, total dissolved solids, total

Table 41. Trip blank results and comparison to sample results for detected analytes in WAG 1 groundwater at ORNL from September 7 - October 4, 1990

Well	Analyte	Trip[a]	Sample[a]
	Unfiltered		
807	Methylene chloride (μg/L)	J 1.0	U 5.0
808	Methylene chloride (μg/L)	J 1.0	J 1.0
811	Methylene chloride (μg/L)	J 1.0	U 5.0
812	Carbon disulfide (μg/L)	9.0	U 5.0
813	Methylene chloride (μg/L)	J 1.0	J 3.0
814	Methylene chloride (μg/L)	J 1.0	U 5.0
818	Methylene chloride (μg/L)	J 1.0	J 3.0
820[b]	Methylene chloride (μg/L)	J 1.0	J 1.0
822	Methylene chloride (μg/L)	J 1.0	U 5.0
828	2-Butanone (μg/L)	92	U 10
828	2-Hexanone (μg/L)	12	U 10
828	Acetone (μg/L)	92	U 10
828	Methylene chloride (μg/L)	J 1.0	U 5.0
830	2-Butanone (μg/L)	93	U 10
830	2-Hexanone (μg/L)	12	U 10
830	Acetone (μg/L)	94	U 10
830	Methylene chloride (μg/L)	J 1.0	U 5.0

[a] Prefixes U, J, and B mean that the value was undetected, estimated, or found in the laboratory blank, respectively.

[b] Field blank.

Table 42. Wells for which there were no detected analytes in trip blanks in WAG 1 groundwater at ORNL from September 7 - October 4, 1990

Well	Well	Well
806	819	826
809	820	827
810	821	829
810[a]	823	946
815	824	947
816	825	

[a] Duplicate sample.

Table 43. Tentatively identified compounds in trip blanks in WAG 1 groundwater at ORNL during the first sampling period of 1990, September 7 - October 4.

Well	Analyte	Value[a]
	Unfiltered	
810	HEXANE-20.17 (μg/L)	JB 16
810[b]	HEXANE-20.25 (μg/L)	JB 14
811	HEXANE-20.1 (μg/L)	JB 15
813	HEXANE-20.38 (μg/L)	JB 13
815	HEXANE-20.38 (μg/L)	JB 14
816	HEXANE-20.39 (μg/L)	JB 15
818	HEXANE-20.38 (μg/L)	JB 13
819	HEXANE-20.24 (μg/L)	JB 3.0
820	ETHANOL-6.4 (μg/L)	J 29
820[c]	HEXANE-20.28 (μg/L)	JB 15
820	HEXANE-20.38 (μg/L)	JB 16
822	HEXANE-20.25 (μg/L)	JB 15
823	HEXANE-20.25 (μg/L)	JB 15
828	3-HEPTANONE-34.22 (μg/L)	J 4.0
828	3-PENTANONE-18.46 (μg/L)	J 4.0
830	3-HEPTANONE-34.23 (μg/L)	J 4.0

[a] Prefixes J, B, and JB mean that the value was estimated, found in the laboratory blank, or estimated and found in the laboratory blank, respectively.

[b] Duplicate sample.

[c] Field blank.

suspended solids, alkalinity, radioactivity parameters (H-3, Tc-99, total radioactive strontium, gamma scan results, gross alpha and gross beta), and field parameters (pH, turbidity, conductivity (specific conductance), and temperature).

3.6.2.2 Results

Perimeter wells at WAG 5 were sampled once during 1990, between July 31 and August 16. A summary of the analytical results by well type, up-gradient and down-gradient, is presented in Table 44. The two up-gradient wells appear to be unaffected by contamination. However, H-3 was detected in both wells.

Tritium was detected in most WAG 5 wells; concentrations were the highest along the south and west perimeters. Those values exceeding 4% of the DCG were 860,000 Bq/L at well 969, 260,000 Bq/L at well 976, 240,000 Bq/L at well 978, 230,000 Bq/L at well 981, 43,000 Bq/L at well 971, 34,000 Bq/L at well 970, 16,000 Bq/L at well 972, 4,300 Bq/L at well 979, and 2,700 Bq/L at well 973. The high H-3 concentration observed in well 976 is not observed in its nearest neighbor, well 975, a shallower well. Tritium was undetected in well 975.

Total radioactive strontium is the major beta emitter other than H-3 found in WAG 5 groundwater; it was detected only in shallow wells. There were six values exceeding the primary drinking water standard for Sr-90. They are 20 Bq/L at well 960, 8.9 Bq/L at well 975, 3.8 Bq/L at well 973, 0.89 Bq/L at well 971, 0.75 Bq/L at well 974, and 0.30 Bq/L at well 977.

Gross beta values exceeding the primary drinking water standard are 23 Bq/L at well 975, 7.8 Bq/L at well 973, 3.6 Bq/L at well 969, and 2.5 Bq/L at well 971. In most cases the source of the gross beta appears to be the radioactive strontium.

Gross alpha values exceeding the primary drinking water standard are 1.1 Bq/L at well 982 and 0.67 Bq/L at well 973.

There is evidence of organics in some of the down-gradient south perimeter shallow wells. This was concluded after applying a rough rule of thumb; use twice the background level of total organic halides to indicate presence of organics.

A value of approximately 50 μg/L would be used for the background level. Wells 978 (2200-4600 μg/L), 969 (123-133 μg/L), and perhaps well 973 (67-123 μg/L) would be flagged. Applying this rule for total organic carbon, the background level might be taken as 0.70 mg/L. The wells flagged would be 973 (3.5-4.9 mg/L), 971(2.5-2.6 mg/L), 975 (2.2-2.5 mg/L), 978 (1.9-2.3 mg/L), 977 (1.4-1.5 mg/L), and 969 (1.2-1.5 mg/L).

In summary, the primary radionuclides found in WAG 5 groundwater are H-3 and radioactive strontium. Tritium appears to be prevalent in most wells but is highest along the south and west perimeters. Radioactive strontium and organics are found in the shallower wells on the south perimeter.

Table 44. Constituents in WAG 5 groundwater at ORNL from July 31 - August 16, 1990

Analyte	N Det./ N Total	Values greater than the detection limit			Reference value[c]	N values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
		Down-Gradient Well Type				
Anions -- Unfiltered						
Chloride (mg/L)	20/20	56	1.0	12*	250	0[3]
Fluoride (mg/L)	5/20	1.0	1.0	1.0	4.0	0[2]
Sulfate (as SO4) (mg/L)	18/20	330	5.8	58*	200	2[3]
Field Measurements -- Unfiltered						
Conductivity (mS/cm)	20/20	0.72	0.12	0.40*	e	[e]
Temperature (°C)	20/20	18	14	15*	31	0[1]
pH (standard units)	20/20	8.7	6.0	7.0*	(6.5, 8.5)	4[3]
Metals -- Filtered						
Aluminum, total (mg/L)	18/20	0.53	0.051	0.21*	e	[e]
Boron, total (mg/L)	3/14	0.42	0.18	0.33*	e	[e]
Cadmium, total (mg/L)	1/20	0.0050	0.0050	0.0050	0.010	0[1]
Calcium, total (mg/L)	20/20	760	3.4	130*	e	[e]
Cobalt, total (mg/L)	1/20	0.0077	0.0077	0.0077	e	[e]
Iron, total (mg/L)	19/20	2.1	0.053	0.65*	0.30	11[3]
Magnesium, total (mg/L)	20/20	36	1.3	19*	e	[e]
Manganese, total (mg/L)	19/20	0.69	0.0016	0.20*	0.050	13[3]
Mercury, total (mg/L)	1/20	0.00010	0.00010	0.00010	0.00020	0[1]
Nickel, total (mg/L)	13/20	0.037	0.0041	0.016*	0.10	0[1]
Silicon, total (mg/L)	14/14	13	2.7	8.6*	e	[e]
Sodium, total (mg/L)	19/20	150	5.1	25*	e	[e]
Strontium, total (mg/L)	14/14	5.0	0.079	0.70*	e	[e]
Uranium, total (mg/L)	4/20	0.0021	0.00060	0.0011*	e	[e]
Vanadium, total (mg/L)	1/20	0.0030	0.0030	0.0030	e	[e]
Zinc, total (mg/L)	2/20	0.0083	0.0054	0.0069	5.0	0[1]

Table 44. (continued)

Analyte	N Det./ N Total	Values greater than the detection limit: Max[a]	Min[a]	Average[b]	Reference value[c]	N values exceeding reference [ref][d]
Others -- Filtered						
Alkalinity (mg/L)	20/20	520	96	300*	e	[e]
Others -- Unfiltered						
Alkalinity-unfiltered (mg/L)	20/20	530	95	300*	e	[e]
Carbon, total organic (mg/L)	17/20	4.3	0.40	1.4*	e	[e]
Halides, total organic (μg/L)	8/20	3,600	6.3	490	e	[e]
Solids, total dissolved (mg/L)	20/20	790	150	410*	500	6[1]
Solids, total suspended (mg/L)	8/20	68	6.0	22*	e	[e]
Radionuclides -- Filtered						
Co-60 (Bq/L)	2/20	1.4	0.27	0.84	7.4	0[4]
Cs-137 (Bq/L)	2/20	0.31	0.22	0.27	4.4	0[4]
Gross alpha (Bq/L)	6/20	1.1	0.053	0.36*	0.56	2[2]
Gross beta (Bq/L)	13/20	23	0.14	3.2*	1.9	4[2]
Sr-89 + Sr-90 (Bq/L)	6/20	20	0.30	5.8	0.30	6[2]
Radionuclides -- Unfiltered						
H-3 (Bq/L)	16/20	860,000	31	110,000*	740	9[2]
			Up-Gradient Well Type			
Anions -- Unfiltered						
Chloride (mg/L)	2/2	1.9	1.6	1.8*	250	0[3]
Sulfate (as SO4) (mg/L)	2/2	21	6.7	14	200	0[3]

Table 44. (continued)

Analyte	N Det./ N Total	Values greater than the detection limit			Reference value[c]	values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
Field Measurements -- Unfiltered						
Conductivity (mS/cm)	2/2	1.7	0.22	0.96	e	[e]
Temperature (°C)	2/2	15	14	14*	31	0[1]
pH (standard units)	2/2	7.1	6.7	6.9*	(6.5, 8.5)	0[3]
Metals -- Filtered						
Aluminum, total (mg/L)	2/2	0.55	0.14	0.35	e	[e]
Calcium, total (mg/L)	2/2	75	66	71*	e	[e]
Iron, total (mg/L)	2/2	0.83	0.16	0.50	0.30	1[3]
Magnesium, total (mg/L)	2/2	13	2.8	7.9	e	[e]
Manganese, total (mg/L)	2/2	0.10	0.022	0.061	0.050	1[3]
Silicon, total (mg/L)	1/1	7.1	7.1	7.1	e	[e]
Sodium, total (mg/L)	1/2	6.4	6.4	6.4	e	[e]
Strontium, total (mg/L)	1/1	0.11	0.11	0.11	e	[e]
Others -- Filtered						
Alkalinity (mg/L)	2/2	210	170	190*	e	[e]
Others -- Unfiltered						
Alkalinity-unfiltered (mg/L)	2/2	210	170	190*	e	[e]
Carbon, total organic (mg/L)	1/2	0.60	0.60	0.60	e	[e]
Solids, total dissolved (mg/L)	2/2	280	160	220	500	0[1]
Solids, total suspended (mg/L)	1/2	41	41	41	e	[e]

Table 44. (continued)

Analyte	N Det./ N Total	Values greater than the detection limit			Reference value[c]	N values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
Radionuclides -- Unfiltered						
H-3 (Bq/L)	2/2	49	49	49	740	0[2]

[a] Prefixes J and B mean that the value was estimated or found in the laboratory blank.

[b] An asterisk (*) follows a mean that is significantly greater than zero.

[c] Tennessee or federal reference limit or guideline if one exists.

[d] If a reference limit exists, the source is coded as:

1 Rules of Tennessee Department of Health and Environment, Bureau of Environment, Division of Water Pollution Control, Chapter 1200-4-3, General Water Quality Criteria, February 1987.

2 40CFR (7-1-1989 Edition) Part 141 - National Primary Drinking Water Regulations, Subpart B, Maximum Contaminant Levels.

3 40CFR (7-1-1989 Edition) Part 143 - National Secondary Drinking Water Regulations.

4 DOE Order 5400.5, February 8, 1990. Chapter III, Derived Concentration Guides for Air and Water.

[e] Not applicable.

3.6.2.3 Trends

The 1990 sampling period was the first sampling period.

3.6.3 SWSA 6

3.6.3.1 Program Description

Groundwater in SWSA 6 is monitored to comply with Tennessee's Hazardous Waste Management Rule 1200-1-11-.05 (6) (a) 4. (iv). The second set of groundwater samples taken at SWSA 6 during 1990 were obtained from October 30 through November 15, 1990.

SWSA 6 is one of three SWMUs that make up WAG 6. WAG 6 is located about 1.5 km southwest of the ORNL main site (Fig. 15). 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 it still receives radioactive wastes. In the course of its operation, SWSA 6 has received a broad spectrum of 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) up-gradient perimeter wells, which are intended to provide reference information; (2) down-gradient 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 pertains only to the up-gradient and down-gradient wells.

3.6.3.2 Results

Analyte summaries in Table 45 are those for detected analytes. The number detected and the total number of samples, the maximum, minimum and average of those above the detection limit, a regulatory reference value (when one exits) and the number of values exceeding the reference are included in the table. With the exception of well 842, only two analytes for which observed values exceeded regulatory reference values were pH and H-3. In the case of pH, wells either quite alkaline or acidic are characteristic of background water at those depths. Tritium values exceeding 3,000 Bq/L, 4% of the DCG, which corresponds to a 4 mrem/y human exposure as discussed in DOE Order 5400.5, were obtained at down-gradient wells on the northeast corner of SWSA 6. Those values were 4,800 Bq/L at well 841, 5,700 Bq/L at well 842, 22,000 Bq/L at well 843, and 3,200 Bq/L at well 847. At well 842 both carbon tetrachloride (33 μg/L) and trichloroethene (310 μg/L) were observed at values in excess of regulatory reference values.

Carbon disulfide was quantified at 110 μg/L in the sample from well 860. It was also present in the trip blank at 9.0 μg/L during this sampling period. Although the well 860 value is high enough to give confidence that it is real and not an artifact of laboratory procedures, this was the first and only

Table 45. Constituents in SWSA 6 groundwater at ORNL from October 30 - November 15, 1990

Analyte	N Det./ N Total	Values above the detection limit			Reference value[c]	N values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
Down-Gradient Well Type						
Field Measurements -- Unfiltered						
Conductivity (mS/cm)	15/15	0.80	0.029	0.33*	e	[e]
Temperature (°C)	15/15	18	14	16*	31	0[1]
pH (standard units)	15/15	7.9	4.8	6.7*	(6.5, 8.5)	4[3]
Others -- Unfiltered						
Alkalinity-unfiltered (mg/L)	15/15	450	5.0	210*	e	[e]
Radionuclides -- Filtered						
Co-60 (Bq/L)	3/15	2.9	0.41	1.2	7.4	0[4]
Gross alpha (Bq/L)	12/15	0.28	0.0079	0.077*	0.56	0[2]
H-3 (Bq/L)	11/15	22,000	39	3,800*	3,000	4[4]
Sr-89 + Sr-90 (Bq/L)	3/15	0.075	0.051	0.063*	1.5	0[4]
Tentatively Identified Compounds -- Unfiltered						
1,4-Dioxane-14.56 (µg/L)	1/1	J 26	J 26	26	e	[e]
1-Propanethiol-9.21 (µg/L)	1/1	J 7.0	J 7.0	7.0	e	[e]
1-Propanethiol-9.26 (µg/L)	1/1	J 17	J 17	17	e	[e]
Aceticacid,methylester-6.09 (µg/L)	1/1	J 38	J 38	38	e	[e]
Ethane,1,1,'-oxybis--4.97 (µg/L)	1/1	J 120	J 120	120	e	[e]
Ethanethiol-5.12 (µg/L)	1/1	J 22	J 22	22	e	[e]
Ethanethiol-5.16 (µg/L)	1/1	J 45	J 45	45	e	[e]
Methane,trichlorofluoro--4.42 (µg/L)	1/1	J 9.0	J 9.0	9.0	e	[e]
Methanethiol-3.87 (µg/L)	1/1	J 59	J 59	59	e	[e]
Methanethiol-3.91 (µg/L)	1/1	J 45	J 45	45	e	[e]
Sulfurdioxide-3.14 (µg/L)	1/1	J 71	J 71	71	e	[e]

Table 45. (continued)

Analyte	N Det./ N Total	Values above the detection limit Max[a]	Min[a]	Average[b]	Reference value[c]	N values exceeding reference [ref][d]
Volatile Organics -- Unfiltered						
1,1-Dichloroethane (μg/L)	1/15	J 3.0	J 3.0	3.0	e	[e]
1,1-Dichloroethene (μg/L)	1/15	J 1.0	J 1.0	1.0	7.0	0[5]
1,2-Dichloroethane (μg/L)	1/15	15	15	15	5.0	1[5]
1,2-Dichloroethene (μg/L)	1/15	J 1.0	J 1.0	1.0	e	[e]
Acetone (μg/L)	10/15	B 11	JB 2.0	4.3*	e	[e]
Carbon disulfide (μg/L)	7/15	110	J 1.0	19	e	[e]
Carbon tetrachloride (μg/L)	1/15	33	33	33	5.0	1[5]
Chloroform (μg/L)	4/15	63	J 2.0	17	100	0[2]
Tetrachloroethene (μg/L)	7/15	J 4.0	J 1.0	2.4*	e	[e]
Trichloroethene (μg/L)	2/15	E 310	J 3.0	160	5.0	1[5]
Up-Gradient Well Type						
Field Measurements -- Unfiltered						
Conductivity (mS/cm)	7/7	3.2	0.050	0.69	e	[e]
Temperature (°C)	7/7	16	14	15*	31	0[1]
pH (standard units)	7/7	8.4	6.9	7.6*	(6.5, 8.5)	0[3]
Others -- Unfiltered						
Alkalinity-unfiltered (mg/L)	4/7	99	6.0	72*	e	[e]
Radionuclides -- Filtered						
Co-60 (Bq/L)	1/7	1.5	1.5	1.5	7.4	0[4]
Gross alpha (Bq/L)	3/7	0.063	0.047	0.054*	0.56	0[2]
H-3 (Bq/L)	2/7	35	33	34*	3,000	0[4]
Sr-89 + Sr-90 (Bq/L)	1/7	0.25	0.25	0.25	1.5	0[4]

Table 45. (continued)

Analyte	N Det./ N Total	Values above the detection limit			Reference value[c]	N values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
Volatile Organics -- Unfiltered						
Acetone (μg/L)	1/7	J 4.0	J 4.0	4.0	e	[e]
Tetrachloroethene (μg/L)	3/7	5.0	J 2.0	3.3*	e	[e]

[a] Prefixes J, B, and E mean that the value was estimated, found in the laboratory blank, or exceeded the calibration range, respectively.

[b] An asterisk (*) follows a mean that is significantly greater than zero.

[c] If a reference limit exists, the source is coded as:

1 Rules of Tennessee Department of Health and Environment, Bureau of Environment, Division of Water Pollution Control, Chapter 1200-4-3, General Water Quality Criteria, February 1987.
2 40CFR (7-1-1989 Edition) Part 141 - National Primary Drinking Water Regulations, Subpart B - Maximum Contaminant Levels.
3 40CFR (7-1-1989 Edition) Part 143 - National Secondary Drinking Water Regulations.
4 DOE Order 5400.5, February 8, 1990. Chapter III, Derived Concentration Guides for Air and Water.
5 40CFR (7-1-1990 Edition) Part 141 - National Primary Drinking Water Regulations, Subpart D - Reporting, Public Notification and Recordkeeping.

[d] The source of the reference limit is enclosed within brackets.

[e] Not applicable.

occurrence of its apparent presence at this well since the initiation of sampling. The location of the well is such that contamination would not be expected. Further, the presence of carbon disulfide, in the absence of any of the other more likely contaminants for SWSA 6 wastes, is highly unlikely. Thus, this value is considered spurious. Two other values obtained at two other wells during the sampling period are near the detection limit and are considered questionable.

One analyte that is commonly acknowledged to be laboratory contaminant was detected below its quantitation limit, acetone. The tentatively identified compounds listed were obtained from the samples taken from wells 835, 842, 844, and 859.

3.6.3.3 Trends

Analytical results from SWSA 6 during the 1990 sampling periods were comparable to those obtained during 1988-1989 detection monitoring. The observed differences involved in nearly every case general water quality parameters, pH, conductivity, and temperature. In most of these cases the differences were slight. Groundwater quality at the perimeter of SWSA 6 has not materially changed since detection monitoring began in June 1988. Results from four additional wells positioned outside the east boundary of SWSA 6 indicate that volatile organic contamination associated with wells 841 and 842 is a localized phenomenon. Wells 841, 842, 843, and 847, where observed values exceeded the regulatory reference value for H-3, will be sampled quarterly in 1991.

3.6.4 WAG 7

3.6.4.1 Program Description

The sites at WAG 7 are currently remedial action sites regulated under RCRA 3004(u), which does not specify sampling schedules. ORNL sampled the sites once during 1990 and has plans to sample on a semiannual schedule.

WAG 7 is located in Melton Valley about 1.6 km south of the ORNL main plant area (Fig. 15). In terms of radioactivity, the major SWMUs in WAG 7 are the seven pits and trenches used from 1951 to 1966 for the disposal of LLW. WAG 7 also includes a decontamination facility, three leak sites, a storage area containing shielded transfer tanks and other equipment, and seven fuel wells containing the acid solutions containing enriched uranium (primarily) from Homogeneous Reactor Experiment fuel.

Parameters measured included selected atomic absorption metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), inductively coupled argon plasma metals, total fluorometric uranium, anions (chloride, fluoride, nitrate and sulfate), total organic halides, total organic carbon, total dissolved solids, total suspended solids, alkalinity, radioactivity parameters (H-3, Tc-99, total radioactive strontium, gamma scan results, gross alpha and gross beta), and field parameters (pH, turbidity, conductivity (specific conductance), and temperature).

3.6.4.2 Results

Perimeter wells at WAG 7 were sampled once during 1990, between June 7 and June 25. A summary of the analytical results by well type, up-gradient and down-gradient, is presented in Table 46. The two up-gradient wells appear to be unaffected by contamination. However, Cs-137 was detected in one well, and total radioactive strontium was detected in the other well.

Fluoride at well 1075 (6.5 mg/L), nitrate at wells 1079 (1,900 mg/L) and 1078 (38 mg/L), and Ni at wells 1079 (0.36 mg/L) and 1085 (0.24 mg/L) exceed primary drinking water standards. The sample from well 1078 contained concentrations of Tc-99 and Co-60 exceeding 4% of their DCGs, described in DOE Order 5400.5, 410 Bq/L of Tc-99 and 31 Bq/L of Co-60. A gross alpha value of 11 Bq/L from well 1079 exceeded the primary drinking water standard.

Four gross beta concentrations exceeded the primary drinking water standard. They are 240 Bq/L at well 1078, 11 Bq/L at well 1079, 6.7 Bq/L at well 1084, and 2.8 Bq/L at well 1083. In all cases, these values are likely the result of the Tc-99 and Co-60.

Tritium concentrations were quite high at the west (next to SWSA 6) and south (along WAG 2) perimeter wells. There were five values exceeding 4% of the DCG. They are 46,000 Bq/L at well 1076, 22,000 Bq/L at well 1079, 6,400 Bq/L at well 1084, 1,700 Bq/L at well 1078, and 760 Bq/L. With the exception of well 1079 on the west side of WAG 7 next to SWSA 6, high concentrations of H-3 are found in shallower wells.

In summary, the primary radionuclides found in WAG 7 groundwater are H-3, Tc-99 and Co-60. Tritium appears to be prevalent in most wells but is highest along the west perimeter, next to SWSA 6. Some fluoride, nickel, and nitrate values exceeded the primary drinking water standards.

3.6.4.3 Trends

The 1990 sampling period was the first sampling period.

3.6.5 Off-Site

3.6.5.1 Program Description

Under the direction of the Energy Systems Environmental and Safety Activities Organization, ORNL implemented a long-term, off-site, residential drinking water quality monitoring program in 1989. The objective of the program is to document water quality from groundwater sources in areas adjacent to the reservation to help assure residents that DOE-OR plant operations do not affect the quality of groundwater sources.

Twenty-one wells were selected on the basis of their proximity to the reservation and a representative distribution of sources from the different geologic formations of the area. The wells were sampled once during 1990. Analytical parameters used for monitoring include volatile organics; selected atomic absorption metals (arsenic, mercury, lead, selenium); inductively

Table 46. Constituents in WAG 7 groundwater at ORNL from June 7 - June 25, 1990

Analyte	N Det./ N Total	Values above the detection limit			Reference value[c]	N values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
		Down-Gradient Well Type				
Anions -- Unfiltered						
Chloride (mg/L)	14/14	84	1.0	13*	250	0[3]
Fluoride (mg/L)	6/14	6.5	1.0	2.2*	4.0	1[2]
Nitrate (mg/L)	2/14	1,900	38	970	10	2[2]
Sulfate (as SO4) (mg/L)	14/14	690	8.9	160*	200	4[3]
Field Measurements -- Unfiltered						
Conductivity (mS/cm)	14/14	3.0	0.24	0.73*	e	[e]
Temperature (°C)	14/14	17	14	15*	31	0[1]
Turbidity (JTU)	14/14	660	350	430*	1.0	14[2]
pH (standard units)	14/14	8.6	6.6	7.7*	(6.5, 8.5)	2[3]
Metals -- Filtered						
Aluminum, total (mg/L)	6/14	0.51	0.068	0.22*	e	[e]
Calcium, total (mg/L)	14/14	360	2.8	91*	e	[e]
Chromium, total (mg/L)	1/14	0.020	0.020	0.020	0.050	0[1]
Cobalt, total (mg/L)	2/14	0.036	0.034	0.035*	e	[e]
Copper, total (mg/L)	1/14	0.016	0.016	0.016	1.0	0[1]
Iron, total (mg/L)	10/14	7.7	0.024	1.1	0.30	5[3]
Lead, total (mg/L)	1/14	0.020	0.020	0.020	0.050	0[1]
Magnesium, total (mg/L)	14/14	130	0.63	22*	e	[e]
Manganese, total (mg/L)	13/14	1.3	0.0011	0.24*	0.050	7[3]
Mercury, total (mg/L)	1/14	0.00020	0.00020	0.00020	0.00020	0[1]

Table 46. (continued)

Analyte	N Det./ N Total	Values above the detection limit			Reference value^c	N values exceeding reference [ref]^d
		Max^a	Min^a	Average^b		
Nickel, total (mg/L)	6/14	0.36	0.0064	0.11	0.10	2[1]
Potassium (mg/L)	14/14	10	0.90	4.1*	e	[e]
Sodium, total (mg/L)	12/14	590	5.4	130*	e	[e]
Thorium, total (mg/L)	9/14	7.6	0.088	1.4	e	[e]
Uranium, total (mg/L)	4/14	0.026	0.00070	0.0073	e	[e]
Vanadium, total (mg/L)	1/14	0.0022	0.0022	0.0022	e	[e]
Zinc, total (mg/L)	3/14	0.021	0.0052	0.011	5.0	0[1]
Others -- Filtered						
Alkalinity (mg/L)	14/14	630	40	280*	e	[e]
Others -- Unfiltered						
Alkalinity-unfiltered (mg/L)	14/14	630	39	280*	e	[e]
Carbon, total organic (mg/L)	14/14	2.3	0.58	1.2*	e	[e]
Halides, total organic (μg/L)	4/14	15	5.5	9.9*	e	[e]
Solids, total dissolved (mg/L)	14/14	3,200	270	750*	500	6[1]
Solids, total suspended (mg/L)	7/14	130	16	59*	e	[e]
Radionuclides -- Filtered						
Co-60 (Bq/L)	4/14	31	0.18	8.8	7.4	1[4]
Cs-137 (Bq/L)	1/14	0.31	0.31	0.31	4.4	0[4]
Gross alpha (Bq/L)	1/14	11	11	11	0.56	1[2]
Gross beta (Bq/L)	11/14	240	0.25	24	1.9	4[2]
Sr-89 + Sr-90 (Bq/L)	2/14	0.13	0.098	0.11*	0.30	0[2]
Tc-99 (Bq/L)	6/14	410	0.26	71	150	1[4]

Table 46. (continued)

Analyte	N Det./ N Total	Values above the detection limit			Reference value[c]	N values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
Radionuclides -- Unfiltered						
H-3 (Bq/L)	12/14	46,000	31	6,500	740	5[2]
Up-Gradient Well Type						
Anions -- Unfiltered						
Chloride (mg/L)	2/2	3.6	1.0	2.3	250	0[3]
Sulfate (as SO4) (mg/L)	2/2	91	5.8	48	200	0[3]
Field Measurements -- Unfiltered						
Conductivity (mS/cm)	2/2	0.34	0.010	0.18	e	[e]
Temperature (°C)	2/2	15	15	15	31	0[1]
Turbidity (JTU)	2/2	550	370	460	1.0	2[2]
pH (standard units)	2/2	8.0	6.1	7.0*	(6.5, 8.5)	1[3]
Metals -- Filtered						
Calcium, total (mg/L)	2/2	25	1.2	13	e	[e]
Iron, total (mg/L)	1/2	0.022	0.022	0.022	0.30	0[3]
Magnesium, total (mg/L)	2/2	5.7	1.7	3.7	e	[e]
Manganese, total (mg/L)	2/2	0.22	0.074	0.15	0.050	2[3]
Nickel, total (mg/L)	1/2	0.021	0.021	0.021	0.10	0[1]
Potassium (mg/L)	2/2	9.3	0.60	5.0	e	[e]
Sodium, total (mg/L)	1/2	99	99	99	e	[e]
Thorium, total (mg/L)	2/2	0.40	0.12	0.26	e	[e]

Table 46. (continuned)

Analyte	N Det./ N Total	Values above the detection limit			Reference value[c]	N values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
Others -- Filtered						
Alkalinity (mg/L)	2/2	190	13	100	e	[e]
Others -- Unfiltered						
Alkalinity-unfiltered (mg/L)	2/2	190	13	100	e	[e]
Carbon, total organic (mg/L)	1/2	0.58	0.58	0.58	e	[e]
Solids, total dissolved (mg/L)	2/2	370	71	220	500	0[1]
Solids, total suspended (mg/L)	2/2	75	5.0	40	e	[e]
Radionuclides -- Filtered						
Cs-137 (Bq/L)	1/2	0.25	0.25	0.25	4.4	0[4]
Sr-89 + Sr-90 (Bq/L)	1/2	0.10	0.10	0.10	0.30	0[2]

[a] Prefixes J and B mean that the value was estimated or found in the laboratory blank.

[b] An asterisk (*) follows a mean that is significantly greater than zero.

[c] Tennessee or federal reference limit or guideline if one exists.

[d] If a reference limit exists, the source is coded as:

1 Rules of Tennessee Department of Health and Environment, Bureau of Environment, Division of Water Pollution Control, Chapter 1200-4-3, General Water Quality Criteria, February 1987.

2 40CFR (7-1-1989 Edition) Part 141 - National Primary Drinking Water Regulations, Subpart B - Maximum Contaminant Levels.

3 40CFR (7-1-1989 Edition) Part 143 - National Secondary Drinking Water Regulations.

4 DOE Order 5400.5, February 8, 1990. Chapter III, Derived Concentration Guides for Air and Water.

[e] Not applicable.

coupled argon plasma metals; anions (fluoride, chloride, sulfate, nitrate, and nitrite); total fluorometric uranium; and the radioactive parameters gross alpha, gross beta, total radioactive strontium, Tc-99, H-3, and radionuclides observed in a gamma scan. These data are presented in Table 47.

3.6.3.2 Results

Six of the wells had parameter concentrations exceeding primary drinking water standards. Those parameters were cadmium in one well, fluoride in one well, nitrate and cadmium in one well, and gross beta in one well. The gross beta value was obtained from a well within but at a perimeter of the reservation.

3.6.3.3 Trends

The values for cadmium, nitrate, and gross beta at the wells where a primary drinking water standard was exceeded were below that standard in 1989. The fluoride result that exceeded the standard is consistent with the level observed in that well during 1989.

Table 47. Constituents in off-site ORNL groundwater during 1990

Analyte	N Det./ N Total	Values above the detection limit			Reference value[c]	No. of values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
Anions						
Chloride (mg/L)	21/21	62	1.0	6.1*	250	0[3]
Fluoride (mg/L)	13/21	6.0	0.10	0.68	4.0	1[2]
Nitrate (mg/L)	11/21	17	2.0	4.3*	10	1[2]
Sulfate (as SO4) (mg/L)	21/21	51	2.0	13*	200	0[3]
Field Measurements						
Conductivity (mS/cm)	21/21	1.2	0.11	0.29*	e	[e]
pH (standard units)	21/21	9.2	6.9	7.5*	(6.5, 8.5)	2[3]
Temperature (^oC)	21/21	24	14	19*	31	0[1]
Metals						
Arsenic, total (mg/L)	1/21	0.0050	0.0050	0.0050	0.050	0[2]
Barium, total (mg/L)	16/21	0.32	0.0097	0.093*	1.0	0[2]
Calcium, total (mg/L)	21/21	93	1.8	43*	e	[e]
Cadmium, total (mg/L)	7/21	0.022	0.0033	0.0096*	0.010	2[1]
Cobalt, total (mg/L)	1/21	0.0081	0.0081	0.0081	e	[e]
Copper, total (mg/L)	20/21	0.21	0.0042	0.029*	1.0	0[1]
Iron, total (mg/L)	13/21	10	0.0047	1.7	0.30	5[3]
Magnesium, total (mg/L)	21/21	29	0.69	14*	e	[e]
Manganese, total (mg/L)	6/21	0.73	0.0090	0.19	0.050	5[3]
Sodium, total (mg/L)	21/21	340	0.49	31*	e	[e]
Nickel, total (mg/L)	1/21	0.010	0.010	0.010	0.10	0[1]
Lead, total (mg/L)	9/21	0.027	0.0041	0.011*	0.050	0[1]
Uranium, total (mg/L)	4/21	0.0010	0.0010	0.0010	e	[e]
Zinc, total (mg/L)	20/21	1.1	0.0034	0.15*	5.0	0[1]

Table 47. (continued)

Analyte	N Det./ N Total	Values above the detection limit			Reference value[c]	No. of values exceeding reference [ref][d]
		Max[a]	Min[a]	Average[b]		
Radionuclides						
Co-60 (Bq/L)	1/21	0.26	0.26	0.26	7.4	0[4]
Gross alpha (Bq/L)	20/21	0.17	0.040	0.12*	0.56	0[2]
Gross beta (Bq/L)	19/21	1.9	0.18	0.38*	1.9	1[2]
Tc-99 (Bq/L)	5/21	0.086	0.035	0.059*	150	0[4]
Sr-89 + Sr-90 (Bq/L)	11/21	0.13	0.027	0.057*	1.5	0[4]
Tentatively Identified Compounds						
Cyclohexane (μg/L)	8/8	6.0	JB 5.0	5.6*	e	[e]

[a] Prefixs J and B mean that the value was estimated or found in the laboratory blank.

[b] An asterisk (*) follows a mean that is significantly greater than zero.

[c] If a reference limit exists, the source is coded as:

1 Rules of Tennessee Department of Health and Environment, Bureau of Environment, Division of Water Pollution Control, Chapter 1200-4-3, General Water Quality Criteria, February 1987.

2 40CFR (7-1-1989 Edition) Part 141 - National Primary Drinking Water Regulations, Subpart B - Maximum Contaminant Levels.

3 40CFR (7-1-1989 Edition) Part 143 - National Secondary Drinking Water Regulations.

4 DOE Order 5400.5, February 8, 1990. Chapter III, Derived Concentration Guides for Air and Water.

[d] The source of the reference limit is enclosed within brackets.

[e] Not applicable.

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 m, and tower C with sensors mounted at 10, 30, and 100 m. Locations of these towers are shown in Fig. 16. Data from the sensors are acquired, stored, edited, and formatted by a data collection system consisting of a central processor and remote data logger. One-minute vector averages of wind velocity are calculated in the conventional way and retained for 24 h. These velocities are processed into 15-min averages using a procedure that avoids the unrealistically low windspeed values obtained when appreciable winds of nearly opposite direction are vector averaged in the conventional way. This alternative averaging procedure involves calculating a unit vector to represent the direction of each 1-min wind velocity, finding the vector average of those unit vectors, scaling that average to a unit vector, and multiplying the result by the mean (scalar) windspeed. A similar calculation is used to convert the 15-min averages into hourly averages. The 15-min averages are retained for 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. 17-23) 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.

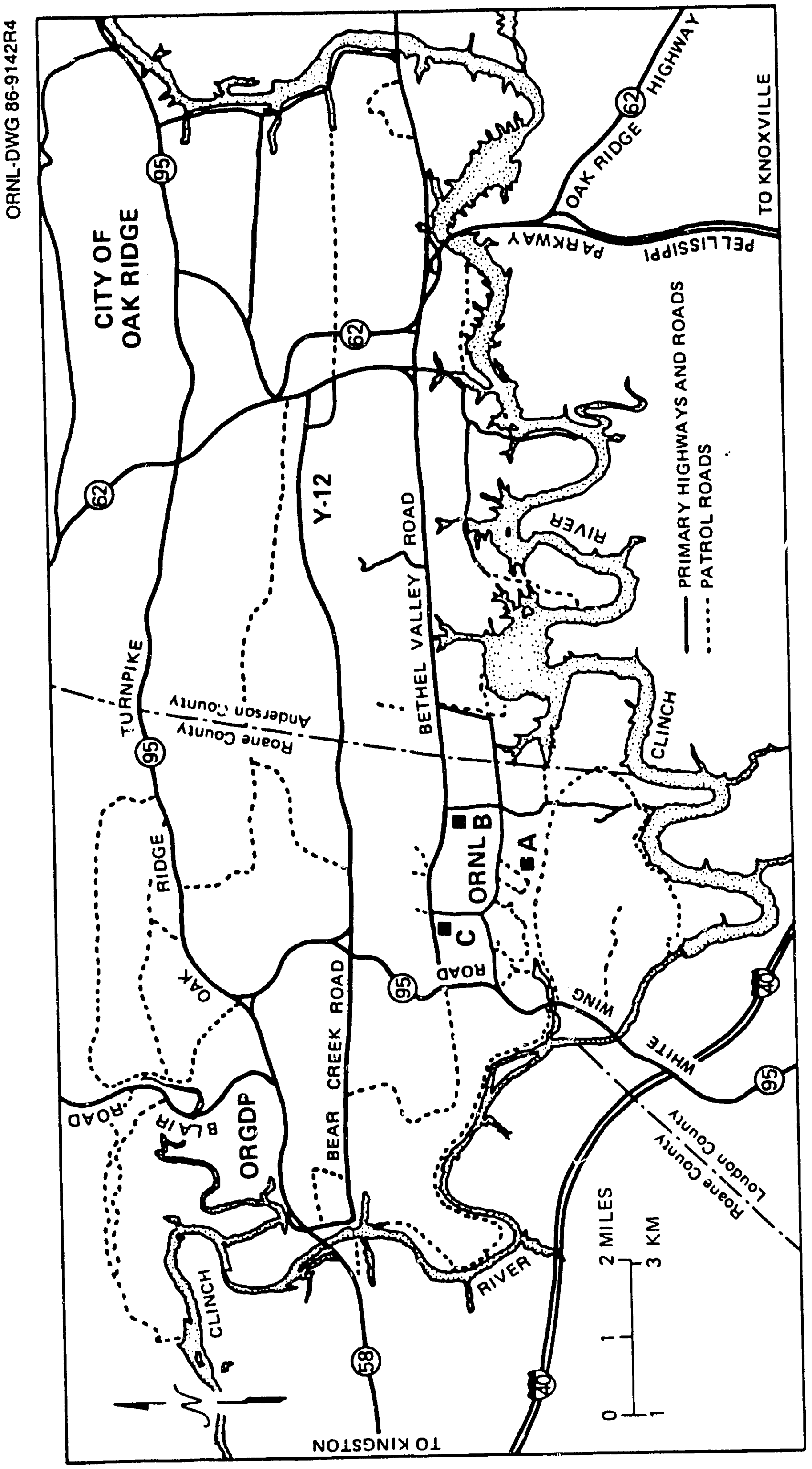

Fig. 16. Location map of meteorological towers at ORNL.

with 91.2% of possible data

ORNL-DWG 91-2128

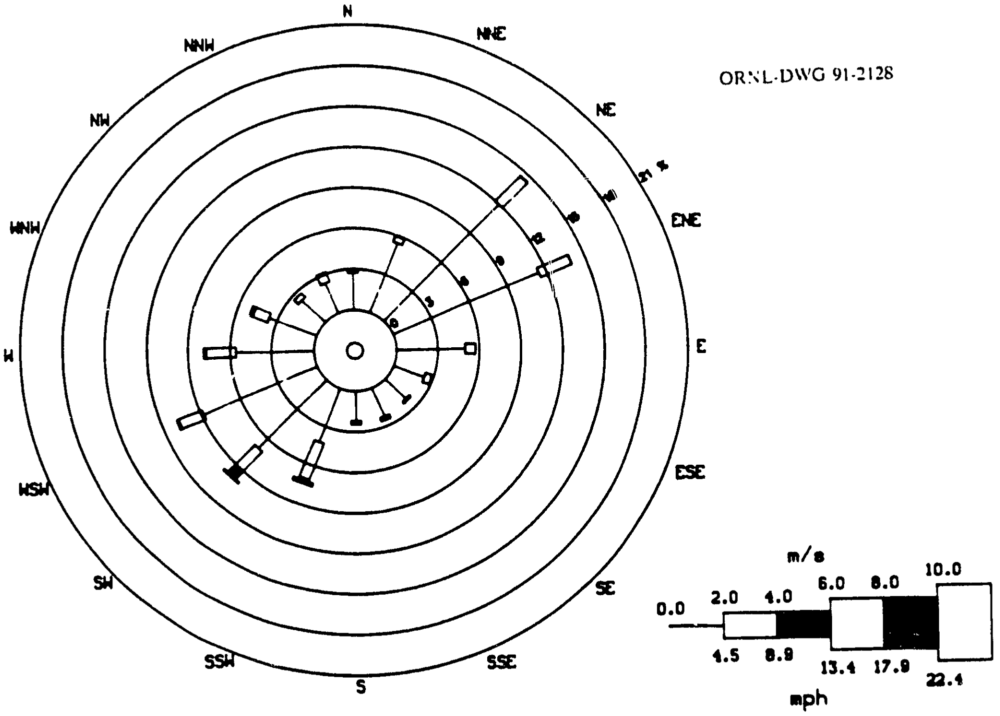

Fig. 17. Wind rose at 10-m level of meteorological tower A, October - December

with 92.1% of possible data

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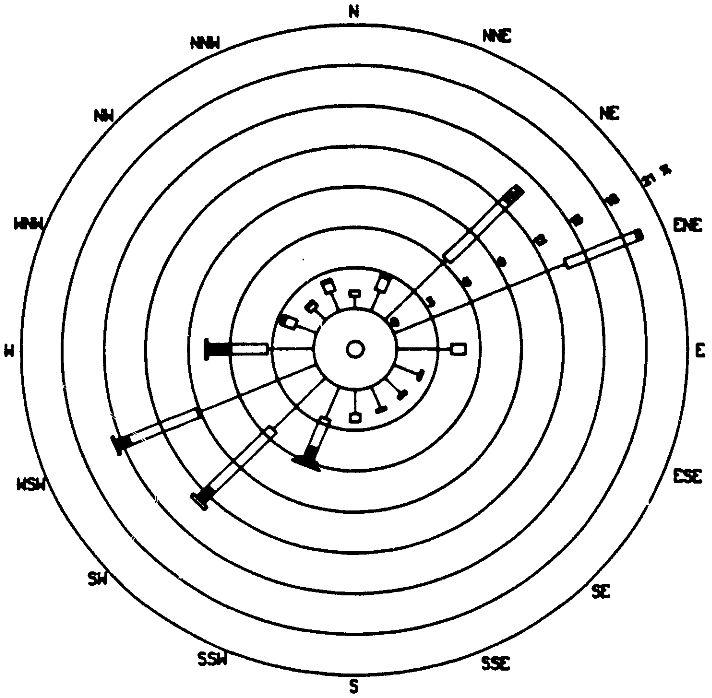


Fig. 18. Wind rose at 30-m level of meteorological tower A, October - December 1990

with 87.0% of possible data

ORNL-DWG 91-2130

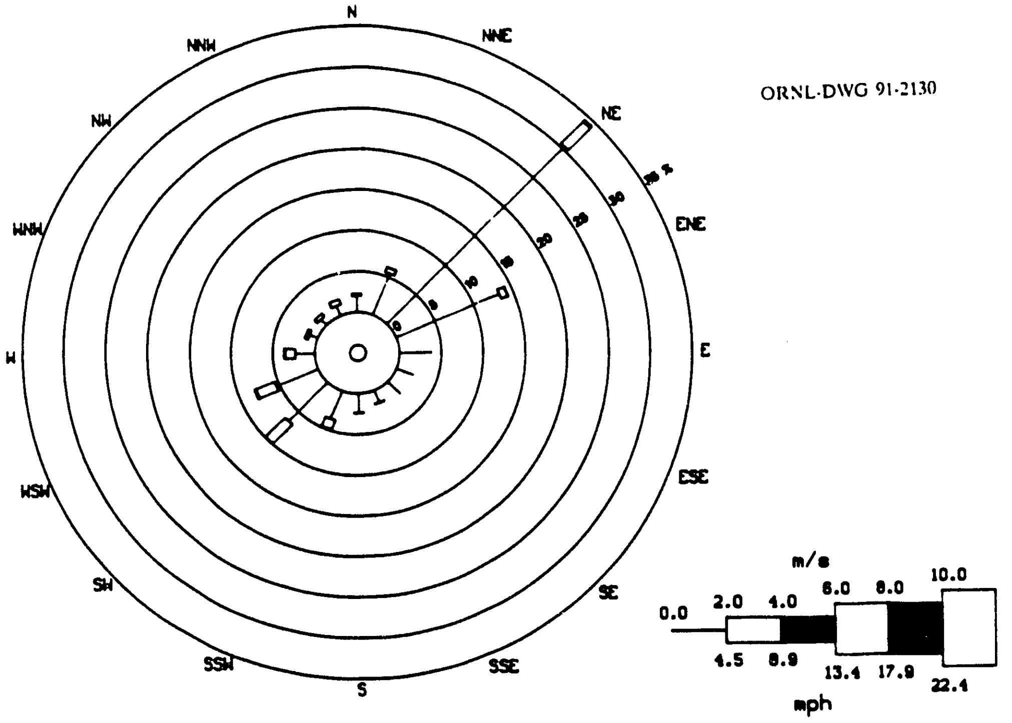


Fig. 19. Wind rose at 10-m level of meteorological tower B, October - December 1990

with 83.1% of possible data

ORNL-DWG 91-2131

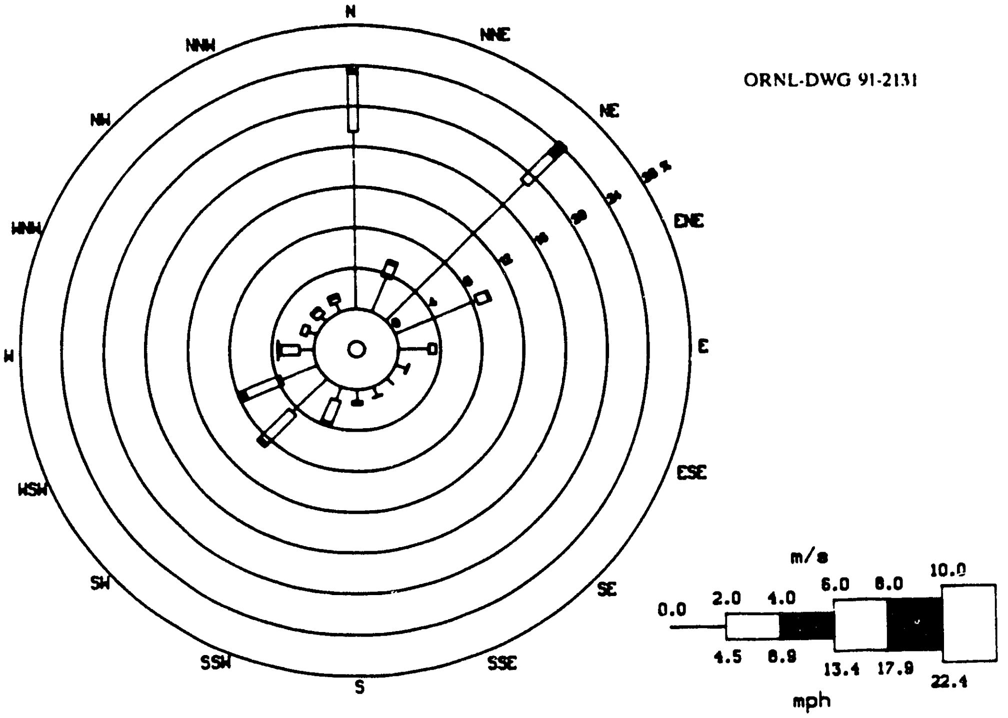
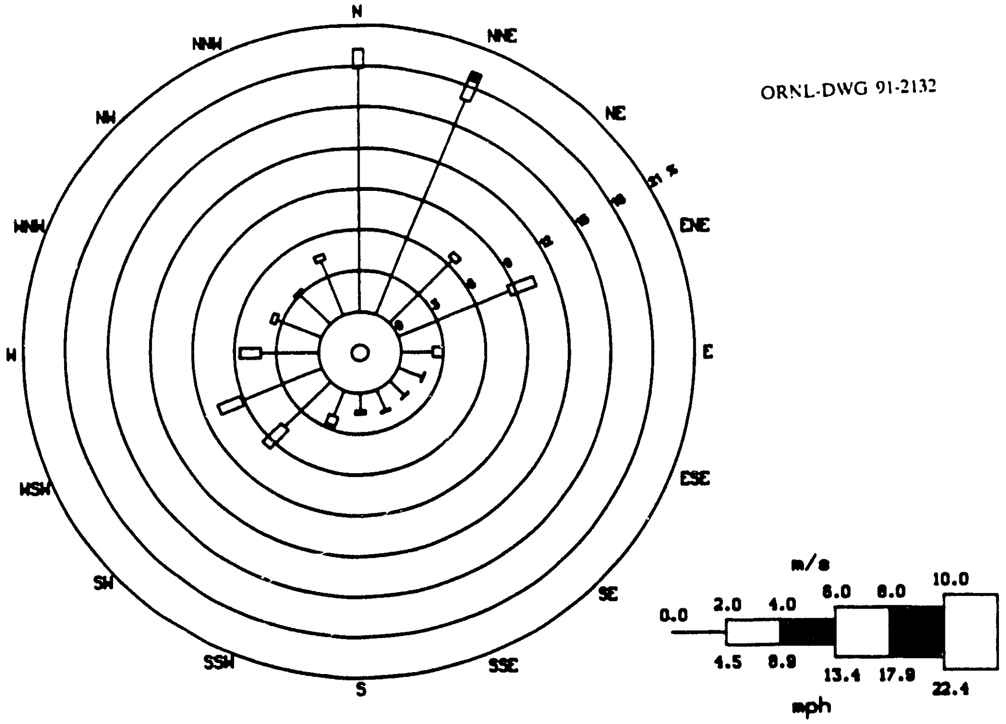


Fig. 20. Wind rose at 30-m level of meteorological tower B, October - December 1990

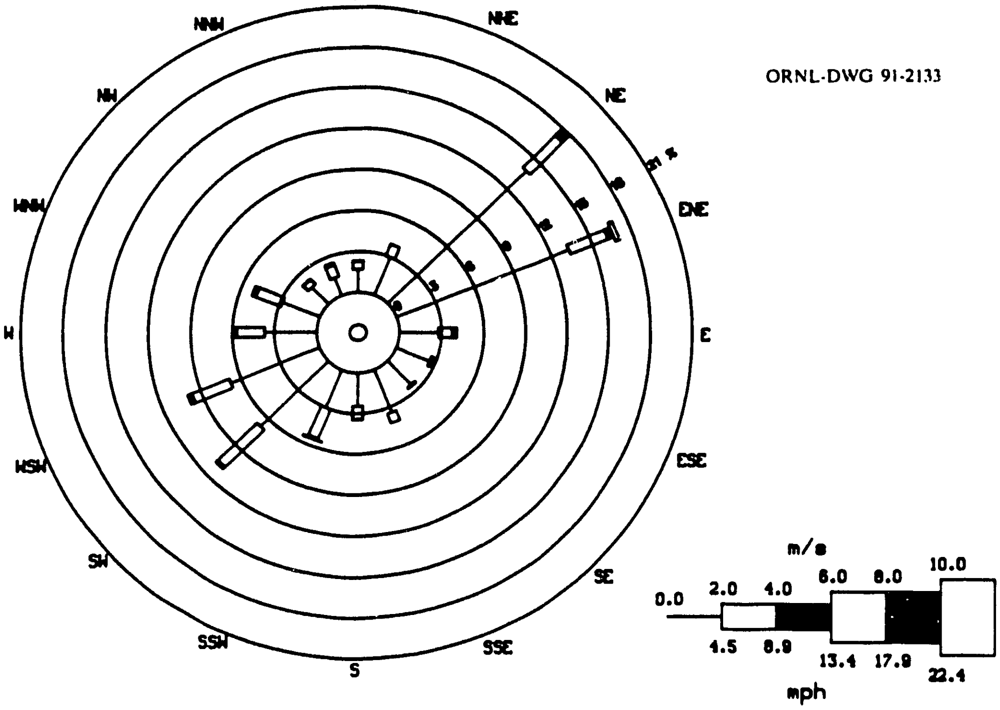
with 85.6% of possible data



ORNL-DWG 91-2132

Fig. 21. Wind rose at 10-m level of meteorological tower C, October - December 1990

with 85.5% of possible data



ORNL-DWG 91-2133

Fig. 22. Wind rose at 30-m level of meteorological tower C, October - December 1990

with 90.2% of possible data

ORNL-DWG 91-2127

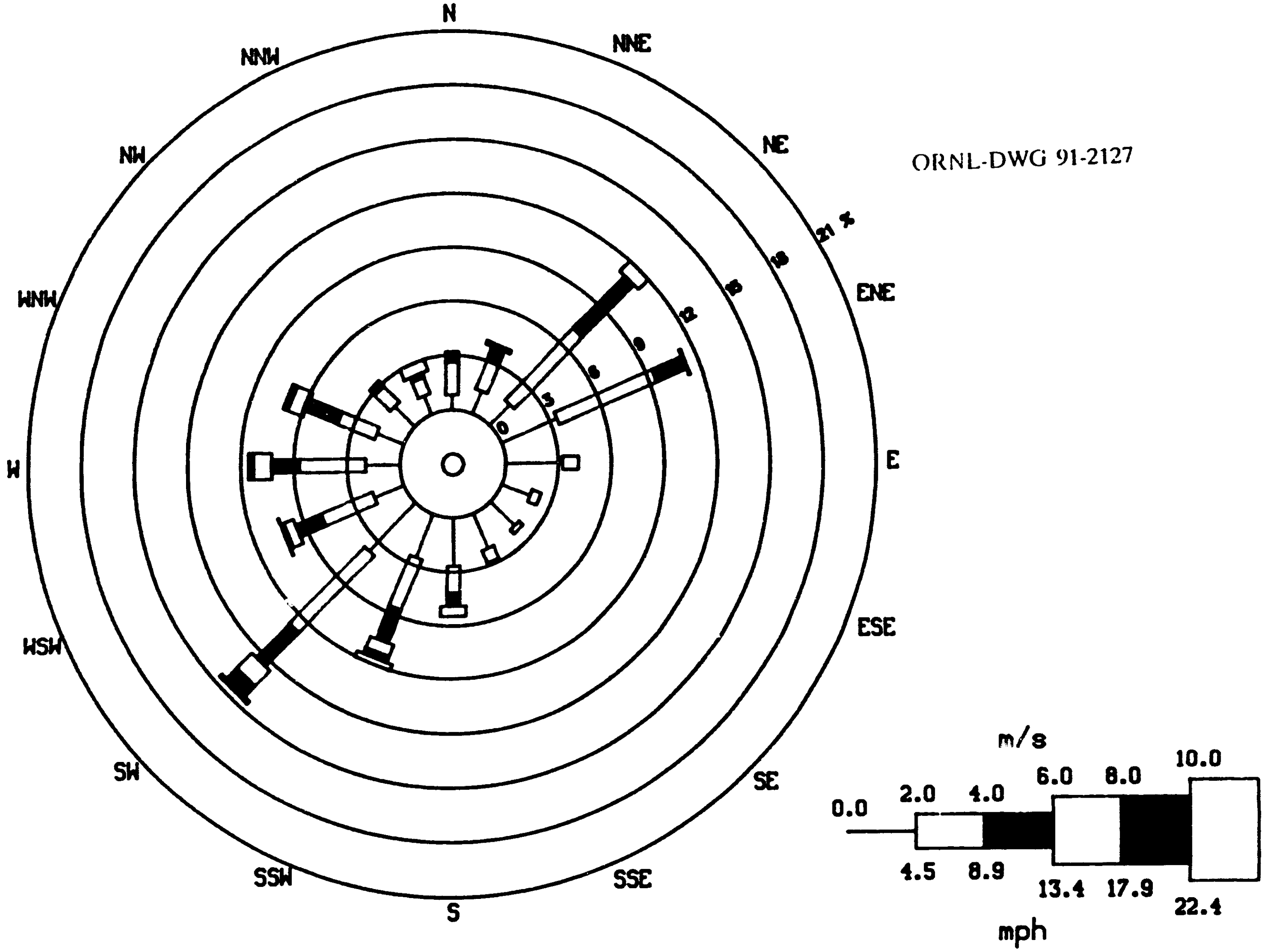


Fig. 23. Wind rose at 100-m level of meteorological tower C, October-December 1990

5. BIOLOGICAL MONITORING

The environmental surveillance programs include biotic and abiotic environments that may be affected by the releases from the Oak Ridge Department of Energy (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. Strontium-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. 24). 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 strontium in milk samples, and net activity concentrations are summarized.

5.1.2 Results

Concentrations of total radioactive strontium are shown in Table 48. The estimated overall average concentration of total radioactive strontium at the stations in the immediate Oak Ridge area was 0.061 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 49. The estimated overall average concentration of I-131 at the stations in the immediate Oak Ridge area was 0.0053 Bq/L.

Dose was calculated for a station when the average value obtained was statistically greater than zero. The measured average concentrations of total radioactive strontium (assuming 100% Sr-90) and I-131 in milk were used to calculate the potential 50-y committed effective dose equivalents given in Tables 48 and 52. 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 μSv.

ORNL DWG 85-9421R6

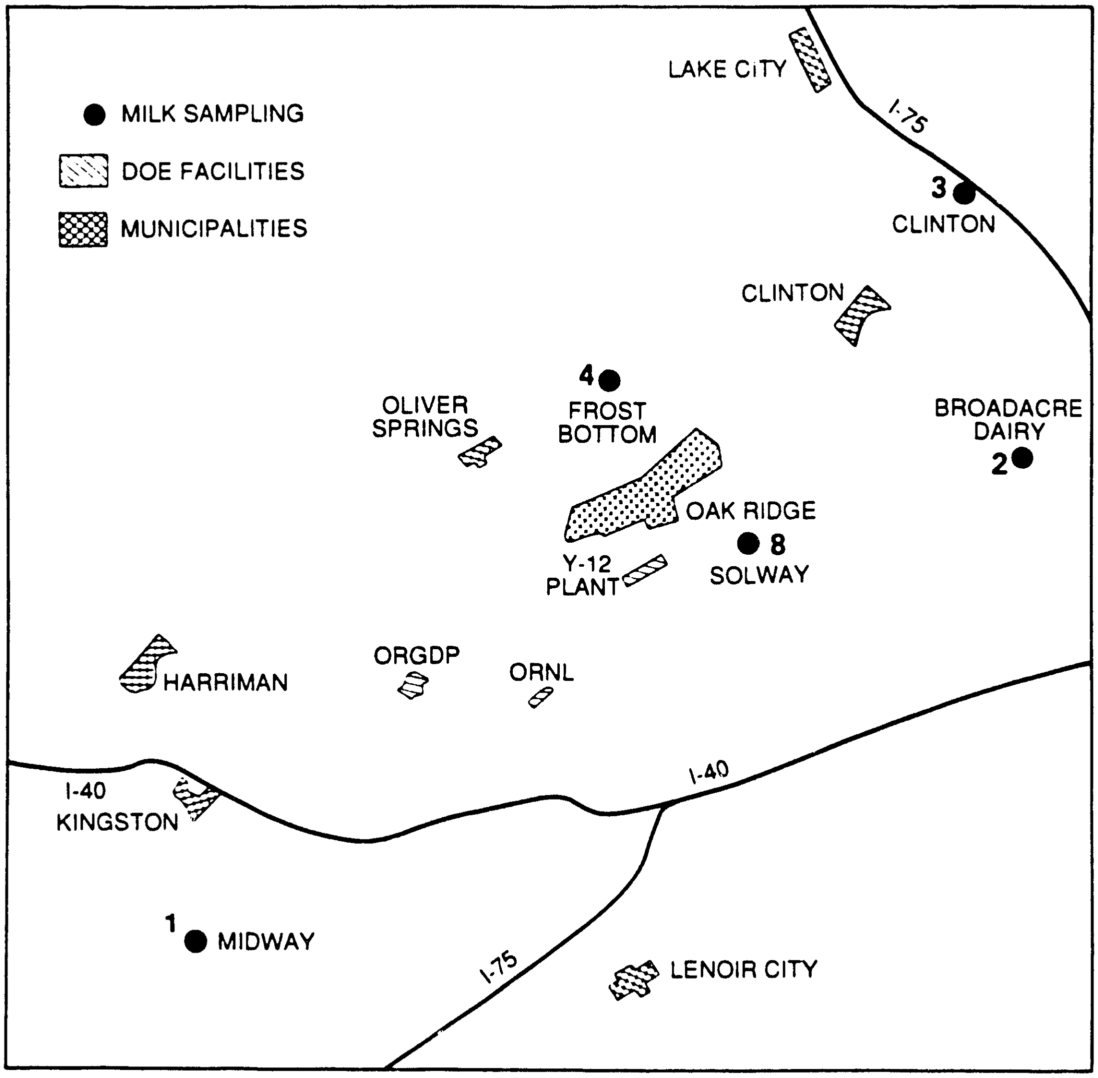


Fig. 24. **Location map of milk-sampling stations near the Oak Ridge facilities.**

Table 48. Concentrations of total radioactive strontium in milk and calculated doses, October-December 1990

Number of Station[a]	Samples	Concentration (Bq/L) Max	Min	Av[b]	Standard error[c]	Dose (μSv)[d]
		Immediate environ[e]				
1	3	0.11	-0.0070	0.051	0.034	
2	3	0.053	0.041	0.047*	0.0035	0.61
3	3	0.094	0.018	0.055	0.022	
4	3	0.092	0.012	0.059	0.024	
8	3	0.16	0.012	0.091	0.043	
Network Summary						
	15	0.16	-0.0070	0.061*	0.012	0.78

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

[b] An * identifies average values significantly greater than zero.

[c] Standard error of mean.

[d] Potential 50-y 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 24.

Table 49. Concentrations of I-131 in milk and calculated doses, October-December 1990

Station[a]	Number of Samples	Concentration (Bq/L) Max	Min	Av	Standard error[b]	Dose (μSv)[c]
		Immediate environs[d]				
1	3	0.050	-0.040	0.010	0.026	
2	3	0.060	-0.070	-0.0067	0.038	
3	3	0.020	-0.020	0.0067	0.013	
4	3	0.020	-0.010	0.0067	0.0088	
8	3	0.030	-0.010	0.010	0.012	
Network Summary						
	15	0.060	-0.070	0.0053	0.0086	

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

[b] Standard error of mean.

[c] Potential 50-y 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.

[d] See Figure 24.

5.1.3 Trends

Current trends in the I-131 and strontium 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 two years. In the current quarter I-131 and total strontium concentrations are below the maximum and average values for the last two years at all stations.

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 polychlorinated biphenyls (PCBs) (Fig. 25). Sampling is performed semiannually. The last sampling was reported in the second quarter of 1990. Sampling locations include the following Clinch River kilometers (CRK): (1) 40.0, which is above Melton Hill Dam and most of the Oak Ridge DOE facilities' outfalls serves as a background location; (2) 33.3, which is Oak

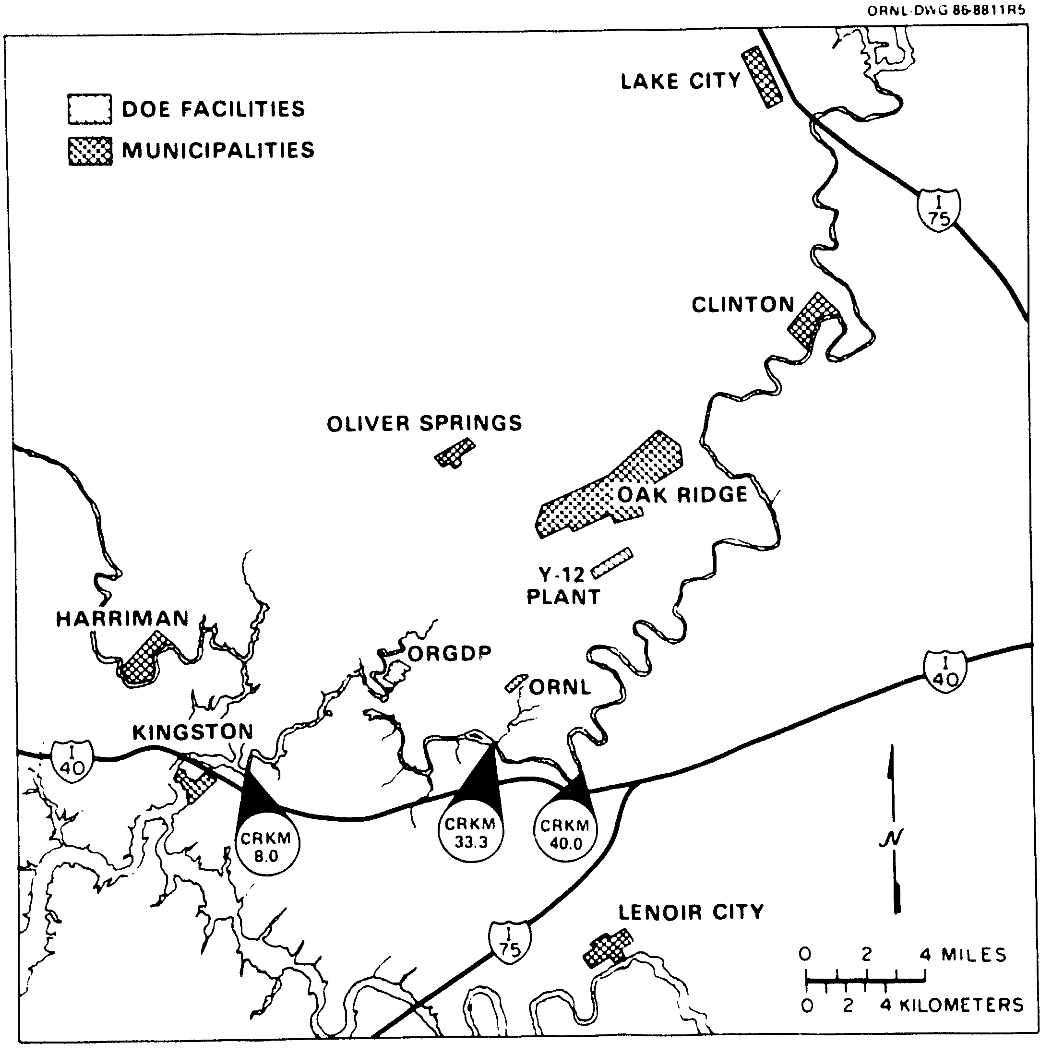


Fig. 25. Location map of fish-sampling points along the Clinch River.

Ridge National Laboratory's (ORNL) discharge point from White Oak Creek to the Clinch River; and (3) 8.0, which is downstream from both ORNL and Oak Ridge K-25 Site.

The primary radionuclides of concern at ORNL, because of fish consumption, are total radioactive strontium 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 six to ten 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 atomic absorption technique. PCB's are determined by extraction of the PCB from the fish tissue and determination of PCB by gas chromatography.

5.2.2 Results

Concentrations of mercury in fish are shown in Table 50. Average mercury concentrations range from a low of <0.10 μg/g to a high of <0.19 μg/g of wet weight. These concentrations represent <10 to <19% of the Food and Drug Administration (FDA) action level for mercury in fish.

Concentrations of PCBs are shown in Table 51. Average concentrations of PCBs in fish during this period were all less than detection limits. All concentrations of PCBs (individual types and the sum) were less than 21% of the FDA's tolerance level of 2.0 μg/g wet weight for fish.

Table 50. Mercury concentrations in Clinch River Bluegill, July-December 1990

Location[a]	No. of Fish Sampled	Concentration (μg/g Wet Wt.) Max	Min	Av	Standard error	% FDA Level[b]
CRK 8.0	6	0.30	<0.10	<0.19	0.036	<19
CRK 33.3	6	0.17	<0.10	<0.13	0.013	<13
CRK 40.0	6	<0.10	<0.10	<0.10	0	<10

[a] See Figure 25.

[b] Percent of FDA action Level for mercury in fish (1.0 μg/g) for the average concentration.

Table 51. PCB concentrations in Clinch River Bluegill, July-December 1990

Location[a]	PCB Type	No. of Fish Sampled	Concentration (μg/g wet wt) Max	Min	Av	Std. error[b]	% of Level[c]
CRK 8.0	1254	6	<0.35	<0.18	<0.24	0.023	12
CRK 8.0	1260	6	<0.35	<0.18	<0.24	0.023	12
CRK 33.3	1254	6	<0.23	<0.18	<0.20	0.0083	9.9
CRK 33.3	1260	6	<0.23	<0.18	<0.20	0.0083	9.9
CRK 40.0	1254	6	<0.54	<0.38	<0.43	0.026	21
CRK 40.0	1260	6	<0.54	<0.38	<0.43	0.026	21

[a] See Figure 25.

[b] Standard error of the mean.

[c] Percent of FDA action level of PCBs in fish (2.0 μg/g) for the average concentration.

Concentrations and summary statistics are presented in Table 52. Average radionuclides found in bluegill were highest for CS-137 with a range of 0.27 to 6.9 Bq/kg wet weight. Total radioactive strontium ranged from 0.099 to 0.66 Bq/kg, and Co-60 ranged from 0.043 to 0.12 Bq/kg. Average radionuclide values that were statistically determined to be greater than zero were found at CRK 8.0, CRK 33.3 and CRK 40.0. No guide lines currently exist for radionuclides in fish.

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 remained below the two-year maximum and average concentration at CRK 8.0, CRK 33.3, and CRK 40.0. The maximum and average concentration of PCBs also remains below the two-year maximum and average value at all sampling sites. Radionuclides in fish have exceeded the two-year maximum and average value for Cs-137 at CRK 33.3. The maximum and average values for Co-60 have been exceeded at CRK 33.0 and CRK 40.0. These values are only slightly higher than past values and will require more data to determine if they are significant.

Table 52. Radionuclide concentrations in Clinch River Bluegill, July-December 1990

Location[a]	Radionuclide	Number of Samples[b]	Concen. (Bq/kg wet wt)			Standard error[d]
			Max	Min	Av[c]	
CRK 8.0	Co-60	3	0.19	-0.048	0.043	0.074
	Cs-137	3	1.5	1.4	1.5*	0.036
	Total radioactive Sr[e]	3	0.44	-0.012	0.22	0.13
CRK 33.3	Co-60	3	0.29	-0.013	0.099	0.097
	Cs-137	3	14	3.2	6.9	3.5
	Total radioactive Sr[e]	3	0.85	0.52	0.66*	0.097
CRK 40.0	Co-60	3	0.18	0.080	0.12*	0.033
	Cs-137	3	0.31	0.26	0.27*	0.019
	Total radioactive Sr[e]	3	0.13	0.082	0.099*	0.015
Network Summary	Co-60	9	0.29	-0.048	0.086*	0.038
	Cs-137	9	14	0.26	2.9*	1.4
	Total radioactive Sr[e]	9	0.85	-0.012	0.33*	0.098

[a] See Fig. 25.
[b] A sample is a composite of six to ten fish.
[c] An * identifies average values significantly greater than zero.
[d] Standard error of mean.
[e] Total radioactive strontium (Sr-89 + Sr-90)

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