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ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR
THE SECOND QUARTER OF 1992

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LIST OF ACRONYMS AND ABBREVIATIONS

BMP	Best management practice
CAA	Clean Air Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
CYRTF	Coal Yard Runoff Treatment Facility
DCG	derived concentration guide
DOE	U.S. Department of Energy
DWL	drinking water limit
DWS	drinking water standard
EPA	Environmental Protection Agency
EC	Environmental Compliance Section of OECD
ESP	Environmental Surveillance and Protection Section of OECD
ICP	inductively coupled plasma
LLW	Low-level waste
MB	Melton Branch
MHD	Melton Hill Dam
N det	Number of detected samples
N total	Total number of samples
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NRWTF	Nonradiological Wastewater Treatment Facility
NWT	Northwest Tributary
OECD	Office of Environmental Compliance and Documentation
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PAM	Perimeter Air Monitoring
PCB	polychlorinated biphenyl
PWTP	Process Waste Treatment Plant
QA/QC	Quality assurance/Quality control
RCRA	Resource Conservation and Recovery Act
SAS	SAS Institute, Inc.
STP	Sewage Treatment Plant
SWMU	Solid Waste Management Unit
SWSA	Solid Waste Storage Area
TDEC	Tennessee Department of Environment and Conservation
Total rad Sr	Total radioactive strontium (Sr-89 + Sr-90)
WAG	Waste Area Grouping
WOC	White Oak Creek
WOD	White Oak Dam
WOL	White Oak Lake

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1.0 INTRODUCTION

The Environmental Surveillance and Protection Section within the Office of Environmental Compliance and Documentation 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 programs that assess off-site impacts of 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 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 the "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance (the Regulatory Guide)" DOE/EH-0173T.

Environmental monitoring, as defined by the Regulatory Guide, 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 medium 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 m³ of air in a year and to drink 730 L of water in a year. When there are multiple DCGs for a given isotope, the most restrictive value is used for comparisons. When the 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 instrument 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 standard normal distribution (z value) or the t distribution (t value) and a one-tailed test with 95% confidence level. 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 level of the test. With a specified 95% confidence level there is a 5% error rate, wrongly declaring a result greater than zero 5% of the time. This is a commonly used confidence level that represents a compromise between incorrectly declaring that a value is greater than zero and incorrectly declaring that a value is equal to zero.

The lower confidence limit for a single radioactivity measurement is computed by multiplying the counting standard deviation by 1.645 (z value for a one-tailed test at a 95% confidence level) and subtracting that from the sample result. If that difference is equal to or greater than zero, the result is said to be significantly greater than zero. Otherwise it is said to be not significantly greater than zero.

Multiple value summaries are of two types: averages and sums. An average is tested for difference from zero using the standard error of the mean and the appropriate t value with n-1 degrees of freedom. All sources of variation, counting uncertainty in the case of radionuclide measurements, laboratory preparation, sampling variance and population variation, are inherently

estimated by the calculated standard error used in this test. As a result, inference is on the whole process that generated the measurements. Sums of radioactivity measurements are tested for differences from zero using only the propagated counting uncertainties. The 95% lower bound on the sum is the calculated sum minus 1.645 times the square root of the summed counting variances. Estimates of the sampling and population variability are not available in this situation. As a result, inference is on the observed sum, not on an underlying population from which the observations were taken.

Presentations of radioactivity data throughout the report follow the convention of flagging data that 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" (<) or as "undetected" (U) values. The average value is expressed with a ~ (tilde) when at least one of the results used for the average is less than the detection limit.

Results obtained in the laboratory are often reported as "less than" or "below detection." In these situations the detection limit is reported along with the "less than" designation. The sample mean and standard error of the mean are affected by these values; they become "biased"--biased high for the mean and low for the standard error of the mean. That is, the sample standard error of the mean is estimating something smaller than the true standard error.

A further consequence of the bias is an increased likelihood that a population mean will be declared greater than zero in a statistical test using the biased sample mean and standard error. A statistically significant result may be a consequence of the number of values below the detection limit. If, however, there were a number of values above the detection limit, the conclusion that the true mean is greater than zero may be valid even though the estimate of true mean is biased.

2.0 AIR

The Department of Energy (DOE) Oak Ridge facilities are subject to regulations issued by the Tennessee Department of Environment and Conservation (TDEC) Air Pollution Control Board and the Environmental Protection Agency (EPA) as well as DOE orders. Nonradioactive emission sources are regulated by TDEC, and radioactive emission sources are regulated by EPA under the National Emission Standards for Hazardous Air Pollutants (NESHAP). The authority for these regulations is derived from the Tennessee Air Quality Control Act (TAQC) and the Clean Air Act (CAA).

The TDEC air pollution control rules regulate pollution sources to protect the public health and welfare and the environment. These rules include regulations for maximum allowable ambient air concentrations of certain pollutants, open burning, pollution sources such as coal-fired boilers and processes, fugitive emission sources, performance standards for new sources, and hazardous air pollutants. State-issued permits are required for air pollution sources with the exception of certain very small emission sources that are specifically exempt from permit requirements.

The EPA rules for radioactive emission sources limit the amount of exposure to radioactivity to the nearest or the most affected member of the public. The EPA sets the limit on exposure to radioactivity by first determining (1) a safe exposure level and (2) then adding a margin of safety. The dose, to the most affected member of the public, is determined by EPA-approved radioactive emissions dose modeling. The NESHAP regulations were reissued in December 1989. The ORR is currently not in compliance with the stack sampling criteria. A Federal Facility Compliance Agreement (FFCA) was signed in May 1992 by the DOE field office manager and is being implemented to achieve full compliance by December 1992.

DOE regulations governing airborne emissions are established in DOE orders 5400.1 and 5400.5 and DOE/ESH-0173T. Using the criteria in NESHAP regulations and DOE orders, major effluent sources are defined as emission points with the potential to discharge radionuclides in quantities that could cause an annual effective dose equivalent of 0.1 mrem/year or greater to a member of the public. Potential emissions are calculated for a source by assuming the loss of pollution control equipment while the source is otherwise operating normally.

ORNL has a comprehensive air pollution control and monitoring program to ensure that airborne discharges meet regulatory requirements and do not adversely affect ambient air quality. Air pollution controls include exhaust gas scrubbers, baghouses, and exhaust filtration systems designed to remove airborne pollution from the exhaust gases before their release to the atmosphere. Process modifications and material substitutions are also made in an effort to minimize air emissions. In addition, administrative controls play a role in regulating emissions. ORNL has developed an emissions inventory program that includes stack sampling to determine the amounts of pollutants that are not removed by the air pollution control equipment.

(Ambient air monitoring is also conducted around the facilities and at two locations within surrounding East Tennessee communities to assess the impacts of ORR operations on the ambient air quality of the region.)

2.1 AIRBORNE EMISSIONS

Laurice V. Hamilton and Joan F. Hughes

2.1.1 Program Description

The major gaseous emission point sources for ORNL consist of the following four stacks located in Bethel and Melton Valleys:

Building	Description
2026	High Radiation Level Analytical Laboratory
3020	Radiochemical Processing Plant
3039	3500 and 4500 areas cell ventilation system Central off-gas and scrubber system Isotope solid state ventilation system
7911	3025 and 3026 areas cell ventilation system Melton Valley complex (High Flux Isotope Reactor, Radiochemical Engineering Development Center)

Fig. 1 shows the locations of the four main stacks whose emissions are routinely quantified.

Discharges from each stack are unique because of the wide variety of research activities performed at ORNL. Radiological emissions from ORNL typically consist of particulates, adsorbable gases (e.g., iodine), tritium, and nonabsorbable gases (e.g., xenon).

Gaseous effluents at ORNL originate from ventilation air from contaminated or potentially contaminated areas, vents from tanks and processes, and ventilation for reactor facilities. Many sources, mostly nonradioactive, are permitted by the TDEC Air Pollution Control Board. Most gaseous emissions are treated and filtered before discharge to the atmosphere. Typically, contaminated and potentially contaminated gaseous wastes are treated, then filtered with HEPA and/or charcoal filters before discharge to ensure that any radioactivity released is within acceptable levels.

2.1.2 Procedures and Results

Sampling systems were being upgraded to meet the criteria in NESHAP regulations and DOE orders and were completed by September 30, 1992. In general the present sampling systems consist of in-stack sampling probes, sample transport lines, a particulate filter, an activated charcoal canister, a silica-gel tritium trap, flow measurement and totalizing instruments, a sampling pump,

and a sample flow measurement and totalizing instruments, a sampling pump, and a sample return line to the stack. The present sampling systems at stacks 2026 and 3020 do not have tritium traps.

Due to major program changes, data for the second quarter will be presented in a future report.

2.2 AMBIENT AIR

Laurice V. Hamilton and Joan F. Hughes

2.2.1 Program Description

The objectives for the ambient program are (1) to sample at locations that are most likely to show impacts of airborne emissions from the operation of ORNL, (2) to maintain surveillance of airborne radionuclides at the ORR perimeter, and (3) to collect reference data from remote locations. Figs. 2-4 show the stations that are in the ORNL Ambient Air Program. The specific stations associated with each of these objectives are as follows:

Fig. 2. The ORNL Perimeter Air Monitoring (PAM) network includes stations 1, 2, 3, and 7.

Fig. 3. The DOE ORR PAM network includes stations 35, 37, 38, 39, 40, 42, 46, and 48.

Fig. 4. The Remote Air Monitoring (RAM) network consists of stations 52 and 58.

Annual composites of particulate air filters from each station are analyzed for specific radionuclides. Annual compositing of the particulate air filters for analysis of long-lived isotopes has been adopted because the data from previous years showed very low concentrations of these radionuclides. Stations 3 and 48 are equipped with tritium collection systems. Airborne radioactive particulates are sampled biweekly by pumping a continuous flow of air through a 47-mm (1.88-in.) diameter paper filter. Airborne adsorbable gases are collected biweekly (at ORNL PAM stations only) using a canister containing activated charcoal that is downstream of the particulate filter. The charcoal canister is analyzed within 24 hours after collection. The initial and final dates, time on and off, and flow rates are recorded when a sample is mounted or removed. The total volume of air that flowed through the sampler is obtained from a flow totalizer, with the exception of tritium. The concentration of radionuclides in air is calculated by dividing the total activity per sample by the total volume of air sampled.

Data summaries for isotopic identification of particulates on the air filters will be included in the 4th Quarter Report.

The sampling system is currently being upgraded. Tritium samplers were installed at all sampling locations during the end of the third quarter. In addition, hi-volume air samplers will be used at all ORR locations. These new

ORR-018

Fig. 2. ORNL perimeter monitoring locations.

Fig. 3. ORR perimeter monitoring locations.

DAA-017

ORNL-DWG 92-15485

Fig. 4. ORR remote air monitoring locations.

samplers will provide a more concentrated particulate sample which will allow for better quantification of each isotope with more frequent analysis.

2.2.2 Procedures and Results

In the second quarter 27 out of 28 adsorbable gas samples were collected, yielding a collection rate of 96%. Out of the 27 samples, there were no measurable amounts of I-131 on any sample that was distinguishable from zero. Collection results are shown in Table 1.

All ambient tritium samples were collected for the quarter yielding a 100% collection rate. The two locations that are equipped with tritium samplers are at the east and west ends of Bethel Valley. Both samplers collected measurable amounts of tritium. The results are summarized in Table 2.

2.3 EXTERNAL GAMMA RADIATION

Laurice Hamilton and Betsy Horwedel

2.3.1 Program Description

At ORNL and the reservation perimeter air monitoring stations, external gamma radiation measurements (exposure rates) were recorded on a near real-time data acquisition system until February 1992. The locations of these PAMs are shown in Fig. 2. The readings were averaged at 10-minute intervals and stored in a database on the host computer. From these data, hourly averages were computed and also stored in a database. Readings were marked as invalid by the system if less than 75% of the data were available for the computation of the average as well as if the data are out of a predefined range. If a station had been marked off poll, which means the host computer was not collecting data from the station, no readings were returned to the data acquisition system for inclusion in the databases.

In mid February, the station locations were changed to coincide with the new ambient air locations. External gamma measurements are recorded at stations 39, 40, 42, 46, and 48, which are five of the ten ambient air stations. In addition, external gamma measurements were still collected at the DOE museum (station 41). After the relocation, the external gamma measurements were recorded weekly in the field. The readings for the quarter are entered into SAS data sets and a statistical evaluation completed. The equivalent dose rate is calculated using the average reading for each station during the quarter.

2.3.2 Procedures and Results

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 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 3 are within the above range of background values. Table 3 summarizes the weekly measurements from April-June 1992.

Table 1. Ambient air concentrations of I-131 at ORNL air monitoring stations,^a April-June 1992

Station	Number Collected	Number Possible	Number Detected
1	7	7	0
2	7	7	0
3	7	7	0
7	6	7	0
Overall Summary	27	28	0

^aSee Fig. 2.

Table 2. Atmospheric tritium concentrations at ambient air stations,
April-June 1992

Station ^a	N det/ N total	Concentration (10^{-4} Bq/L)			Standard error ^c	Percent of DCG ^d
		Max	Min	Av ^b		
3	4/4	23	4.0	11*	4.3	0.030
48	4/4	19	6.1	12*	2.9	0.033
Overall Summary	8/8	23	4.0	12*	2.4	0.032

^aStation locations are shown in Fig. 2.

^bAverage concentrations significantly greater than zero are identified by an *.

^cStandard error of the mean.

^dPercent of DCG = Average/DCG x 100. The DCG for tritium is 3.7 Bq/L.

Table 3. External gamma radiation measurements at reservation perimeter air monitoring stations,^a April-June 1992

Station	Number of Readings	Exposure rate (nC/kg/h) ^b				Equivalent Dose (μ Sv/h)
		Max	Min	Av	Standard error ^c	
39	10	2.8	2.7	2.7	0.013	0.088
40	12	2.1	2.0	2.1	0.0050	0.070
41	12	1.3	1.2	1.2	0.0017	0.042
42	4	2.6	1.9	2.1	0.18	0.070
46	3	2.3	2.2	2.3	0.0064	0.076
48	12	1.8	1.7	1.8	0.0029	0.060
Overall Summary	53	2.8	1.2	1.9	0.068	0.066

^aSee Fig. 2.

^bNanocoulomb per kilogram per hour.

^cStandard error of the mean.

3.0 WATER

The Oak Ridge National Laboratory (ORNL) site is located in the 17 km² 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. 5. 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 mile from WOL. The final point of control for the watershed is at White Oak Dam (WOD), which is the structure that forms WOL. The lake is about two-thirds of a mile long and less than a tenth of mile wide. The receiving water for the watershed is Watts Bar Lake of the Clinch River.

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 Discharge Elimination System (NPDES) effluent points, and 3 CFS (2 MGD) is attributed to cooling towers and blowdown. The base flow during drought is estimated at 1.75 CFS (1.14 MGD).

Surveillance of the water environment consists of the collection of surface water, effluent and sediment samples required under the NPDES Permit, and groundwater from Waste Area Groupings 1-9, 11 and 17. Of the WAGs, WAGs 7, 8, 9, 17, and Solid Waste Storage Area (SWSA) 6 within WAG 6 were sampled during this quarter. Samples are analyzed for radionuclides and nonradioactive chemicals.

3.1 SURFACE WATER

Melinda C. Salmons and 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 4.

3.1.2 Procedure and Results

Treated water samples are collected weekly at the Kingston and Gallaher potable water treatment plants (Fig. 6) and are analyzed quarterly. Table 5 contains the concentrations measured at these stations during this quarter. At Gallaher, gross alpha, total rad Sr, and H-3 were significantly greater than zero but at levels no greater than 43% of the Environmental Protection

ORNL-DWG 92M-6985

Fig. 5. ORNL surface water, NPDES, and reference sampling stations.

Table 4. Summary of collection and analysis frequencies of surface and effluent water samples for radionuclide analysis

Station	Parameter	Collection Frequency	Sample Type	Analysis Frequency
STP	Gamma scan, Gross beta, Total rad Sr	Weekly	Flow proportional	Monthly
7500 Bridge, MB1, MB2, WOC	Gamma scan, H-3, Total rad Sr	Weekly	Flow proportional	Monthly
First Creek, Fifth Creek, Raccoon Creek	Gamma scan, Total rad Sr	Weekly	Grab	Monthly
Gallaher	Gamma scan, Gross alpha, Gross beta, H-3, Pu-238, Pu-239, Total rad Sr, Total U	Weekly	Time proportional	Quarterly
Kingston	Gamma scan, Gross alpha, Gross beta, H-3, Pu-238, Pu-239, Total rad Sr, Total U	Weekly	Grab	Quarterly
MHD	Gamma scan, Gross alpha ^a , Gross beta ^b	Weekly	Flow proportional	Monthly
NRWTF	Gamma scan, Gross alpha, Gross beta, H-3, Total rad Sr	Weekly	Flow proportional	Monthly
NWT	Gamma scan, Total rad Sr	Weekly	Flow proportional	Monthly
WOC Headwaters	Gamma scan, Gross alpha ^a , Gross beta ^b	Weekly	Flow proportional	Monthly
WOD	Gamma scan, Gross alpha ^a , Gross beta ^b	Weekly	Flow proportional	Weekly
WOD	H-3, Total rad Sr	Weekly	Flow proportional	Monthly

Table 4. (continued)

Station	Parameter	Collection Frequency	Sample Type	Analysis Frequency
Category I Outfalls	Gamma scan, Gross beta ^b , Total rad Sr	Annually	Flow proportional	Annually
Category II Outfalls	Gamma scan, Gross beta ^b , Total rad Sr	Quarterly	Flow proportional	Quarterly

^aIf 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.

^bIf gross beta >30 Bq/L, analyze for total rad Sr.

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

Table 5. Summary of radionuclide concentrations in water off-site ORNL,
April-June 1992

Radionuclide	Concentration ^a (Bq/L)	Drinking Water Standard ^b (DWS) (Bq/L)	Percent DWS ^c
<i>Gallaher^d</i>			
Co-60	-0.0060	e	e
Cs-137	0.0030	e	e
Gross alpha	0.24*	0.555	43
Gross beta	0.17	1.85	e
Pu-238	0.00072*	e	e
Pu-239	-0.00015	e	e
Total rad Sr	0.058*	0.296	20
Total U ^f (mg/L)	0.00017	e	e
Total U ^{fg}	0.0042	e	e
H-3	53*	740	7.2
<i>Kingston^d</i>			
Co-60	0.014*	e	e
Cs-137	0.0060	e	e
Gross alpha	0.037	0.555	e
Gross beta	0.010	1.85	e
Pu-238	0.00016	e	e
Pu-239	-0.00025	e	e
Total rad Sr	0.0020	0.296	e
Total U ^f (mg/L)	0.00019	e	e
Total U ^{fg}	0.0047	e	e
H-3	3.0	740	e

^aConcentrations significantly greater than zero are identified by an *.

^bNational Primary Drinking Water Standard. From 40 CFR 141, as amended.
The value for total rad Sr is based upon the Sr-90 limit. The value for gross beta is a regulatory guide for assessing compliance without further analysis.

^cConcentration as a percentage of the DWS.

^dSee Fig. 6.

^eNot applicable.

^fNo test for significance is possible.

^gActivity derived from mass assuming natural abundance of U-234, U-235 and U-238.

Agency (EPA) drinking water standards. Pu-238 at Callaher was significantly greater than zero; however, there are no drinking water standards for Pu-238. At Kingston, Co-60 was significantly greater than zero; however, there are no drinking water standards for Co-60. No test of significance was possible for the single total uranium measurement (the uranium fluorometric measurement is converted to an activity by assuming natural abundance of uranium isotopes U-234, U-235 and U-238) at each site, but the concentrations at Callaher and Kingston are less than 0.9% of the gross alpha standard.

Derived concentration guides (DCG) are estimates of the rate of exposure to a given radioisotope via one exposure pathway that would result in an effective dose equivalent 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 "DOE Order 5400.5" 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 a sum ever exceeds 100%, an analysis of the best available technology to reduce the signature would be conducted as specified in "DOE Order 5400.5".

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, Northwest Tributary, and Raccoon Creek (Fig. 5). Summary statistics for each radionuclide at each surface water sampling location are given in Table 6. Average gross beta (0.88 Bq/L) and gross alpha (0.099 Bq/L) at Melton Hill Dam and average gross beta (0.66 Bq/L) at WOC headwaters were significantly greater than zero.

Average total rad Sr concentrations at First Creek (8.5 Bq/L), Northwest Tributary (1.9 Bq/L), and 7500 Bridge (2.9 Bq/L) were 23%, 7.8%, and 5.2% of the DCG for Sr-90, respectively. Otherwise, all average radionuclide concentrations at First Creek, Northwest Tributary, Fifth Creek, Raccoon Creek, MB2, and 7500 Bridge were no greater than 5% of the respective DCGs.

Locations that are sampled for nonradioactive chemicals under the requirements of the NPDES Permit (see Section 3.3) are also sampled for radionuclides (Fig. 5). Radiological analysis and the frequency of analysis are given in Table 4. Table 7 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 56% of its DCG. Average total rad Sr significantly greater than zero were observed at MB1 (18 Bq/L, 48% of DCG), WOD (8.1 Bq/L, 22% of DCG), at STP (7.1 Bq/L, 19% of DCG), and at WOC (3.6 Bq/L, 9.6% of DCG). Average H-3 concentration at MB1 (37,000 Bq/L) and at WOD (7,900 Bq/L) are 50% and 11% of the H-3 DCG, respectively. Average Cs-137 at NRWTF (62 Bq/L) was 56% of its DCG. All other concentrations were no greater than 5% of the DCGs.

Table 6. Radionuclide concentrations in surface waters around ORNL,^a
April-June 1992

Radionuclide	N det/ N total	Concentration (Bq/L)				DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c	Standard error ^d		
Melton Hill Dam							
Co-60	1/3	1.1*	-0.090	0.64	0.37	185	g
Cs-137	1/3	0.40	-0.60	0.027	0.32	111	g
Gross alpha	2/3	0.13*	0.056	0.099*	0.022	g	g
Gross beta	3/3	1.3*	0.43*	0.88*	0.25	g	g
White Oak Creek Headwaters							
Co-60	1/3	0.60*	-0.20	0.15	0.24	185	g
Cs-137	2/3	1.1*	-0.40	0.41	0.44	111	g
Gross alpha	1/3	0.17*	-0.0015	0.10	0.052	g	g
Gross beta	3/3	0.93*	0.48*	0.66*	0.14	g	g
7500 Bridge							
Co-60	0/3	0.90	-2.1	-0.38	0.89	185	g
Cs-137	3/3	5.5*	2.3*	4.3*	1.0	111	3.9
Total rad Sr	3/3	3.4*	2.1*	2.9*	0.40	37	7.8
H-3	3/3	320*	60*	170	77	74,000	g
First Creek							
Co-60	0/3	0.40	-1.0	-0.19	0.42	185	g
Cs-137	0/3	0.90	0.18	0.56	0.21	111	g
Total rad Sr	3/3	11*	5.7*	8.5*	1.5	37	23
Fifth Creek							
Co-60	1/3	0.18	-0.10	0.073	0.087	185	g
Cs-137	1/3	0.38*	-0.10	0.17	0.14	111	g
Total rad Sr	3/3	1.8*	1.1*	1.4*	0.20	37	3.9
Melton Branch 2							
Co-60	1/3	0.17*	-0.30	-0.077	0.14	185	g
Cs-137	1/3	0.23*	-0.20	0.077	0.14	111	g
Total rad Sr	2/3	0.20*	0.015	0.13	0.056	37	g
H-3	3/3	210*	110*	150*	31	74,000	0.20

Table 6. (continued)

Radionuclide	N det/ N total	Concentration (Bq/L)				DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c	Standard error ^d		
Northwest Tributary							
Co-60	0/3	0.23	0.15	0.19*	0.023	185	0.10
Cs-137	1/3	1.4*	-0.040	0.55	0.43	111	g
Total rad Sr	3/3	2.3*	1.5*	1.9*	0.23	37	5.2
Raccoon Creek							
Co-60	0/3	1.0	-0.60	0.15	0.46	185	g
Cs-137	1/3	1.2	0.60	0.97*	0.19	111	0.87
Total rad Sr	3/3	1.0*	0.37*	0.78*	0.21	37	2.1

^aLocations are shown in Fig. 5.

^bIndividual concentrations significantly greater than zero are identified by an *.

^cMean concentrations significantly greater than zero are identified by an *.

^dStandard error of the mean.

^eDCG for ingestion of water. From DOE Order 5400.5.

^fMean concentration as a percentage of the DCG, calculated only when a DCG exists and the mean concentration is significantly greater than zero.

^gNot applicable.

Table 7. Radionuclide concentrations at ORNL NPDES locations,^a
April-June 1992

Radionuclide	N det/ N total	Concentration (Bq/L)				DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c	Standard error ^d		
Sewage Treatment Plant (X01)							
Co-60	1/3	1.4*	0.16	0.99	0.41	185	g
Cs-137	1/3	0.22*	-0.10	0.0067	0.11	111	g
Gross beta	3/3	19*	14*	17*	1.5	g	g
Total rad Sr	3/3	8.9*	5.4*	7.1*	1.0	37	19
Nonradiological Wastewater Treatment Facility (X12)							
Co-60	2/3	1.4*	0.28*	0.96	0.34	185	g
Cs-137	3/3	82*	44*	62*	11	111	56
Gross alpha	3/3	0.78*	0.28*	0.51*	0.15	g	g
Gross beta	3/3	67*	41*	50*	8.5	g	g
Total rad Sr	3/3	9.8*	2.1*	4.9	2.5	37	g
H-3	3/3	3,800*	1,500*	2,300*	750	74,000	3.1
Melton Branch 1 (X13)							
Co-60	0/3	0.70	-0.070	0.24	0.23	185	g
Cs-137	1/3	0.22*	-0.70	-0.13	0.29	111	g
Total rad Sr	3/3	19*	17*	18*	0.67	37	48
H-3	3/3	42,000*	29,000*	37,000*	3,900	74,000	50
White Oak Creek (X14)							
Co-60	1/3	0.15*	-0.30	-0.12	0.14	185	g
Cs-137	3/3	3.2*	1.3*	2.4*	0.58	111	2.2
Total rad Sr	3/3	5.0*	2.7*	3.6*	0.72	37	9.6
H-3	3/3	2,100*	500*	1,100	500	74,000	g

Table 7. (continued)

Radionuclide	N det/ N total	Concentration (Bq/L)				DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c	Standard error ^d		
White Oak Dam (X15)							
Co-60	10/13	0.40*	-0.070	0.21*	0.032	185	0.11
Cs-137	13/13	5.9*	0.84*	2.5*	0.39	111	2.3
Gross alpha	12/13	0.67*	0.11*	0.31*	0.045		
Gross beta	13/13	32*	7.9*	19*	1.9		
Total rad Sr	3/3	9.9*	6.6*	8.1*	0.97		
H-3	3/3	11,000*	5,000*	7,900*	1,700		

^aLocations are shown in Fig. 5.

^bIndividual concentrations significantly greater than zero are identified by an *.

^cMean concentrations significantly greater than zero are identified by an *.

^dStandard error of the mean.

^eDCG for ingestion of water. From DOE Order 5400.5.

^fMean concentration as a percentage of the DCG, calculated only when a DCG exists and the mean concentration is significantly greater than zero.

^gNot applicable.

The discharge of radioactive contaminants from ORNL is affected by the stream flows. Flows in MB (as measured at station MB1), WOC (as measured above its confluence with MB and at WOD), and the Clinch River (as measured at Melton Hill Dam) are given in Table 8. Clinch River flows are regulated by a series of Tennessee Valley Authority dams, one of which is Melton Hill Dam. The flow in MB is usually less than one-third that in WOC. The monthly ratio of flow in WOC (measured at WOD) to flow in the Clinch River (measured at Melton Hill Dam) is reported in the last column of the table. The ratios given were calculated daily and averaged for the month. If complete mixing is assumed, this ratio gives an indication of the dilution factor that may be expected for potential contaminants entering the Clinch River from WOC. The ratio for the quarter ranged from 0.0053 to 0.0067.

Discharges of radioactivity into WOC at the STP, at the NRWTF, 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, NRWTF, 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 9-11). In addition, weekly flow-proportional samples were obtained at WOD and analyzed for radionuclides other than H-3 and total rad Sr, at weekly intervals. The average concentration during the calendar month was calculated as a weighted sum of all concentrations obtained for sampling periods overlapping the calendar month. The weights were proportional to the calendar period total flow attributable to the sampling periods. This average concentration was multiplied by the calendar month total flow to arrive at the discharge.

Each average flow-weighted concentration was compared with an existing DCG. Co-60 concentrations at any of these stations did not exceed 0.76% of the DCG during this quarter. Cs-137 concentrations ranged up to 3.4% of the DCG at stations other than the NRWTF; concentrations there ranged from 40% to 74% of the DCG. Total rad Sr concentrations were fairly constant at STP (15%-24%), WOC (7.3%-14%), MB1 (46%-51%), and WOD (18%-27%). At the NRWTF the concentrations ranged from 5.7% to 26% of the Sr-90 DCG. Where measured, H-3 concentrations were no greater than 5.1% of the DCG, except at MB1 (39%-57%) and WOD (6.8%-15%).

3.2 REFERENCE SURFACE WATERS

Melinda C. Salmons

3.2.1 Program Description

Locations for sampling the natural surface waters are upstream of the various facilities on the ORR. These data can be used to assess water quality prior to the impacts of the ORR. The term "reference" is used instead of "background" because the latter typically implies an environmental medium that is pristine, or unaffected by human activity. The Clinch River is the major surface water system that is affected by the ORR. This river integrates many human activities upstream of the reservation. The net impact of the ORR can be evaluated by comparing the reference data to information from samples

Table 8. Stream^a flows, April-June 1992

Month	Flow (10 ⁹ L)				Average Ratio ^d
	Melton Branch 1	White Oak Creek ^b	White Oak Dam ^c	Clinch River	
April	0.21	0.47	0.74	140	0.0067
May	0.12	0.31	0.50	100	0.0053
June	0.092	0.31	0.49	140	0.0054

^aSee Fig. 5.

^bWhite Oak Creek at confluence of Melton Branch.

^cWhite Oak Creek at White Oak Dam.

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

Table 9. Radionuclide concentrations and releases at ORNL NPDES surface water stations,^a April 1992

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>Melton Branch 1 (03/25-04/29)</i>					
Co-60	250	f	0.10	185	f
Cs-137	250	f	0.10	111	f
Total rad Sr	250	0.48	19*	37	51
H-3	250	1,100	42,000*	74,000	57
<i>Nonradiological Wastewater Treatment Facility (03/25-04/29)</i>					
Co-60	59	f	1.2	185	f
Cs-137	59	0.26	44*	111	40
Gross alpha	59	0.0046	0.78*	f	f
Gross beta	59	0.24	41*	f	f
Total rad Sr	59	0.017	2.8*	37	7.6
H-3	59	23	3,800*	74,000	5.1
<i>Sewage Treatment Plant (03/26-04/30)</i>					
Co-60	17	f	1.4	185	f
Cs-137	17	f	-0.10	111	f
Gross beta	17	0.033	19*	f	f
Total rad Sr	17	0.015	8.9*	37	24
<i>White Oak Creek (03/25-04/29)</i>					
Co-60	610	f	-0.20	185	f
Cs-137	610	0.079	1.3*	111	1.2
Total rad Sr	610	0.30	5.0*	37	14
H-3	610	130	2,100*	74,000	2.8
<i>White Oak Dam (03/25-04/29)</i>					
Total rad Sr	920	0.91	9.9*	37	27
H-3	920	1,000	11,000*	74,000	15

Table 9. (continued)

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>White Oak Dam^g (04/01-05/01)</i>					
Co-60	740	0.014	0.19*	185	0.10
Cs-137	740	0.28	3.8*	111	3.4
Gross alpha	740	0.030	0.41*	f	f
Gross beta	740	1.5	21*	f	f

^aLocations are shown in Fig. 5.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an *.

^dDerived concentration guide for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG, calculated only when a DCG exists and the mean concentration is significantly greater than zero.

^fNot applicable.

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

Table 10. Radionuclide concentrations and releases at ORNL NPDES surface water stations,^a May 1992

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>Melton Branch 1 (04/29-05/27)</i>					
Co-60	100	f	0.70	185	f
Cs-137	100	f	-0.70	111	f
Total rad Sr	100	0.17	17*	37	46
H-3	100	400	39,000*	74,000	53
<i>Nonradiological Wastewater Treatment Facility (04/29-05/27)</i>					
Co-60	47	0.0065	1.4*	185	0.76
Cs-137	47	0.29	61*	111	55
Gross alpha	47	0.0022	0.48*	f	f
Gross beta	47	0.20	42*	f	f
Total rad Sr	47	0.0098	2.1*	37	5.7
H-3	47	7.0	1,500*	74,000	2.0
<i>Sewage Treatment Plant (04/30-05/28)</i>					
Co-60	15	0.0021	1.4*	185	0.76
Cs-137	15	f	-0.10	111	f
Gross beta	15	0.021	14*	f	f
Total rad Sr	15	0.0082	5.4*	37	15
<i>White Oak Creek (04/29-05/27)</i>					
Co-60	280	f	-0.30	185	f
Cs-137	280	0.078	2.8*	111	2.5
Total rad Sr	280	0.075	2.7*	37	7.3
H-3	280	21	740*	74,000	1.0
<i>White Oak Dam (04/29-05/27)</i>					
Total rad Sr	460	0.30	6.6*	37	18
H-3	460	350	7,700*	74,000	10

Table 10. (continued)

Radionuclide	Flow (10^6 L)	Discharge ^b (10^{10} Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>White Oak Dam^g (05/01-06/01)</i>					
Co-60	500	0.013	0.25*	185	0.13
Cs-137	500	0.10	2.0*	111	1.8
Gross alpha	500	0.012	0.23*	f	f
Gross beta	500	0.99	20*	f	f
Total rad Sr	500	0.16	17*	37	46

^aLocations are shown in Fig. 5.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an *.

^dDerived concentration guide for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG, calculated only when a DCG exists and the mean concentration is significantly greater than zero.

^fNot applicable.

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

Table 11. Radionuclide concentrations and releases at ORNL NPDES surface water stations,^a June 1992

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>Melton Branch 1 (05/27-06/24)</i>					
Co-60	92	f	-0.070	185	f
Cs-137	92	0.0020	0.22*	111	0.20
Total rad Sr	92	0.16	17*	37	46
H-3	92	270	29,000*	74,000	39
<i>Nonradiological Wastewater Treatment Facility (05/27-06/24)</i>					
Co-60	50	0.0014	0.28*	185	0.15
Cs-137	50	0.41	82*	111	74
Gross alpha	50	0.0014	0.28*	f	f
Gross beta	50	0.33	67*	f	f
Total rad Sr	50	0.049	9.8*	37	26
H-3	50	7.9	1,600*	74,000	2.2
<i>Sewage Treatment Plant (05/28-06/25)</i>					
Co-60	19	f	0.16	185	f
Cs-137	19	0.00043	0.22*	111	0.20
Gross beta	19	0.033	17*	f	f
Total rad Sr	19	0.013	6.9*	37	19
<i>White Oak Creek (05/27-06/24)</i>					
Co-60	290	0.0044	0.15*	185	0.081
Cs-137	290	0.093	3.2*	111	2.9
Total rad Sr	290	0.087	3.0*	37	8.1
H-3	290	15	500*	74,000	0.68
<i>White Oak Dam (05/27-06/24)</i>					
Total rad Sr	470	0.36	7.7*	37	21
H-3	470	230	5,000*	74,000	6.8

Table 11. (continued)

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>White Oak Dam^g (06/01-07/01)</i>					
Co-60	490	0.0074	0.15*	185	0.081
Cs-137	490	0.094	1.9*	111	1.7
Gross alpha	490	0.0087	0.18*	f	f
Gross beta	490	0.80	16*	f	f

^aLocations are shown in Fig. 5.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an *.

^dDerived concentration guide for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG, calculated only when a DCG exists and the mean concentration is significantly greater than zero.

^fNot applicable.

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

collected downstream of the facilities. Monthly surface water samples are collected at two sampling locations for the purpose of determining contamination levels before the influence of ORNL. One sampling location is MHD above ORNL's discharge point into the CR (Fig. 5). The other sampling location is WOC headwaters above the point where ORNL discharges to WOC (Fig. 5).

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, total 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 water samples analyzed for inorganics, O&G, and total dissolved solids were collected flow proportionally 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 for the first quarter are found in Table 12 and the second quarter are found in Table 13. 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 for the first quarter and 1.6 mg/L for the second quarter.

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.

3.3 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.

Quarterly summary statistics for the second quarter of 1992 are given for each sampling location in Tables 14 through 22.

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 Table 23.

Table 12. Surface water analyses at reference locations,
January-March 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard Error ^b
		Max	Min	Av ^a	
<i>Melton Hill Dam^c</i>					
Anions					
Fluoride	0/3	< 0.10	< 0.10	~ 0.10	0
Nitrate (as N)	0/3	< 1.0	< 1.0	~ 1.0	0
Sulfate (as SO ₄)	3/3	20	17	19*	0.88
Field Measurements					
Conductivity (mS/cm)	3/3	0.40	0.20	0.29*	0.059
Dissolved oxygen (ppm)	3/3	12	8.9	10*	0.86
Temperature (°C)	3/3	14	8.5	11*	1.5
Turbidity (NTU)	3/3	71	42	52*	9.8
pH (SU)	3/3	8.1	7.4	7.8*	0.22
Metals					
Aluminum, total	3/3	0.61	0.21	0.36	0.13
Antimony, total	0/3	< 0.050	< 0.050	~ 0.050	0
Arsenic, total	0/3	< 0.010	< 0.010	~ 0.010	0
Barium, total	3/3	0.034	0.029	0.031*	0.0015
Beryllium, total	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Boron, total	0/3	< 0.080	< 0.080	~ 0.080	0
Cadmium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Calcium, total	3/3	35	32	34*	0.88
Chromium, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Cobalt, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Copper, total	0/3	< 0.0070	< 0.0070	~ 0.0070	0
Iron, total	3/3	0.55	0.21	0.35*	0.10
Lead, total	0/3	< 0.050	< 0.050	~ 0.050	0
Lithium, total	0/3	< 15	< 15	~ 15	0
Magnesium, total	3/3	9.1	8.9	9.0*	0.058
Manganese, total	3/3	0.16	0.080	0.11*	0.025
Molybdenum, total	0/3	< 0.040	< 0.040	~ 0.040	0
Nickel, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Phosphorus, total	0/3	< 0.30	< 0.30	~ 0.30	0
Selenium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Silicon, total	3/3	3.0	2.0	2.5*	0.29
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Sodium, total	1/3	5.2	< 5.0	~ 5.1*	0.067
Strontium, total	3/3	0.088	0.083	0.085*	0.0015

Table 12. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard Error ^b
		Max	Min	Av ^a	
Metals					
Tin, total	0/3	< 0.050	< 0.050	~ 0.050	0
Titanium, total	0/3	< 0.020	< 0.020	~ 0.020	0
Vanadium, total	0/3	< 0.0020	< 0.0020	~ 0.0020	0
Zinc, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zirconium, total	0/3	< 0.020	< 0.020	~ 0.020	0
Others					
Oil and grease	3/4	21	< 2.0	~ 8.5	4.4
Total dissolved solids	3/3	160	140	150*	3.5
Total suspended solids	3/3	20	8.0	13*	3.6
Total organic carbon	3/3	2.4	2.1	2.3*	0.088
White Oak Creek Headwaters ^c					
Anions					
Fluoride	0/3	< 0.10	< 0.10	~ 0.10	0
Nitrate (as N)	0/3	< 1.0	< 1.0	~ 1.0	0
Sulfate (as SO ₄)	3/3	3.3	2.6	2.9*	0.21
Field Measurements					
Conductivity (mS/cm)	3/3	0.70	0.32	0.54*	0.11
Dissolved oxygen (ppm)	3/3	11	9.0	11*	0.77
Temperature (°C)	3/3	14	9.7	11*	1.2
Turbidity (NTU)	3/3	53	25	43*	8.8
pH (SU)	3/3	7.9	7.2	7.6*	0.20
Metals					
Aluminum, total	3/3	0.55	0.086	0.28	0.14
Antimony, total	0/3	< 0.050	< 0.050	~ 0.050	0
Arsenic, total	0/3	< 0.010	< 0.010	~ 0.010	0
Barium, total	3/3	0.13	0.044	0.075	0.028
Beryllium, total	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Boron, total	0/3	< 0.080	< 0.080	~ 0.080	0
Cadmium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Calcium, total	3/3	21	15	17*	2.0
Chromium, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Cobalt, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Copper, total	0/3	< 0.0070	< 0.0070	~ 0.0070	0
Iron, total	3/3	0.51	0.092	0.26	0.13

Table 12. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard Error ^b
		Max	Min	Av ^a	
Metals					
Lead, total	0/3	< 0.050	< 0.050	~ 0.050	0
Lithium, total	0/3	< 15	< 15	~ 15	0
Magnesium, total	3/3	9.9	6.7	7.9*	1.0
Manganese, total	3/3	0.050	0.030	0.037*	0.0067
Molybdenum, total	0/3	< 0.040	< 0.040	~ 0.040	0
Nickel, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Phosphorus, total	0/3	< 0.30	< 0.30	~ 0.30	0
Selenium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Silicon, total	3/3	4.2	3.2	3.6*	0.32
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Sodium, total	0/3	< 5.0	< 5.0	~ 5.0	0
Strontium, total	3/3	0.023	0.019	0.020*	0.0013
Tin, total	0/3	< 0.050	< 0.050	~ 0.050	0
Titanium, total	0/3	< 0.020	< 0.020	~ 0.020	0
Vanadium, total	1/3	0.0021	< 0.0020	~ 0.0020*	0.000033
Zinc, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zirconium, total	0/3	< 0.020	< 0.020	~ 0.020	0
Others					
Oil and grease	0/3	< 2.0	< 2.0	~ 2.0	0
Total dissolved solids	3/3	130	85	100*	12
Total suspended solids	2/3	17	< 5.0	~ 10	3.6
Total organic carbon	3/3	0.80	0.60	0.73*	0.067

^aAverage concentrations significantly greater than zero are identified by an

*,

^bStandard error of the mean.

^cSee Fig. 5.

Table 13. Surface water analyses at reference locations,
April-June 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard Error ^b
		Max	Min	Av ^a	
Melton Hill Dam ^c					
Anions					
Fluoride	1/3	0.30	< 0.10	~ 0.17	0.067
Nitrate (as N)	0/3	< 1.0	< 1.0	~ 1.0	0
Sulfate (as SO ₄)	3/3	22	18	20*	1.2
Field Measurements					
Conductivity (mS/cm)	3/3	1.2	0.050	0.44	0.38
Dissolved oxygen (ppm)	3/3	12	8.0	9.5*	1.1
Temperature (°C)	3/3	19	13	16*	1.8
Turbidity (NTU)	3/3	38	32	36*	2.1
pH (SU)	3/3	8.2	7.8	8.0*	0.12
Metals					
Aluminum, total	1/3	1.3	< 0.050	~ 0.47	0.42
Antimony, total	0/3	< 0.050	< 0.050	~ 0.050	0
Arsenic, total	0/3	< 0.010	< 0.010	~ 0.010	0
Barium, total	3/3	0.037	0.026	0.030*	0.0034
Beryllium, total	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Boron, total	0/3	< 0.080	< 0.080	~ 0.080	0
Cadmium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Calcium, total	3/3	37	35	36*	0.67
Chromium, total	1/3	0.0040	< 0.0040	~ 0.0040	0
Cobalt, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Copper, total	0/3	< 0.0070	< 0.0070	~ 0.0070	0
Iron, total	2/3	1.3	< 0.050	~ 0.47	0.41
Lead, total	0/3	< 0.050	< 0.050	~ 0.050	0
Lithium, total	0/3	< 15	< 15	~ 15	0
Magnesium, total	3/3	10	9.1	9.6*	0.27
Manganese, total	3/3	0.060	0.040	0.050*	0.0058
Molybdenum, total	0/3	< 0.040	< 0.040	~ 0.040	0
Nickel, total	1/3	0.0060	< 0.0040	~ 0.0047*	0.00067
Phosphorus, total	0/3	< 0.30	< 0.30	~ 0.30	0
Selenium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Silicon, total	3/3	3.9	1.5	2.3	0.80
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Sodium, total	0/3	< 5.0	< 5.0	~ 5.0	0
Strontium, total	3/3	0.088	0.081	0.085*	0.0021

Table 13. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard Error ^b
		Max	Min	Av ^a	
Metals					
Tin, total	0/3	< 0.050	< 0.050	~ 0.050	0
Titanium, total	1/3	0.022	< 0.020	~ 0.021*	0.00067
Vanadium, total	0/3	< 0.0020	< 0.0020	~ 0.0020	0
Zinc, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zirconium, total	0/3	< 0.020	< 0.020	~ 0.020	0
Others					
Oil and grease	1/3	3.0	< 2.0	~ 2.3*	0.33
Total dissolved solids	3/3	170	160	160*	2.0
Total suspended solids	2/3	28	< 5.0	~ 13	7.7
Total organic carbon	3/3	2.8	2.0	2.3*	0.24
White Oak Creek Headwaters ^c					
Anions					
Fluoride	1/3	0.40	< 0.10	~ 0.20	0.10
Nitrate (as N)	0/3	< 1.0	< 1.0	~ 1.0	0
Sulfate (as SO ₄)	3/3	14	2.3	6.2	3.9
Field Measurements					
Conductivity (mS/cm)	3/3	0.30	0.030	0.12	0.088
Dissolved oxygen (ppm)	3/3	12	8.8	11*	1.1
Temperature (°C)	3/3	15	10	13*	1.3
Turbidity (NTU)	3/3	46	34	39*	3.7
pH (SU)	3/3	8.2	7.9	8.1*	0.088
Metals					
Aluminum, total	2/3	1.9	< 0.050	~ 1.2	0.59
Antimony, total	0/3	< 0.050	< 0.050	~ 0.050	0
Arsenic, total	0/3	< 0.010	< 0.010	~ 0.010	0
Barium, total	3/3	0.092	0.071	0.083*	0.0063
Beryllium, total	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Boron, total	0/3	< 0.080	< 0.080	~ 0.080	0
Cadmium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Calcium, total	3/3	32	22	27*	2.9
Chromium, total	3/3	0.0070	0.0052	0.0062*	0.00054
Cobalt, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Copper, total	0/3	< 0.0070	< 0.0070	~ 0.0070	0
Iron, total	3/3	2.0	0.051	1.3	0.62

Table 13. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard Error ^b
		Max	Min	Av ^a	
Metals					
Lead, total	0/3	< 0.050	< 0.050	~ 0.050	0
Lithium, total	0/3	< 15	< 15	~ 15	0
Magnesium, total	3/3	16	10	13*	1.7
Manganese, total	3/3	0.36	0.030	0.25	0.11
Molybdenum, total	0/3	< 0.040	< 0.040	~ 0.040	0
Nickel, total	1/3	0.0056	< 0.0040	~ 0.0045*	0.00053
Phosphorus, total	0/3	< 0.30	< 0.30	~ 0.30	0
Selenium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Silicon, total	3/3	7.4	3.8	6.0*	1.1
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Sodium, total	0/3	< 5.0	< 5.0	~ 5.0	0
Strontium, total	3/3	0.034	0.024	0.029*	0.0029
Tin, total	0/3	< 0.050	< 0.050	~ 0.050	0
Titanium, total	2/3	0.030	< 0.020	~ 0.025*	0.0029
Vanadium, total	1/3	0.0043	< 0.0020	~ 0.0028*	0.00077
Zinc, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zirconium, total	0/3	< 0.020	< 0.020	~ 0.020	0
Others					
Oil and grease	1/3	3.0	< 2.0	~ 2.3*	0.33
Total dissolved solids	3/3	160	100	140*	17
Total suspended solids	2/3	85	< 5.0	~ 52	24
Total organic carbon	3/3	1.3	0.70	0.97*	0.18

^aAverage concentrations significantly greater than zero are identified by an

*,

^bStandard error of the mean.

^cSee Fig. 5.

Table 14. NPDES discharge point X01,^a April-June 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Field Measurements					
Chlorine, total residual	40/40	0.39	0.10	0.22*	0.010
Dissolved oxygen (ppm)	63/63	15	6.2	9.5*	0.17
Downstream pH (SU)	13/13	8.1	7.5	d	d
Flow (Mgd)	63/63	0.26	0.095	0.16*	0.0052
pH (SU)	13/13	8.0	7.2	d	d
Temperature (°C)	76/76	27	14	22*	0.38
Metals					
Copper, total	0/3	< 0.0070	< 0.0070	< 0.0070	0
Mercury, total	0/3	< 0.000050	< 0.000050	< 0.000050	0
Silver, total	0/3	< 0.0050	< 0.0050	< 0.0050	0
Zinc, total	3/3	0.047	0.019	0.036*	0.0085
Others					
Ammonia (as N)	40/40	0.47	0.030	0.11*	0.017
Biochemical oxygen demand	1/40	7.0	< 5.0	< 5.1*	0.050
Cyanide, total	0/3	< 0.0020	< 0.0020	< 0.0020	0
Fecal Coliform (col/100 mL) ^e	16/40	200	< 1.0	< 12*	5.6
Oil and grease	16/40	11	< 2.0	< 2.7*	0.31
Phenolics, total recoverable	0/3	< 0.0010	< 0.0010	< 0.0010	0
Total suspended solids	3/40	20	< 5.0	< 5.5*	0.38
Volatile Organics					
Bromodichloromethane	0/3	< 0.0050	< 0.0050	< 0.0050	0
Trichloroethene	0/3	< 0.0050	< 0.0050	< 0.0050	0

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.^eThe geometric mean is computed rather than the average.

Table 15. NPDES discharge point X02,^a April-June 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Anions					
Sulfate (as SO ₄)	3/3	1,700	1,100	1,400*	200
Field Measurements					
Downstream pH (SU)	63/63	8.3	7.5	d	d
Flow (Mgd)	24/63	0.076	0	0.0076*	0.0019
pH (SU)	63/63	8.5	7.0	d	d
Temperature (°C)	63/63	27	9.8	20*	0.57
Metals					
Arsenic, total	0/9	< 0.050	< 0.050	< 0.050	0
Cadmium, total	0/9	< 0.0050	< 0.0050	< 0.0050	0
Chromium, total	7/9	0.011	< 0.0040	< 0.0062*	0.00070
Copper, total	0/9	< 0.0070	< 0.0070	< 0.0070	0
Iron, total	9/9	0.40	0.13	0.24*	0.025
Lead, total	0/9	< 0.050	< 0.050	< 0.050	0
Manganese, total	9/9	0.073	0.012	0.027*	0.0061
Nickel, total	5/9	< 0.011	< 0.0040	< 0.0058*	0.00076
Selenium, total	9/9	0.20	0.020	0.057*	0.019
Silver, total	0/9	< 0.020	< 0.0050	< 0.0067*	0.0017
Zinc, total	0/9	< 0.0050	< 0.0050	< 0.0050	0
Others					
Oil and grease	5/8	10	< 2.0	< 3.5*	0.98
Total suspended solids	9/9	7.0	5.0	5.9*	0.31

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 16. NPDES discharge point X12,^a April-June 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Anions					
Fluoride	14/14	1.5	1.0	1.3*	0.046
Nitrate (as N)	14/14	79	1.2	12*	5.7
Sulfate (as SO ₄)	14/14	310	180	220*	11
Field Measurements					
Downstream pH (SU)	63/63	8.4	7.0	d	d
Flow (Mgd)	63/63	0.58	0.36	0.46*	0.0064
pH (SU)	^e	7.6	7.2	d	d
Temperature (°C)	63/63	25	14	20*	0.36
Metals					
Arsenic, total	0/14	< 0.080	< 0.050	< 0.052*	0.0021
Cadmium, total	0/14	< 0.0050	< 0.0050	< 0.0050	0
Chromium, total	4/14	0.0061	< 0.0040	< 0.0044*	0.00017
Copper, total	4/14	0.0092	< 0.0070	< 0.0074*	0.00021
Iron, total	1/14	0.072	< 0.050	< 0.052*	0.0016
Lead, total	0/14	< 0.050	< 0.050	< 0.050	0
Mercury, total	2/14	0.00030	< 0.000050	< 0.000083*	0.000022
Nickel, total	4/14	0.017	< 0.0040	< 0.0052*	0.00094
Phosphorus, total	10/14	0.40	< 0.20	< 0.27*	0.017
Selenium, total	0/14	< 0.050	< 0.050	< 0.050	0
Silver, total	0/14	< 0.010	< 0.0050	< 0.0054*	0.00036
Zinc, total	13/14	0.029	< 0.0050	< 0.019	0.0017
Others					
Biochemical oxygen demand	0/14	< 5.0	< 5.0	< 5.0	0
Cyanide, total	1/14	0.0060	< 0.0020	< 0.0023*	0.00029
Oil and grease	3/14	3.0	< 2.0	< 2.1*	0.097
Phenolics, total recoverable	0/14	< 0.0010	< 0.0010	< 0.0010	0
Total suspended solids	0/14	< 5.0	< 5.0	< 5.0	0
Total toxic organics	0/14	< 0.010	< 0.010	< 0.010	0

Table 16. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Volatile Organics					
1,1-Dichloroethane	0/14	< 0.0050	< 0.0050	< 0.0050	0
Benzene	0/14	< 0.0050	< 0.0050	< 0.0050	0
Bromodichloromethane	0/14	< 0.0050	< 0.0050	< 0.0050	0
Chlorobenzene	0/14	< 0.0050	< 0.0050	< 0.0050	0
Chloroform	0/14	< 0.0050	< 0.0050	< 0.0050	0
Methylene chloride	0/14	< 0.0050	< 0.0050	< 0.0050	0
Tetrachloroethene	0/14	< 0.0050	< 0.0050	< 0.0050	0
Trichloroethene	0/14	< 0.0050	< 0.0050	< 0.0050	0

^aSee Fig. 5.

^bAverage concentrations significantly greater than zero are identified by an *.

^cStandard error of the mean.

^dNot applicable.

^epH monitoring is continuous.

Table 17. NPDES discharge point X13,^a April-June 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Anions					
Fluoride	3/3	1.1	0.50	0.87*	0.19
Nitrate (as N)	3/3	0.60	0.20	0.43*	0.12
Sulfate (as SO ₄)	3/3	140	89	110*	15
Field Measurements					
Chlorine, total residual	0/13	< 0.010	< 0.010	< 0.010	0
Conductivity (mS/cm)	3/3	1.8	0.15	0.74	0.53
Dissolved oxygen (ppm)	13/13	12	7.7	9.8*	0.31
Flow (Mgd)	63/63	7.3	0.59	1.1*	0.11
pH (SU)	3/3	7.8	7.6	d	d
Temperature (°C)	16/16	23	14	18*	0.85
Turbidity (NTU)	3/3	58	6.0	24	17
Metals					
Aluminum, total	3/3	0.54	0.12	0.39*	0.13
Arsenic, total	0/3	< 0.050	< 0.050	< 0.050	0
Cadmium, total	0/3	< 0.0020	< 0.0020	< 0.0020	0
Chromium, total	3/3	0.0089	0.0069	0.0076*	0.00067
Copper, total	0/3	< 0.0070	< 0.0070	< 0.0070	0
Iron, total	3/3	0.56	0.23	0.44*	0.11
Lead, total	0/3	< 0.0040	< 0.0040	< 0.0040	0
Mercury, total	0/3	< 0.000050	< 0.000050	< 0.000050	0
Manganese, total	3/3	0.23	0.091	0.15*	0.042
Nickel, total	1/3	0.0044	< 0.0040	< 0.0041*	0.00013
Phosphorus, total	3/3	0.60	0.40	0.48*	0.060
Silver, total	0/3	< 0.0050	< 0.0050	< 0.0050	0
Zinc, total	2/3	0.025	< 0.0050	< 0.015	0.0058
Others					
Ammonia (as N)	3/3	0.42	0.040	0.17	0.13
Biochemical oxygen demand	0/3	< 5.0	< 5.0	< 5.0	0
Oil and grease	6/13	3.0	< 2.0	< 2.2*	0.12
Phenolics, total recoverable	0/3	< 0.0010	< 0.0010	< 0.0010	0
Total dissolved solids	3/3	450	310	390*	42
Total organic carbon	3/3	5.5	2.5	3.6*	0.95
Total suspended solids	2/3	58	< 5.0	< 25	17

Table 17. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
PCBs					
PCB, total	0/3	< 0.0020	< 0.0020	< 0.0020	0
Volatile Organics					
Chloroform	0/3	< 0.0050	< 0.0050	< 0.0050	0
Trichloroethene	0/3	< 0.0050	< 0.0050	< 0.0050	0

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 18. NPDES discharge point X14,^a April-June 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Anions					
Fluoride	3/3	0.70	0.30	0.57*	0.13
Nitrate (as N)	3/3	2.3	1.2	1.6*	0.37
Sulfate (as SO ₄)	3/3	44	36	39*	2.7
Field Measurements					
Chlorine, total residual	0/13	< 0.010	< 0.010	< 0.010	0
Conductivity (mS/cm)	3/3	1.1	0.040	0.43	0.34
Dissolved oxygen (ppm)	13/13	12	7.8	9.6*	0.33
Flow (Mgd)	63/63	6.8	0.010	3.2*	0.14
pH (SU)	3/3	8.0	7.7	d	d
Temperature (°C)	16/16	23	14	18*	0.80
Turbidity (NTU)	3/3	30	6.0	15	7.7
Metals					
Aluminum, total	3/3	0.23	0.055	0.15	0.051
Arsenic, total	0/3	< 0.050	< 0.050	< 0.050	0
Cadmium, total	0/3	< 0.0020	< 0.0020	< 0.0020	0
Chromium, total	1/3	0.0042	< 0.0040	< 0.0041*	0.000067
Copper, total	0/3	< 0.0070	< 0.0070	< 0.0070	0
Iron, total	3/3	0.26	0.093	0.19*	0.049
Lead, total	0/3	< 0.0040	< 0.0040	< 0.0040	0
Mercury, total	1/3	0.000050	< 0.000050	< 0.000050	0
Manganese, total	3/3	0.066	0.015	0.035	0.016
Nickel, total	1/3	0.0042	< 0.0040	< 0.0041*	0.000067
Phosphorus, total	3/3	0.37	0.20	0.26*	0.057
Silver, total	0/3	< 0.0050	< 0.0050	< 0.0050	0
Zinc, total	2/3	0.023	< 0.0050	< 0.016	0.0055
Others					
Ammonia (as N)	3/3	0.43	0.040	0.18	0.13
Biochemical oxygen demand	1/3	7.0	< 5.0	< 5.7*	0.67
Oil and grease	7/13	5.0	< 2.0	< 2.5*	0.31
Phenolics, total recoverable	0/3	< 0.0010	< 0.0010	< 0.0010	0
Total dissolved solids	3/3	250	140	210*	33
Total organic carbon	3/3	3.7	1.6	2.8*	0.62
Total suspended solids	2/3	8.0	< 5.0	< 6.3	0.88

Table 18. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
PCBs					
PCB, total	0/3	< 0.0020	< 0.0020	<0.0020	0
Volatile Organics					
Chloroform	3/3	~ 0.0020	~ 0.0020	~0.0020	0
Trichloroethene	0/3	< 0.0050	< 0.0050	<0.0050	0

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 19. NPDES discharge point X15,^a April-June 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Anions					
Fluoride	3/3	0.80	0.30	0.57*	0.15
Nitrate (as N)	3/3	1.4	0.30	0.70	0.35
Sulfate (as SO ₄)	3/3	46	28	40*	6.0
Field Measurements					
Chlorine, total residual	0/13	< 0.010	< 0.010	< 0.010	0
Conductivity (mS/cm)	3/3	0.90	0.16	0.42	0.24
Dissolved oxygen (ppm)	13/13	11	7.1	9.8*	0.40
Flow (Mgd)	63/63	10	3.0	5.1*	0.21
pH (SU)	3/3	9.4	7.9	d	d
Temperature (°C)	16/16	28	13	20*	1.1
Turbidity (NTU)	3/3	18	18	18*	0
Metals					
Aluminum, total	3/3	2.9	0.92	1.6	0.63
Arsenic, total	0/3	< 0.010	< 0.010	< 0.010	0
Cadmium, total	0/3	< 0.0020	< 0.0020	< 0.0020	0
Chromium, total	3/3	0.056	0.013	0.028	0.014
Copper, total	1/3	0.056	< 0.0070	< 0.023	0.016
Iron, total	3/3	2.7	0.73	1.5	0.62
Lead, total	1/3	0.0040	< 0.0040	< 0.0040*	0
Mercury, total	1/3	0.00029	< 0.000050	< 0.00013	0.000080
Manganese, total	3/3	0.56	0.057	0.25	0.16
Nickel, total	1/3	0.086	< 0.0040	< 0.031	0.027
Phosphorus, total	1/3	0.37	< 0.20	< 0.26	0.057
Silver, total	0/3	< 0.0050	< 0.0050	< 0.0050	0
Zinc, total	2/3	0.048	< 0.0050	< 0.019	0.014
Others					
Ammonia (as N)	3/3	0.59	0.040	0.24	0.17
Biochemical oxygen demand	1/3	6.0	< 5.0	< 5.3*	0.33
Oil and grease	11/13	45	< 2.0	< 13	3.3
Total dissolved solids	3/3	280	260	270*	8.0
Total organic carbon	3/3	3.4	2.9	3.1*	0.15
Total suspended solids	3/3	39	13	22	8.5

Table 19. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
PCBs					
PCB, total	0/3	< 0.0020	< 0.0020	< 0.0020	0
Volatile Organics					
Chloroform	0/3	< 0.0050	< 0.0050	< 0.0050	0
Trichloroethene	0/3	< 0.0050	< 0.0050	< 0.0050	0

^aSee Fig. 5.

^bAverage concentrations significantly greater than zero are identified by an *.

^cStandard error of the mean.

^dNot applicable.

Table 20. NPDES category II outfalls,^a April-June 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Field Measurements					
Downstream pH (SU)	44/44	8.4	7.3	d	d
Flow (Mgd)	44/44	0.24	0.00036	0.033*	0.0076
pH (SU)	44/44	8.2	7.4	d	d
Temperature (°C)	45/45	48	12	19*	1.1
Others					
Oil and grease	22/46	7.0	< 2.0	< 2.6*	0.16
Total suspended solids	24/44	140	< 5.0	< 18*	3.8
Radionuclides (Bq/L)					
Gross beta	44/44	27	-0.30	1.7*	0.76

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 21. NPDES category III outfalls,^a April-June 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Field Measurements:					
Conductivity (mS/cm)	2 /2	0.090	0.050	0.070	0.020
Dissolved oxygen (ppm)	2 /2	9.9	9.8	9.9*	0.050
Flow (Mgd)	15/15	0.19	0.00036	0.027*	0.013
pH (SU)	17/17	8.8	7.3	d	d
Temperature (°C)	17/17	24	14	17*	0.52
Turbidity (NTU)	2 /2	8.0	7.0	7.5*	0.50

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 22. NPDES cooling towers,^a April-June 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Field Measurements:					
Chlorine, total residual	13/13	0.19	0.030	0.12*	0.015
Downstream pH (SU)	13/13	8.5	7.7	d	d
Flow (Mgd)	13/13	0.19	0.00010	0.034*	0.019
pH (SU)	13/13	8.9	7.5	d	d
Temperature (°C)	13/13	36	14	22*	1.6
Metals:					
Chromium, total	13/13	0.44	0.0051	0.056	0.033
Copper, total	12/13	1.1	< 0.0070	< 0.24	0.081
Zinc, total	13/13	6.1	0.081	0.72	0.45

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 23. NPDES permit limit noncompliances, April-June 1992

Location	Limit Violated	Date	mg/L	
			Permit Limit	Value
Cooling Tower CS2026	Zn	23APR92	1.0	6.1
CS3089	Cu	23APR92	1.0	1.1
Category II Outfall 203	Total suspended solids	08MAY92	50.0	85
Outfall 204	Total suspended solids	08MAY92	50.0	51
Outfall 209	Total suspended solids	08MAY92	50.0	54
Outfall 224	Total suspended solids	08MAY92	50.0	146
Outfall 281	Temperature	05JUN92	30.5	33.3

3.3.2 Noncompliances

3.3.2.1 April 1992

3.3.2.1.1 Inappropriate and/or Unpermitted Discharges

On April 30, 1992, ORNL Cooling Tower CS4521 was treated with chlorine biocide to control bacterial growth within the tower. Due to administrative error, the blowdown discharge valve from the tower was opened before the chlorine concentration in the tower had dissipated to an acceptable level. The resulting discharge of chlorine was greater than 3.5 mg/L which exceeded the chlorine permit limit of 0.2 mg/L. The discharge resulted in a kill of 303 fish of various minnow species in White Oak Creek. The manual discharge valve was closed and locked, to be opened only by the CS4521 supervisor following verification that CS4521 chlorine is within limits. ORNL personnel are revising cooling tower maintenance procedures to guard against recurrence.

3.3.2.1.2 Exceedences of NPDES Permit Limits

On April 23, 1992 there was an exceedence of zinc at Cooling Tower CS2026 and an exceedence of copper at Cooling Tower CS3089. Both exceedences were attributed to oxidation of galvanized cooling tower components during the inactive winter period.

3.3.2.2 May 1992

3.3.2.2.1 Inappropriate and/or Unpermitted Discharges

None reported.

3.3.2.2.2 Exceedences of NPDES Permit Limits

The total suspended solids (TSS) exceedence that occurred at the Category II outfall 203 was attributed to storm water runoff from an ORNL storage area. Repairs are planned for the Outfall 203 discharge pipe under an upcoming project. The TSS exceedence at Outfall 204 was attributed to storm water runoff from ORNL streets. BMPs are in place at a nearby environmental restoration excavation to minimize sediment transport. The TSS exceedence at Outfall 209 was attributed to storm water runoff from an ORNL street. BMPs including frequent street sweeping are practiced. The TSS exceedence at Outfall 224 was attributed to storm water runoff from an ORNL street and a building roof. BMPs including frequent street sweeping are in place.

3.3.2.3 June 1992

3.3.2.3.1 Inappropriate and/or Unpermitted Discharges

On June 3, 1992, a small oil sheen was noted on First Creek. The oil sheen was attributed to parking lot storm water runoff discharged through Outfall 243. The oil was contained and cleaned up.

3.3.2.3.2 Exceedences of NPDES Permit Limits

On June 5, 1992, a temperature exceedence occurred. The exceedence was attributed to a leak in a 7500 area cooling loop. The leakage is being routed away from Outfall 281 and back into the system, pending permanent repair.

3.4 MONITORING FOR POLYCHLORINATED BIPHENYLS

Betsy M. Horwedel and Martha M. Stevens

3.4.1 Program Description

Duplicate sediment samples were collected at nine locations in May 1992 (Figs. 7 and 8). Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260 were analyzed at each location, which was done in order to comply with the Clean Water Act and is an integral part of ORNL's NPDES activities. The program to collect water samples was dropped this year; results from previous years were below the analytical quantitation limit at all sites. There are currently no regulatory guidelines for PCB concentrations in stream sediment.

3.4.2 Results

Results from analysis for the aroclors are shown in Table 24. By sampling site, the table lists each aroclor, the number of samples, and summary statistics for the concentrations. Laboratory quantitation limits vary for sediment samples. Only one location had results above detection limits. On WOC, upstream of the weir at 7500 Road Bridge, a maximum concentration of 1,400 $\mu\text{g/kg}$ was reported for aroclor-1254. This location represents the area of maximum sediment deposition and collectively represents all potential releases. Results for all other sediment samples were either below detection limits or estimated by the analytical laboratory.

3.5 MERCURY IN THE AQUATIC ENVIRONMENT

Betsy M. Horwedel and Martha M. Stevens

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 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 results 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. 9). These processes are no longer in operation at ORNL. During the time of operation, an unknown number of mercury spills took place.

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Fig. 7. Sampling locations for PCB monitoring in the ORNL environs.

Fig. 8. Sampling locations for PCB monitoring in the greater ORNL area.

Table 24. PCB concentrations in sediment^a, May 1992

Analyte	N det/ N total	Concentration (μg/kg)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
Confluence of Fifth Creek and White Oak Creek					
AROCLOR-1016	0/2	U 140	U 130	~ 140	6.5
AROCLOR-1221	0/2	U 140	U 130	~ 140	6.5
AROCLOR-1232	0/2	U 140	U 130	~ 140	6.5
AROCLOR-1242	0/2	U 140	U 130	~ 140	6.5
AROCLOR-1248	0/2	U 140	U 130	~ 140	6.5
AROCLOR-1254	2/2	J 280	J 110	~ 200	84
AROCLOR-1260	0/2	U 280	U 260	~ 270	13
Upstream of Weir at 7500 Road Bridge					
AROCLOR-1016	0/2	U 140	U 120	~ 130	5.5
AROCLOR-1221	0/2	U 140	U 120	~ 130	5.5
AROCLOR-1232	0/2	U 140	U 120	~ 130	5.5
AROCLOR-1242	0/2	U 140	U 120	~ 130	5.5
AROCLOR-1248	0/2	U 140	U 120	~ 130	5.5
AROCLOR-1254	2/2	1,400	1,200	1,300	110
AROCLOR-1260	0/2	U 230	U 140	~ 180	47
Upstream of Weir at Melton Branch					
AROCLOR-1016	0/2	U 140	U 130	~ 130	5.5
AROCLOR-1221	0/2	U 140	U 130	~ 130	5.5
AROCLOR-1232	0/2	U 140	U 130	~ 130	5.5
AROCLOR-1242	0/2	U 140	U 130	~ 130	5.5
AROCLOR-1248	0/2	U 140	U 130	~ 130	5.5
AROCLOR-1254	0/2	U 280	U 260	~ 270	11
AROCLOR-1260	0/2	U 280	U 260	~ 270	11
Melton Hill Lake southeast of 7600					
AROCLOR-1016	0/2	U 120	U 110	~ 110	6.0
AROCLOR-1221	0/2	U 120	U 110	~ 110	6.0
AROCLOR-1232	0/2	U 120	U 110	~ 110	6.0
AROCLOR-1242	0/2	U 120	U 110	~ 110	6.0
AROCLOR-1248	0/2	U 120	U 110	~ 110	6.0
AROCLOR-1254	0/2	U 240	U 210	~ 230	12
AROCLOR-1260	0/2	U 240	U 210	~ 230	12

Table 24. (continued)

Analyte	N det/ N total	Concentration (µg/kg)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
Melton Hill Lake west of PCB Storage Areas 7652 and 7656					
AROCLOR-1016	0/2	U 110	U 100	~ 110	5.0
AROCLOR-1221	0/2	U 110	U 100	~ 110	5.0
AROCLOR-1232	0/2	U 110	U 100	~ 110	5.0
AROCLOR-1242	0/2	U 110	U 100	~ 110	5.0
AROCLOR-1248	0/2	U 110	U 100	~ 110	5.0
AROCLOR-1254	0/2	U 230	U 210	~ 220	10
AROCLOR-1260	0/2	U 230	U 210	~ 220	10
White Oak Lake at Mouth of White Oak Creek					
AROCLOR-1016	0/2	U 4,000	U 4,000	~ 4,000	0
AROCLOR-1221	0/2	U 4,000	U 4,000	~ 4,000	0
AROCLOR-1232	0/2	U 4,000	U 4,000	~ 4,000	0
AROCLOR-1242	0/2	U 4,000	U 4,000	~ 4,000	0
AROCLOR-1248	0/2	U 4,000	U 4,000	~ 4,000	0
AROCLOR-1254	1/2	U 8,000	J 1,100	~ 4,500	3,500
AROCLOR-1260	2/2	J 1,600	J 1,400	~ 1,500	58
Melton Hill Lake east of 7600 and south of 7709					
AROCLOR-1016	0/2	U 130	U 110	~ 120	8.0
AROCLOR-1221	0/2	U 130	U 110	~ 120	8.0
AROCLOR-1232	0/2	U 130	U 110	~ 120	8.0
AROCLOR-1242	0/2	U 130	U 110	~ 120	8.0
AROCLOR-1248	0/2	U 130	U 110	~ 120	8.0
AROCLOR-1254	2/2	J 37	J 8.0	~ 23	15
AROCLOR-1260	0/2	U 260	U 230	~ 240	16
Watts Bar Lake south of 7700, Tower Shielding Facility					
AROCLOR-1016	0/2	U 110	U 100	~ 100	4.0
AROCLOR-1221	0/2	U 110	U 100	~ 100	4.0
AROCLOR-1232	0/2	U 110	U 100	~ 100	4.0
AROCLOR-1242	0/2	U 110	U 100	~ 100	4.0
AROCLOR-1248	0/2	U 110	U 100	~ 100	4.0
AROCLOR-1254	2/2	J 20	J 19	~ 20	0.50
AROCLOR-1260	0/2	U 220	U 200	~ 210	8.0

Table 24. (continued)

Analyte	N det/ N total	Concentration ($\mu\text{g/kg}$)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
White Oak Dam					
AROCLOR-1016	0/2	U 110	U 110	~ 110	0
AROCLOR-1221	0/2	U 110	U 110	~ 110	0
AROCLOR-1232	0/2	U 110	U 110	~ 110	0
AROCLOR-1242	0/2	U 110	U 110	~ 110	0
AROCLOR-1248	0/2	U 110	U 110	~ 110	0
AROCLOR-1254	2/2	J 21	J 21	~ 21	0
AROCLOR-1260	0/2	U 210	U 210	~ 210	0
Headwaters of White Oak Creek					
AROCLOR-1016	0/2	U 150	U 130	~ 140	10
AROCLOR-1221	0/2	U 150	U 130	~ 140	10
AROCLOR-1232	0/2	U 150	U 130	~ 140	10
AROCLOR-1242	0/2	U 150	U 130	~ 140	10
AROCLOR-1248	0/2	U 150	U 130	~ 140	10
AROCLOR-1254	2/2	J 58	J 41	~ 50	8.5
AROCLOR-1260	0/2	U 290	U 250	~ 270	20

^aSee Figs. 7 and 8.

^bPrefixes containing J or U mean that the value was estimated or was not detected at that level, respectively.

^cThe ~ prefix indicates that estimated and/or "undetected" values were used in the calculation of the average.

^dStandard error of the mean.

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Fig. 9. Water sampling locations for mercury monitoring in the ORNL main plant area.

The spills were cleaned up; however, quantities of mercury escaped and reached the surrounding environment. The sampling locations have been placed in areas surrounding known mercury spills. Sampling locations have also been placed near outfalls from building areas with a past history of mercury concern and outfalls from storage areas, spill areas, road, and parking lot drains. Additional sampling locations have been placed downstream from the outfalls and drains to determine the extent to which any mercury is being transported in the surface water and sediment. The surface water sampling locations are shown on Fig. 9. The sediment sampling locations are shown on Fig. 10. A total of 39 surface water samples and 27 sediment samples were taken from 13 surface water locations and 9 sediment locations. 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 25 shows the maximum, minimum, and average concentrations of mercury in surface water sampled in June 1992. 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 $2.4 \mu\text{g/L}$ (ppb) for the acute criteria. The percentage TWQ column shows the reported maximum concentration as a percentage of this limit for each sampling location. The highest value reported was at outfall 367 on Fifth Creek. The average concentrations at all other sampling locations were less than $0.25 \mu\text{g/L}$.

Table 26 shows the maximum, minimum, and average concentrations of mercury in sediment sampled in June 1992. The standard error of the mean is also included. There is no established state or EPA standard for mercury in sediment. The highest concentrations of mercury were measured in the samples from Fifth Creek, with averages of $100 \mu\text{g/g}$ and $14 \mu\text{g/g}$ at the two locations. Two sites on White Oak Creek had average concentrations of $4.5 \mu\text{g/g}$ and $3.3 \mu\text{g/g}$. Average concentrations of mercury at all other sampling locations were much lower; they ranged from $0.024 \mu\text{g/g}$ to $0.093 \mu\text{g/g}$.

3.6 GROUNDWATER

Regis S. Loffman

Groundwater at ORNL is monitored to comply with 3004(U) of RCRA and to meet data needs for remediation activities. Because of the large number of Solid Waste Management Unit (SWMU) sites at ORNL located close to one another and the proven hydrologic interconnections 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. Fig. 11 shows the location of the WAGs.

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Fig. 10. Sediment sampling locations for mercury monitoring in the ORNL environs.

Table 25. Mercury concentrations in water, June 1992

Stream ^a standard ^d	Site	N det/ N total	Concentration ($\mu\text{g/L}$)			Standard error ^c	Percent of TWQ
			Max	Min	Av ^b		
1st Creek	341	3/3	0.21	0.20	0.21*	0.0033	10
5th Creek	261	3/3	0.030	0.020	0.023*	0.0033	1.4
	363	3/3	0.030	0.020	0.023*	0.0033	1.4
	367	3/3	3.2	0.41	1.5	0.85	153
WOC	106	3/3	0.26	0.25	0.25*	0.0033	12
	202	3/3	0.10	0.10	0.10	0	4.8
	207	3/3	0.17	0.15	0.16*	0.0067	8.1
	222	3/3	0.050	0.040	0.043*	0.0033	2.4
	301	3/3	0.090	0.070	0.083*	0.0067	4.3
	302	3/3	0.080	0.080	0.080	0	3.8
	304	3/3	0.14	0.12	0.13*	0.0058	6.7
	HDW	3/3	0.050	0.030	0.037*	0.0067	2.4
	X01	3/3	0.060	0.040	0.050*	0.0058	2.9

^aSee Fig. 9.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dMaximum concentration as a percentage of proposed TWQ Standard, 2.4 $\mu\text{g/L}$, for the protection of fish and aquatic life.

Table 26. Mercury concentrations in sediment, June 1992

Stream	Site ^a	N det/ N total	Concentration ($\mu\text{g/g}$)			
			Max	Min	Av ^b	Standard error ^c
1st Creek	Upstream NWT	3/3	0.15	0.067	0.093*	0.026
5th Creek	Outfall 261	3/3	140	84	110*	17
	Outfall 362	3/3	15	13	14*	0.72
MB	Headwaters	3/3	0.025	0.023	0.024*	0.00058
WOC	Upstream 5th Creek	3/3	6.1	2.2	4.5*	1.2
	Downstream 1st Creek	3/3	4.5	2.5	3.3*	0.62
	Headwaters	3/3	0.11	0.058	0.079*	0.014
	Upstream MB	3/3	0.062	0.019	0.037	0.013
	Downstream WOD	3/3	0.033	0.029	0.030*	0.0013

^aSee Fig. 10.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.

Fig. 11. ORNL WAGs.

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 27 contains a listing of all of the analyses conducted on groundwater at ORNL during second quarter 1992 and the regulatory limits associated with each. Not all parameters were quantified for each sample; however, Table 27 in conjunction with the sampling plan synopsis provided for each WAG can be used to determine the respective specific analyte lists. Groundwater and its related quality are not regulated like other environmental media (e.g., surface water by NPDES, air by CAA). Consequently, there are no mandated groundwater quality criteria. In an effort to provide a basis for evaluation of analytical results and for assessing groundwater quality at ORNL WAGs, drinking water limits and DOE DCGs have been used to analyze the analytical data. It should be emphasized that while drinking water limits are used herein it is unrealistic to assume that members of the public are going to drink groundwater from ORNL WAGs.

Duplicate, field blank, and trip blank samples are also collected with each WAG as part of the groundwater QA/QC program.

Two types of tables are presented which depict the monitoring parameters' values for each WAG sampled during second quarter 1992. The first table is a summary table presented by well type (i.e., down-gradient and up-gradient). The table contains the number of detected values and the total number of samples; the maximum, minimum, and average of all values; and the standard error of the mean. Various prefixes with different meanings precede the maxima and minima. "U" (analyte was undetected and the instrument was calibrated at the associated value), "<" (the analyte was not able to be quantified above the associated value), "J" (below quantification, estimated), "B" (found in the associated laboratory blank), "JB" (estimated and found in the associated laboratory blank), "E" (value exceeded instrument calibration range, estimated), and "Y" (value from reanalysis after dilution when the calibration range was exceeded).

The second table contains WAG-specific values which exceed a reference value. This reference value may be a regulatory limit or, for organic analytes which do not have regulatory limits, five times the laboratory detection limit was used as a rough rule for assessing the presence of contaminants (or ten times in the case of common organic laboratory contaminants). Tentatively identified compounds (TICs) are also presented in this table of exceedences.

All radionuclide values are corrected for background. A radionuclide value is determined to be significantly greater than zero when the value exceeds 1.645 times its estimated standard error (see Section 1.0 for discussion).

Table 27. Analytes sought and applicable standards in groundwater at ORNL in WAGs 6, 7, 8, 9, and 17 during April-June 1992

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	DOE DCG
Anions (mg/L)				
Bromide				
Chloride		250		
Fluoride	4.0	3.0		
Nitrate	10			
Phosphate				
Sulfate (as SO ₄)		250		
Base/Neutral/Acid Extractable Organics ^a (µg/L)				
1,2,4-Trichlorobenzene				
1,2-Dichlorobenzene				
1,3-Dichlorobenzene				
1,4-Dichlorobenzene	75			
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				

Table 27. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	DOE DCG
Anthracene				
Benzo(a)anthracene				
Benzo(a)pyrene				
Benzo(b)fluoranthene				
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				
Field Measurements				
Conductivity (mS/cm)				
Dissolved oxygen (ppm)				
Redox (mV)				

Table 27. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	DOE DCG
Temperature (°C)			30.5	
Turbidity (JTU)	1.0			
pH (SU)		(6.5, 8.5)	(6.0, 9.0)	
Metals (mg/L)				
Aluminum		0.20		
Antimony				
Arsenic	0.050		0.050	
Barium	2.0			
Beryllium				
Boron				
Cadmium	0.010		0.010	
Calcium				
Chromium	0.050		0.050	
Cobalt				
Copper		1.0		
Iron		0.30		
Lead	0.050		0.050	
Lithium				
Magnesium				
Manganese		0.050		
Mercury	0.0020		0.0020	
Molybdenum				
Nickel				
Phosphorus				
Potassium				
Selenium	0.010		0.010	
Silicon				
Silver		0.10	0.050	
Sodium				
Strontium				
Thallium				
Tin				
Titanium				
Vanadium				
Zinc		5.0		
Zirconium				
Others				
Alkalinity (mg/L)				
Phenolics, total recoverable (mg/L)				

Table 27. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	DOE DCG
Total dissolved solids (mg/L)		500	500	
Total organic carbon (mg/L)				
Total organic halides ($\mu\text{g/L}$)				
Total suspended solids (mg/L)				
Radionuclides (Bq/L) ^b				
Co-60				7.4
Cs-137				4.44
Gross alpha	0.555			
Gross beta	1.85			
H-3	740			2,960
Total rad Sr	0.296			1.48
Volatile Organics ($\mu\text{g/L}$) ^a				
1,1,1-Trichloroethane	200		200	
1,1,2,2-Tetrachloroethane				
1,1,2-Trichloroethane				
1,1-Dichloroethane				
1,1-Dichloroethene	7.0		7.0	
1,2-Dichloroethane	5.0		5.0	
1,2-Dichloroethene				
1,2-Dichloropropane				
2-Butanone				
2-Hexanone				
4-Methyl-2-pentanone				
Acetone				
Benzene	5.0		5.0	
Bromodichloromethane	100			
Bromoform	100			
Bromomethane				
Carbon disulfide				
Carbon tetrachloride	5.0		5.0	
Chlorobenzene				
Chloroethane	200			
Chloroform	100			
Chloromethane				
Dibromochloromethane	100			
Ethylbenzene				
Methylene chloride				
Styrene				
Tetrachloroethene				

Table 27. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	DOE	DCG
Toluene					
Trichloroethene	5.0		5.0		
Vinyl acetate					
Vinyl chloride	2.0		2.0		
Xylene, total					
cis-1,3-Dichloropropene					
trans-1,3-Dichloropropene					

^aDivide $\mu\text{g/L}$ by 1000 to convert to mg/L .

^bDivide Bq/L by 0.037 to convert to pCi/L .

A number of the wells show vinyl chloride results of "U 10 $\mu\text{g/L}$ " which appear to exceed the primary drinking water standard of 2 $\mu\text{g/L}$. A better way to interpret these results is that vinyl chloride was undetected and the instrument used in the analysis was able to accurately detect vinyl chloride at 10 $\mu\text{g/L}$ or above.

It is unlikely that vinyl chloride was present in the sample; an estimated value (i.e., a value less than 10, accompanied by a "J" prefix) would have been returned by the laboratory if the instrument detected vinyl chloride.

3.6.1 WAG 6

3.6.1.1 Program Description

Groundwater in Solid Waste Storage Area (SWSA) 6 is monitored to comply with Tennessee's Hazardous Waste Management Rule 1200-1-11-.05 (6) (a) 4. (iv). SWSA 6 is one of three SWMUs that make up WAG 6. WAG 6 is located about 1.5 km southwest of the ORNL main site. 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 low-level waste (LLW) materials. The basin has not been used since its construction was completed in 1962. The Explosives Detonation Trench is used for explosive and shock-sensitive chemicals requiring disposal.

The wells at SWSA 6 are divided into three types: up-gradient perimeter, down-gradient perimeter, and internal site-characterization wells which provide information about conditions within the site. The SWSA 6 data reported here pertains only to the up- and down-gradient perimeter wells.

SWSA 6 is currently being monitored as part of RCRA assessment monitoring. Fig. 12 shows the groundwater monitoring well network. Eight of the wells at SWSA 6 (wells 840-844, 847, 1242, 1243) are monitored quarterly for ten volatile organic compounds, alkalinity, gross alpha, total rad Sr, Co-60, Cs-137, tritium, alkalinity, and field parameters as part of this program. (Wells 1244 and 1245 used to be monitored quarterly as part of the SWSA 6 network. They were determined early in 1992 to not reflect groundwater conditions at SWSA 6. They are now monitored as part of the WAG 2 network.) The remaining 16 wells are monitored semi-annually. During second quarter 1992 only the eight "quarterly" wells were monitored.

3.6.1.2 Results

The eight "quarterly" perimeter assessment wells at SWSA 6 were sampled May 18-22, 1992. A summary of the analytical results for the assessment wells is presented in Table 28; Table 29 presents the data which exceed some reference criteria for all of the assessment wells.

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Fig. 12. Location map of WAG 6.

Table 28. ORNL WAG 6 groundwater summary statistics from
May 18-22, 1992 for the down-gradient well type

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	8/8	0.75	0.21	0.47*	0.060
Oxygen, dissolved (ppm)	8/8	8.9	7.1	8.0*	0.22
Redox (mV)	8/8	240	120	170*	15
Temperature (°C)	8/8	15	13	14*	0.19
Turbidity (JTU)	8/8	190	11	55*	21
pH (SU)	8/8	7.6	6.7	7.3*	0.097
Others -- Unfiltered					
Alkalinity (mg/L)	8/8	440	190	320*	28
Radionuclides (Bq/L) -- Filtered					
Co-60	2/8	18*	-0.030	2.4	2.2
Gross alpha	6/8	0.27*	0.010	0.14*	0.028
H-3	8/8	62,000*	89*	15,000*	7,900
Total rad Sr	3/8	0.11*	-0.064	0.043*	0.022
Volatile Organics (µg/L) -- Unfiltered					
1,2-Dichloroethane	1/8	8.0	U 5.0	~ 5.4*	0.38
1,2-Dichloroethene	2/8	6.0	U 5.0	~ 5.1*	0.13
Benzene	1/8	U 5.0	J 2.0	~ 4.6*	0.38
Carbon disulfide	2/8	20	J 2.0	~ 6.5*	2.0
Carbon tetrachloride	1/8	42	U 5.0	~ 9.6*	4.6
Chloroform	3/8	40	J 1.0	~ 8.5	4.5
Methylene chloride	1/8	9.0	U 5.0	~ 5.5*	0.50
Trichloroethene	2/8	200	U 5.0	~ 29	24

^aPrefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bAverage concentrations significantly greater than zero are identified by an *. The ~ prefix indicates that estimated and/or "undetected" values were used in the calculation of the average.

^cStandard error of the mean.

^dNot applicable.

Table 29. ORNL WAG 6 groundwater constituents that exceed a reference value from May 18-22, 1992

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 840, Sampling Date 19MAY92				
Ground Elevation 766.94 ft, Water Elevation 747.83				
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 841, Sampling Date 18MAY92				
Ground Elevation 766.04 ft, Water Elevation 754.60				
Radionuclides (Bq/L) -- Filtered				
H-3	3,600*	100	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 842, Sampling Date 19MAY92				
Ground Elevation 767.25 ft, Water Elevation 758.31				
Volatile Organics (µg/L) -- Unfiltered				
1,2-Dichloroethane	8.0	c	5	1
Carbon tetrachloride	42	c	5	1
Chloroform	40	c	5.0	D
Trichloroethene	200	c	5	1
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Methane, trichlorofluoro-6.92	J 6.0	c	c	T
Well 843, Sampling Date 19MAY92				
Ground Elevation 781.43 ft, Water Elevation 776.76				
Radionuclides (Bq/L) -- Filtered				
H-3	37,000*	1,000	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 29. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 844, Sampling Date 21MAY92				
Ground Elevation 780.95 ft, Water Elevation 769.75				
Radionuclides (Bq/L) -- Filtered				
H-3	3,100*	100	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 847, Sampling Date 20MAY92				
Ground Elevation 839.62 ft, Water Elevation 803.65				
Radionuclides (Bq/L) -- Filtered				
H-3	3,400*	100	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1242, Sampling Date 22MAY92				
Ground Elevation 775.11 ft, Water Elevation 758.32				
Radionuclides (Bq/L) -- Filtered				
H-3	9,700*	100	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1243, Sampling Date 22MAY92				
Ground Elevation 778.66 ft, Water Elevation 759.96				
Radionuclides (Bq/L) -- Filtered				
Co-60	18*	1.0	7.4	4
H-3	62,000*	1,000	2,960	4

Table 29. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics ($\mu\text{g/L}$) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs ($\mu\text{g/L}$) -- Unfiltered				
Unknown-28.73	J 6.0	c	c	T

^aPrefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bIf a reference limit exists, the source is coded as:

- 1 Rules of Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Chapter 1200-4-3, General Water Quality Criteria, as amended.
 - 2 40CFR Part 141--National Primary Drinking Water Regulations, Subparts B and G, as amended.
 - 3 40CFR Part 143--National Secondary Drinking Water Regulations, as amended.
 - 4 DOE Order 5400.5, Chapter III, Derived Concentration Guides for Air and Water, as amended.
- D The value exceeds the laboratory detection limit.
T A tentatively identified compound (TIC).
^cNot applicable.

Well 842 continues to exhibit the highest level of volatile organic contamination, including carbon tetrachloride, chloroform, 1,2-dichloroethane, and trichloroethene. Tritium levels were highest at wells 1243, 843, 1242, 841, 847, and 844 with levels ranging from 3,100 to 62,000 Bq/L.

3.6.2 WAG 7

3.6.2.1 Program Description

The sites at WAG 7 are currently remedial investigation sites regulated under RCRA 3004(u). ORNL has sampled WAG 7 since 1990 and has plans to continue sampling every year.

WAG 7 is located in Melton Valley about 1.6 km (1 mile) south of the ORNL main plant area (Fig. 13). The major sites in WAG 7 are the seven pits and trenches used from 1951 to 1966 for the disposal of liquid low-level waste. WAG 7 also includes a decontamination facility, three leak sites, a storage area containing shielded transfer tanks and other equipment, and seven fuel wells used to dispose acid solutions containing enriched uranium (primarily from HRE fuel).

Sixteen wells comprise the groundwater perimeter well network at WAG 7 (wells 1071-1086); the up-gradient wells for WAG 7 are 1072 and 1073.

Parameters measured consisted of the Toxic Compound List for organics, metals by atomic absorption for mercury and potassium, metals by ICP/MS (antimony, arsenic, lead, mercury, selenium, silver, and thallium), metals by ICP, anions (bromide, chloride, fluoride, nitrate, phosphate, and sulfate), total organic halides, total organic carbon, total dissolved solids, total suspended solids, alkalinity, radionuclides (H-3, total rad Sr, gamma emitting isotopes, gross alpha, and gross beta), and field parameters (pH, specific conductance, temperature, dissolved oxygen, redox, and turbidity). In addition, Tc-99 analysis was conducted on samples taken from wells 1078, 1079, 1083, and 1084.

3.6.2.2 Results

Perimeter wells at WAG 7 were sampled April 22-May 13, 1992. A summary of the analytical results by well type (i.e., up-gradient and down-gradient) is presented in Table 30; Table 31 presents the data which exceed some reference criteria.

Gross beta activity was detected at wells 1083, 1072, 1076, 1084, 1079, 1075, and 1078 with values ranging from 2.1 to 190 Bq/L. Tritium was detected at several of the wells. The wells which had the most significant levels are 1078, 1084, 1079, and 1076, which had tritium levels ranging from 1,100 to 33,000 Bq/L. Of the four wells where Tc-99 analysis was conducted, well 1078 is the only well where results were significant, 280 Bq/L. Low levels of gross alpha activity were detected at well 1079 and Co-60 was detected at well 1078. Minimal volatile organic contamination was detected in the WAG 7 wells.

Table 30. ORNL WAG 7 groundwater summary statistics from
April 22-May 13, 1992

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Down-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	14/14	110	1.0	22*	8.8
Fluoride	2/14	8.0	< 0.10	~ 0.80	0.57
Nitrate	10/14	1,900	< 0.10	~ 140	140
Sulfate (as SO ₄)	14/14	730	8.0	160*	59
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	14/14	3.3	0.15	0.82*	0.24
Oxygen, dissolved (ppm)	14/14	9.8	6.9	8.0*	0.22
Redox (mV)	14/14	250	140	170*	8.2
Temperature (°C)	14/14	15	11	13*	0.24
Turbidity (JTU)	14/14	100	8.4	35*	8.0
pH (SU)	14/14	9.1	7.0	7.7*	0.15
Metals (mg/L) -- Filtered					
Aluminum	9/14	0.23	< 0.050	~ 0.072*	0.013
Barium	14/14	0.23	0.011	0.10*	0.019
Boron	4/14	0.42	< 0.080	~ 0.14*	0.031
Calcium	14/14	330	3.1	91*	23
Chromium	11/14	0.018	< 0.0040	~ 0.0094*	0.0013
Cobalt	2/14	0.036	< 0.0040	~ 0.0083*	0.0030
Copper	14/14	0.030	0.0071	0.018*	0.0017
Iron	5/14	8.4	< 0.050	~ 0.67	0.59
Lead	1/14	0.025	< 0.020	~ 0.020*	0.00036
Magnesium	14/14	110	0.77	22*	7.6
Manganese	14/14	1.5	0.0013	0.20*	0.11
Nickel	13/14	0.39	< 0.0040	~ 0.046	0.027
Potassium	14/14	9.0	1.1	3.1*	0.58
Selenium	2/14	0.000	< 0.0050	~ 0.0061*	0.0011
Silicon	14/14	12	4.4	7.0*	0.56
Sodium	12/14	660	< 5.0	~ 120*	49
Vanadium	2/14	0.0056	< 0.0020	~ 0.0023*	0.00027
Zinc	1/14	0.0079	< 0.0050	~ 0.0052*	0.00021

Table 30. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Metals (mg/L) -- Unfiltered					
Aluminum	10/14	4.8	< 0.050	~ 1.3*	0.43
Barium	14/14	0.21	0.012	0.10*	0.017
Beryllium	4/14	0.0011	< 0.0010	~ 0.0010*	0.0000073
Boron	4/14	0.39	< 0.080	~ 0.14*	0.030
Calcium	14/14	330	3.1	89*	23
Chromium	11/14	0.037	< 0.0040	~ 0.014*	0.0026
Cobalt	3/14	0.031	< 0.0040	~ 0.0079*	0.0026
Copper	2/14	0.010	< 0.0070	~ 0.0074*	0.00031
Iron	14/14	11	0.051	2.1*	0.85
Lead	1/14	0.028	< 0.020	~ 0.021*	0.00057
Magnesium	14/14	110	0.80	21*	7.4
Manganese	14/14	1.4	0.0063	0.24*	0.11
Nickel	11/14	0.38	< 0.0040	~ 0.043	0.026
Potassium	14/14	9.7	0.70	3.3*	0.71
Silicon	14/14	13	4.6	8.4*	0.73
Silver	1/14	0.011	< 0.0050	~ 0.0054*	0.00043
Sodium	12/14	610	< 5.0	~ 110*	46
Vanadium	5/14	0.0062	< 0.0020	~ 0.0027*	0.00034
Zinc	7/14	0.020	< 0.0050	~ 0.0082*	0.0012
Others -- Filtered					
Alkalinity (mg/L)	14/14	640	58	290*	34
Total dissolved solids (mg/L)	14/14	3,500	280	780*	240
Others -- Unfiltered					
Alkalinity (mg/L)	14/14	640	60	290*	34
Total organic carbon (mg/L)	14/14	2.5	0.50	1.2*	0.16
Total organic halides (µg/L)	1/14	100	5.0	12	6.9
Total suspended solids (mg/L)	9/14	130	2.0	~ 36*	12
Radionuclides (Bq/L) -- Filtered					
Co-60	4/14	20*	-0.18	1.6	1.4
Cs-137	3/14	0.77*	-0.080	0.12*	0.054
Gross alpha	6/14	5.1*	0.020	0.46	0.36
Gross beta	13/14	110*	0.16	14	8.1
H-3	8/14	33,000*	-78	4,200	2,600
Tc-99	4/4	280*	0.95*	73	69
Total rad Sr	10/14	0.32*	-0.034	0.15*	0.031

Table 30. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Radionuclides (Bq/L) -- Unfiltered					
Co-60	3/14	20*	-0.030	1.6	1.4
Cs-137	4/14	1.4*	-0.010	0.23*	0.097
Gross alpha	8/14	5.0*	-0.090	0.50	0.35
Gross beta	14/14	190*	0.23*	17	13
H-3	9/14	33,000*	-86	4,200	2,600
Total rad Sr	6/14	0.22*	-0.050	0.089*	0.021
Volatile Organics (µg/L) -- Unfiltered					
Benzene	1/14	U 5.0	J 3.0	~ 4.9*	0.14
Carbon disulfide	1/14	17	U 5.0	~ 5.9*	0.86
Styrene	1/14	U 5.0	J 1.0	~ 4.7*	0.29
Trichloroethene	1/14	U 5.0	J 3.0	~ 4.9*	0.14
Up-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	2/2	4.1	0.90	2.5	1.6
Fluoride	1/2	0.10	< 0.10	~ 0.10	0
Sulfate (as SO ₄)	2/2	84	6.4	45	39
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	2/2	0.35	0.030	0.19	0.16
Oxygen, dissolved (ppm)	2/2	11	7.9	9.3*	1.4
Redox (mV)	2/2	180	160	170*	12
Temperature (°C)	2/2	14	14	14*	0.21
Turbidity (JTU)	2/2	120	2.1	59	57
pH (SU)	2/2	7.8	5.5	6.6	1.1
Metals (mg/L) -- Filtered					
Aluminum	2/2	0.069	0.061	0.065*	0.0043
Barium	2/2	0.054	0.037	0.045	0.0086
Calcium	2/2	45	1.1	23	22
Chromium	1/2	0.0058	< 0.0040	~ 0.0049	0.00089
Cobalt	1/2	0.0047	< 0.0040	~ 0.0044*	0.00035
Copper	2/2	0.024	0.020	0.022*	0.0023
Magnesium	2/2	9.0	1.9	5.4	3.6
Manganese	2/2	0.58	0.038	0.31	0.27
Nickel	2/2	0.019	0.0066	0.013	0.0060
Potassium	2/2	4.7	0.70	2.7	2.0

Table 30. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Metals (mg/L) -- Filtered					
Silicon	2/2	11	9.5	10*	0.70
Sodium	1/2	70	< 5.0	~ 38	33
Vanadium	1/2	0.0023	< 0.0020	~ 0.0021*	0.00014
Zinc	1/2	0.0095	< 0.0050	~ 0.0072	0.0022
Metals (mg/L) -- Unfiltered					
Aluminum	1/2	0.39	< 0.050	~ 0.22	0.17
Barium	2/2	0.060	0.033	0.046	0.014
Calcium	2/2	41	1.2	21	20
Chromium	1/2	0.0043	< 0.0040	~ 0.0042*	0.00017
Cobalt	1/2	0.0047	< 0.0040	~ 0.0044*	0.00036
Copper	1/2	0.0082	< 0.0070	~ 0.0076*	0.00061
Iron	2/2	0.50	0.29	0.39	0.10
Magnesium	2/2	7.9	2.1	5.0	2.9
Manganese	2/2	0.53	0.046	0.29	0.24
Nickel	1/2	0.013	< 0.0040	~ 0.0086	0.0046
Potassium	2/2	4.2	0.60	2.4	1.8
Silicon	2/2	9.7	9.5	9.6*	0.11
Sodium	1/2	62	< 5.0	~ 33	28
Zinc	2/2	0.0095	0.0080	0.0087*	0.00074
Others -- Filtered					
Alkalinity (mg/L)	2/2	210	14	110	96
Total dissolved solids (mg/L)	2/2	360	54	210	150
Others -- Unfiltered					
Alkalinity (mg/L)	2/2	210	13	110	96
Total organic carbon (mg/L)	2/2	1.3	0.58	0.95	0.38
Total suspended solids (mg/L)	1/2	17	< 5.0	~ 11	6.0
Radionuclides (Bq/L) -- Filtered					
Cs-137	1/2	0.13*	0.13	0.13	0
Gross alpha	2/2	0.094*	0.071*	0.083*	0.012
Gross beta	2/2	2.4*	0.71*	1.6	0.85
H-3	1/2	27*	1.0	14	13
Total rad Sr	1/2	0.24*	0.050	0.15	0.095

Table 30. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Radionuclides (Bq/L) -- Unfiltered					
Cs-137	1/2	0.24*	0.040	0.14	0.10
Gross alpha	2/2	0.13*	0.086*	0.11	0.022
Gross beta	2/2	1.5*	0.55*	1.0	0.48
H-3	1/2	26*	13	20	6.5
Total rad Sr	1/2	0.16*	0.070	0.12	0.045

^aPrefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bAverage concentrations significantly greater than zero are identified by an *. The ~ prefix indicates that estimated and/or "undetected" values were used in the calculation of the average.

^cStandard error of the mean.

^dNot applicable.

Table 31. ORNL WAG 7 groundwater constituents that exceed a reference value
from April 22-May 13, 1992

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 1071, Sampling Date 23APR92				
Ground Elevation 809.96 ft, Water Elevation 804.72				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	49	c	1.0	D
Metals (mg/L) -- Filtered				
Aluminum	0.070	c	0.050	D
Chromium	0.014	c	0.0040	D
Copper	0.023	c	0.0070	D
Manganese	0.023	c	0.0010	D
Nickel	0.0084	c	0.0040	D
Sodium	17	c	5.0	D
Zinc	0.0079	c	0.0050	D
Metals (mg/L) -- Unfiltered				
Aluminum	4.8	c	0.2	3
Beryllium	0.0010	c	0.0010	D
Chromium	0.030	c	0.0040	D
Copper	0.010	c	0.0070	D
Iron	6.5	c	0.3	3
Manganese	0.18	c	0.05	3
Nickel	0.016	c	0.0040	D
Sodium	15	c	5.0	D
Vanadium	0.0062	c	0.0020	D
Zinc	0.020	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	1.3	0.082	0.50	D
Total suspended solids (mg/L)	75	c	5.0	D
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 1072, Sampling Date 22APR92				
Ground Elevation 834.00 ft, Water Elevation 816.99				
Anions (mg/L) -- Unfiltered				
Fluoride	0.10	c	0.10	D
Sulfate (as SO ₄)	84	c	1.0	D
Metals (mg/L) -- Filtered				
Aluminum	0.061	c	0.050	D
Chromium	0.0058	c	0.0040	D
Copper	0.020	c	0.0070	D
Manganese	0.58	c	0.05	3
Nickel	0.0066	c	0.0040	D
Sodium	70	c	5.0	D
Vanadium	0.0023	c	0.0020	D
Zinc	0.0095	c	0.0050	D
Metals (mg/L) -- Unfiltered				
Chromium	0.0043	c	0.0040	D
Copper	0.0082	c	0.0070	D
Iron	0.29	c	0.050	D
Manganese	0.53	c	0.05	3
Sodium	62	c	5.0	D
Zinc	0.0080	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	1.3	0.19	0.50	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	2.4*	0.30	1.85	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1073, Sampling Date 22APR92				
Ground Elevation 833.82 ft, Water Elevation 822.18				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	6.4	c	1.0	D

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Field Measurements -- Unfiltered pH (SU)	5.5	0.037	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Aluminum	0.069	c	0.050	D
Cobalt	0.0047	c	0.0040	D
Copper	0.024	c	0.0070	D
Manganese	0.038	c	0.0010	D
Nickel	0.019	c	0.0040	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.39	c	0.2	3
Cobalt	0.0047	c	0.0040	D
Iron	0.50	c	0.3	3
Manganese	0.046	c	0.0010	D
Nickel	0.013	c	0.0040	D
Zinc	0.0095	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.58	0.096	0.50	D
Total suspended solids (mg/L)	17	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1074, Sampling Date 23APR92				
Ground Elevation 769.75 ft, Water Elevation 764.95				
Anions (mg/L) -- Unfiltered				
Fluoride	1.8	c	0.10	D
Nitrate	0.60	c	0.10	D
Sulfate (as SO ₄)	140	c	1.0	D
Metals (mg/L) -- Filtered				
Aluminum	0.23	c	0.2	3
Boron	0.36	c	0.080	D
Copper	0.011	c	0.0070	D
Iron	0.11	c	0.050	D

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Filtered				
Manganese	0.0014	c	0.0010	D
Nickel	0.011	c	0.0040	D
Sodium	260	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	3.8	c	0.2	3
Beryllium	0.0010	c	0.0010	D
Boron	0.38	c	0.080	D
Chromium	0.0072	c	0.0040	D
Iron	2.3	c	0.3	3
Manganese	0.028	c	0.0010	D
Nickel	0.0094	c	0.0040	D
Sodium	260	c	5.0	D
Zinc	0.011	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	700	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	1.3	0.24	0.50	D
Total organic halides (µg/L)	100	0.82	5.0	D
Total suspended solids (mg/L)	100	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1075, Sampling Date 24APR92				
Ground Elevation 768.98 ft, Water Elevation 769.27				
Anions (mg/L) -- Unfiltered				
Fluoride	8.0	c	4	2
Nitrate	1.0	c	0.10	D
Sulfate (as SO ₄)	730	c	250	3
Field Measurements -- Unfiltered				
pH (SU)	9.1	0	(6.5, 8.5)	3

Table 31. (continued)

Analyte	Concentration			Reference value	Reference source ^b
	Value ^a	Uncertainty			
Metals (mg/L) -- Filtered					
Aluminum	0.084	c	0.050		D
Boron	0.42	c	0.080		D
Copper	0.020	c	0.0070		D
Manganese	0.0021	c	0.0010		D
Sodium	660	c	5.0		D
Metals (mg/L) -- Unfiltered					
Aluminum	0.38	c	0.2		3
Boron	0.39	c	0.080		D
Iron	0.35	c	0.3		3
Manganese	0.0063	c	0.0010		D
Nickel	0.0047	c	0.0040		D
Sodium	610	c	5.0		D
Zinc	0.0062	c	0.0050		D
Others -- Filtered					
Total dissolved solids (mg/L)	1,800	c	500		1
Others -- Unfiltered					
Total organic carbon (mg/L)	1.8	0.24	0.50		D
Total suspended solids (mg/L)	8.0	c	5.0		D
Radionuclides (Bq/L) -- Filtered					
Gross beta	42*	2.0	1.85		2
Radionuclides (Bq/L) -- Unfiltered					
Gross alpha	0.97*	0.54	0.555		2
Gross beta	3.2*	0.80	1.85		2
Volatile Organics (µg/L) -- Unfiltered					
Vinyl chloride	U 10	c	2		1
Volatile Organics-TICs (µg/L) -- Unfiltered					
Unknown-5.56	J 5.0	c	c		T

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 1076, Sampling Date 28APR92				
Ground Elevation 779.09 ft, Water Elevation 773.70				
Anions (mg/L) -- Unfiltered				
Nitrate	5.2	c	0.10	D
Sulfate (as SO ₄)	330	c	250	3
Metals (mg/L) -- Filtered				
Chromium	0.014	c	0.0040	D
Copper	0.021	c	0.0070	D
Iron	0.20	c	0.050	D
Manganese	0.22	c	0.05	3
Nickel	0.013	c	0.0040	D
Sodium	16	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.31	c	0.2	3
Chromium	0.017	c	0.0040	D
Iron	0.80	c	0.3	3
Manganese	0.22	c	0.05	3
Nickel	0.012	c	0.0040	D
Sodium	15	c	5.0	D
Others -- Filtered				
Total dissolved solids (mg/L)	880	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	1.3	0.21	0.50	D
Total suspended solids (mg/L)	17	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	3.3*	0.40	1.85	2
H-3	33,000*	1,000	740	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	2.2*	0.30	1.85	2
H-3	33,000*	1,000	740	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics-TICs (µg/L) -- Unfiltered				
Unknown-25.45	J 6.0	c	c	T
Well 1077, Sampling Date 28APR92				
Ground Elevation 776.27 ft, Water Elevation 777.14				
Anions (mg/L) -- Unfiltered				
Nitrate	0.40	c	0.10	D
Sulfate (as SO ₄)	15	c	1.0	D
Metals (mg/L) -- Filtered				
Aluminum	0.067	c	0.050	D
Boron	0.25	c	0.080	D
Chromium	0.0082	c	0.0040	D
Copper	0.024	c	0.0070	D
Manganese	0.022	c	0.0010	D
Nickel	0.0096	c	0.0040	D
Sodium	92	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.062	c	0.050	D
Boron	0.22	c	0.080	D
Chromium	0.0087	c	0.0040	D
Iron	0.063	c	0.050	D
Manganese	0.023	c	0.0010	D
Nickel	0.0053	c	0.0040	D
Sodium	83	c	5.0	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.95	0.058	0.50	D
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	11*	2.0	1.85	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Unknown-25.45	J 5.0	c	c	T

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 1078, Sampling Date 28APR92				
Ground Elevation 769.00 ft, Water Elevation 766.23				
Anions (mg/L) -- Unfiltered				
Nitrate	53	c	10	2
Sulfate (as SO ₄)	100	c	1.0	D
Metals (mg/L) -- Filtered				
Cobalt	0.032	c	0.0040	D
Copper	0.022	c	0.0070	D
Manganese	0.21	c	0.05	3
Nickel	0.070	c	0.0040	D
Selenium	0.020	c	0.01	1
Sodium	200	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.50	c	0.2	3
Cobalt	0.031	c	0.0040	D
Iron	0.34	c	0.3	3
Manganese	0.23	c	0.05	3
Nickel	0.060	c	0.0040	D
Sodium	190	c	5.0	D
Others -- Filtered				
Total dissolved solids (mg/L)	610	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	1.2	0.29	0.50	D
Radionuclides (Bq/L) -- Filtered				
Co-60	20*	1.0	7.4	4
Gross beta	110*	10	1.85	2
H-3	1,100*	100	740	2
Tc-99	280*	10	148	4
Radionuclides (Bq/L) -- Unfiltered				
Co-60	20*	1.0	7.4	4
Gross beta	190*	10	1.85	2
H-3	1,100*	100	740	2

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Unknown-5.6	J 22	c	c	T
Well 1079, Sampling Date 30APR92				
Ground Elevation 768.40 ft, Water Elevation 759.13				
Anions (mg/L) -- Unfiltered				
Nitrate	1,900	c	10	2
Sulfate (as SO ₄)	500	c	250	3
BNAE Organics-TICs (µg/L) -- Unfiltered				
Benzenederivative-7.64	J 9.0	c	c	T
Metals (mg/L) -- Filtered				
Chromium	0.018	c	0.0040	D
Cobalt	0.036	c	0.0040	D
Copper	0.016	c	0.0070	D
Lead	0.025	c	0.020	D
Manganese	0.031	c	0.0010	D
Nickel	0.39	c	0.0040	D
Selenium	0.0051	c	0.0050	D
Sodium	300	c	5.0	D
Vanadium	0.0056	c	0.0020	D
Metals (mg/L) -- Unfiltered				
Beryllium	0.0011	c	0.0010	D
Chromium	0.018	c	0.0040	D
Cobalt	0.031	c	0.0040	D
Iron	0.30	c	0.050	D
Lead	0.028	c	0.020	D
Manganese	0.042	c	0.0010	D
Nickel	0.38	c	0.0040	D
Sodium	290	c	5.0	D
Vanadium	0.0046	c	0.0020	D
Others -- Filtered				
Total dissolved solids (mg/L)	3,500	c	500	1

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Others -- Unfiltered				
Total organic carbon (mg/L)	2.1	0	0.50	D
Total suspended solids (mg/L)	11	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross alpha	5.1*	0.80	0.555	2
Gross beta	24*	1.0	1.85	2
H-3	20,000*	1,000	740	2
Total rad Sr	0.32*	0.19	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross alpha	5.0*	0.80	0.555	2
Gross beta	18*	1.0	1.85	2
H-3	19,000*	1,000	740	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1080, Sampling Date 30APR92 Ground Elevation 757.61 ft, Water Elevation 749.30				
Anions (mg/L) -- Unfiltered				
Nitrate	0.60	c	0.10	D
Sulfate (as SO ₄)	8.0	c	1.0	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
Benzenederivative-7.67	J 8.0	c	c	T
Metals (mg/L) -- Filtered				
Aluminum	0.064	c	0.050	D
Chromium	0.0079	c	0.0040	D
Copper	0.021	c	0.0070	D
Manganese	0.0017	c	0.0010	D
Nickel	0.0060	c	0.0040	D
Metals (mg/L) -- Unfiltered				
Chromium	0.0072	c	0.0040	D
Iron	0.051	c	0.050	D
Manganese	0.019	c	0.0010	D

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1081, Sampling Date 05MAY92				
Ground Elevation 758.33 ft, Water Elevation 754.43				
Anions (mg/L) -- Unfiltered				
Nitrate	0.10	c	0.10	D
Sulfate (as SO ₄)	15	c	1.0	D
Metals (mg/L) -- Filtered				
Aluminum	0.061	c	0.050	D
Chromium	0.014	c	0.0040	D
Copper	0.0092	c	0.0070	D
Iron	0.088	c	0.050	D
Manganese	0.010	c	0.0010	D
Nickel	0.0070	c	0.0040	D
Sodium	8.4	c	5.0	D
Metals (mg/L) -- Unfiltered				
Chromium	0.016	c	0.0040	D
Iron	0.10	c	0.050	D
Manganese	0.012	c	0.0010	D
Sodium	7.7	c	5.0	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.90	0	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1082, Sampling Date 06MAY92				
Ground Elevation 758.22 ft, Water Elevation 751.01				
Anions (mg/L) -- Unfiltered				
Nitrate	1.0	c	0.10	D
Sulfate (as SO ₄)	60	c	1.0	D

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Filtered				
Chromium	0.0060	c	0.0040	D
Copper	0.0071	c	0.0070	D
Manganese	0.057	c	0.05	3
Nickel	0.011	c	0.0040	D
Sodium	8.4	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	2.6	c	0.2	3
Chromium	0.012	c	0.0040	D
Iron	3.1	c	0.3	3
Manganese	0.26	c	0.05	3
Nickel	0.011	c	0.0040	D
Sodium	7.3	c	5.0	D
Vanadium	0.0032	c	0.0020	D
Zinc	0.012	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.80	0	0.50	D
Total suspended solids (mg/L)	38	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1083, Sampling Date 08MAY92				
Ground Elevation 754.27 ft, Water Elevation 750.84				
Anions (mg/L) -- Unfiltered				
Nitrate	0.20	c	0.10	D
Sulfate (as SO ₄)	24	c	1.0	D
Metals (mg/L) -- Filtered				
Aluminum	0.067	c	0.050	D
Chromium	0.011	c	0.0040	D
Copper	0.016	c	0.0070	D
Iron	0.21	c	0.050	D
Manganese	0.81	c	0.05	3
Nickel	0.0081	c	0.0040	D
Sodium	15	c	5.0	D

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Aluminum	2.4	c	0.2	3
Chromium	0.016	c	0.0040	D
Iron	4.0	c	0.3	3
Manganese	0.85	c	0.05	3
Sodium	14	c	5.0	D
Zinc	0.011	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	1.6	0.050	0.50	D
Total suspended solids (mg/L)	130	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	1.9*	0.40	1.85	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	2.1*	0.40	1.85	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1084, Sampling Date 11MAY92				
Ground Elevation 758.40 ft, Water Elevation 752.31				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	180	c	1.0	D
Metals (mg/L) -- Filtered				
Chromium	0.0090	c	0.0040	D
Copper	0.016	c	0.0070	D
Iron	8.4	c	0.3	3
Manganese	1.5	c	0.05	3
Nickel	0.039	c	0.0040	D
Sodium	55	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	2.5	c	0.2	3
Beryllium	0.0010	c	0.0010	D
Chromium	0.011	c	0.0040	D
Cobalt	0.0047	c	0.0040	D

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Iron	11	c	0.3	3
Manganese	1.4	c	0.05	3
Nickel	0.045	c	0.0040	D
Sodium	53	c	5.0	D
Vanadium	0.0032	c	0.0020	D
Zinc	0.0079	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	650	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	2.5	0.14	0.50	D
Total suspended solids (mg/L)	100	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	6.0*	0.70	1.85	2
H-3	4,700*	100	740	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	5.7*	0.60	1.85	2
H-3	4,700*	100	740	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1085, Sampling Date 12MAY92				
Ground Elevation 758.80 ft, Water Elevation 752.28				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	13	c	1.0	D
Metals (mg/L) -- Filtered				
Aluminum	0.057	c	0.050	D
Boron	0.16	c	0.080	D
Chromium	0.014	c	0.0040	D
Copper	0.013	c	0.0070	D
Manganese	0.016	c	0.0010	D

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Filtered				
Nickel	0.056	c	0.0040	D
Sodium	44	c	5.0	D
Vanadium	0.0032	c	0.0020	D
Metals (mg/L) -- Unfiltered				
Boron	0.14	c	0.080	D
Chromium	0.037	c	0.0040	D
Iron	0.19	c	0.050	D
Manganese	0.016	c	0.0010	D
Nickel	0.051	c	0.0040	D
Sodium	40	c	5.0	D
Vanadium	0.0029	c	0.0020	D
Others -- Unfiltered				
Total organic carbon (mg/L)	~ 0.55	0.10	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1086, Sampling Date 13MAY92				
Ground Elevation 762.37 ft, Water Elevation 754.14				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	8.0	c	1.0	D
Metals (mg/L) -- Filtered				
Aluminum	0.055	c	0.050	D
Chromium	0.0042	c	0.0040	D
Copper	0.030	c	0.0070	D
Manganese	0.0013	c	0.0010	D
Nickel	0.0090	c	0.0040	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.12	c	0.050	D
Copper	0.0099	c	0.0070	D
Iron	0.083	c	0.050	D
Manganese	0.010	c	0.0010	D

Table 31. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Nickel	0.0048	c	0.0040	D
Silver	0.011	c	0.0050	D
Zinc	0.013	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.55	0.058	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

^aPrefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bIf a reference limit exists, the source is coded as:

- 1 Rules of Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Chapter 1200-4-3, General Water Quality Criteria, as amended.
- 2 40CFR Part 141--National Primary Drinking Water Regulations, Subparts B and G, as amended.
- 3 40CFR Part 143--National Secondary Drinking Water Regulations, as amended.
- 4 DOE Order 5400.5, Chapter III, Derived Concentration Guides for Air and Water, as amended.

D The value exceeds the laboratory detection limit.

T A tentatively identified compound (TIC).

^cNot applicable.

3.6.3 WAGs 8 and 9

3.6.3.1 Program Description

The sites at WAGs 8 and 9 are currently remedial investigation sites regulated under RCRA 3004(u). ORNL sampled WAGs 8 and 9 in 1991 and has plans to continue sampling every year. Because of the small number of groundwater monitoring wells in WAG 8 (wells 1087-1095) and WAG 9 (wells 1096 and 1097), they are sampled together. The analytical results for the two WAGs are also reported together.

WAG 8 is located in Melton Valley, south of Melton Valley Drive (Fig. 14), and is comprised of 21 SWMUs which are associated with the reactor facilities in Melton Valley, excluding those in the main ORNL plant area. The SWMUs consist of four active LLW collection and storage tanks; eight leak/spill sites and contaminated soils locations; four radioactive waste ponds and impoundments; three chemical and sewage waste treatment facilities; one chemical waste SWSA, and one mixed waste SWSA. WAG 8 includes the Molten Salt Reactor Experiment facility and the High Flux Isotope Reactor, the Transuranium Processing Plant, and the Thorium-Uranium Recycle Facility.

Radioactive wastes from these facilities are collected in on-site, LLW tanks and periodically pumped to WAG 1 for storage and treatment. The waste includes demineralizer backwash, regeneration effluents, decontamination fluids, experimental coolant, drainage from the compartmental areas of filter pits, etc. chemical and radiochemical analyses are not routinely conducted on the LLW; however, the major nuclides are probably Sr-90, Cs-137, Ru-106, Co-60, and various rare earth.

Leaks related to these SWMUs have occurred; however, in many instances, specific information on individual leak sites is not documented and information about the volume of leakage and extent of the leak are deficient. Previous studies have identified WAG 8 as a major source of Co-60 contamination with measurable releases of Cs-137 also being detected. There is also evidence that WAG 8 was a potential source of Zn and Cr releases.

WAG 9 is located in Melton Valley about 0.6 mile southeast of the ORNL main plant area (Fig. 15). WAG 9 is comprised of three SWMUs: the HRE pond, which was used during 1958-1961 to hold contaminated condensate and shield water from the reactor; LLW collection and storage tanks, which were used from 1957-86; and a septic tank which has been used since 1950 for the treatment of sewage from building 7501.

Eleven wells comprise the groundwater perimeter well network at WAGs 8 and 9; the up-gradient wells for WAGs 8 and 9 are wells 1089 and 1090.

Parameters measured consisted of the Toxic Compound List for organics, metals by atomic absorption for mercury and potassium, metals by ICP/MS (antimony, arsenic, lead, mercury, selenium, silver, and thallium), metals by ICP, anions (bromide, chloride, fluoride, nitrate, phosphate, and sulfate), total organic halides, total organic carbon, total dissolved solids, total suspended solids,

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Fig. 15. Location map of WAG 9.

alkalinity, radionuclides (H-3, total rad Sr, gamma emitting isotopes, gross alpha, and gross beta), and field parameters (pH, specific conductance, temperature, dissolved oxygen, redox, and turbidity).

3.6.3.2 Results

Perimeter wells at WAGs 8 and 9 were sampled May 27-June 12, 1992. A summary of the analytical results by well type (i.e., up-gradient and down-gradient) is presented in Table 32; Table 33 presents the data which exceed some reference criteria.

Radioactive contaminants were detected at about half of the WAGs 8 and 9 wells. Tritium was detected at well 1088 at a level of 2,100 Bq/L. Gross beta activity was detected at wells 1088, 1090, 1087, 1096, and 1097 at levels ranging from 3.3 to 79 Bq/L. Total rad Sr was detected at wells 1087, 1096, and 1097 at levels ranging from 22 to 40 Bq/L.

Well 1096 had 6 µg/L of trichloroethene. The other wells did not have any volatile organic contamination detected.

3.6.4 WAG 17

3.6.4.1 Program Description

The sites at WAG 17 are currently remedial investigation sites regulated under RCRA 3004(u). ORNL sampled WAG 17 in 1991 and has plans to continue sampling every year.

WAG 17 is located about one mile directly east of the ORNL Main Plant Area. It is the major craft and machine shop area for ORNL since the late 1940s. The area encompasses 33.9 acres and includes the receiving and shipping departments, machine shops, carpenter shops, paint shops, lead burning facilities, garage facilities, welding facilities, material storage areas, etc., which are required to support ORNL's routine and experimental operations. It is comprised of eight SWMUS: SWMU 17.1 which is a former septic tank now used as a sewage collection/pumping station for the area; SWMUS 17.2a, 17.2b, 17.2c, and 17.3 which are tanks used for waste oil collection and storage (one of these is a tank truck); and SWMUS 17.4a and 17.4b which are tanks used for storage of photographic reproduction wastes. The location of the wells in WAG 17 is shown in Fig. 16.

There are eight perimeter groundwater quality monitoring wells at WAG 17 (wells 1196-1203); the up-gradient wells are wells 1196-1199.

Parameters measured consisted of the Toxic Compound List for organics, metals by atomic absorption for mercury and potassium, metals by ICP/MS (antimony, arsenic, lead, mercury, selenium, silver, and thallium), metals by ICP, anions (bromide, chloride, fluoride, nitrate, phosphate, and sulfate), total organic halides, total organic carbon, total dissolved solids, total suspended solids, alkalinity, radionuclides (H-3, total rad Sr, gamma emitting isotopes, gross alpha, and gross beta), and field parameters (pH, specific conductance, temperature, dissolved oxygen, redox, and turbidity).

Table 32. ORNL WAGs 8 and 9 groundwater summary statistics from
May 27-June 12, 1992

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Down-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	9/9	8.3	3.8	5.3*	0.58
Fluoride	3/9	1.5	< 0.10	~ 0.29*	0.15
Nitrate	2/9	4.4	< 0.50	~ 1.1*	0.44
Sulfate (as SO ₄)	9/9	280	8.6	63*	29
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered					
Benzyl butyl phthalate	1/9	U 10	J 2.0	~ 9.1*	0.89
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	9/9	0.63	0.046	0.36*	0.065
Oxygen, dissolved (ppm)	9/9	15	3.1	7.8*	1.1
Temperature (°C)	9/9	16	14	15*	0.31
Turbidity (JTU)	9/9	570	19	350*	61
pH (SU)	9/9	9.2	5.0	7.0*	0.42
Metals (mg/L) -- Filtered					
Aluminum	3/9	0.19	< 0.050	~ 0.066*	0.016
Antimony	1/9	0.0056	< 0.0050	~ 0.0051*	0.000067
Arsenic	1/9	0.015	< 0.010	~ 0.011*	0.00056
Barium	9/9	0.20	0.027	0.10*	0.020
Boron	3/9	0.74	< 0.080	~ 0.17*	0.072
Calcium	9/9	120	1.3	51*	13
Chromium	8/9	0.015	< 0.0040	~ 0.0088*	0.0013
Cobalt	1/9	0.019	< 0.0040	~ 0.0057*	0.0017
Copper	5/9	0.025	< 0.0070	~ 0.010*	0.0019
Iron	9/9	25	0.051	3.5	2.8
Magnesium	9/9	24	0.14	14*	2.6
Manganese	9/9	3.2	0.0051	0.72*	0.37
Mercury	1/9	0.00019	< 0.000050	~ 0.000066*	0.000016
Nickel	5/9	0.0080	< 0.0040	~ 0.0051*	0.00049
Potassium	9/9	5.1	1.8	2.9*	0.36
Silicon	9/9	16	3.0	7.7*	1.3
Sodium	9/9	210	5.7	48*	24
Strontium	1/1	1.6	1.6	1.6	c
Vanadium	2/9	0.0052	< 0.0020	~ 0.0025*	0.00037

Table 32. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Metals (mg/L) -- Unfiltered					
Aluminum	7/9	1.3	< 0.050	~ 0.33*	0.14
Barium	9/9	0.21	0.035	0.11*	0.020
Boron	3/9	0.74	< 0.080	~ 0.17*	0.072
Calcium	9/9	110	1.5	48*	12
Chromium	8/9	0.013	< 0.0040	~ 0.0084*	0.00093
Cobalt	1/9	0.015	< 0.0040	~ 0.0053*	0.0013
Copper	1/9	0.0091	< 0.0070	~ 0.0072*	0.00024
Iron	9/9	25	0.060	3.7	2.7
Magnesium	9/9	23	0.15	13*	2.4
Manganese	9/9	3.0	0.0090	0.68*	0.35
Nickel	3/9	0.0073	< 0.0040	~ 0.0046*	0.00038
Potassium	9/9	5.0	1.5	2.5*	0.37
Selenium	1/9	0.0064	< 0.0050	~ 0.0052*	0.00016
Silicon	9/9	18	3.1	7.9*	1.4
Silver	1/9	0.0051	< 0.0050	~ 0.0050*	0.000011
Sodium	8/9	200	< 5.0	~ 46*	23
Strontium	1/1	1.6	1.6	1.6	c
Thallium	1/9	0.0051	< 0.0050	~ 0.0050*	0.000011
Vanadium	3/9	0.0033	< 0.0020	~ 0.0022*	0.00015
Zinc	2/9	0.0081	< 0.0050	~ 0.0057*	0.00045
Others - Filtered					
Alkalinity (mg/L)	9/9	350	85	200*	31
Total dissolved solids (mg/L)	9/9	600	140	340*	53
Others -- Unfiltered					
Alkalinity (mg/L)	9/9	350	85	200*	30
Total organic carbon (mg/L)	4/9	1.0	0.50	0.66*	0.071
Total organic halides (µg/L)	1/9	23	5.0	7.0*	2.0
Total suspended solids (mg/L)	6/9	48	2.0	~ 15*	5.0
Radionuclides (Bq/L) -- Filtered					
Cs-137	2/9	0.43*	-0.010	0.10*	0.046
Gross alpha	6/9	0.25*	0.0020	0.082*	0.025
Gross beta	7/9	79*	0.090	20*	10
H-3	3/9	2,100*	-33	240	230
Total rad Sr	7/9	40*	0.010	11*	5.6

Table 32. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Radionuclides (Bq/L) -- Unfiltered					
Co-60	1/9	0.14*	-0.11	0.0078	0.026
Cs-137	3/9	0.50*	0.010	0.14*	0.051
Gross alpha	7/9	0.24*	-0.010	0.12*	0.028
Gross beta	6/9	62*	0.060	18*	9.2
H-3	3/9	2,100*	-30	240	230
Total rad Sr	6/9	34*	-0.020	9.7*	5.0
Volatile Organics (µg/L) -- Unfiltered					
1,2-Dichloroethene	1/9	11	U 5.0	~ 5.7*	0.67
Toluene	1/9	U 5.0	J 2.0	~ 4.7*	0.33
Trichloroethene	1/9	6.0	U 5.0	~ 5.1*	0.11
Xylene, total	1/9	J 5.0	U 5.0	~ 5.0	0
Up-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	2/2	4.8	3.7	4.3*	0.55
Fluoride	1/2	0.10	< 0.10	~ 0.10	0
Sulfate (as SO ₄)	2/2	120	27	73	46
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered					
Benzyl butyl phthalate	1/2	B 15	U 10	~ 13	2.5
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	2/2	0.30	0.27	0.28*	0.016
Oxygen, dissolved (ppm)	2/2	9.2	8.1	8.7*	0.55
Redox (mV)	1/1	150	150	150	c
Temperature (°C)	2/2	14	13	13*	0.51
Turbidity (JTU)	2/2	38	8.4	23	15
pH (SU)	2/2	8.5	7.0	7.8*	0.75
Metals (mg/L) -- Filtered					
Barium	2/2	0.092	0.030	0.061	0.031
Boron	1/2	0.32	< 0.080	~ 0.20	0.12
Calcium	2/2	50	17	34	16
Chromium	1/2	0.013	< 0.0040	~ 0.0084	0.0044
Copper	2/2	0.016	0.011	0.014	0.0023
Iron	1/2	4.9	< 0.050	~ 2.5	2.4
Magnesium	2/2	21	4.1	12	8.4
Manganese	2/2	4.5	0.055	2.3	2.2

Table 32. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Metals (mg/L) -- Filtered					
Nickel	1/2	0.0091	< 0.0040	~ 0.0066	0.0026
Potassium	2/2	6.5	4.2	5.4	1.2
Silicon	2/2	14	6.3	9.9	3.6
Sodium	2/2	74	14	44	30
Metals (mg/L) -- Unfiltered					
Aluminum	2/2	0.87	0.49	0.68	0.19
Barium	2/2	0.095	0.039	0.067	0.028
Boron	1/2	0.33	< 0.080	~ 0.20	0.12
Calcium	2/2	47	17	32	15
Chromium	1/2	0.013	< 0.0040	~ 0.0086	0.0046
Iron	2/2	5.7	0.34	3.0	2.7
Magnesium	2/2	20	4.1	12	7.7
Manganese	2/2	4.1	0.064	2.1	2.0
Nickel	2/2	0.0045	0.0042	0.0043*	0.00016
Potassium	2/2	3.4	2.6	3.0*	0.40
Silicon	2/2	14	7.3	11	3.3
Sodium	2/2	68	8.9	38	30
Others -- Filtered					
Alkalinity (mg/L)	2/2	170	120	140	25
Total dissolved solids (mg/L)	2/2	390	250	320	70
Others -- Unfiltered					
Alkalinity (mg/L)	2/2	170	110	140	28
Total suspended solids (mg/L)	2/2	22	11	17	5.5
Radionuclides (Bq/L) -- Filtered					
Cs-137	1/2	2.3*	-0.010	1.1	1.2
Gross alpha	1/2	0.12*	0.012	0.066	0.054
Gross beta	2/2	2.1*	0.25*	1.2	0.93
Total rad Sr	2/2	0.27*	0.23*	0.25*	0.020

Table 32. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Radionuclides (Bq/L) -- Unfiltered					
Cs-137	1/2	1.1*	0.030	0.57	0.54
Gross alpha	2/2	1.2*	0.10*	0.65	0.55
Gross beta	2/2	24*	0.17*	12	12
Total rad Sr	2/2	0.19*	0.18*	0.19*	0.0050

^aPrefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bAverage concentrations significantly greater than zero are identified by an *. The ~ prefix indicates that estimated and/or "undetected" values were used in the calculation of the average.

^cStandard error of the mean.

^dNot applicable.

Table 33. ORNL WAGs 8 and 9 groundwater constituents that exceed a reference value from May 27-June 12, 1992

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 1087, Sampling Date 01JUN92				
Ground Elevation 779.48 ft, Water Elevation 774.59				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	20	c	1.0	D
Field Measurements -- Unfiltered				
pH (SU)	5.0	0	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Aluminum	0.055	c	0.050	D
Chromium	0.0042	c	0.0040	D
Cobalt	0.019	c	0.0040	D
Copper	0.0073	c	0.0070	D
Iron	25	c	0.3	3
Manganese	3.2	c	0.05	3
Nickel	0.0080	c	0.0040	D
Sodium	5.7	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.38	c	0.2	3
Chromium	0.0047	c	0.0040	D
Cobalt	0.015	c	0.0040	D
Iron	25	c	0.3	3
Manganese	3.0	c	0.05	3
Nickel	0.0041	c	0.0040	D
Sodium	5.2	c	5.0	D
Others -- Unfiltered				
Total organic carbon (mg/L)	1.0	0	0.50	D
Total suspended solids (mg/L)	28	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	39*	1.0	1.85	2
Total rad Sr	22*	1.0	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	40*	1.0	1.85	2
Total rad Sr	21*	1.0	0.296	2

Table 33. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1088, Sampling Date 01JUN92 Ground Elevation 820.66 ft, Water Elevation 808.14				
Anions (mg/L) -- Unfiltered				
Fluoride	0.30	c	0.10	D
Sulfate (as SO ₄)	20	c	1.0	D
Field Measurements -- Unfiltered				
pH (SU)	5.7	0.029	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Chromium	0.0069	c	0.0040	D
Copper	0.0071	c	0.0070	D
Iron	4.4	c	0.3	3
Manganese	1.9	c	0.05	3
Sodium	9.3	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	1.3	c	0.2	3
Chromium	0.0086	c	0.0040	D
Iron	6.5	c	0.3	3
Manganese	1.9	c	0.05	3
Sodium	8.0	c	5.0	D
Others -- Unfiltered				
Total suspended solids (mg/L)	48	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	3.3*	0.30	1.85	2
H-3	2,100*	100	740	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	2.3*	0.30	1.85	2
H-3	2,100*	100	740	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 33. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 1089, Sampling Date 28MAY92				
Ground Elevation 855.34 ft, Water Elevation 841.20				
Anions (mg/L) -- Unfiltered				
Fluoride	0.10	c	0.10	D
Sulfate (as SO ₄)	120	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Benzyl butyl phthalate	B 15	c	10	D
Metals (mg/L) -- Filtered				
Chromium	0.013	c	0.0040	D
Copper	0.016	c	0.0070	D
Iron	4.9	c	0.3	3
Manganese	4.5	c	0.05	3
Sodium	14	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.87	c	0.2	3
Chromium	0.013	c	0.0040	D
Iron	5.7	c	0.3	3
Manganese	4.1	c	0.05	3
Nickel	0.0042	c	0.0040	D
Sodium	8.9	c	5.0	D
Others -- Unfiltered				
Total suspended solids (mg/L)	11	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1090, Sampling Date 27MAY92				
Ground Elevation 855.22 ft, Water Elevation 853.69				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	27	c	1.0	D
Metals (mg/L) -- Filtered				
Boron	0.32	c	0.080	D
Copper	0.011	c	0.0070	D

Table 33. (continued)

Analyte	Concentration			Reference source ^b
	Value ^a	Uncertainty	Reference value	
Metals (mg/L) -- Filtered				
Manganese	0.055	c	0.05	3
Nickel	0.0091	c	0.0040	D
Sodium	74	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.49	c	0.2	3
Boron	0.33	c	0.080	D
Iron	0.34	c	0.3	3
Manganese	0.064	c	0.05	3
Nickel	0.0045	c	0.0040	D
Sodium	68	c	5.0	D
Others -- Unfiltered				
Total organic carbon (mg/L)	~ 0.55	0.10	0.50	D
Total suspended solids (mg/L)	22	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	2.1*	0.30	1.85	2
Radionuclides (Bq/L) -- Unfiltered				
Gross alpha	1.2*	0.20	0.555	2
Gross beta	24*	1.0	1.85	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Well 1091, Sampling Date 05JUN92
Ground Elevation 829.46 ft, Water Elevation 823.26

Anions (mg/L) -- Unfiltered				
Fluoride	0.20	c	0.10	D
Sulfate (as SO ₄)	72	c	1.0	D
Field Measurements -- Unfiltered				
pH (SU)	6.3	0	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Chromium	0.0091	c	0.0040	D
Iron	0.66	c	0.3	3

Table 33. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^c	Uncertainty		
Metals (mg/L) -- Filtered				
Manganese	0.42	c	0.05	3
Nickel	0.0062	c	0.0040	D
Sodium	36	c	5.0	D
Metals (mg/L) -- Unfiltered				
Chromium	0.0088	c	0.0040	D
Iron	0.68	c	0.3	3
Manganese	0.35	c	0.05	3
Sodium	34	c	5.0	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.90	0	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1092, Sampling Date 08JUN92				
Ground Elevation 838.67 ft, Water Elevation 832.22				
Anions (mg/L) -- Unfiltered				
Fluoride	1.5	c	0.10	D
Nitrate	2.0	c	0.10	D
Sulfate (as SO ₄)	86	c	1.0	D
Field Measurements -- Unfiltered				
pH (SU)	9.2	0.029	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Aluminum	0.19	c	0.050	D
Antimony	0.0056	c	0.0050	D
Arsenic	0.015	c	0.010	D
Boron	0.74	c	0.080	D
Iron	0.10	c	0.050	D
Manganese	0.0072	c	0.0010	D
Mercury	0.00019	c	0.000050	D
Nickel	0.0048	c	0.0040	D
Sodium	210	c	5.0	D
Vanadium	0.0035	c	0.0020	D

Table 33. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Aluminum	0.28	c	0.2	3
Boron	0.74	c	0.080	D
Iron	0.30	c	0.050	D
Manganese	0.012	c	0.0010	D
Nickel	0.0057	c	0.0040	D
Selenium	0.0064	c	0.0050	D
Silver	0.0051	c	0.0050	D
Sodium	200	c	5.0	D
Thallium	0.0051	c	0.0050	D
Vanadium	0.0024	c	0.0020	D
Zinc	0.0081	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	570	c	500	1
Others -- Unfiltered				
Total suspended solids (mg/L)	13	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1093, Sampling Date 29MAY92				
Ground Elevation 839.97 ft, Water Elevation 826.79				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	280	c	250	3
Metals (mg/L) -- Filtered				
Boron	0.18	c	0.080	D
Chromium	0.015	c	0.0040	D
Iron	0.22	c	0.050	D
Manganese	0.11	c	0.05	3
Sodium	110	c	5.0	D
Vanadium	0.0052	c	0.0020	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.14	c	0.050	D
Boron	0.18	c	0.080	D
Chromium	0.011	c	0.0040	D

Table 33. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Iron	0.26	c	0.050	D
Manganese	0.10	c	0.05	3
Sodium	110	c	5.0	D
Vanadium	0.0033	c	0.0020	D
Others -- Filtered				
Total dissolved solids (mg/L)	600	c	500	1
Others -- Unfiltered				
Total suspended solids (mg/L)	9.0	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1094, Sampling Date 10JUN92				
Ground Elevation 782.45 ft, Water Elevation 781.54				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	8.6	c	1.0	D
Metals (mg/L) -- Filtered				
Boron	0.11	c	0.080	D
Chromium	0.0091	c	0.0040	D
Copper	0.011	c	0.0070	D
Iron	0.051	c	0.050	D
Manganese	0.015	c	0.0010	D
Sodium	30	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.13	c	0.080	D
Chromium	0.0092	c	0.0040	D
Iron	0.064	c	0.050	D
Manganese	0.015	c	0.0010	D
Nickel	0.0073	c	0.0040	D
Sodium	30	c	5.0	D
Vanadium	0.0025	c	0.0020	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.60	0	0.50	D
Total organic halides (µg/L)	23	0	5.0	D

Table 33. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1095, Sampling Date 10JUN92				
Ground Elevation 780.02 ft, Water Elevation 775.86				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	16	c	1.0	D
Metals (mg/L) -- Filtered				
Aluminum	0.051	c	0.050	D
Chromium	0.0087	c	0.0040	D
Copper	0.025	c	0.0070	D
Iron	0.23	c	0.050	D
Manganese	0.24	c	0.05	3
Sodium	7.3	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.056	c	0.050	D
Chromium	0.0080	c	0.0040	D
Iron	0.27	c	0.050	D
Manganese	0.25	c	0.05	3
Sodium	6.7	c	5.0	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.90	0	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1096, Sampling Date 11JUN92				
Ground Elevation 812.97 ft, Water Elevation 808.46				
Anions (mg/L) -- Unfiltered				
Nitrate	4.4	c	0.10	D
Sulfate (as SO ₄)	31	c	1.0	D
Metals (mg/L) -- Filtered				
Chromium	0.0081	c	0.0040	D
Copper	0.013	c	0.0070	D

Table 33. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Filtered				
Iron	0.091	c	0.050	D
Manganese	0.0051	c	0.0010	D
Nickel	0.0043	c	0.0040	D
Sodium	8.2	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.097	c	0.050	D
Chromium	0.0082	c	0.0040	D
Iron	0.060	c	0.050	D
Manganese	0.0090	c	0.0010	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	62*	2.0	1.85	2
Total rad Sr	35*	1.0	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	61*	2.0	1.85	2
Total rad Sr	32*	1.0	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Trichloroethene	6.0	c	5	1
Vinyl chloride	U 10	c	2	1

Well 1097, Sampling Date 12JUN92
Ground Elevation 810.85 ft, Water Elevation 801.30

Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	34	c	1.0	D
Metals (mg/L) -- Filtered				
Chromium	0.014	c	0.0040	D
Iron	0.12	c	0.050	D
Manganese	0.59	c	0.05	3
Nickel	0.0066	c	0.0040	D
Sodium	11	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.56	c	0.2	3
Chromium	0.013	c	0.0040	D

Table 33. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Copper	0.0091	c	0.0070	D
Iron	0.85	c	0.3	3
Manganese	0.57	c	0.05	3
Sodium	9.7	c	5.0	D
Zinc	0.0080	c	0.0050	D
Others -- Unfiltered				
Total suspended solids (mg/L)	21	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	79*	2.0	1.85	2
Total rad Sr	40*	2.0	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	62*	2.0	1.85	2
Total rad Sr	34*	2.0	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

^aPrefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bIf a reference limit exists, the source is coded as:

- 1 Rules of Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Chapter 1200-4-3, General Water Quality Criteria, as amended.
- 2 40CFR Part 141--National Primary Drinking Water Regulations, Subparts B and G, as amended.
- 3 40CFR Part 143--National Secondary Drinking Water Regulations, as amended.
- 4 DOE Order 5400.5, Chapter III, Derived Concentration Guides for Air and Water, as amended.

D The value exceeds the laboratory detection limit.

T A tentatively identified compound (TIC).

^cNot applicable.

3.6.4.2 Results

Perimeter wells at WAG 17 were sampled April 7-14, 1992. A summary of the analytical results by well type (i.e., up-gradient and down-gradient) is presented in Table 34; Table 35 presents the data which exceed some reference criteria.

Wells 1201 and 1203 showed evidence of volatile organic contamination. Well 1201 had 13,000 $\mu\text{g/L}$ of trichloroethene, 2,700 $\mu\text{g/L}$ of 1,2-dichloroethene, 160 $\mu\text{g/L}$ of vinyl chloride, 22 $\mu\text{g/L}$ of 1,1-dichloroethene, and 18 $\mu\text{g/L}$ of benzene (also detected in the laboratory blank). Well 1203 had 53 $\mu\text{g/L}$ of trichloroethene (also detected in the laboratory blank). Small amounts of gross alpha activity were detected at wells 1197 and 1200.

Table 34. ORNL WAG 17 groundwater summary statistics from
April 7-14, 1992

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Down-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	4/4	21	3.0	12*	4.7
Fluoride	2/4	0.40	< 0.10	~ 0.18	0.075
Nitrate	2/4	5.3	< 0.20	~ 1.7	1.2
Sulfate (as SO ₄)	4/4	51	26	38*	6.8
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	4/4	0.59	0.22	0.46*	0.082
Oxygen, dissolved (ppm)	4/4	6.0	4.4	5.0*	0.35
Redox (mV)	4/4	190	160	170*	6.7
Temperature (°C)	4/4	17	12	15*	1.0
Turbidity (JTU)	4/4	19	8.4	13*	2.2
pH (SU)	4/4	7.2	6.9	7.1*	0.087
Metals (mg/L) -- Filtered					
Barium	4/4	0.17	0.026	0.092*	0.038
Boron	1/4	0.085	< 0.080	~ 0.081*	0.0014
Calcium	4/4	120	70	100*	12
Chromium	3/4	0.011	< 0.0040	~ 0.0081*	0.0015
Copper	2/4	0.013	< 0.0070	~ 0.0098*	0.0016
Iron	1/4	0.21	< 0.050	~ 0.090	0.040
Magnesium	4/4	38	6.8	25*	6.5
Manganese	3/4	0.19	< 0.0010	~ 0.060	0.043
Nickel	1/4	0.0097	< 0.0040	~ 0.0054*	0.0014
Potassium	4/4	2.4	0.70	1.6*	0.37
Silicon	4/4	6.8	2.0	4.6*	0.99
Sodium	3/4	15	< 5.0	~ 9.0*	2.1
Metals (mg/L) -- Unfiltered					
Barium	4/4	0.17	0.026	0.094*	0.039
Boron	1/4	0.10	< 0.080	~ 0.086*	0.0060
Calcium	4/4	130	66	100*	14
Chromium	3/4	0.021	< 0.0040	~ 0.011*	0.0036
Iron	2/4	0.23	< 0.050	~ 0.095	0.045
Magnesium	4/4	40	6.3	25*	7.0
Manganese	4/4	0.18	0.0031	0.061	0.042

Table 34. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Metals (mg/L) -- Unfiltered					
Nickel	1/4	0.013	< 0.0040	~ 0.0063*	0.0023
Potassium	4/4	1.9	0.60	1.4*	0.32
Silicon	4/4	6.8	2.0	4.7*	1.1
Sodium	3/4	15	< 5.0	~ 9.2*	2.1
Vanadium	1/4	0.0022	< 0.0020	~ 0.0021*	0.000053
Others -- Filtered					
Alkalinity (mg/L)	4/4	430	170	320*	55
Total dissolved solids (mg/L)	4/4	520	240	430*	63
Others -- Unfiltered					
Alkalinity (mg/L)	4/4	430	170	320*	55
Total organic carbon (mg/L)	4/4	3.3	1.7	2.5*	0.35
Total organic halides (µg/L)	3/4	8,300	5.0	2,100	2,100
Radionuclides (Bq/L) -- Filtered					
Co-60	1/4	0.11	-0.060	0.055	0.039
Gross alpha	3/4	0.29*	-0.0050	0.14*	0.060
Gross beta	3/4	0.38*	-0.12	0.22	0.11
H-3	4/4	460*	130*	260*	74
Total rad Sr	1/4	0.073*	-0.020	0.046	0.022
Radionuclides (Bq/L) -- Unfiltered					
Gross alpha	4/4	0.78*	0.13*	0.33	0.15
Gross beta	4/4	0.51*	0.30*	0.39*	0.043
H-3	4/4	320*	100*	220*	51
Total rad Sr	1/4	0.12*	-0.023	0.074	0.033
Volatile Organics (µg/L) -- Unfiltered					
1,1-Dichloroethene	1/4	22	U 5.0	~ 9.3	4.3
1,2-Dichloroethene	2/4	Y 2,700	U 5.0	~ 680	670
Benzene	1/4	B 18	U 5.0	~ 8.3*	3.3
Tetrachloroethene	1/4	14	U 5.0	~ 7.3*	2.3
Trichloroethene	3/4	Y 13,000	U 5.0	~ 3,200	3,100
Vinyl chloride	1/4	160	U 10	~ 48	38

Table 34. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Up-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	4/4	45	1.7	14	10
Fluoride	1/4	0.20	< 0.10	~ 0.13*	0.025
Nitrate	2/4	1.2	< 1.0	~ 1.1*	0.050
Sulfate (as SO ₄)	4/4	60	12	33*	12
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered					
Diethyl phthalate	1/4	U 10	J 1.0	~ 7.8*	2.3
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	4/4	0.63	0.33	0.47*	0.061
Oxygen, dissolved (ppm)	4/4	10	4.6	6.9*	1.2
Redox (mV)	4/4	190	130	160*	14
Temperature (°C)	4/4	14	12	14*	0.50
Turbidity (JTU)	4/4	130	29	68*	22
pH (SU)	4/4	7.6	6.6	7.1*	0.20
Metals (mg/L) -- Filtered					
Barium	4/4	0.10	0.021	0.061*	0.020
Boron	1/4	0.12	< 0.080	~ 0.090*	0.010
Calcium	4/4	160	53	110*	23
Chromium	3/4	0.0082	< 0.0040	~ 0.0061*	0.00089
Copper	3/4	0.032	< 0.0070	~ 0.018*	0.0056
Iron	1/4	0.11	< 0.050	~ 0.065*	0.015
Magnesium	4/4	38	6.5	24*	7.2
Manganese	3/4	0.017	< 0.0010	~ 0.0070	0.0036
Potassium	4/4	3.0	0.60	1.9*	0.52
Silicon	4/4	8.3	3.9	6.0*	1.0
Sodium	4/4	11	5.2	7.7*	1.2
Metals (mg/L) -- Unfiltered					
Barium	4/4	0.11	0.028	0.064*	0.020
Boron	1/4	0.15	< 0.080	~ 0.097*	0.017
Calcium	4/4	170	53	110*	24
Chromium	3/4	0.0091	< 0.0040	~ 0.0073*	0.0011
Iron	3/4	0.24	< 0.050	~ 0.13*	0.041
Magnesium	4/4	39	6.7	24*	7.2

Table 34. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Metals (mg/L) -- Unfiltered					
Manganese	4/4	0.027	0.0018	0.010	0.0057
Potassium	4/4	2.6	0.44	1.5*	0.47
Silicon	4/4	8.5	4.1	6.2*	1.0
Sodium	3/4	12	< 5.0	~ 7.8*	1.4
Others -- Filtered					
Alkalinity (mg/L)	4/4	390	250	320*	31
Total dissolved solids (mg/L)	4/4	500	320	420*	38
Others -- Unfiltered					
Alkalinity (mg/L)	4/4	390	250	320*	30
Total organic carbon (mg/L)	4/4	2.4	1.5	1.8*	0.19
Total suspended solids (mg/L)	1/4	49	< 5.0	~ 16	11
Radionuclides (Bq/L) -- Filtered					
Gross alpha	4/4	0.86*	0.053*	0.30	0.19
Gross beta	4/4	0.66*	0.15*	0.34*	0.11
H-3	4/4	490*	63*	260*	94
Total rad Sr	1/4	0.14*	0.010	0.073*	0.027
Radionuclides (Bq/L) -- Unfiltered					
Cs-137	1/4	1.6*	-0.20	0.57	0.39
Gross alpha	4/4	0.70*	0.11*	0.37*	0.12
Gross beta	4/4	0.57*	0.14*	0.41*	0.095
H-3	4/4	530*	64*	260*	100
Total rad Sr	1/4	0.21*	0.030	0.098*	0.039
Volatile Organics (µg/L) -- Unfiltered					
Acetone	1/4	B 11	U 10	~ 10*	0.25

^aPrefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bAverage concentrations significantly greater than zero are identified by an *. The ~ prefix indicates that estimated and/or "undetected" values were used in the calculation of the average.

^cStandard error of the mean.

^dNot applicable.

Table 35. ORNL WAG 17 groundwater constituents that exceed a reference value from April 7-14, 1992.

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 1196, Sampling Date 08APR92				
Ground Elevation 856.60 ft, Water Elevation 849.18				
Anions (mg/L) -- Unfiltered				
Fluoride	0.20	c	0.10	D
Nitrate	1.0	c	0.10	D
Sulfate (as SO ₄)	60	c	1.0	D
Metals (mg/L) -- Filtered				
Chromium	0.0055	c	0.0040	D
Sodium	7.4	c	5.0	D
Metals (mg/L) -- Unfiltered				
Chromium	0.0078	c	0.0040	D
Manganese	0.0018	c	0.0010	D
Sodium	7.9	c	5.0	D
Others -- Unfiltered				
Total organic carbon (mg/L)	1.7	0.15	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1197, Sampling Date 07APR92				
Ground Elevation 868.67 ft, Water Elevation 845.35				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	45	c	1.0	D
Metals (mg/L) -- Filtered				
Chromium	0.0066	c	0.0040	D
Copper	0.032	c	0.0070	D
Iron	0.11	c	0.050	D
Manganese	0.0065	c	0.0010	D
Sodium	7.0	c	5.0	D

Table 35. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Chromium	0.0091	c	0.0040	D
Iron	0.14	c	0.050	D
Manganese	0.0077	c	0.0010	D
Sodium	7.0	c	5.0	D
Others -- Unfiltered				
Total organic carbon (mg/L)	1.6	0.096	0.50	D
Radionuclides (Bq/L) -- Filtered				
Gross alpha	0.86*	0.22	0.555	2
Radionuclides (Bq/L) -- Unfiltered				
Gross alpha	0.70*	0.20	0.555	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1198, Sampling Date 08APR92				
Ground Elevation 882.08 ft, Water Elevation 852.35				
Anions (mg/L) -- Unfiltered				
Nitrate	1.2	c	0.10	D
Sulfate (as SO ₄)	12	c	1.0	D
Metals (mg/L) -- Filtered				
Copper	0.023	c	0.0070	D
Manganese	0.017	c	0.0010	D
Sodium	11	c	5.0	D
Metals (mg/L) -- Unfiltered				
Iron	0.24	c	0.050	D
Manganese	0.027	c	0.0010	D
Sodium	12	c	5.0	D
Others -- Unfiltered				
Total organic carbon (mg/L)	2.4	0.17	0.50	D
Total suspended solids (mg/L)	49	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 35. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 1199, Sampling Date 09APR92				
Ground Elevation 882.39 ft, Water Elevation 848.72				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	13	c	1.0	D
Metals (mg/L) -- Filtered				
Boron	0.12	c	0.080	D
Chromium	0.0082	c	0.0040	D
Copper	0.012	c	0.0070	D
Manganese	0.032	c	0.0010	D
Sodium	5.2	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.15	c	0.080	D
Chromium	0.0081	c	0.0040	D
Iron	0.10	c	0.050	D
Manganese	0.0037	c	0.0010	D
Others -- Unfiltered				
Total organic carbon (mg/L)	1.5	0.096	0.50	D
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1200, Sampling Date 13APR92				
Ground Elevation 835.77 ft, Water Elevation 824.27				
Anions (mg/L) -- Unfiltered				
Nitrate	0.20	c	0.10	D
Sulfate (as SO ₄)	51	c	1.0	D
Metals (mg/L) -- Filtered				
Chromium	0.011	c	0.0040	D
Copper	0.013	c	0.0070	D
Manganese	0.0083	c	0.0010	D
Sodium	9.4	c	5.0	D

Table 35. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Chromium	0.0089	c	0.0040	D
Manganese	0.0092	c	0.0010	D
Sodium	10	c	5.0	D
Others -- Unfiltered				
Total organic carbon (mg/L)	3.3	0.26	0.50	D
Total organic halides (µg/L)	19	3.7	5.0	D
Radionuclides (Bq/L) -- Unfiltered				
Gross alpha	0.78*	0.30	0.555	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1201, Sampling Date 10APR92				
Ground Elevation 835.85 ft, Water Elevation 825.89				
Anions (mg/L) -- Unfiltered				
Fluoride	0.10	c	0.10	D
Sulfate (as SO ₄)	26	c	1.0	D
Metals (mg/L) -- Filtered				
Boron	0.085	c	0.080	D
Chromium	0.0096	c	0.0040	D
Copper	0.012	c	0.0070	D
Iron	0.21	c	0.050	D
Manganese	0.043	c	0.0010	D
Sodium	15	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.10	c	0.080	D
Chromium	0.021	c	0.0040	D
Iron	0.23	c	0.050	D
Manganese	0.047	c	0.0010	D
Sodium	15	c	5.0	D
Others -- Unfiltered				
Total organic carbon (mg/L)	2.7	0.10	0.50	D
Total organic halides (µg/L)	8,300	1,200	5.0	D

Table 35. (continued)

Analyte	Concentration			
	Value ^a	Uncertainty	Reference value	Reference source ^b
Volatile Organics (µg/L) -- Unfiltered				
1,1-Dichloroethene	22	c	7	1
1,2-Dichloroethene	Y 2,700	c	5.0	D
Benzene	B 18	c	5	1
Trichloroethene	Y 13,000	c	5	1
Vinyl chloride	160	c	2	1
Well 1202, Sampling Date 13APR92				
Ground Elevation 835.80 ft, Water Elevation 826.95				
Anions (mg/L) -- Unfiltered				
Fluoride	0.40	c	0.10	D
Nitrate	5.3	c	0.10	D
Sulfate (as SO ₄)	27	c	1.0	D
Metals (mg/L) -- Unfiltered				
Manganese	0.0031	c	0.0010	D
Others -- Unfiltered				
Total organic carbon (mg/L)	1.7	0.17	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1203, Sampling Date 14APR92				
Ground Elevation 824.56 ft, Water Elevation 819.68				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO ₄)	49	c	1.0	D
Metals (mg/L) -- Filtered				
Chromium	0.0078	c	0.0040	D
Manganese	0.19	c	0.05	3
Nickel	0.0097	c	0.0040	D
Sodium	7.0	c	5.0	D
Metals (mg/L) -- Unfiltered				
Chromium	0.011	c	0.0040	D
Iron	0.051	c	0.050	D
Manganese	0.18	c	0.05	3

Table 35. (continued)

Analyte	Concentration			Reference source ^b
	Value ^a	Uncertainty	Reference value	
Metals (mg/L) -- Unfiltered				
Nickel	0.013	c	0.0040	D
Sodium	7.0	c	5.0	D
Vanadium	0.0022	c	0.0020	D
Others -- Filtered				
Total dissolved solids (mg/L)	520	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	2.3	0.22	0.50	D
Total organic halides (μg/L)	32	1.5	5.0	D
Volatile Organics (μg/L) -- Unfiltered				
Trichloroethene	B 53	c	5	1
Vinyl chloride	U 10	c	2	1

^aPrefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bIf a reference limit exists, the source is coded as:

- 1 Rules of Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Chapter 1200-4-3, General Water Quality Criteria, as amended.
- 2 40CFR Part 141--National Primary Drinking Water Regulations, Subparts B and G, as amended.
- 3 40CFR Part 143--National Secondary Drinking Water Regulations, as amended.
- 4 DOE Order 5400.5, Chapter III, Derived Concentration Guides for Air and Water, as amended.

D The value exceeds the laboratory detection limit.

T A tentatively identified compound (TIC).

^cNot applicable.

4.0 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. Total rad Sr 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 monthly.

4.1 MILK

Joan F. Hughes

4.1.1 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 rad Sr. Samples are collected each month from the stations located near the Oak Ridge area (Fig. 17). Samples are analyzed for I-131 by gamma spectroscopy and for total rad Sr by chemical separation and low-level beta counting. Instrument background values are subtracted from the measured values of I-131 and total rad Sr in milk samples, and net activity concentrations are summarized.

4.1.2 Procedure and Results

Concentrations of I-131 are shown in Table 36. Values of I-131 for the second quarter were often less than instrument background, as is indicated by negative values. Concentrations of total rad Sr are shown in Table 37.

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

Fig. 17. Map showing milk sampling locations.

Table 36. Concentrations of I-131 in milk and calculated doses,
April-June 1992

Station	Number of Samples	Concentration (Bq/L)				Dose (μ Sv) ^c
		Max	Min	Av ^a	Standard error ^b	
1	3	-0.020	-0.050	-0.037	0.009	
2	3	0.010	-0.010	-0.003	0.006	
3	2	0.009	-0.004	0.003	0.007	
4	3	0.040	-0.010	0.020	0.015	
8	3	0.020	-0.060	-0.010	0.025	

^aAverage concentrations significantly greater than zero are identified by an *.

^bStandard error of the mean.

^cPotential 50-year committed effective dose equivalents from drinking 315L of milk per year containing average radionuclide concentrations at each location.

^dSee Fig. 17.

Table 37. Concentrations of total rad Sr in milk and calculated doses,
April-June 1992

Station	Number of Samples	Concentration (Bq/L)				Dose (μ Sv) ^c
		Max	Min	Av ^a	Standard error ^b	
1	3	0.140	0.028	0.076	0.033	0.8
2	3	0.084	0.052	0.065*	0.010	
3	2	0.038	0.022	0.030	0.008	
4	3	0.150	0.022	0.076	0.038	1.3
8	3	0.150	0.056	0.10*	0.027	

^aAverage concentrations significantly greater than zero are identified by an *.

^bStandard error of the mean.

^cPotential 50-year committed effective dose equivalents from drinking 315L of milk per year containing average radionuclide concentrations at each location. Dose is estimated for stations whose average value is statistically greater than zero.

^dSee Fig. 17.

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