5. ORNL Environmental Monitoring Programs

Compliance and environmental monitoring programs required by federal and state regulations and by DOE orders are conducted for air, water, and a variety of environmental media. These programs include regulatory and monitoring activities for ORNL site facilities and other locations in Bethel Valley, Melton Valley, and the ORR.

5.1 ORNL RADIOLOGICAL AIRBORNE EFFLUENT MONITORING

Airborne discharges from DOE Oak Ridge facilities, both radioactive and nonradioactive, are subject to regulation by EPA and the TDEC Division of Air Pollution Control. Radioactive emissions are regulated by EPA under NESHAP regulations in 40 CFR 61, Subpart H, and by the rules of the TDEC Division of Air Pollution Control, 1200-3-11.08. (See Appendix F, Table F.1 for a list of radionuclides and their radioactive half-lives.)

Radioactive airborne discharges at ORNL consist primarily of ventilation air from radioactively contaminated or potentially contaminated areas, vents from tanks and processes, and ventilation for reactor facilities. These airborne emissions are treated and then filtered with high-efficiency particulate air filters and/or charcoal filters before discharge. Radiological airborne emissions from ORNL consist of solid particulates, adsorbable gases (e.g., iodine), tritium (^{3}H), and nonadsorbable gases (i.e., noble gases). The major radiological emission point sources for ORNL consist of the following five stacks located in Bethel and Melton Valleys (Fig. 5.1):

- 2026 High Radiation Level Analytical Laboratory;
- 3020 Radiochemical Processing Plant;
- 3039 central off-gas and scrubber system, which includes 3500 and 4500 areas' cell ventilation system, isotope solid-state ventilation system, 3025 and 3026 areas' cell ventilation system, 3042 ventilation system, and 3092 central off-gas system;
- 7503 (formerly 7512) Molten Salt Reactor Experiment remediation; and
- 7911 Melton Valley complex, which includes the HFIR and the Radionuclide Engineering Development Center.

In 2003, there were 24 minor point/group sources, and emission calculations/estimates were made for each of them.

5.1.1 Sample Collection and Analytical Procedure

Each of the five major point sources is equipped with a variety of surveillance instrumentation. Only data resulting from analysis of the continuous samples are used in this report. ORNL in-stack source sampling systems comply with criteria in the American National Standards Institute (ANSI) standard ANSI N 13.1 (ANSI 1969). The sampling systems generally consist of a multipoint in-stack sampling probe, a sample transport line, a particulate filter, activated charcoal cartridges, a silica-gel cartridge (if required), flow-measurement and totalizing instruments, a sampling pump, and a return line to the stack. In addition to that instrumentation, the system at Stack 7911 includes a high-purity germanium detector with a NOMAD™ analyzer, which allows continuous isotopic identification and quantification of radioactive noble gases (e.g., ^{41}Ar) in the effluent stream. The sample probes are annually removed, inspected, and cleaned.

Velocity profiles are performed quarterly following the criteria in EPA Method 2 at major and some minor sources. The profiles provide accurate stack flow data for subsequent emission-rate calculations. An annual leak-check program is carried out to verify the integrity of the sample transport system.

In addition to the major sources, ORNL has a number of minor sources that have the potential to emit radionuclides to the atmosphere. A minor

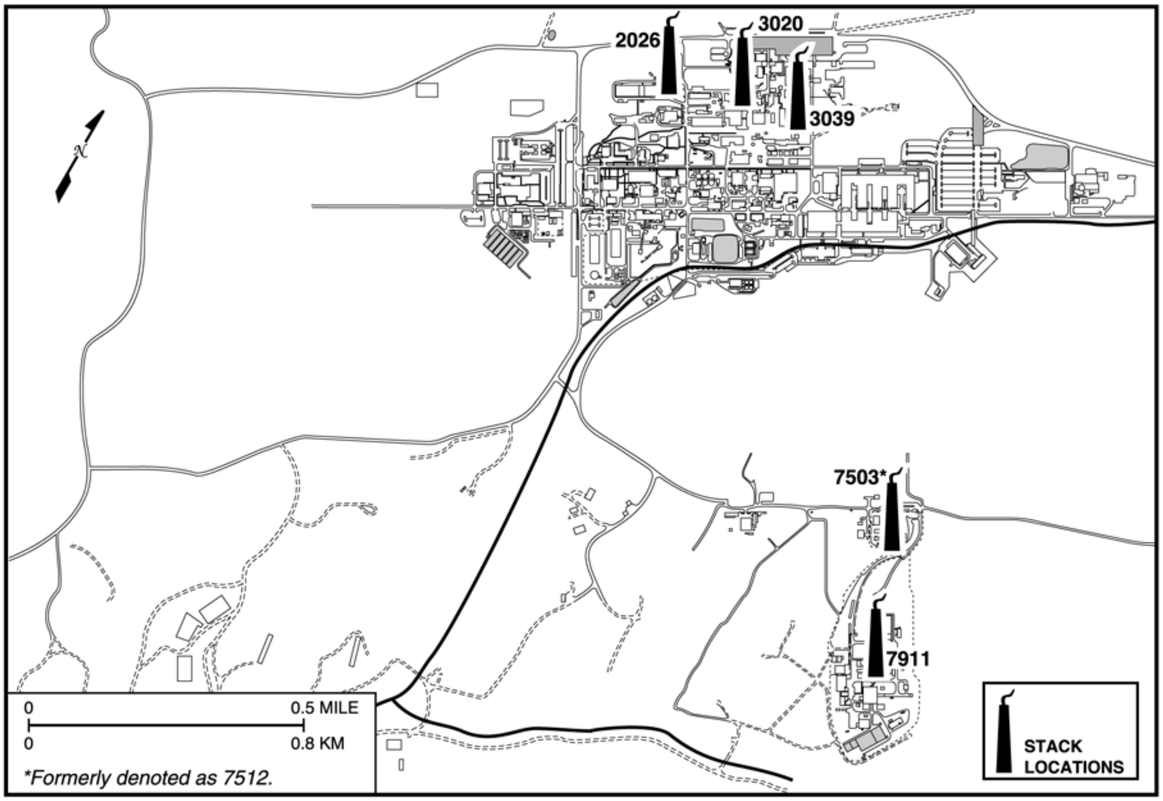

Fig. 5.1. Locations of major stacks (rad emission points) at ORNL.

source is composed of any ventilation system or component such as a vent, a laboratory hood, room exhaust, or stack that does not meet the approved regulatory criteria for a major source but that is located in or vents from a radiological control area as defined by Radiological Support Services of the ORNL Operational Safety Services Division. A variety of methods are used to determine the emissions from the various minor sources. Methods used for minor source emission calculations comply with criteria agreed upon by EPA. These minor sources are evaluated on a 1- to 5-year basis. Emissions, both major and minor, are compiled annually to determine the overall ORNL source term and associated dose.

The charcoal cartridges, particulate filters, and silica-gel traps are collected weekly to biweekly. The use of charcoal cartridges is a standard method for capturing and quantifying radioactive iodines in airborne emissions. Gamma spectrometric analysis of the charcoal samples quantifies the adsorbable gases. Analysis is performed weekly to biweekly. Particulate filters are held for 8 days prior to a weekly gross alpha and gross beta analysis to minimize the contribution from short-lived isotopes such as ^{220}Rn and its daughter products. At Stack 7911, a weekly gamma scan is conducted to better detect short-lived gamma isotopes. The weekly to biweekly filters are then composited quarterly and are analyzed for alpha-, beta-, and gamma-emitting isotopes. Compositing provides a better opportunity for quantification of these low-concentration isotopes. Silica-gel traps are used to capture tritium water vapor. Analysis is performed weekly to biweekly. At the end of the year, each sample probe is rinsed, and the rinsate is collected and submitted for isotopic analysis identical to that of the particulate filter. The data from the charcoal cartridges, silica gel, probe wash, and the quarterly filter composites are compiled to give the annual emissions for each major source and some minor sources.

5.1.2 Results

Annual radioactive airborne emissions for ORNL major sources in 2003 are presented in Table 5.1. All data presented were determined to be statistically different from zero at the 95% confidence level. Any number not statistically different from zero was not included in the emission calculation. Because measuring a radio-

Table 5.1. Major sources of radiological airborne emissions at ORNL, 2003 (Ci)[a]

Isotope	Stack				
	X-2026	X-3020	X-3039	X-7503[b]	X-7911
^{241}Am	2.84E-07	2.19E-04	1.76E-07	1.76E-06	9.45E-06
^{41}Ar					2.31E+03
^{139}Ba					1.44E+00
^{140}Ba			3.41E-06		2.90E-04
^{7}Be	8.69E-07	1.76E-07	9.46E-06	1.03E-07	
^{252}Cf					2.01E-08
^{244}Cm	2.91E-06	1.84E-05	5.85E-08	1.49E-05	7.71E-05
^{60}Co			9.63E-06	4.48E-08	
^{137}Cs	1.01E-05	1.26E-03	6.39E-05	1.75E-05	7.10E-03
^{138}Cs					2.81E+03
^{152}Eu			1.50E-06		
^{3}H	9.45E-02		1.30E+01	2.36E+00	8.71E+01
^{130}I					1.34E-10
^{131}I			3.85E-05		5.92E-02
^{132}I					6.98E-01
^{133}I			5.58E-04		3.04E-01
^{134}I					9.26E-01
^{135}I					9.18E-01
^{85}Kr					8.58E+02
^{85m}Kr					3.77E+01
^{87}Kr					1.42E+02
^{88}Kr					1.06E+02
^{89}Kr					6.65E+01
^{140}La					1.92E-04
^{191}Os			3.10E+00		1.57E-05
^{212}Pb	6.38E-01	1.54E-01	1.18E+00	1.06E-01	7.64E-02
^{238}Pu	1.24E-07	1.26E-04	1.85E-08	9.66E-07	2.31E-09
^{239}Pu	4.07E-07	2.33E-04	6.52E-07	3.16E-06	1.61E-06
^{75}Se			3.34E-05		
^{90}Sr	1.31E-06	1.21E-03	7.32E-05	7.03E-06	1.50E-03
^{228}Th	1.51E-08	2.03E-06	1.34E-08	5.28E-07	1.32E-08
^{230}Th	3.71E-09	1.68E-06	1.74E-08	9.35E-10	1.09E-08
^{232}Th	2.54E-09	1.38E-06	1.84E-08	9.33E-10	1.10E-08
^{234}U	4.38E-07	9.09E-05	1.20E-07	4.75E-06	1.34E-05
^{235}U	1.18E-08	8.39E-06	2.03E-08	5.97E-07	3.94E-06
^{238}U	1.63E-08	5.59E-06	4.37E-08	5.45E-07	3.32E-06
^{131m}Xe					1.64E+02
^{133}Xe					1.64E+02
^{133m}Xe	3.97E-05				1.80E+01
^{135}Xe			3.17E-05		1.25E+02
^{135m}Xe					7.17E+01
^{137}Xe					2.61E+02
^{138}Xe					4.04E+02
^{90}Y	1.31E-06		7.32E-05		1.50E-03

[a] 1 Ci = 3.7E+10 Bq.
[b] Formerly 7512.

nuclide requires a process of counting random radioactive emissions from a sample, the same result may not be obtained if the sample is analyzed repeatedly. This deviation is referred to as the "counting uncertainty." Statistical significance at the 95% confidence level means that there is a 5% chance that the results could be in error.

Historical trends for ^{3}H and ^{131}I are presented in Figs. 5.2 and 5.3, respectively. The ^{3}H emissions for 2003 totaled approximately 104 Ci (Fig. 5.2), which is an increase from 2002, but consistent with emissions from 1999 and 2000. The ^{131}I emissions for 2003 decreased from that for 2002 to 0.06 Ci (Fig. 5.3). The major contributor to the off-site dose at ORNL historically is ^{41}Ar, which is emitted as a nonadsorbable gas from the HFIR facility stack (7911). However, due to a long maintenance period in 2001, ^{138}Cs, also emitted from 7911, has remained the major contributor to the off-site dose since 2001. The ^{138}Cs emissions for 2003 were 2,810 Ci (Fig. 5.4).

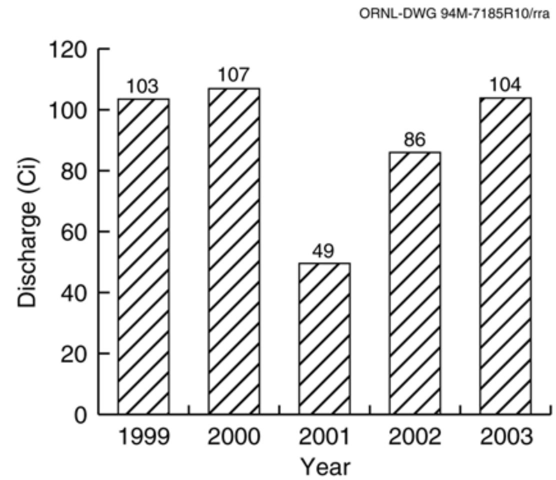

Fig. 5.2. Total discharges of ^{3}H from ORNL to the atmosphere, 1999–2003.

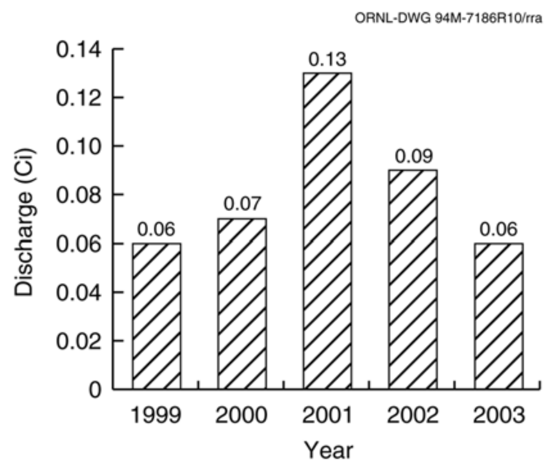

Fig. 5.3. Total discharges of ^{131}I from ORNL to the atmosphere, 1999–2003.

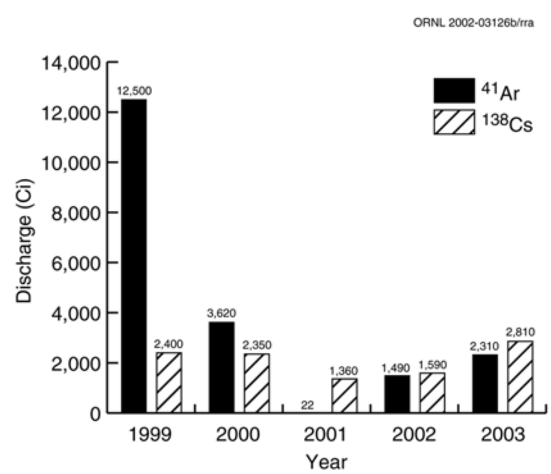

Fig. 5.4. Total discharges of ^{41}Ar and ^{138}Cs from ORNL to the atmosphere, 1999–2003.

5.2 ORNL NONRADIOLOGICAL AIRBORNE EMISSIONS MONITORING

ORNL holds a total of 12 TDEC air permits, including 11 operating permits and 1 construction permit (see Appendix E , Table E.2). The ORNL Steam Plant (six boilers) and four small package-unit boilers account for 75% of ORNL's allowable emissions. The ORNL steam plant is subject to permitting requirements for fuel monitoring and hourly and annual emissions limits for criteria pollutants. In addition, Boiler 6, a 125-MBtu/h boiler, is subject to 40 CFR 60 Subpart Db continuous emission monitoring requirements for NOx and opacity. During CY 2003, no exceedances of any permit limits occurred.

During CY 2003 ORNL and TDEC negotiated a new operating permit for the ORNL Steam Plant that combined the six fossil-fuel-fired boilers under one operating permit. The new permit applies federally enforceable limits for sulfur dioxide and particulate emissions from the steam plant and applies a federally enforceable limit on hazardous air pollutant emissions. The limits will reduce annual emission fees and will ensure that hazardous air pollutant emissions are below the major source threshold as defined in 40 CFR 63, "National Emissions Standards for Hazardous Air Pollutants for Source Categories." ORNL could accept these emission limits because emissions have been reduced with the elimination of coal as a fuel. Only natural gas and fuel oil are now used.

For the period from July 1, 2002, through June 30, 2003, ORNL paid $35,934.50 in annual emission fees to TDEC. These fees are based on allowable emissions (actual emissions are lower than allowable emissions). During 2003, TDEC and EPA inspected all permitted emissions sources; all were found to be in compliance.

ORNL's Clean Air Act (CAA) Title V Permit application was submitted to TDEC on May 5, 1997. In a letter dated June 5, 1997, TDEC indicated that the application was complete and that ORNL met the requirement to submit an application. ORNL will continue to operate with existing permits until the Title V permit is issued. TDEC anticipated that ORNL's Title V permit will be issued in 2004.

As required by Title VI of the CAA Amendments of 1990, actions have been implemented to comply with the prohibition against releasing ozone-depleting substances during maintenance activities performed on refrigeration equipment. In addition, service requirements for refrigeration systems (including motor vehicle air conditioners), technician certification requirements, and labeling requirements have been implemented. ORNL has implemented a plan to phase out the use of all Class I ozone-depleting substances. All critical applications of Class I ozone-depleting substances have been eliminated, replaced, or retrofitted with other materials. Work is progressing as funding becomes available for noncritical applications with no disruption of service.

5.2.1 Results

The primary sources of nonradioactive emissions at ORNL include the steam plant, boilers 1–6 on the main ORNL site, two boilers located at the 7600 complex, and two boilers located at the SNS site. These units use fossil fuels; therefore, criteria pollutants are emitted. Actual and allowable emissions from these sources are compared in Table 5.2. Actual emissions were calculated from fuel usage and EPA emission factors. All ORNL emission sources operated in compliance with permit conditions during 2003.

5.3 ORNL AMBIENT AIR MONITORING

The objectives of the ORNL ambient air monitoring program are to collect samples at perimeter air monitoring (PAM) stations most likely to show impacts of airborne emissions from the operation of ORNL and to provide for emergency response capability. Four stations, identified as Stations 1, 2, 3, and 7 (Fig. 5.5), make up the ORNL PAM network. Sampling is conducted at each ORNL station to quantify levels of ^{3}H; adsorbable gases (e.g., iodine); and gross alpha-, beta-, and gamma-emitting radionuclides (Table 5.3).

The sampling system consists of a low-volume air sampler for particulate collection in a 47-mm glass-fiber filter. The filters are collected biweekly, composited annually, then submitted to the laboratory for analysis. Following the filter is a charcoal cartridge used to collect adsorbable gases (e.g., iodine). The charcoal cartridges are analyzed biweekly by gamma spectroscopy for adsorbable gas quantification. A silica-gel column is used for collection of ^{3}H as tritiated water. These samples are collected biweekly or weekly. The silica gel from each station is composited each quarter and is then submitted to the laboratory for ^{3}H analysis.

5.3.1 Results

The ORNL PAM stations are designed to provide data for collectively assessing the specific impact of ORNL operations on local air quality. Sampling data from the ORNL PAM stations (Table 5.3) are compared with the DCGs for air and water established by DOE as reference values for conducting radiological environmental

Table 5.2. Actual vs allowable air emissions from ORNL steam production, 2003

Pollutant	Emissions (tons/year)		Percentage of allowable
	Actual	Allowable	
Sulfur dioxide	13	1277	1.0
Particulate	3	71	4.4
Carbon monoxide	31	196	16.0
Volatile organic compounds	2	14	15.0
Nitrogen oxides	65	380	17.2

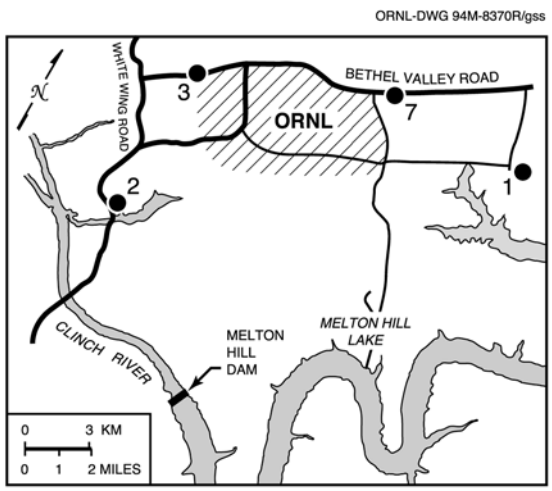

Fig. 5.5. Locations of ambient air monitoring stations at ORNL.

Table 5.3. Radionuclide concentrations measured at ORNL perimeter air monitoring stations, 2003 (pCi/mL)

	Station			
	1		2	
Parameter	Av. concen.	No. detected/total	Av. concen.	No. detected/total
^{7}Be	1.26E-08	1/1	1.11E-08	1/1
^{3}H	-2.14E-06	0/4	4.54E-05	4/4
^{40}K	2.56E-07	9/23	2.84E-07	14/23
^{234}U	6.97E-12	1/1	5.90E-12	1/1
^{235}U	8.69E-13	0/1	4.84E-13	0/1
^{238}U	5.23E-12	1/1	5.27E-12	1/1
	3		7	
Parameter	Av. concen.	No. detected/total	Av. concen.	No. detected/total
^{7}Be	1.49E-08	1/1	1.25E-08	1/1
^{3}H	9.95E-06	0/4	2.89E-06	0/4
^{40}K	2.57E-07	11/23	2.82E-07	14/23
^{234}U	1.02E-11	1/1	6.41E-12	1/1
^{235}U	4.49E-13	0/1	5.71E-13	0/1
^{238}U	5.70E-12	1/1	6.38E-12	1/1

protection programs at DOE sites. (DCGs are listed in DOE Order 5400.5.) Average radionuclide concentrations measured for the ORNL network were less than 1% of the applicable DCG in all cases.

5.4 LIQUID DISCHARGES—ORNL RADIOLOGICAL MONITORING SUMMARY

ORNL monitors radioactivity at National Pollutant Discharge Elimination System (NPDES) outfalls that have a potential to discharge radioactivity and at three instream monitoring stations under a radiological monitoring plan that is required by Part III, Section J, of the ORNL NPDES permit. The current version of the plan was implemented on November 1, 1999. Table 5.4 contains the details of the locations, frequency, and target analyses for monitoring of dry-weather discharges and instream monitoring locations. Monitoring of radioactivity in effluents occurs at three ORNL treatment facilities: the Sewage Treatment Plant, the Coal Yard Runoff Treatment Facility, and the Process Waste Treatment Complex. Other effluents monitored in 2003 included 23 category discharges, which are relatively minor discharges that receive little or no treatment prior to discharge. Wastewaters discharged through category outfalls are primarily storm water runoff, cooling water, groundwater, and steam condensate. Some category outfalls listed in Table 5.4 were not sampled in 2003, either because they are no longer in service or because they were not discharging or were otherwise not able to be sampled during sampling attempts. The three instream locations monitored under the Radiological Monitoring Plan are X13 on Melton Branch, X14 on White Oak Creek, and X15 at White Oak Dam (Fig. 5.6).

The DOE derived concentration guide (DCG) values are used in this section as a means of standardized comparison for effluent points with different radioisotope signatures. Annual average concentrations were compared to DCG concentrations if a DCG existed (there are no DCGs for gross alpha and gross beta activities) and if the average concentration was significantly greater than zero at the 95% confidence level. For analyses that cannot differentiate between two radioisotopes (e.g., $^{89/90}$Sr) and for radioisotopes that have more than one DCG for different gastrointestinal tract absorption factors, the most restrictive (lowest) DCG was used in the comparisons. DCGs are not intended for comparison to instream values. However, they are useful as a frame of reference, so instream values were also compared to DCGs. The comparison of effluent and instream concentrations to DCGs for ingestion of water does not imply that effluents from ORNL outfalls or ORNL ambient-water-sampling stations are sources of drinking water.

In 2003, no NPDES outfall had measured annual average concentrations of radioactivity equaling or exceeding 100% of DCG concentrations. (As required by DOE Order 5400.5, where more than one radionuclide was detected at an outfall, the DCG percentages of the individually measured radionuclides were summed and the sum of percentages was compared with 100%.) The annual average concentration of at least one radionuclide exceeded 4% of the relevant DCG concentration at five NPDES outfalls (X01, X12, 086, 302, and 304) and at instream sampling locations X13, X14, and X15 (Figure 5.7). Four percent of the DCG is roughly equivalent to the 4-mrem dose limit on which the EPA radionuclide drinking water standards are based (4% of a DCG is a convenient comparison point, but it should not be concluded that ORNL effluents or ambient waters are direct sources of drinking water). The annual average concentration of $^{89/90}$Sr in the ORNL Sewage Treatment Plant discharge (Outfall X01) was 14% of the DCG. Concentrations of four radionuclides measured in the discharge from the Process Waste Treatment Complex (Outfall X12) were greater than 4% of the DCG: ^{137}Cs (13%), $^{89/90}$Sr (10%), $^{233/234}$U (5.6%), and ^{3}H (5.5%). Three category outfalls had measured concentrations of a parameter that was greater than 4% of a DCG: Outfall 086 (^{3}H, 6.8%), Outfall 302 ($^{89/90}$Sr, 5.4%) and Outfall 304 ($^{89/90}$Sr, 16%). At the instream monitoring station on Melton Branch (Location X13), ^{3}H and $^{89/90}$Sr were measured at concentrations exceeding 4% of the DCG (18% and 29%, respectively). At Monitoring Station X14 on White Oak Creek, $^{89/90}$Sr was measured at 4.8% of the DCG. At the X15 monitoring station

Table 5.4. ORNL National Pollutant Discharge Elimination System Radiological Monitoring Plan

Location	Frequency	Gross alpha[a]	Gross beta[a]	Gamma scan	Tritium	Total rad Sr	Isotopic uranium
Outfall 001	Annually	X					
Outfall 080	Monthly	X	X	X	X	X	
Outfall 081	Annually		X				
Outfall 085	Quarterly	X	X				
Outfall 086	When discharges		X		X		
Outfall 087	Annually		X	X			
Outfall 203	Annually		X				
Outfall 204	Quarterly	X	X			X	
Outfall 205	Annually		X				
Outfall 207	Quarterly	X	X	X		X	
Outfall 211	Quarterly		X			X	
Outfall 217	Annually		X				
Outfall 219	Annually		X				
Outfall 234	Annually	X					
Outfall 241[b]	Annually		X				
Outfall 265	Annually		X	X			
Outfall 281	Quarterly	X	X	X	X		
Outfall 282	Quarterly	X	X				
Outfall 284[b]	Annually		X				
Outfall 290	Annually			X			
Outfall 302	Monthly	X	X	X	X	X	
Outfall 304	Monthly	X	X	X	X	X	
Outfall 365	Quarterly	X	X				
Outfall 368	Quarterly	X	X	X			
Outfall 381	Quarterly		X	X	X		
Outfall 382[c]	Annually		X	X			
Outfall 383	Annually		X		X		
Sewage Treatment Plant (X01)	Monthly	X	X			X	
Coal Yard Runoff Treatment Facility (X02)	Monthly	X	X				
Process Waste Treatment Complex (X12)	Monthly	X	X	X	X	X	X
Melton Branch 1 (X13)	Monthly	X	X	X	X	X	
White Oak Creek (X14)	Monthly	X	X	X	X	X	
White Oak Dam (X15)	Monthly	X	X	X	X	X	

[a]Isotopic analyses are performed to identify contributors to gross activities when results exceed screening criteria described in the Radiological Monitoring Plan, June 1999.
[b]No discharge present.
[c]No longer discharges (plugged).

ORNL-DWG 92M-6985R4/gss

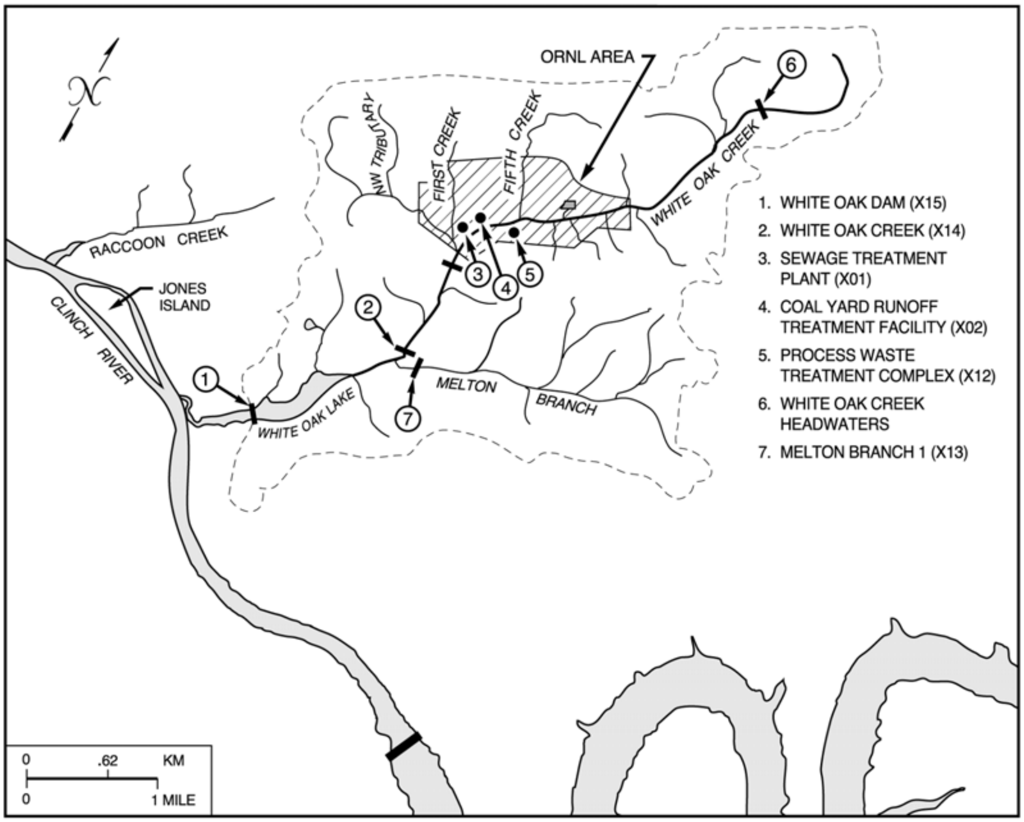

Fig. 5.6. ORNL surface water, National Pollutant Discharge Elimination System, and reference sampling locations.

ORNL-DWG 94M-8673R10/rra

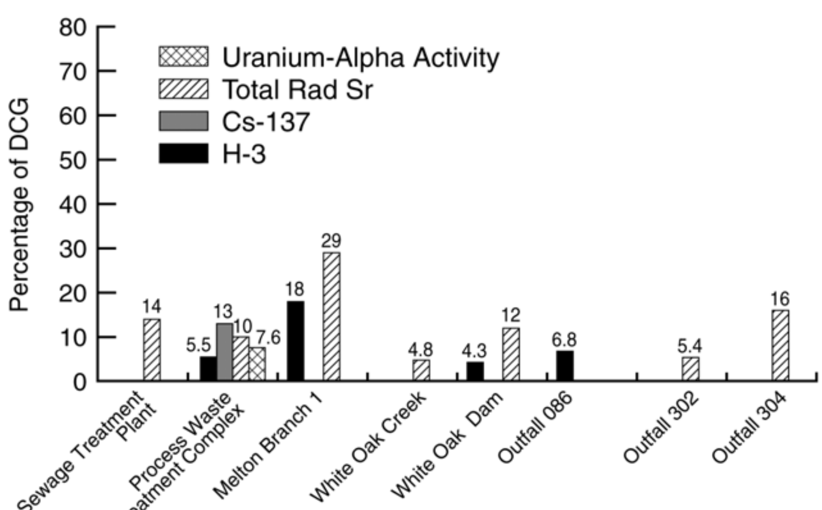

Fig. 5.7. Radionuclides at ORNL sampling sites having average concentrations greater than 4% of the relevant derived concentration guides in 2003.

at White Oak Dam, ^{3}H was measured at 4.3% of the DCG, and $^{89/90}Sr$ was measured at 12% of the DCG.

The amounts of radioactivity in stream water passing White Oak Dam, the final monitoring point on White Oak Creek before the stream flow leaves ORNL, were calculated from concentration and flow. The total annual discharges (or amounts) of radioactivity released at White Oak Dam during each of the past 5 years are shown in Figs. 5.8 through 5.13. The amounts of radioactivity passing this monitoring station in 2003 were similar to previous years. The elevated level of ^{137}Cs discharge at White Oak Dam that was seen in 2002 (theorized to be caused by disturbances in the White Oak Creek watershed associated with environmental restoration activities) was near normal levels in 2003.

The ORNL Radiological Monitoring Plan also includes monitoring of radioactivity at category outfalls during storm conditions. There were 102 outfalls targeted for periodic storm water sampling when the plan was developed. Since that time, one of those outfalls was physically removed (Outfall 115) and another was plugged (Outfall 382). The storm water outfalls were grouped into eight different categories with the knowledge that outfalls may move from one category to another as storm water data are collected. The storm water categories were defined by the availability of historic and data and, when data were available, by the levels of radioactivity detected in past monitoring. The goal set for storm water monitoring in the Radiological Monitoring Plan is to perform monitoring at the rate of 20 outfalls per NPDES permit year (February 3 to February 2). The plan set frequency goals rather than strict requirements because opportunities for storm water sampling depends on the weather.

Monitoring of storm water runoff through NPDES-permitted outfalls for radioactivity is conducted on an NPDES permit-year basis; however, storm water results are discussed on a calendar-year basis in this report. A total of 17 storm water outfalls were monitored in CY 2003.

When storm water monitoring locations are selected, outfalls are chosen so that various areas of the ORNL site are represented. Storm water samples are analyzed for gross alpha, gross beta, and ^{3}H activities. A gamma scan is also routinely performed. Under the Radiological Monitoring Plan, additional analyses are added when there is enough gross alpha and/or gross beta activity in an outfall's discharges to indicate that DCG levels may be exceeded. In 2003, no storm water discharges required additional analyses.

Of the 85 individual storm water sample results collected in 2003, 62 (73%) were less than the minimum detectable activities of the tests. As was done with non-storm water discharges, storm water discharges were compared to DCGs. Three outfalls had measurements of a radionuclide concentration that was greater than 4% of DCG levels: Outfall 004 (^{137}Cs, 6.3%), Outfall 092 (^{3}H, 28%), and Outfall 287 (^{3}H, 24.5%).

5.5 ORNL NPDES SUMMARY

5.5.1 NPDES Permit Monitoring

ORNL submitted the application for renewal of NPDES Permit TN0002941 on June 1, 2001, fulfilling the requirement that an application be made six months prior to permit expiration. The December 6, 1996, ORNL NPDES Permit expired in December 2001, and the limits and conditions of that permit remain in effect until renewal by TDEC. Data collected as required by the permit are submitted to the state of Tennessee in the monthly *NPDES Discharge Monitoring Report*. The 1996 NPDES permit includes 164 separate outfalls and monitoring points.

The ORNL NPDES Permit requires that point-source outfalls be sampled before they are discharged into receiving waters or before they mix with any other wastewater stream (see Fig. 5.6). Under the existing permit, there are numeric and narrative effluent limits applied at the following locations:

- X01—Sewage Treatment Plant;
- X02—Coal Yard Runoff Treatment Facility;
- X12—Process Waste Treatment Complex;
- X13—Melton Branch (MB1);
- X14—White Oak Creek;
- X15—White Oak Dam;
- instream chlorine monitoring points (X16–X26);
- steam condensate outfalls;
- groundwater from building foundation drains;

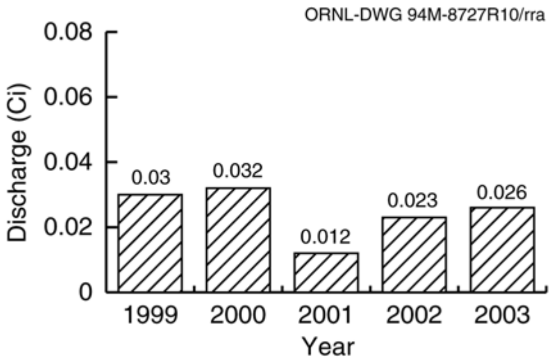

Fig. 5.8. Cobalt-60 discharges at White Oak Dam, 1999–2003.

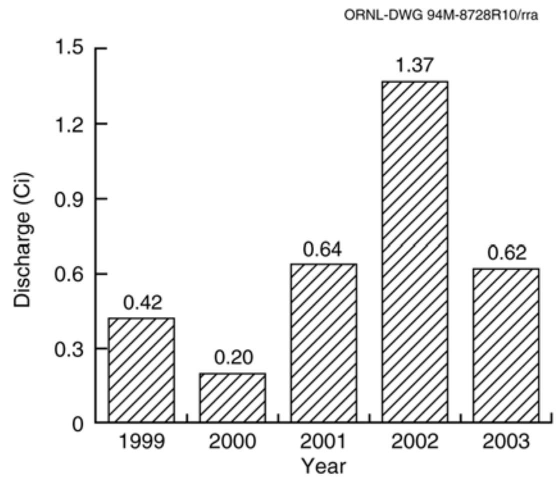

Fig. 5.9. Cesium-137 discharges at White Oak Dam, 1999–2003.

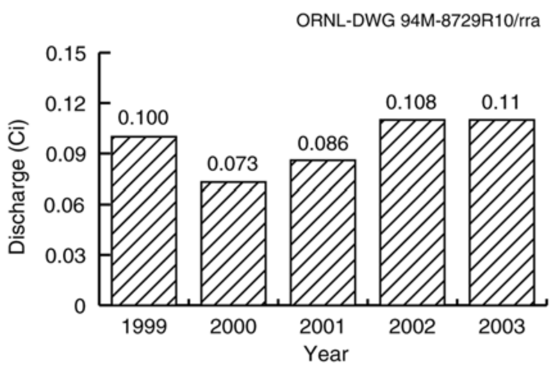

Fig. 5.10. Gross alpha discharges at White Oak Dam, 1999–2003.

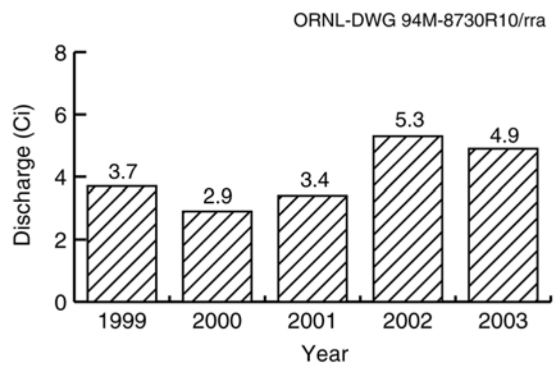

Fig. 5.11. Gross beta discharges at White Oak Dam, 1999–2003.

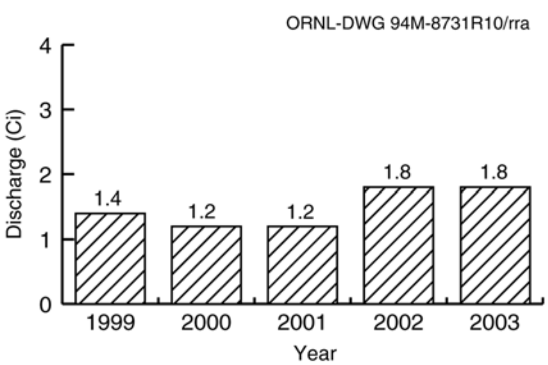

Fig. 5.12. Total radioactive strontium discharges at White Oak Dam, 1999–2003.

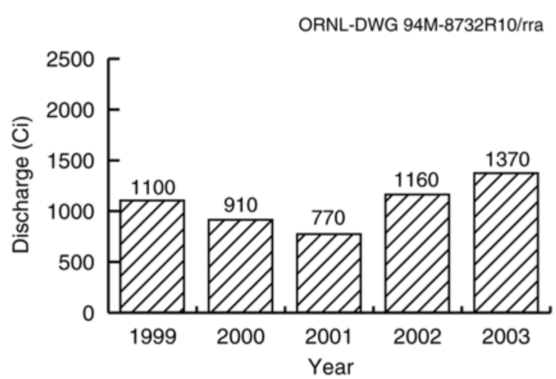

Fig. 5.13. Tritium discharges at White Oak Dam, 1999–2003.

- Category I outfalls (storm drains, water discharged under best management practices, groundwater, steam, and water condensate);
- Category II outfalls (storm drains, water discharged under best management practices, groundwater, steam, and water condensate);
- Category III outfalls (storm drains, water discharged under best management practices, groundwater, steam, water condensate, cooling water, and cooling tower blowdown);
- Category IV outfalls (storm drains, water discharged under best management practices, groundwater, steam, water condensate, cooling water, and cooling tower blowdown); and
- cooling systems (cooling water and cooling tower blowdown).

Permit limits and compliance statistics are shown in Table 5.5. Instream data collection points X-13, X-14, and X-15 are not included in the table because only flow measurements and narrative conditions are required under the ORNL NPDES Permit at those three points. Permit noncompliances in 2003 are discussed below and are shown in Appendix D.

During 2003, ORNL experienced one instance of noncompliance with numeric NPDES permit limits. Based on approximately 8300 compliance measurements and analyses, the rate of compliance with the ORNL NPDES permit was approximately 99.9%. The instance of nonconformance occurred at the ORNL Sewage Treatment Plant and resulted from a combination of low flow rate and foam accumulation, which are believed to have caused accumulated residue in the compositor and a total suspended solids excursion. During low effluent flow conditions, the water level drops within the transitional effluent chamber to the level of the compositor intake tube, causing any foam that may have accumulated in the chamber to be taken into the compositor. Because it is a vertical drop to the effluent piping, no foam was released from the transitional chamber to White Oak Creek. Tiny solids can be suspended within the foam bubbles. The intake tube has been relocated such that foam will not be taken into the compositor during low-flow conditions. Figure 5.14 shows the number and types of noncompliances at each respective location.

Under the NPDES permit, ORNL conducts several monitoring plans and programs. These include the Radiological Monitoring Plan, the Chlorine Control Strategy, and the Storm Water Pollution Prevention Plan. These are discussed in the following sections.

5.5.1.1 Radiological Monitoring Plan

In 2003, ORNL continued to sample and analyze under the revised Radiological Monitoring Plan implemented on November 1, 1999. Results for the 2003 monitoring are presented in Sect. 5.4.

5.5.1.2 Chlorine Control Strategy

The NPDES permit regulates the discharge of chlorinated water at ORNL by setting either total residual chlorine concentration limits or total residual oxidant mass-loading action levels on outfalls, depending on the outfall's location and the volume of its discharge. At ORNL, total residual oxidant measurements may include both chlorine and bromine residuals. Most outfalls with total residual oxidant mass-loading action levels are monitored semiannually, and the remainder of them are monitored either weekly, semimonthly, or quarterly. A number of outfalls that do not have dry-weather total residual oxidant discharges were dropped from the Chlorine Control Strategy during the duration of the NPDES permit. However, no additional outfalls were dropped in 2002. Outfalls included in the Chlorine Control Strategy have a mass-loading action level for total residual oxidants that requires ORNL to reduce or

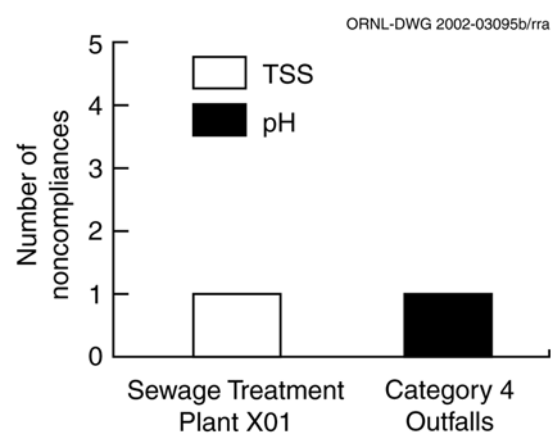

Fig. 5.14. ORNL National Pollutant Discharge Elimination System permit limit noncompliances in 2003.

Table 5.5. National Pollutant Discharge Elimination System (NPDES) compliance at ORNL, 2003
(NPDES permit effective February 3, 1997)

Discharge point	Effluent parameters[a]	Permit limits: Monthly avg (kg/d)	Daily max (kg/d)	Monthly avg (mg/L)	Daily max (mg/L)	Daily min (mg/L)	Permit compliance: Number of noncompliances	Number of samples	Percentage of compliance[b]
X01 (Sewage Treatment Plant)	LC_{50} for *Ceriodaphnia* (%)					41.1	0	4	100
	LC_{50} for fathead minnows (%)					41.1	0	4	100
	Ammonia, as N (summer)	2.84	4.26	2.5	3.75		0	79	100
	Ammonia, as N (winter)	5.96	8.97	5.25	7.9		0	78	100
	Carbonaceous biochemical oxygen demand	8.7	13.1	10	15		0	157	100
	Dissolved oxygen					6	0	157	100
	Fecal coliform (col/100 mL)			1000	5000		0	157	100
	NOEC for *Ceriodaphnia* (%)					12.3	0	4	100
	NOEC for fathead minnows (%)					12.3	0	4	100
	Oil and grease	8.7	13.1	10	15		0	157	100
	pH (std. units)				9	6	0	157	100
	Total residual chlorine			0.038	0.066		0	157	100
	Total suspended solids	26.2	39.2	30	45		1	157	99.4
X02 (Coal Yard Runoff Treatment Facility)	LC_{50} for *Ceriodaphnia* (%)					4.2	0	4	100
	LC_{50} for fathead minnows (%)					4.2	0	4	100
	Copper, total			0.07	0.11		0	24	100
	Iron, total			1.0	1.0		0	24	100
	NOEC for *Ceriodaphnia* (%)					1.3	0	0[c]	100
	NOEC for fathead minnows (%)					1.3	0	0[c]	100
	Oil and grease			10	15		0	52	100
	pH (std. units)				9.0	6.0	0	52	100
	Selenium, total			0.22	0.95		0	24	100
	Silver, total				0.008		0	24	100
	Total suspended solids				50		0	52	100
	Zinc, total			0.87	0.95		0	24	100

Table 5.5 (continued)

Discharge point	Effluent parameters[a]	Permit limits: Monthly avg (kg/d)	Daily max (kg/d)	Monthly avg (mg/L)	Daily max (mg/L)	Daily min (mg/L)	Permit compliance: Number of noncompliances	Number of samples	Percentage of compliance[b]
X12 (Process Waste Treatment Complex)	LC_{50} for *Ceriodaphnia* (%)					100	0	4	100
	LC_{50} for fathead minnows (%)					100	0	4	100
	Cadmium, total	0.79	2.09	0.008	0.034		0	52	100
	Chromium, total	5.18	8.39	0.22	0.44		0	52	100
	Copper, total	6.27	10.24	0.07	0.11		0	52	100
	Cyanide, total	1.97	3.64	0.008	0.046		0	4	100
	Lead, total	1.3	2.09	0.028	0.69		0	52	100
	Nickel, total	7.21	12.06	0.87	3.98		0	52	100
	NOEC for *Ceriodaphnia* (%)					30.9	0	4	100
	NOEC for fathead minnows (%)					30.9	0	4	100
	Oil and grease	30.3	45.4	10	15		0	52	100
	pH (std. units)				9.0	6.0	0	157	100
	Silver, total	0.73	1.3		0.008		0	52	100
	Temperature (°C)				30.5		0	157	100
	Total toxic organics		6.45		2.13		0	12	100
	Zinc, total	4.48	7.91	0.87	0.95		0	52	100
Instream chlorine monitoring points	Total residual oxidant			0.011	0.019		0	264	100
Steam condensate outfalls	pH (std. units)				9.0/8.5	6.0/6.5	0	11	100
Groundwater/ pumpwater outfalls	pH (std. units)				9.0/8.5	6.0/6.5	0	5	100

Table 5.5 (continued)

Discharge point	Effluent parameters[a]	Permit limits: Monthly avg (kg/d)	Daily max (kg/d)	Monthly avg (mg/L)	Daily max (mg/L)	Daily min (mg/L)	Permit compliance: Number of noncompliances	Number of samples	Percentage of compliance[b]
Cooling tower blowdown outfalls	pH (std. units)				9.0	6.0	0	4	100
Category I outfalls	pH (std. units)				9.0	6.0	0	18	100
Category II outfalls	pH (std. units)				9.0	6.0	0	21	100
Category III outfalls	pH (std. units)				9.0	6.0	0	48	100
Category IV outfalls	pH (std. units)				9.0	6.0	1	318	99.7
Cooling tower blowdown/ cooling water outfalls	pH (std. units)				9.0	6.0	0	48	100
	Total residual oxidant			0.011	0.019		0	48	100

[a]LC_{50} = the concentration (as a percentage of full-strength wastewater) that kills 50% of the test species in 96 h. NOEC = no-observed-effect concentration; the concentration as a percentage of full-strength wastewater that caused no reduction in *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth.

[b]Percentage compliance = 100 – [(number of noncompliances/number of samples) * 100].

[c]Insufficient discharge for chronic test and determination of no-observed-effect concentration for each of the quarterly tests.

eliminate total residual oxidants in the discharge if they exceed the action level. The action level is 1.2 g/d and is calculated by multiplying the instantaneously measured concentration by the instantaneous flow rate of the outfall.

ORNL monitored 153 measurable dry-weather discharges during 2003 at 22 outfalls. Two outfalls exceeded the action level one or more times. Actions to reduce or eliminate chlorine in these effluents are being investigated. A report detailing monitoring results, corrective actions, and proposed modifications is submitted to TDEC annually.

5.5.1.3 Storm Water Pollution Prevention Plan

The Storm Water Pollution Prevention Plan is a requirement of the ORNL NPDES Permit to document existing material management practices and to evaluate the vulnerability of those practices in contributing pollutants to area streams via storm water runoff. The plan consists of four major components:

1. assessment and mapping of outdoor material storage/handling at ORNL,
2. characterization of storm water runoff by monitoring,
3. training of employees, and
4. implementation of measures to minimize storm water pollution in areas of ORNL that may be vulnerable.

These four components of the plan were initiated in 1997 and are reviewed and updated by the facility at least annually. The plan was last updated in June 2003. This update includes observations and data from the previous year. ORNL has a storm water pollution prevention program that includes an inspection program, the analysis of storm water data collected as part of the NPDES program, training for ORNL employees and contractors, and annual review and revision of the program document. (The document is available to personnel on the ORNL site via the ORNL internal web.)

For sampling purposes, ORNL categorizes its storm water outfalls into four broad groups based on common land uses or pollutant sources and storm water pollutant potential. These four groups are further subdivided based on permit categorizations that have different monitoring schedule requirements. The permit requires that Category I and II outfalls be characterized over a 5-year period and that Category III and IV outfalls be characterized over a 3-year period. The outfalls chosen to be sampled were thought to be representative of the group or were thought to be more vulnerable to runoff pollution. Other factors considered in selecting representative outfalls from each group include interest in a particular runoff quality at an outfall and ease of obtaining a representative sample. A rotation of representative outfalls occurs each sampling period as directed by the permit. The results of the storm water outfall effluent sampling as of 2003 are provided in Attachment 6.0 of the Storm Water Pollution Prevention Plan.

The EPA Nationwide Urban Runoff Program was developed to expand the understanding of urban runoff pollution by instituting data collection and applied research projects in the urban areas of the United States. Urban storm water runoff pollutant loading factors for ten standard water quality constituents, called “event mean concentrations” (EMCs), were developed for the 1983 program’s final report. Program findings were again updated in 1999 by using results of storm water data collected by the U.S. Geological Survey and the NPDES Storm Water Program to refine the EMCs.

In a comparison of recent ORNL data from 18 storm water outfalls with data from the Nationwide Urban Runoff Program, most values for the ten water quality constituents measured are well below the EMCs. Patterns of values exceeding the EMCs can be generalized by exceedances of copper or zinc. Copper is found naturally in the soils and could also occur from coal-burning activities or corrosion of copper pipes. Zinc can be attributed to vehicular degradation. There were also a few exceedances of suspended solids that can probably be attributed to the numerous construction projects in and around the main ORNL campus.

5.5.2 ORNL Results and Progress in Implementing Programs and Corrective Actions

5.5.2.1 ORNL Sink and Drain Survey Program

In 1997, ORNL completed a comprehensive verification of the routing of all wastewater discharges from points of entry such as sinks and floor drains. As a result, more than 9000 sink and drain records were produced and are stored in a central database. ORNL has continued its efforts annually and in 2003 continued an annual division-by-division recertification of ORNL sinks and drains to ensure that sinks and drains continue to discharge to the proper wastewater collection systems. Program management continues to communicate sink and drain responsibilities to the ORNL site population.

5.6 ORNL WASTEWATER BIOMONITORING

Under the NPDES permit, wastewaters from the Sewage Treatment Plant, the Coal Yard Runoff Treatment Facility, and the Process Waste Treatment Complex were evaluated for toxicity. The results of the toxicity tests of wastewaters from the three treatment facilities are given in Table 5.6. This table provides, for each wastewater, the month the test was conducted, the wastewater's no-observed-effect concentration (NOEC), and the concentration that kills 50% of the test organisms (LC_{50}) for fathead minnows (*Pimephales promelas*) and daphnia (*Ceriodaphnia dubia*). The NOEC is the highest concentration tested that does not significantly reduce survival or growth of fathead minnows or survival or reproduction of *Ceriodaphnia*. The 96-h LC_{50} is the concentration of wastewater that kills 50% of the test organisms in 96 h. The NPDES permit defines the limits for the biomonitoring tests. For the X01 (Sewage Treatment Plant) discharge, toxicity is demonstrated if more than 50% lethality of the test organisms occurs in 96 h in 41.1% effluent or if the NOEC is less than 12.3%. For the X02 discharge (Coal Yard Runoff Treatment Facility), toxicity is demonstrated if more than 50% lethality of the test organisms occurs in 96 h in 4.2% effluent or if the NOEC is less than 1.3%. Because of the batch mode of discharge at the Coal Yard Runoff Treatment Facility, the limit for the NOEC only applies if the facility discharges for a sufficient length of time. For the X12 discharge (Process Waste Treatment Complex), toxicity is demonstrated if more than 50% lethality of the test organisms occurs in 96 h in 100% effluent (LC_{50}) or if the NOEC is less than 30.9%.

During 2003, the Sewage Treatment Plant, Coal Yard Runoff Treatment Facility, and Process Waste Treatment Complex were each tested four times. Numeric biomonitoring limits in the NPDES permit were not exceeded during 2003.

5.7 ORNL BIOLOGICAL MONITORING AND ABATEMENT PROGRAM

As a condition of the NPDES permit issued to ORNL in April 1986, the BMAP was set forth to assess the condition of aquatic life in White Oak Creek, the Northwest Tributary of White Oak Creek, Melton Branch, Fifth Creek, and First Creek (Loar et al. 1991); the BMAP continued as a condition of the most recent NPDES permit that was effective February 3, 1997 (Kszos et al. 1997). The program addresses the following objectives as described in the NPDES permit part III (I).

- Temperature loadings shall be within state water criteria for protection of fish and aquatic life for warm summer conditions. This should be verified and reported annually (see Table 5.5).
- Instream water analysis for mercury shall be part of the BMAP so that it can be determined whether mercury at the site is being contributed to the stream and, if so, whether it will impact fish and aquatic life or violate the recreation criteria.
- Sediment and oil and grease from storm discharges shall not create stream impacts.
- The status of PCB contamination in fish tissue in the White Oak Creek watershed shall be determined.

Table 5.6. Toxicity test results of ORNL wastewaters, 2003

Outfall	Test date	Test species	NOEC[a]	LC_{50}[b]
Sewage Treatment Plant (X01)	February	*Ceriodaphnia*	41.1	>41.1
		Fathead minnow	41.1	>41.1
	May	*Ceriodaphnia*	12.3	>41.1
		Fathead minnow	12.3	21.6
	August	*Ceriodaphnia*	41.1	>41.1
		Fathead minnow	41.1	>41.1
	November	*Ceriodaphnia*	12.3	>41.1
		Fathead minnow	41.1	>41.1
Coal Yard Runoff Treatment Facility (X02)	February	*Ceriodaphnia*	NA[c]	>4.2[d]
		Fathead minnow	NA[c]	>4.2[d]
	May	*Ceriodaphnia*	NA[c]	>4.2[d]
		Fathead minnow	NA[c]	>4.2[d]
	August	*Ceriodaphnia*	NA[c]	>4.2[d]
		Fathead minnow	NA[c]	>4.2[d]
	November	*Ceriodaphnia*	NA[c]	>4.2[d]
		Fathead minnow	NA[c]	>4.2[d]
Process Waste Treatment Complex (X12)	February	*Ceriodaphnia*	100	>100
		Fathead minnow	100	>100
	May	*Ceriodaphnia*	100	>100
		Fathead minnow	100	>100
	August	*Ceriodaphnia*	100	>100
		Fathead minnow	100	>100
	November	*Ceriodaphnia*	100	>100
		Fathead minnow	100	>100

[a]NOEC = no-observed-effect concentration; the concentration (as percentage of full-strength wastewater) that caused no reduction in *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth.

[b]LC_{50} = the concentration (as percentage of full-strength wastewater) that kills 50% of the test species in 96 h.

[c]Insufficient duration of discharge for chronic test and determination of NOEC.

[d]48-h LC_{50}.

- The Chlorine Control Strategy's protection of the stream in the main plant area shall be assessed.
- In addition, the BMAP shall continue studies evaluating the receiving streams' biological communities throughout the duration of the permit.

5.7.1 Bioaccumulation Studies

The bioaccumulation task for the BMAP addresses two NPDES permit requirements at ORNL: (1) evaluate whether mercury at the site is contributing to a stream such that it will impact fish and aquatic life or violate the recreational criteria (instream water analyses for mercury should be part of this activity), and (2) monitor the status of PCB contamination in fish tissue in the White Oak Creek watershed.

5.7.1.1 Mercury in water

Water samples were collected for mercury analysis from four sites in White Oak Creek on six occasions in FY 2003. Stream conditions were representative of seasonal baseflow (dry weather) conditions at the time of sampling on all dates except April 10, 2003, which represented wet-weather flow.

Concentrations of total waterborne mercury in White Oak Creek above the Process Waste Treatment Complex [White Oak Creek kilometer (WCK) 4.1] ranged from ~37 ng/L to approximately 155 ng/L (Fig. 5.15). The average for this site during this period was 103 ng/L ± 20 (mean ± SE), which clearly exceeded the Tennessee Water Quality Standard of 51 ng/L. The source is presumed to be storm drains under the two buildings adjacent to Fifth Creek just upstream from its confluence with White Oak Creek. A pilot plant for the process eventually used at Y-12 was built on the site and probably contaminated soils and drains. Sumps and condensate lines discharging to storm drains from buildings have high mercury levels.

However, at the two sites further downstream (WCK 3.4 and WCK 1.5), mercury concentrations in FY 2003 were typically much lower than at WCK 4.1. During this period, average aqueous mercury concentrations were 50 ng/L ± 4.9 at WCK 3.4 , and 37 ng/L ± 7.8 at WCK 1.5 (White Oak Lake). The average annual mercury concentration in water at the upstream reference site (WCK 6.8, data not shown in figure) was much lower than the state standard, averaging 5.0 ng/L ± 2.1.

Temporal trends in mercury in White Oak Creek water show that concentrations were generally lower in 2003 than in 1997, but have changed little over the last 2 to 3 years (Fig. 5.16). High temporal variability is characteristic of waterborne mercury in White Oak Creek, with highest concentrations and greatest variability just upstream of the Process Waste Treatment Complex. The highest mercury concentrations at this site appear to coincide with low-flow conditions.

5.7.1.2 Bioaccumulation

For the 2003 sampling year, fish were collected from White Oak Creek primarily on April 15, but a few fish were collected on June 30 to augment the collection. To provide data directly applicable to assessing human health concerns, redbreast sunfish (*Lepomis auritus*) were collected from WCK 2.9, and bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) were collected from WCK 1.5 (White Oak Lake). Collections were restricted to fish of a size large enough to be taken by sport fisherman (> 50 g for sunfish, and > 500 g for bass). Fillet tissue was taken from six individual fish of each species for both Hg and PCB analysis.

Mercury

Mercury concentrations in four fish from White Oak Creek exceeded 0.5 µg/g, a level currently used by the state of Tennessee in issuing fish consumption advisories. Average mercury concentration in redbreast sunfish from WCK 2.9 (0.37 µg/g ± 0.04; mean ± SE) was approximately five times higher than in Hinds Creek (0.07 µg/g ± 0.01), a nearby reference stream (Table 5.7). Concentrations of mercury in bluegill collected at WCK 1.5 were far lower than at WCK 2.9, with mercury approaching reference stream levels (0.14 µg/g ± 0.02). Mean concentration of mercury in largemouth bass at WCK 1.5 were 0.49 µg/g ± 0.06. This higher concentration in bass reflects their higher position in the food chain. All fish from WCK 2.9 and all largemouth

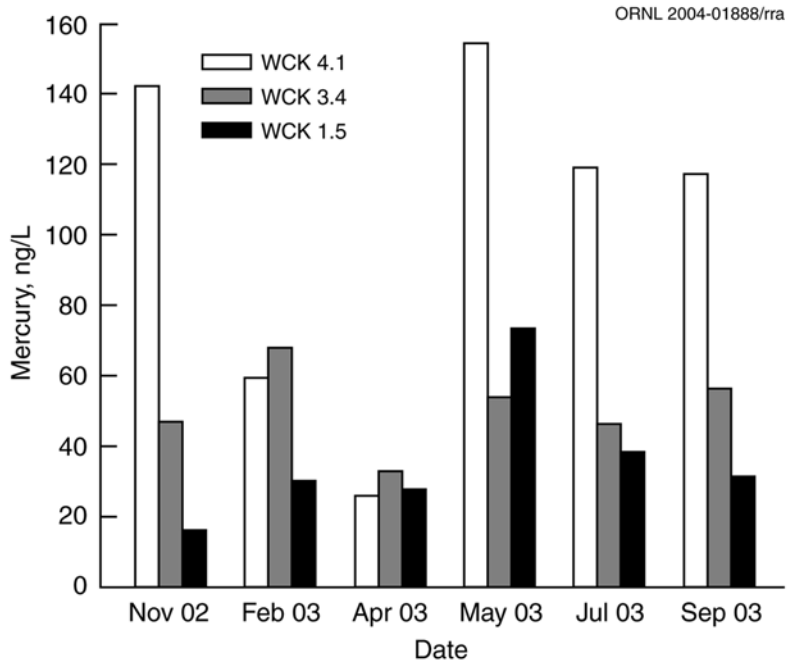

Fig. 5.15. Total mercury in water vs time, from November 2002 to September 2003, at three sites in the White Oak Creek watershed downstream from ORNL.

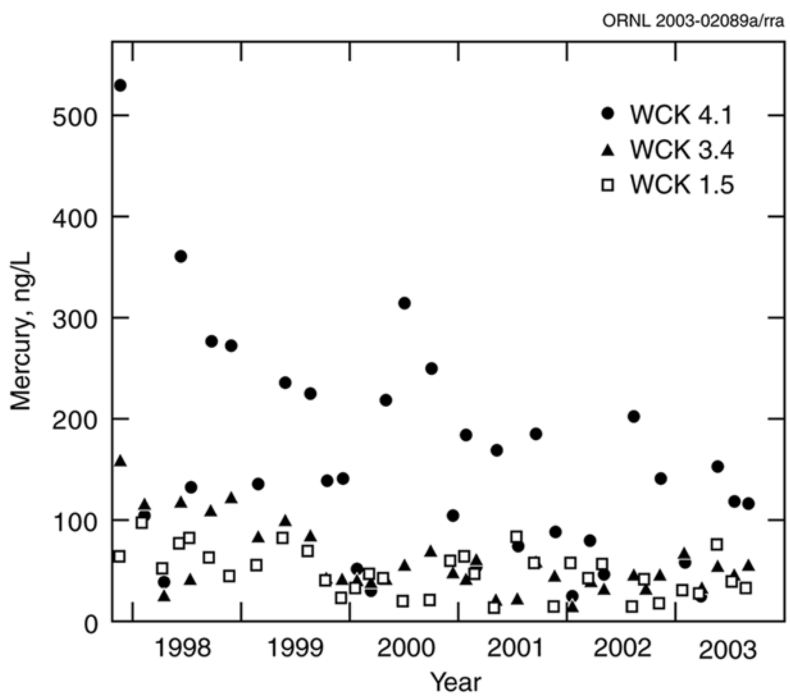

Fig. 5.16. Total mercury in water vs time, 1998–2003, at three sites in the White Oak Creek watershed downstream from ORNL.

Table 5.7. Total mercury and PCB (Aroclor 1254 + 1260) concentrations in fish (mean ± SE; range in parenthesis) from White Oak Creek and reference stream, Hinds Creek, April 2003[a]

Site[b]	Species[c]	Mercury (μg/g)	PCBs (μg/g)
WCK 3.5	Stonerollers	—	3.00 ± 0.15 (2.8 – 3.3)
WCK 2.9	Redbreast sunfish	0.37 ± 0.04 (0.31 – 0.54)	0.32 ± 0.05 (0.19 – 0.49)
WCK 1.5	Bluegill sunfish	0.14 ± 0.02 (0.11 – 0.19)	0.24 ± 0.09 (0.09 – 0.66)
	Largemouth bass	0.49 ± 0.06 (0.30 – 0.66)	0.49 ± 0.11 (0.24 – 0.91)
Hinds Creek	Redbreast sunfish	0.07 ± 0.01 (0.05 – 0.11)	< 0.01

[a]For sunfish and bass, N = 6 individual fish for each site/species combination, and samples are of fillet tissue only. Stoneroller values represent 3 composite samples of 10 whole fish. Two bass from WCK 1.5 were collected in June 2003.

[b]WCK = White Oak Creek kilometer. WCK 1.5 = White Oak Lake.

[c]Stonerollers (*Campostoma oligolepis*); redbreast sunfish (*Lepomis auritus*); bluegill sunfish (*Lepomis macrochirus*); largemouth bass (*Micropterus salmoides*).

bass from WCK 1.5 exceeded EPA's criterion for mercury in fish tissue of 0.3 mg/kg. However, this level was not exceeded in any bluegill collected from WCK 1.5 in 2003.

Temporal trends in mercury concentrations in fish indicated that levels were slightly higher in 2003 than in 2002 (Fig. 5.17). Whether or not this higher concentration represents a true trend of increasing concentrations or just natural temporal variability should be clearer with results from 2004.

PCBs

The highest average PCB concentration (3.0 μg/g ± 0.15; mean ± SE) measured in fish from White Oak Creek in FY 2003 was found in whole-body samples of stonerollers (*Campostoma oligolepis*) collected from the site nearest the ORNL campus (WCK 3.5, Table 5.7). This indicated that exposures to high levels of PCBs near the main ORNL campus continue, resulting in levels that approach or exceed levels that have been found to cause health problems in some piscivorous wildlife.

Sunfish (bluegill and redbreast) have been used by BMAP since 1985 to evaluate changes in PCB exposure over time. Sunfish are relatively short-lived and do not move far from their home territory during their life. Therefore, they provide a site-specific and recent measure of contaminant exposure. In general, concentrations of PCBs in White Oak Creek sunfish in 2003 were similar to those in 2002, but were slightly lower than the 2000–2001 period (Fig. 5.18). Mean PCB concentrations in sunfish from WCK 2.9 and WCK 1.5 were 0.32 μg/g ± 0.05 and 0.24 μg/g ± 0.09, respectively. Such levels of PCBs are relatively high for short-lived, lipid-poor fish such as sunfish. Concentrations of PCBs in sunfish from the reference site (Hinds Creek) averaged <0.01 μg/g in 2003.

Largemouth bass are better indicators of the maximum PCB concentrations likely in a body of water because of their age, lipid content, and presence at the top of the food chain. The mean PCB concentration in bass from WCK 1.5 in the spring of 2003 was 0.49 μg/g ± 0.11 (Fig. 5.18). Although concentrations of PCBs in bass were higher than in sunfish from the same site, the concentrations in bass were substantially lower in 2003 than in the recent past. No individual bass exceeded the U.S. Food and Drug Administration threshold limit (for fish sold commercially)

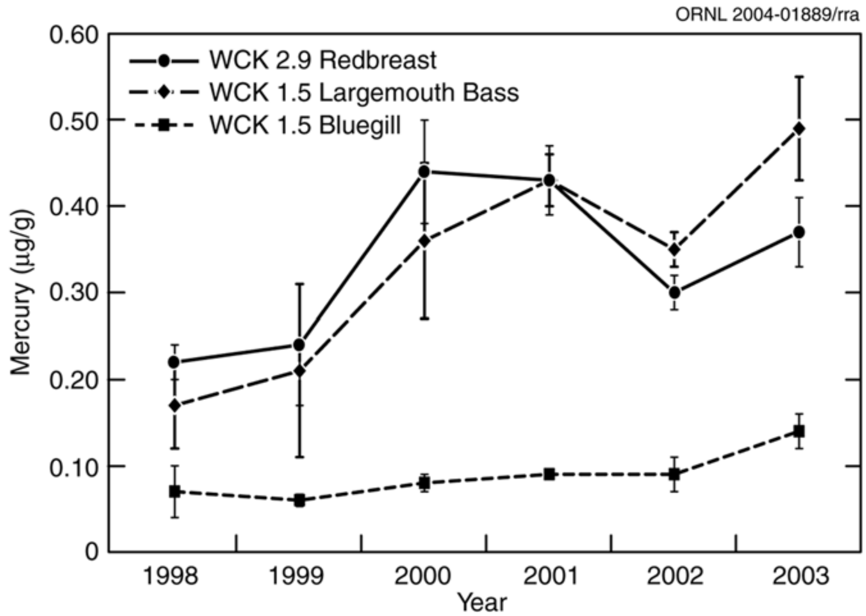

Fig. 5.17. Temporal trends in mercury concentrations in fish, 1998–2003.

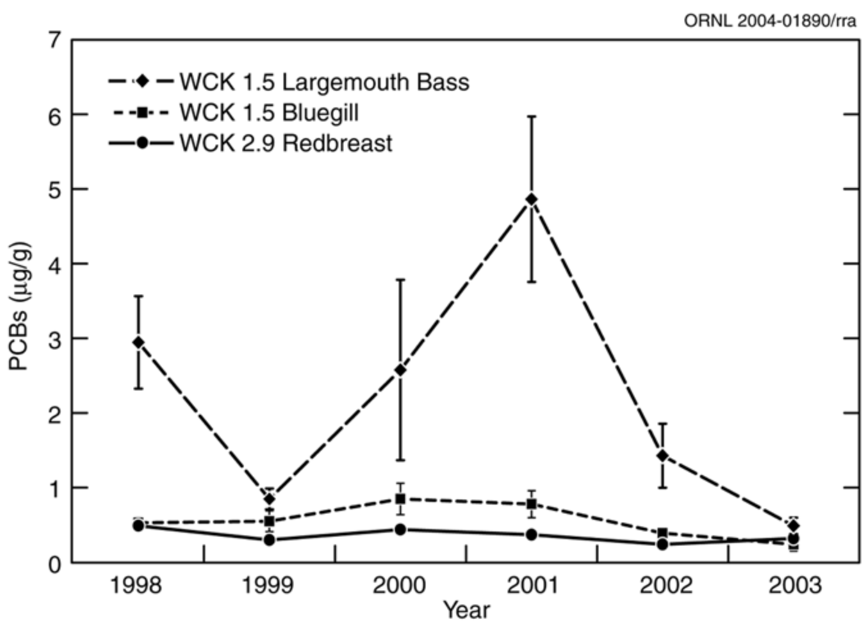

Fig. 5.18. Temporal trends in PCB concentrations in fish, 1998–2003.

of 2 µg/g, and only one fish exceeded the typical state advisory threshold of 0.8 to 1 µg/g. The decrease in PCBs in both largemouth bass and sunfish the last two years could be a result of changes in PCB exposure. A potential explanation for this change could be that increases in silt particles in the water from recent construction activities have acted to bind PCBs and make them less bioavailable. The most dramatic decreases, however, have been in largemouth bass, a species well known for exhibiting highly fluctuating levels of PCBs. Changes in concentrations in bass could be a result of changes not related to source decreases, but rather factors such as changes in prey (e.g., shad can be relatively high in PCBs, bluegill much lower), health condition (lipid changes in muscle can affect PCB concentrations), or greater fish movement from nearby source areas.

5.7.2 Ecological Surveys

5.7.2.1 Benthic Macroinvertebrate Communities

Monitoring of the benthic macroinvertebrate communities in White Oak Creek, First Creek, and Fifth Creek continued in 2003. Benthic macroinvertebrate samples are collected at sites upstream and downstream of the influence of ORNL operations. These sites include impacted and unimpacted (reference sites) locations. The objectives of the benthic macroinvertebrate community task are to (1) help assess ORNL's compliance with the current NPDES permit requirements and (2) evaluate and verify the effectiveness of pollution abatement and remedial actions taken at ORNL.

Results for April 2003 showed that the benthic macroinvertebrate communities in First Creek, Fifth Creek, and White Oak Creek continued to exhibit characteristics of degraded ecological conditions (Figs. 5.19, 5.20, and 5.21). The macroinvertebrate communities in lower First Creek [First Creek kilometer (FCK) 0.1] and Fifth Creek [Fifth Creek kilometer (FFK) 0.2] appear to have stabilized in the past 8 years. Other than the normal fluctuations between years that are characteristic of all streams, including reference locations, the total number of taxa and the number

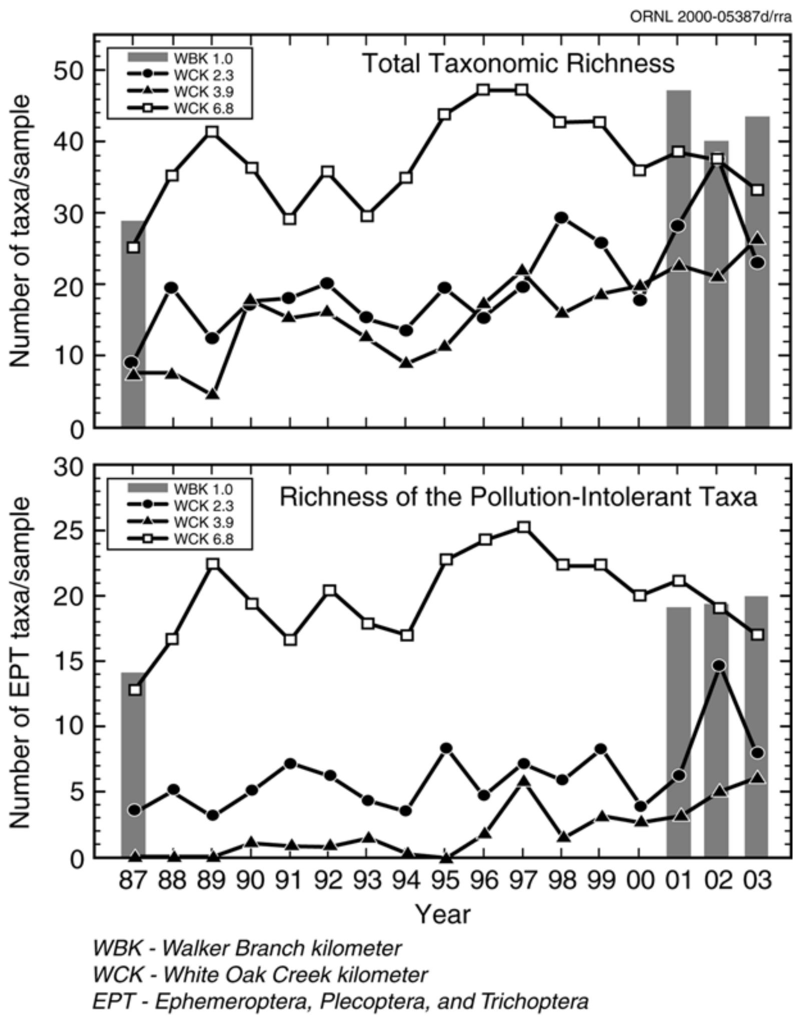

Fig. 5.19. Taxonomic richness and richness of the pollution-intolerant taxa of the benthic macroinvertebrate communities in White Oak Creek during April sampling periods, 1987–2003.

of pollution-intolerant taxa have changed little at these two sites (Figs 5.20 and 5.21). In White Oak Creek in contrast, further improvements in the condition of the macroinvertebrate community at sites WCK 3.9 (near the coal yard) and WCK 2.3 (downstream of White Oak Creek's confluence with Melton Branch) were observed, particularly at WCK 3.9 (Fig. 5.19). While still lower than at reference locations, both the total number of taxa and number of pollution-intolerant taxa have steadily increased at WCK 3.9, most notably since April 2000. Although these results continue to show that the benthic macroinvertebrate communities in streams affected by ORNL operations remain degraded, they also show that the earlier improvements observed in First Creek and Fifth Creek are persisting and that further improvements have occurred in White Oak Creek.

5.7.2.2 Fish Communities

Monitoring of the fish communities in White Oak Creek and its major tributaries continued in 2003. Samples were taken at 11 sites in White Oak Creek watershed and 3 additional nearby reference sites in spring 2003; sites closest to ORNL facilities were emphasized. In White Oak Creek, the fish community continued to display characteristics of degraded conditions, with sites closest to the outfalls having lower species

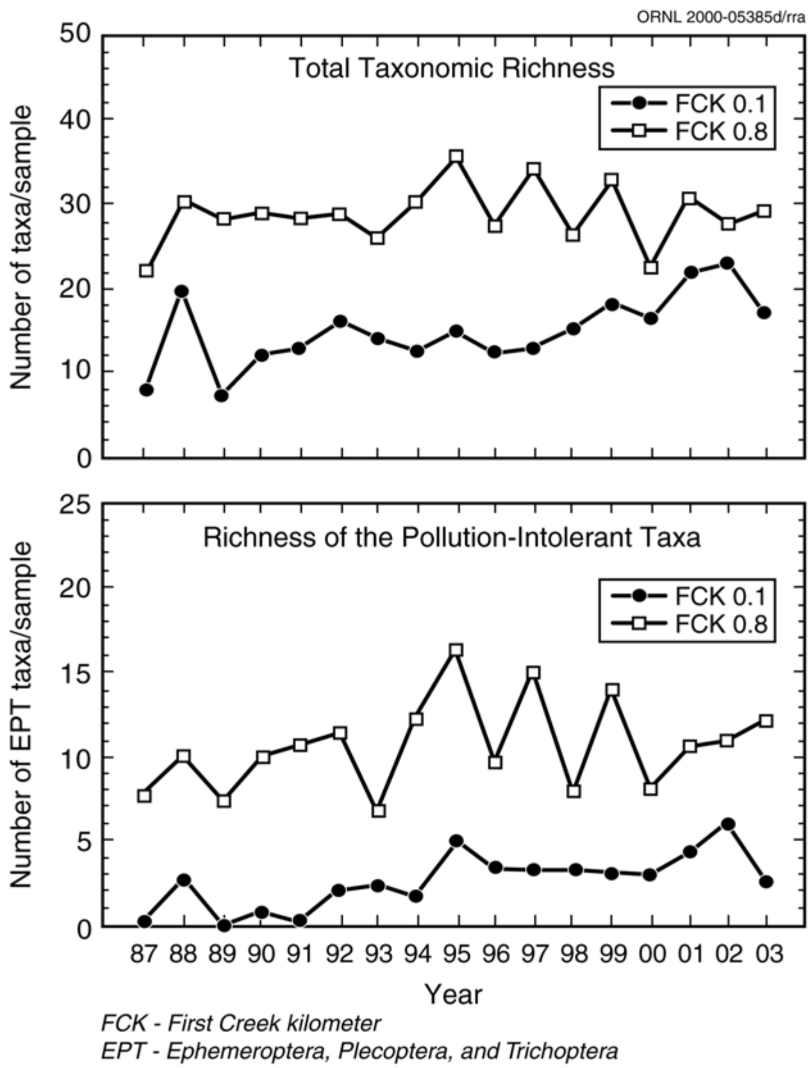

Fig. 5.20. Taxonomic richness and richness of the pollution-intolerant taxa in the benthic macroinvertebrate communities in First Creek during April sampling periods, 1987–2003.

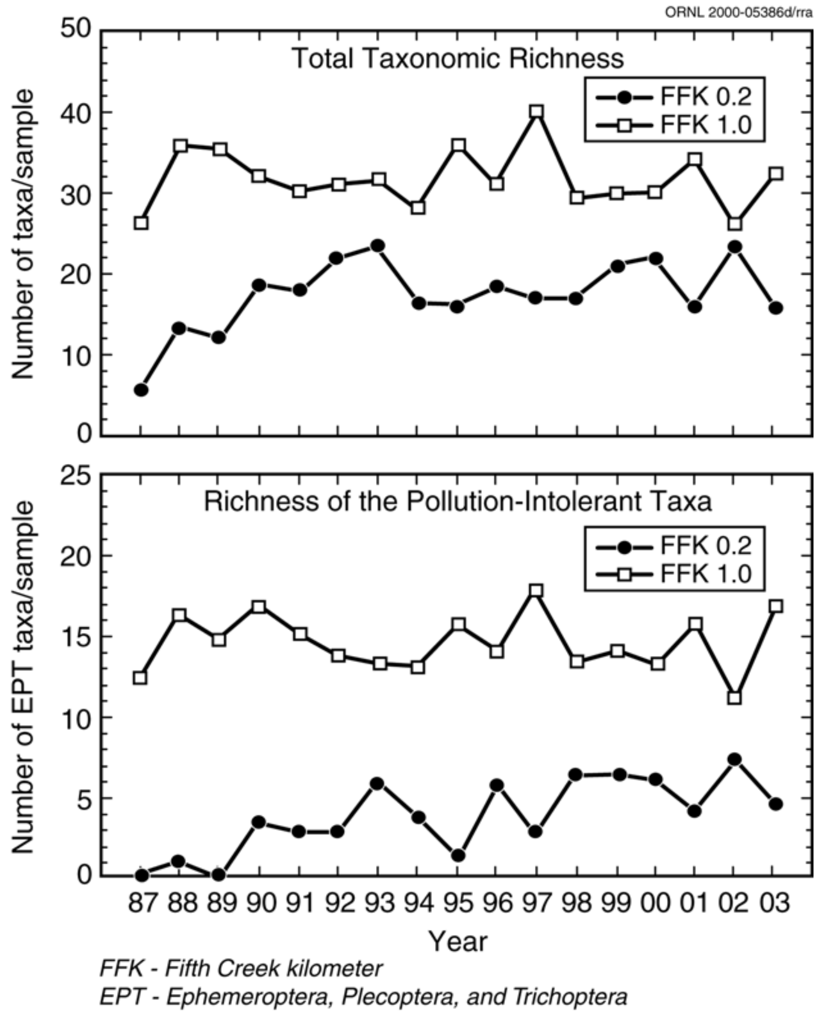

Fig. 5.21. Taxonomic richness and richness of the pollution-intolerant taxa in the benthic macroinvertebrate communities in Fifth Creek during April sampling periods, 1987–2003.

richness (number of species), fewer pollution-sensitive species, more pollution-tolerant species, and higher total densities (number of fish per square meter) than similar-sized reference streams. Compared with results in April 2002, no major changes were apparent in the White Oak Creek fish community.

Species richness of fish in tributaries of White Oak Creek remained low in April 2003, relative to reference streams not in the White Oak Creek watershed. However, as observed in White Oak Creek, the fish communities of First Creek and Melton Branch showed little change in density in spring 2003 relative to spring 2002; sites adjacent to and downstream of ORNL remained somewhat impacted relative to reference streams. The fish community in Fifth Creek, in contrast, showed notable declines in abundances at the reference site (FFK 1.0) and the downstream site (FFK 0.2). The site decline at FFK 1.0 continues a trend that has been occurring since 1998. The low species richness seen in White Oak Creek watershed, relative to off-site reference locations, is partially a result of barriers that limit immigration from the Clinch River drainage.

5.8 ORNL SURFACE WATER MONITORING AT NPDES REFERENCE LOCATION

White Oak Creek headwaters were monitored in 2003 as a background or reference location for ORNL NPDES surface water monitoring.

In an effort to provide a basis for evaluation of analytical results and for assessment of nonradiological surface water quality, Tennessee

General Water Quality Criteria have been used as reference values. The criteria for fish and aquatic life have been used at White Oak Creek headwaters.(See Appendix C, Table C.2, for Tennessee General Water Quality Criteria for all parameters in water. See Tables 2.3 and 3.4 in *Environmental Monitoring on the Oak Ridge Reservation: 2003 Results* (DOE 2004c) for surface water analyes.)

5.9 ORNL Surface Water Surveillance Monitoring

The ORNL surface water monitoring program includes sample collection and analysis from 18 locations at ORNL and around the ORR. This program is conducted in conjunction with the ORR surface water monitoring activities discussed in Chap. 7, to enable an assessment of the impacts of past and current DOE operations on the quality of local surface water. These programs are conducted in addition to the surface water monitoring required by NPDES permits at ORNL facilities; sampling location, frequency, and analytical parameters vary among them. Sampling locations include streams downstream of ORNL waste sources, reference points on streams and reservoirs upstream of waste sources, and public water intakes (see Fig. 5.22).

Sampling frequency and parameters vary by site. Grab samples are collected and analyzed for general water quality parameters at all locations and all are screened for radioactivity and analyzed for specific radionuclides when appropriate. White Oak Lake at White Oak Dam is also checked for volatile organic compounds, PCBs, and metals. Table 5.8 lists the specific locations and their sampling frequencies and parameters.

Ten of the 18 sampling locations are classified by the state of Tennessee for certain uses (e.g., domestic water supplies or recreational use). Tennessee water quality criteria for domestic water supplies, for freshwater fish and aquatic life, and for recreation (water and organisms) are used as references for locations where they are applicable. The Tennessee water quality criteria do not include criteria for radionuclides.

5.9.1 Results

Radionuclides were detected above minimum detectable activity at all surface water locations in 2003. The levels of gross beta, total radioactive strontium, and tritium continue to be highest at Melton Branch kilometer (MEK) 0.2, White Oak Creek at White Oak Dam (WCK 1.0), and WCK 2.6. These data are consistent with historical data and with the processes or legacy activities nearby or upstream from these locations.

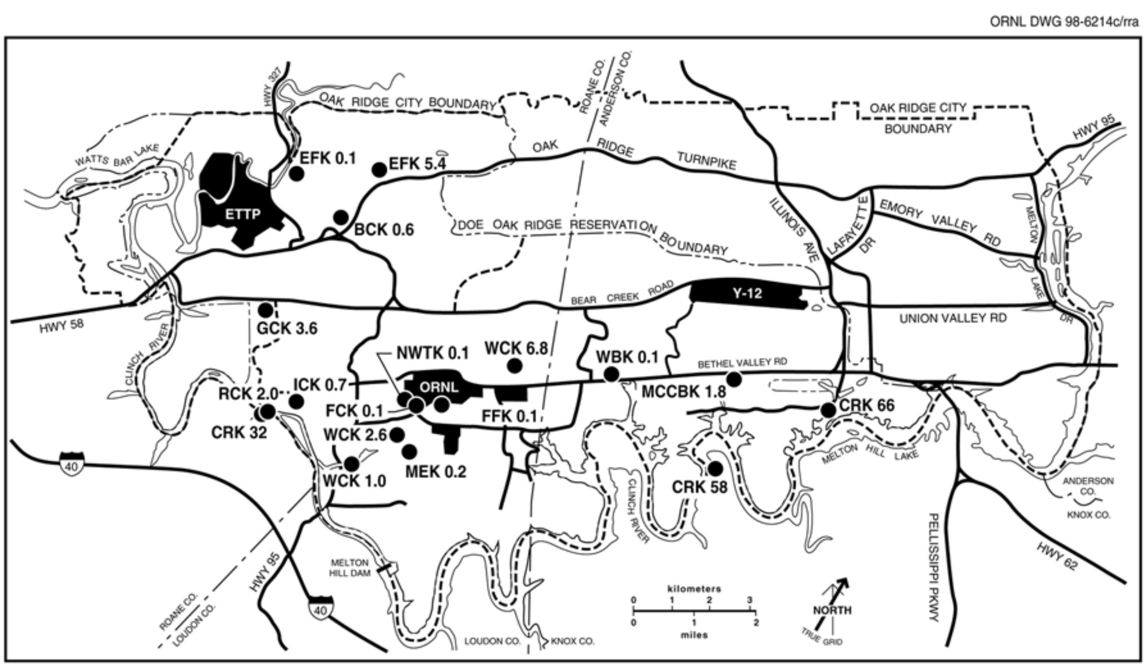

Fig. 5.22. ORNL surface water sampling locations.

Table 5.8. ORNL surface water sampling locations, frequencies, and parameters, 2003

Location[a]	Description	Frequency	Parameters
BCK 0.6	Bear Creek downstream from DOE inputs	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
CRK 32	Clinch River downstream from ORNL	Monthly	Gross alpha, gross beta, gamma scan, total radioactive strontium, ^3H, field measurements[b]
CRK 58	Water supply intake for Knox County	Monthly	Gross alpha, gross beta, gamma scan, field measurements[b]
CRK 66	Melton Hill Reservoir above city of Oak Ridge water intake	Monthly	Gross alpha, gross beta, gamma scan, field measurements[b]
EFK 0.1	East Fork Poplar Creek prior to entering Poplar Creek	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
EFK 5.4	East Fork Poplar Creek downstream from floodplain	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
MEK 0.2	Melton Branch downstream from ORNL	Bimonthly (Jan, Mar, May, Jul, Sep, Nov)	Gross alpha, gross beta, gamma scan, total radioactive strontium, ^3H, field measurements[b]
WCK 1.0	White Oak Lake at White Oak Dam	Monthly	Volatiles, metals, PCBs, gross alpha, gross beta, gamma scan, total radioactive strontium, ^3H, field measurements[b]
WCK 2.6	White Oak Creek downstream from ORNL	Bimonthly (Jan, Mar, May, Jul, Sep, Nov)	Gross alpha, gross beta, gamma scan, total radioactive strontium, ^3H, field measurements[b]
WCK 6.8	White Oak Creek upstream from ORNL	Quarterly (Feb, May, Aug, Nov)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^3H, field measurements[b]
WBK 0.1	Walker Branch prior to entering CRK 53.4	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
GCK 3.6	Grassy Creek upstream of SEG and IT Corp. at CRK 23	Semiannually (Apr, Oct)	Lead, gross alpha, gross beta, gamma scan, field measurements[b]
ICK 0.7	Ish Creek prior to entering CRK 30.8	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
MCCBK 1.8	McCoy Branch prior to entering CRK 60.3	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
RCK 2.0	Raccoon Creek sampling station prior to entering CRK 31	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^3H, field measurements[b]
NWTK 0.1	Northwest Tributary prior to the confluence with First Creek	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^3H, field measurements[b]

Table 5.8 (continued)

Location[a]	Description	Frequency	Parameters
FCK 0.1	First Creek prior to the confluence with Northwest Tributary	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]
FFK 0.1	Fifth Creek just upstream of White Oak Creek (ORNL)	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]

[a]Locations identify bodies of water and locations on them (e.g., CRK 32 = 32 km upstream from the confluence of the Clinch and the Tennessee Rivers).

[b]Field measurements consist of dissolved oxygen, pH, and temperature.

Remediation efforts by Bechtel Jacobs Company (BJC) have resulted in decreases in levels of gross alpha, gross beta, and total radioactive strontium at the First Creek location. The levels are seasonal; for example, they are lower in the spring (wet season) because of dilution. Uranium isotopes, including ^{233}U, ^{234}U, ^{235}U, and ^{238}U, were determined to be the primary alpha emitters. These phenomena are related to radiologically contaminated groundwater whose source is leakage to backfill and soil from Tank W-1A, an underground radioactive waste storage tank located in the North Tank Farm within the main ORNL facilities complex. Work conducted in 1998 indicates that there is infiltration of storm drains that discharge into Outfall 341, which discharges into First Creek. BJC began pumping a well south of the North Tank Farm in 2000 to remediate the groundwater; one of the consequences of this effort is the decline in radionuclides detected in surface water at First Creek (DOE 2001d). This groundwater extraction effort will continue until a final groundwater action is implemented for Bethel Valley.

Volatile organic compounds were detected at White Oak Creek at White Oak Dam in 2003: some chloroform and acetone, which is a common laboratory contaminant.

Two locations, one on Northwest Tributary [Northwest Tributary kilometer (NWTK) 0.1] and one on Raccoon Creek [Raccoon Creek kilometer (RCK) 2.0], also had elevated levels of gross beta and total radioactive strontium. Historically, results at both locations have a seasonal pattern; concentrations at Northwest Tributary are usually higher in the spring, whereas concentrations at Raccoon Creek are usually higher in the fall. This pattern has been disrupted in the past several years. The apparent change in rainfall precipitation patterns since fall 2000 probably accounts for the change in the seasonality pattern. Both of these locations are impacted by contaminated groundwater from SWSA 3.

5.10 ORNL SEDIMENT

Stream and lake sediments act as a record of some aspects of water quality by concentrating and storing certain contaminants. Sampling sites for sediment are the Clinch River downstream from all DOE inputs [Clinch River kilometer (CRK) 16], the Clinch River downstream from ORNL (CRK 32), and the Clinch River at the Solway Bridge, upstream from all DOE inputs (CRK 70) (Fig. 5.23). The locations are sampled annually, and gamma scans are performed on the samples.

In addition, two samples per year containing settleable solids are collected in conjunction with a heavy rain event to characterize sediments that exit ORNL during a storm event. The sampling locations are Melton Branch upstream from ORNL (MEK 2.1), White Oak Lake at White Oak Dam (WCK 1.0), White Oak Creek downstream from ORNL (WCK 2.6), and White Oak Creek Headwaters as a reference location (Fig. 5.23). These samples are filtered, and the residue (settleable solids) is analyzed for gross alpha, gross beta, and gamma emitters.

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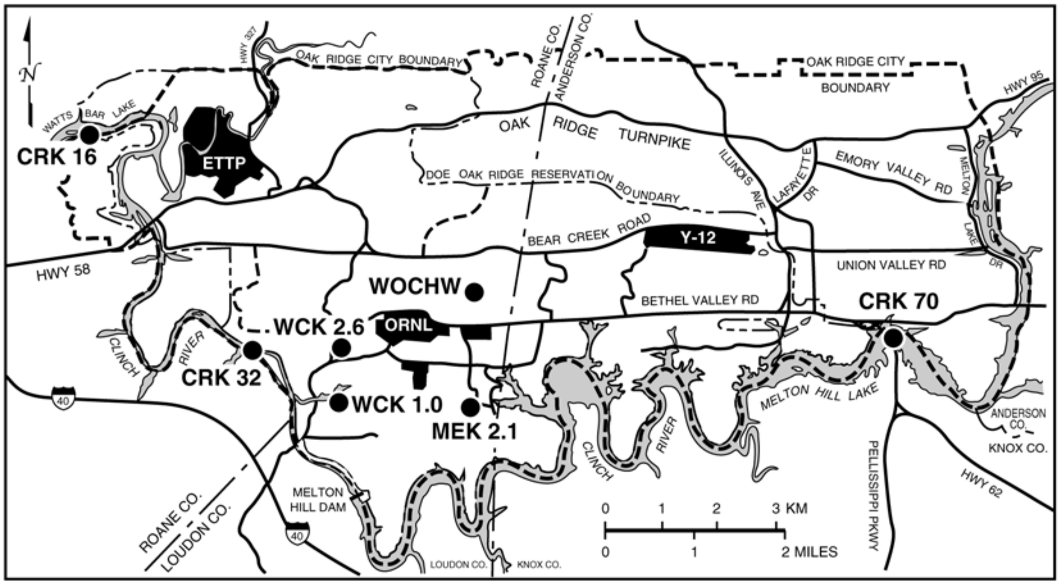

Fig. 5.23. ORNL sediment sampling locations.

5.10.1 Results

Potassium-40, which is a naturally occurring radionuclide, was detected in sediments at all three locations; ^{137}Cs was also detected in the sample collected at CRK 32.

Heavy-rain-event sampling took place in April and May 2003. The concentrations of radionuclides associated with each of these rain events are variable, which is common for these types of samples. Concentrations of ^{137}Cs were higher downstream than upstream, which is consistent with historical results.

5.11 GROUNDWATER MONITORING AT ORNL

5.11.1 Background

The groundwater monitoring program at ORNL consists of a network of wells of two basic types and functions: (1) water quality monitoring wells built to RCRA specifications and used for site characterization and compliance purposes and (2) piezometer wells used to characterize groundwater flow conditions. The Environmental Management and Enrichment Facilities Program, formerly the Environmental Restoration Program, provides comprehensive cleanup of sites where past R&D and waste management activities have resulted in contamination of the environment. The Environmental Management and Enrichment Facilities Program is managed by BJC. Impacts of current R&D activities on groundwater at ORNL are monitored by UT-Battelle via the exit pathway monitoring program. The groundwater exit pathway monitoring program is a major part of the groundwater surveillance monitoring program managed by UT-Battelle for the DOE Office of Science.

Individual monitoring and assessment programs are impractical for each of the waste management and R&D sites because their boundaries are indistinct and there are hydrologic interconnections among many of them. Consequently, the concept of waste area groupings (WAGs) was developed in the late 1980s to facilitate evaluation of potential sources of releases to the environment. A WAG is a grouping of multiple sites that are geographically contiguous and/or that occur within geohydrologically defined areas. WAGs and a watershed-based remediation approach established by BJC allow establishment of suitably comprehensive groundwater and surface water monitoring and remediation programs in a far shorter time than that required to deal with every facility, site, or solid waste management unit individually. At ORNL, 20 WAGs were identified by the RCRA Facility Assessment conducted in 1987. Water quality monitoring wells were established around the perimeters of the WAGs determined to have a potential for release of contaminants. Figure 5.24 shows the location of each of the 20 WAGs.

Groundwater quality monitoring wells for the WAGs are designated as hydraulically upgradient or downgradient (perimeter), depending on their location relative to the general direction of groundwater flow. Upgradient wells are located to provide groundwater samples that are not expected to be affected by possible leakage from the site. Downgradient wells are positioned along the perimeter of the site to detect possible groundwater contaminant migration from the site. No groundwater quality monitoring wells were installed for the WAG 10 grout sheets.

In 1996, DOE established the Integrated Water Quality Program to conduct long-term environmental monitoring throughout the ORR. The Water Resources Restoration Program succeeded the Integrated Water Quality Program in fall 1999. The Integrated Water Quality Program was managed by the Environmental Restoration Program at the time of its initiation.

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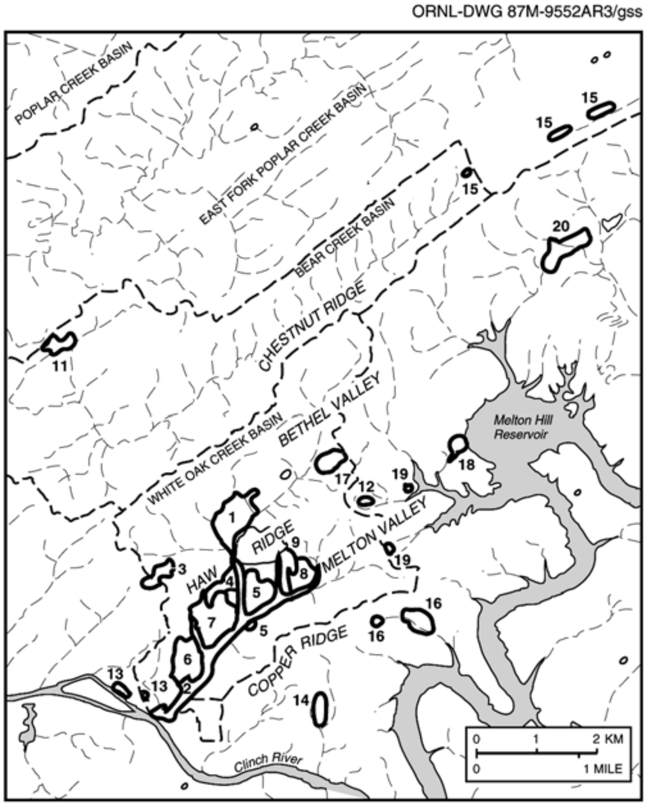

Fig. 5.24. Locations of ORNL waste area groupings (WAGs).

The Water Resources Restoration Program is currently managed by the Environmental Management and Enrichment Facilities Program through BJC and is the vehicle for DOE to carry out the regulatory requirement from the Federal Facility Agreement to conduct postremedial action monitoring. The Water Resources Restoration Program has shifted away from the use of the WAG concept to more of a watershed approach to remediation, which resulted in the assignment of two watersheds to ORNL: Bethel Valley and Melton Valley.

The ORNL groundwater program was reviewed in 1996, and modifications included transfer of monitoring responsibility for some of the WAGs to the Water Resources Restoration Program. A summary of the ORNL groundwater surveillance program is presented in Table 5.9, which indicates whether WAGs are within Bethel Valley or Melton Valley. To provide continuity with previous annual site environmental reports and to allow comparison of activities and sampling results, the WAG concept is used in the following discussions. In the current ORNL program, groundwater quality wells are sampled on an annual basis (Table 5.9).

Monitoring results for remedial actions (under Water Resources Restoration Program purview) that are in progress or that have been completed within specific WAGs are reported annually in the Environmental Management and Enrichment Facilities Program *Remediation Effectiveness Report* (DOE 2003a). Additionally, in the case of WAG 6, which is regulated under both RCRA and CERCLA, specific monitoring results and interpretations required by RCRA are reported in the annual *Groundwater Quality Assessment Report for Solid Waste Storage Area 6* (BJC 2003a), which is issued in February of each year.

UT-Battelle's WAG perimeter monitoring network and the ORNL plant perimeter groundwater surveillance program involved 49 wells in 2003. The ORNL exit pathway program is designated to monitor groundwater at locations that are thought to be likely exit pathways for groundwater affected by activities at ORNL. The program was initiated in 1993 and

Table 5.9. Summary of the ORNL groundwater surveillance program at, 2003[a]

WAG	Regulatory status	Wells		Frequency and last date sampled in 2003	Locations	Parameters
		Upgradient	Downgradient			
			Bethel Valley			
1	CERCLA and DOE Orders 450.1 and 5400.5	3	24	Annually, April 2003	4 wells	Radionuclides[b] and field measurements[c]
3	DOE Orders 450.1 and 5400.5	3	12	*d*	*d*	*d*
17	DOE Orders 450.1 and 5400.5	4	4	Annually, March - April 2003	All wells	Volatile organics, radionuclides,[b] and field measurements[c]
			Melton Valley			
2	CERCLA and DOE Orders 450.1 and 5400.5	12	8	Annually, February 2003	4 wells 16 wells	Full set[e] and field measurements[c] Radionuclides[b] and field measurements[c]
4	CERCLA and DOE Orders 450.1 and 5400.5	4	11	*d*	*d*	*d*
5	CERCLA and DOE Orders 450.1 and 5400.5	2	20	*d*	*d*	*d*
6	RCRA/CERCLA and DOE Orders 450.1 and 5400.5	7	17	*f*	*f*	*f*
7	CERCLA and DOE Orders 450.1 and 5400.5	2	14	*d*	*d*	*d*
8 and 9	DOE Orders 450.1 and 5400.5	2	9	Annually, March 2003	All wells	Radionuclides[b] and field measurements[c]
			White Wing Scrap Yard			
11	DOE Orders 450.1 and 5400.5	6	5	*d*	*d*	*d*

[a]Abbreviations
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
DOE = U.S. Department of Energy
RCRA = Resource Conservation and Recovery Act
WAG = waste area grouping.

[b]Gross alpha and beta, ^{3}H, ^{137}Cs, ^{60}Co, and total radioactive strontium.

[c]Standard field measurements: pH, conductivity, turbidity, oxidation/reduction potential, temperature, and dissolved oxygen.

[d]Water Resources Restoration Program (formerly Integrated Water Quality Program) samples selected wells for various purposes; other wells are inactive.

[e]Volatile organics, metals, gross alpha and beta, ^{3}H, ^{137}Cs, ^{60}Co, and total radioactive strontium.

[f]Sampled by Environmental Management and Enrichment Facilities and data reported in the *Groundwater Quality Assessment Report for Solid Waste Storage Area 6 at Oak Ridge National Laboratory, Oak Ridge, Tennessee CY 2002*, February 2003, Bechtel Jacobs Company, LLC (BJC 2003a).

was reviewed in 1996, which resulted in White Oak Creek and Melton Valley being the focus of the program (Fig. 5.25). A summary of the current program is presented in Table 5.10.

Four of the ten wells that make up ORNL's exit pathway monitoring program are also part of the WAG perimeter monitoring program. These four wells are located on WAG 2, and 2003 data from these four wells were used in conjunction with data from the six exit pathway wells for analyzing the exit pathway monitoring program. The results of the plant perimeter and exit pathway monitoring programs are discussed in part in the following sections.

None of the ORNL WAGs monitored under UT-Battelle's surveillance groundwater monitoring program are regulated under RCRA permits; therefore, no permit standards exist with which to compare sampling results. WAG 6 is monitored under a combined RCRA/CERCLA regulatory strategy and is not monitored under the UT-Battelle surveillance groundwater monitoring program. In an effort to provide a basis for evaluation of analytical results and for assessment of groundwater quality monitored by UT-Battelle at the ORNL WAGs, federal drinking water standards, and Tennessee Water Quality Criteria for domestic water supplies are used as reference values in the following discussions. When no federal or state standard has been established for a radionuclide, then 4% of the DOE DCG is used. Although drinking water standards are used, it is important to realize that no members of the public consume groundwater from ORNL WAGs, nor do any groundwater wells furnish drinking water to personnel at ORNL.

Trend analyses were performed on exit pathway wells of interest, such as wells that monitor areas or facilities actively managed by UT-Battelle whose organic, heavy metal (RCRA metals), or radiological contaminants exceeded their respective reference values during 2003. Naturally occurring inorganic contaminants (metals such as aluminum, iron, manganese, and zinc) whose 2003 concentrations exceeded their reference values were not subjected to trend analysis because these constituents are commonly found in the soil and rock composing the earth's crust and are regularly found in groundwater samples collected from wells at ORNL. The trend analysis was performed using historical data collected from 1991 through the 2003 monitoring period.

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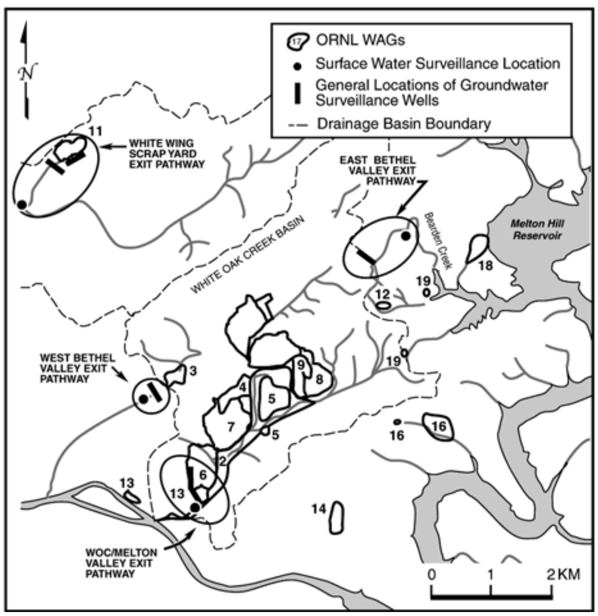

Fig. 5.25. Groundwater exit pathways on the ORR that are likely to be affected by Oak Ridge operations.

Table 5.10. Summary of the ORNL plant perimeter surveillance program,, 2003[a]

Exit pathway	WAG	Number of wells	Surface water locations	Parameters
White Oak Creek/ Melton Valley	6 and 2[b]	10	White Oak Creek at White Oak Dam	Volatile organics, ICP metals, ^{3}H, total radioactive strontium, gross alpha and beta, ^{60}Co, and ^{137}Cs

[a]Abbreviations
ICP = inductively coupled plasma
WAG = waste area grouping
[b]Four wells are part of the ORNL WAG 2 perimeter network.

5.11.2 Bethel Valley

Bethel Valley, located in the southeastern portion of the ORR, lies between two prominent, parallel, northeast-southwest trending ridges, Chestnut Ridge to the north and Haw Ridge to the south. Research and development facilities have been located within it for 50 years, and it contains the main ORNL facilities complex, including buildings, reactors, surface impoundments, and buried waste tank farms with transfer pipelines. In most instances, groundwater flow in Bethel Valley is from the northeast to southwest (i.e., parallel to the strike direction), and contaminant plumes generally enter the surface water system.

5.11.2.1 WAG 1 Area

WAG 1, the ORNL main plant area, contains about one-half of the remedial action sites identified to date by the Environmental Management and Enrichment Facilities Program. WAG 1 lies within the Bethel Valley portion of the White Oak Creek drainage basin. The boundaries of the basin extend to the southeast and northeast along Chestnut Ridge and Haw Ridge. The WAG boundary extends to the water gap in Haw Ridge. The total area of the basin in Bethel Valley is about 2040 acres. Bedrock beneath the main plant area is composed of limestone, siltstone, and calcareous shale facies of the Ordovician Chickamauga Group.

Many of the WAG 1 sites were used to collect and store low-level waste in tanks, ponds, and waste treatment facilities, but some sites also include landfills and contaminated sites resulting from spills and leaks that have occurred over the last 50 years. Because of the nature of cleanup and repair, it is not possible to determine which spill or leak sites still represent potential sources of release. Most of the solid waste management units are related to ORNL's past waste management operations.

WAG 1 Results

UT-Battelle activities to monitor groundwater discharging from WAG 1 include sampling four wells (807, 808, 809, and 830) in the southwest area of WAG 1, near the water gap in Haw Ridge that separates Bethel Valley from Melton Valley. These four wells are located downgradient of the main plant facilities in WAG 1. Shallow groundwater flow within WAG 1 is southward toward White Oak Creek. In 2003, these wells were sampled for radiological contaminants (gross alpha, gross beta, total radioactive strontium, tritium, and gamma-emitting radionuclides). The radiological contaminant concentrations in these wells in 2003 did not exceed reference values used for comparison. Recent Environmental Management and Enrichment Facilities Program activities in WAG 1 are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2003a).

5.11.2.2 WAG 3 Area

WAG 3 is located in Bethel Valley, about 0.6 mile (1 km) west of the main plant area. WAG 3 is composed of three solid waste management units: Solid Waste Storage Area (SWSA) 3, the Closed Scrap Metal Area (1562), and the Contractors' Landfill (1554).

SWSA 3 and the Closed Scrap Metal Area are inactive landfills known to contain radioactive solid wastes and surplus materials generated at ORNL from 1946 to 1979. Burial of solid waste ceased at this site in 1951; however, the site continued to be used as an aboveground scrap metal storage area until 1979. Sometime during the period from 1946 to 1949, radioactive solid wastes removed from SWSA 2 were buried at this site. In 1979, most of the scrap metal stored aboveground at SWSA 3 was either transferred to other storage areas or buried on site in a triangle-shaped disposal area immediately south of SWSA 3.

Records of the composition of radioactive solid waste buried in SWSA 3 were destroyed in a fire in 1961. Sketches and drawings of the site indicate that alpha and beta-gamma wastes were segregated and buried in separate areas or trenches. Chemical wastes were probably also buried in SWSA 3 because there are no records of disposal elsewhere. Although the information is sketchy, the larger scrap metal equipment (such as tanks and drums) stored on the surface at this site was also probably contaminated. Because only a portion of this material is now buried in the Closed Scrap Metal Area, it is not possible to estimate the amount of contamination that exists in this solid waste management unit.

The Contractors' Landfill was opened in 1975 and is now closed. It was used to dispose of various uncontaminated construction materials. No contaminated waste or asbestos was allowed to be buried at the site. ORNL disposal procedures required that only non-RCRA, nonradioactive solid wastes were to be buried in the Contractors' Landfill.

WAG 3 Results

Groundwater monitoring in WAG 3 is performed under the Water Resources Restoration Program. Any activities to be reported are published in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2003a).

5.11.2.3 WAG 17 Area

WAG 17 (7000 Area) is located about 1 mile (1.6 km) directly east of the ORNL main plant area and is situated on a relatively flat limb of the northwest-facing slope of Haw Ridge. It has served as the major craft and machine shop area for ORNL since the late 1940s. The area includes the receiving and shipping departments, machine shops, carpenter shops, paint shops, lead-melting facilities, garage facilities, welding facilities, and material storage areas needed to support ORNL's routine and experimental operations. WAG 17 is composed of 18 solid waste management units. A former septic tank is now used as a sewage collection/pumping station for the area. Photographic waste tanks have been removed. Four old petroleum underground storage tanks (USTs) were removed during the period from 1987 to 1990, and closure approval for them was received from TDEC in 1997. Two relatively new USTs were registered with TDEC and are used to store diesel fuel and gasoline at the ORNL gas station.

WAG 17 Results

Upgradient and downgradient wells surround WAG 17. The upgradient wells (1196, 1197, 1198, and 1199) are located on the eastern boundary of WAG 17, and the downgradient wells (1200, 1201, 1202, and 1203) are located on its western boundary. General groundwater flow is to the north and west toward White Oak Creek. A portion of the area's groundwater flow is to the southeast toward an unnamed tributary to Bearden Creek. In 2003, these wells were sampled for radiological contaminants (gross alpha, gross beta, total radioactive strontium, tritium, and gamma-emitting radionuclides) and volatile organic compounds. The radiological contaminant concentrations in 2003 were below their respective reference values. In 2003, several volatile organic compounds were observed to exceed their respective reference values in Well 1201. Included in this suite were 1,1-dichloroethene, benzene, tetrachloroethene, trichloroethene, and vinyl chloride. Trichloroethene was observed to exceed its reference value in Well 1202.

Trend analysis was performed on those organic contaminants that exceeded their respective reference values during 2003. The trend analysis was performed using historical data collected through 2003. No statistically significant trends were observed for 1,1-dichloroethene, tetrachloroethene, trichloroethene, or vinyl chloride in Well 1201. A statistically significant downward trend was observed for benzene in Well 1201 (at a level of significance of 0.01). A statistically significant upward trend was detected for trichloroethene in Well 1202 (at a significance level of 0.2). The presence of the organic contaminants at the western periphery of WAG 17 is related to continued discharges of legacy contamination associated with past usage of cleaning solvents and operation of garage facilities within WAG 17.

5.11.3 Melton Valley

Melton Valley is the second of the two valleys that comprise ORNL. Melton Valley is of primary importance on the ORR because it is one of the major waste storage areas on the reservation. In addition to containing surface structures, it is the location of shallow waste burial trenches and auger holes, landfills, tanks, impoundments, seepage pits, hydrofracture wells and grout sheets, and waste transfer pipelines and associated leak sites. As with plumes in Bethel Valley, groundwater plumes within Melton Valley generally enter the surface water system where contaminants are frequently encountered.

5.11.3.1 WAG 2 Area

WAG 2 is composed of White Oak Creek discharge points and includes the associated floodplain and subsurface environment. It represents the major drainage system for ORNL and the surrounding facilities.

In addition to natural drainage, White Oak Creek has received treated and untreated effluents and reactor cooling water from ORNL activities since 1943. Controlled releases include those from the Process Waste Treatment Complex, the Sewage Treatment Plant, and a variety of process waste holding ponds throughout the ORNL main plant area (WAG 1). It also receives groundwater discharge and surface drainage from WAGs 1, 4, 5, 6, 7, 8, and 9 (see Fig. 5.24).

WAG 2 represents a source of continuing contaminant release (radionuclides and/or chemical contaminants) to the Clinch River. Although it is known that WAG 2 receives groundwater contamination from other WAGs, the extent to which it may be contributing to groundwater contamination has yet to be completely resolved.

WAG 2 Results

Many of the wells sampled within WAG 2 monitor discharges to White Oak Creek and are therefore classified as downgradient wells. These wells are generally located to the southwest and downstream of the main plant area of ORNL. Downgradient wells monitored during 2003 include 1152, 1154, 1155, 1156, 1185, 1186, 1187, 1188, 1189, 1190, 1191, 1192, 1193, 1194, 1195, 1244, and 1245. Upgradient wells are located upslope and to the south of the main plant area of ORNL. Upgradient wells monitored during 2003 include 1150, 1151, and 1153. In 2003, the following wells were sampled for metals, volatile organic compounds, and radiological contaminants (gross alpha, gross beta, total radioactive strontium, tritium, and gamma-emitting radionuclides): 1189, 1190, 1191, and 1192 (all four wells are WAG 2 and exit pathway wells); all other WAG 2 wells were sampled for radiological contaminants only. Three radiological contaminant constituents exceeded their respective reference values in 2003: tritium in Well 1152, tritium in Well 1156, gross beta activity and tritium in Well 1191, tritium in Well 1190, gross alpha activity in Well 1194, and gross beta activity in Well 1244.

Trend analysis was performed for those wells that are part of the exit pathway monitoring program that exceeded their respective reference values during 2003. Statistically downward trends are observed (at a significance level of 0.01) for tritium in Well 1190 and for gross beta and tritium in Well 1191. Because Well 1152 is located downgradient of the HFIR complex, trend analysis was performed on its historical tritium data collected through 2003. A statistically significant upward trend continues to be observed for tritium in Well 1152 (at a level of significance of 0.01). Well 1152 is located downgradient of the HFIR; the upward trend is most likely due to the tritium leak from the process waste drain line.

The presence of the radiological contaminants is related to continued discharges of legacy contamination associated with past waste disposal activities within the WAGs that drain into WAG 2. Several metal contaminants exceeded their respective reference values during 2003, but these metals (e.g., aluminum, iron, and manganese) are commonly found in the soil and rock composing the earth’s crust. No volatile organic compounds were present above their respective detection limits in 2003. Recent Environmental Management and Enrichment Facilities Program activities in WAG 2 are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2003a).

5.11.3.2 WAG 4 Area

WAG 4 is located in Melton Valley about 0.5 mile (0.8 km) southwest of the main ORNL plant site. It comprises the SWSA 4 waste disposal area, liquid low-level radioactive waste (LLLW) transfer lines, and the experimental Pilot Pit Area (Area 7811).

SWSA 4 was opened for routine burial of solid radioactive wastes in 1951. From 1955 to 1959, SWSA 4 was designated by the Atomic Energy Commission as the Southern Regional Burial Ground. As such, SWSA 4 received a wide variety of poorly characterized solid wastes (including radioactive waste) from about 50 sources. These wastes consisted of paper, clothing, equipment, filters, animal carcasses, and related laboratory wastes. About 50% of the waste was received from sources outside of Oak Ridge facilities. Wastes were placed in trenches, shallow auger holes, and in piles on the ground for covering at a later date.

From 1954 to 1975, LLLW was transported from storage tanks at the main ORNL complex to waste pits and trenches in Melton Valley (WAG 7), and later to the hydrofracture disposal sites through underground transfer lines. The Pilot Pit Area was constructed for use in pilot-scale radioactive waste disposal studies from 1955 to 1959; three large concrete cylinders containing experimental equipment remain embedded in the ground.

WAG 4 Results

Groundwater monitoring in WAG 4 was transferred to the Integrated Water Quality Program (now the Water Resources Restoration Program) in 1996. Recent monitoring activities to be reported are published in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2003a).

5.11.3.3 WAG 5 Area

WAG 5 contains 33 solid waste management units, 13 of which are tanks that were used to store LLLW prior to disposal by the hydrofracture process. WAG 5 also includes the surface facilities constructed in support of both the old and new hydrofracture facilities. The largest land areas in WAG 5 are the areas devoted to transuranic waste in SWSA 5 South and SWSA 5 North. The remaining sites are support facilities for ORNL's hydrofracture operations, two LLW pipeline leak/spill sites, and an impoundment in SWSA 5 used to dewater sludge from the original Process Wastewater Treatment Facility. Currently, LLW tanks at the new hydrofracture facility are being used to store evaporator concentrates pending a decision regarding ultimate disposal of these wastes.

SWSA 5 South was used to dispose of solid low-level radioactive waste (LLW) generated at ORNL from 1959 to 1964. During this time, the burial ground served as the Southern Regional Burial Ground for the Atomic Energy Commission. At the time SWSA 5 burial operations were initiated, about 10 acres of the site were set aside for the retrievable storage of transuranic wastes.

The WAG 5 boundary includes the Old Hydrofracture Facility and the New Hydrofracture Facility. Because Melton Branch flows between these facilities, the New Hydrofracture Facility has a separate boundary.

WAG 5 Results

Groundwater monitoring in WAG 5 was transferred to the Water Resources Restoration Program in 1996. Recent monitoring activities to be reported are published in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2003a).

5.11.3.4 WAG 6 Area

WAG 6 consists of four solid waste management units: (1) SWSA 6, (2) Building 7878, (3) the explosives detonation trench, and (4) Building 7842. SWSA 6 is located in Melton Valley, northwest of White Oak Lake and southeast of Lagoon Road and Haw Ridge. The site is about 1.2 miles (2 km) south of the main ORNL complex. Waste burials at this 68-acre site were initiated in 1973, when SWSA 5 was closed. Various radioactive and chemical wastes were buried in trenches and auger holes. SWSA 6 is the only currently operating disposal area for LLW at ORNL. The emergency waste basin was constructed in 1961 to provide storage of liquid wastes that could not be released from ORNL to White Oak Creek. The basin, located northwest of SWSA 6, has a capacity of 15 million gal but has never been used. Radiological sampling of the small drainage from the basin has shown the presence of some radioactivity. The source of this contamination is not known.

WAG 6 was among the first WAGs to be investigated at ORNL by the Environmental Management and Enrichment Facilities Program. Several RCRA interim status units (having received RCRA-regulated hazardous waste) are located in WAG 6. Environmental monitoring is carried out under CERCLA and RCRA.

WAG 6 Results

Information about WAG 6 monitoring results in 2003 is available in the 2003 *Groundwater Quality Assessment Report for Solid Waste Storage Area 6* (BJC 2003a).

5.11.3.5 WAG 7 Area

WAG 7 is located in Melton Valley about 1 mile (1.6 km) south of the ORNL main plant area. The major sites in WAG 7 are the seven pits and trenches used from 1951 to 1966 for disposal of LLLW. 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 of acid solutions primarily containing enriched uranium from Homogeneous Reactor Experiment fuel.

WAG 7 Results

Groundwater monitoring in WAG 7 was transferred to the Integrated Water Quality Program (now the Water Resources Restoration Program) in 1996. Recent monitoring results activities to be reported are published in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2003a).

5.11.3.6 WAG 8 and 9 Areas

Because of the small number of groundwater monitoring wells in WAGs 8 and 9, they are sampled together. The analytical results for the two WAGs are also reported together. Wells monitored within WAGs 8 and 9 include 1087, 1088, 1089, 1090, 1091, 1092, 1093, 1094, and 1095. Wells monitored within WAG 9 include 1096 and 1097.

WAG 8, located in Melton Valley, south of the main plant area, is composed of 36 solid waste management units associated with the reactor facilities in Melton Valley. The solid waste management units consist of active LLLW collection and storage tanks, leak/spill sites, a contractors' soils area, radioactive waste ponds and impoundments, and chemical and sewage waste treatment facilities. WAG 8 includes the Molten Salt Reactor Experiment facility, the HFIR, and the Radionuclide Engineering Development Center. A removal action was initiated at the Molten Salt Reactor Experiment during 1995 to remove filtration devices contaminated with uranium.

Radioactive wastes from WAG 8 facilities are collected in on-site LLLW tanks and are periodically pumped to the main plant area (WAG 1) for storage and treatment. The waste includes demineralizer backwash, regeneration effluents, decontamination fluids, experimental coolant, and drainage from the compartmental areas of filter pits.

An abnormally high tritium concentration was reported in October 2000, in the foundation drain system associated with the HFIR building (Building 7900). As a result, characterization monitoring was conducted to determine the location of the leak site and the extent of contamination. This monitoring included sampling a number of wells, drains, outfalls, and a groundwater seep located in the immediate vicinity of Building 7900. The characterization effort revealed a leak in the process waste drain system for HFIR. Characterization efforts continued throughout 2001 and revealed a general drop in tritium concentrations during the winter and spring of 2001. Using the data generated during the characaterization effort, the *Operational Monitoring Plan for the High Flux Isotope Reactor Site* (Bonine 2002) was implemented in June 2001. The plan required that upgradient and downgradient wells, drain systems, outfalls, and the seeps be monitored over a period of one year (June 2001 through June 2002). As a result, several monitoring wells were installed hydraulically upgradient and downgradient of Building 7900 to supplement the existing well network used during the characterization effort. The monitoring plan was designed to (1) provide early detection of groundwater contamination due to operational activities or system failures at the HFIR site, (2) monitor significant changes in groundwater contamination caused by the tritium leak, and (3) monitor sources of groundwater contamination located hydraulically upgradient of the HFIR site.

Analysis of monitoring data acquired from the inception of monitoring was used to update the conceptual model of groundwater flow and contaminant movement at the HFIR site. The conceptual model identifies rapid-flow and slow-flow components of the groundwater system. The rapid-flow pathways of subsurface water and contaminant movement are associated with human-made features, including pipelines and their excavated trenches and the HFIR building foundation drainage system. The slow-flow region in the HFIR area is groundwater in soil and bedrock as monitored by the monitoring-well network. Under the *Operational Monitoring Plan*, tritium and gamma-emitting radionuclides were the main contaminants of concern being monitored because their presence would be indicative of further releases from the HFIR. The leak in the process waste drain pipe was repaired during the summer of 2001.

Monitoring required by the *Operational Monitoring Plan* was completed during 2002. Data generated by the *Operational Monitoring Plan* were analyzed, and the findings of the analysis were reported in the *Summary of Baseline Operational Monitoring Activities at the High Flux Isotope Reactor Site* (Bonine and Ketelle 2002).

The information gathered from monitoring activities pursued under the *Operational Monitoring Plan* was used to generate the *Annual Monitoring Plan for the High Flux Isotope Reactor Site* (Bonine 2003) for the period August 2002 through August 2003. This monitoring plan was conducted to meet the three design elements outlined in the *Operational Monitoring Plan*. Under the *Annual Monitoring Plan*, gamma-emitting radionuclides were dropped from consideration as contaminants of concern. Consequently, tritium was the only contaminant of concern monitored during 2003. Additional changes made to the *Operational Monitoring Plan* as outlined in the *Annual Monitoring Plan* included changes in monitoring point locations and sampling frequencies. Details of the changes in the monitoring program from 2002 to 2003 can be found in the *Annual Monitoring Plan*. A summary of the findings of the *Annual Monitoring Plan* are found in the next section.

HFIR *Annual Monitoring Plan* Results

The report *Summary of 2002/2003 Annual Monitoring Activities at the High Flux Isotope Reactor Site: Monitoring Period August 2002 through August 2003* (Bonine and Ketelle 2004**)** presents and interprets the data obtained from the annual tritium monitoring efforts completed at the HFIR site during the period of August 2002 through August 2003. The primary purpose of the monitoring program is to provide continued early detection of releases to groundwater from HFIR operational activities or system failures. Additional objectives are to track the mass of the tritium plume in the vicinity of HFIR and to monitor potential sources of groundwater contamination located hydraulically upgradient of the HFIR.

During the August 2002 through August 2003 monitoring period, the discharge of tritium from the groundwater plume increased because of above average rainfall. Normal annual average rainfall in Oak Ridge is approximately 54 inches compared to the 70 inches of rainfall recorded at the ORNL site for FY 2003. The increased rainfall caused higher recharge to the groundwater system, resulting in increased plume discharge from the bedrock zone into the rapid-flow discharge pathways monitored at the Building 7900 foundation drain system. Tritium concentration action levels and notification requirements established in the *Annual Monitoring Plan* were exercised frequently during the winter of 2003 because of the increased plume discharge. Nonetheless, no evidence of additional contaminant discharge from the HFIR facility or associated systems was detected during 2003.

Despite exceedances of action levels set forth in the *Annual Monitoring Plan* for the foundation drain monitoring points, overall trends in tritium concentration continued to decrease at most monitoring points during 2003. The principal exceptions to the general downward tritium concentration trend were in downgradient wells 661 and 4532, which exhibited a statistically insignificant increase in tritium concentration during 2003. Moreover, tritium concentration achieved its maximum concentration in downgradient Well 892 in June 2002, and during 2003 tritium concentrations showed a statistically significant decrease in Well 892. These wells are located in an area of less permeable bedrock downgradient of the HFIR facility, and migration of tritium into less permeable material is expected to occur more slowly than the rate of tritium movement through the remainder of the hydrologic system (rapid flow associated with the HFIR drain system). The statistically insignificant increases in tritium trend in Wells 661 and 4532 and the statistically significant decrease in trend in Well 892 indicate that the deeper-seated portion of the tritium plume is moving downgradient away from Building 7900 toward eventual discharge into Melton Branch.

No evidence was found that significant sources of contaminant release to the environment have occurred upgradient of the HFIR facility. Monitoring results from three upgradient groundwater monitoring wells installed in response to the tritium investigation showed consistently low to nondetectable concentrations of tritium during 2003.

The 2002/2003 annual monitoring summary report (Bonine and Kettelle 2004) includes a summary of the evolution of the tritium plume and applies a water balance model and trended groundwater tritium concentration information to simulate the tritium concentration history observed in the Building 7900 foundation drain system.

WAGs 8 and 9 Results

Wells in WAGs 8 and 9 were sampled for total radioactive strontium, tritium, gross alpha, gross beta, and gamma-emitting radionuclides in 2003. A total of two radiological constituents exceeded their respective reference values during 2003 in wells located in WAGs 8 and 9 (gross beta activity in Wells 1087, 1096, and 1097 and tritium in Well 1088).

5.11.3.7 WAG 10 Area

WAG 10 consists of the Old Hydrofracture Facility grout sheets, the New Hydrofracture Facility, and the New Hydrofracture Facility grout sheets. The surface facilities are also associated with WAGs 5, 7, and 8.

Hydrofracture Experiment Site 1, located within the boundary of WAG 7 (south of Lagoon Road), was the site of the first experimental injection of grout (October 1959) in a testing program for observing the fracture pattern created in the shale and for identifying potential operating problems. Injected waste was water-tagged with ^{137}Cs and ^{141}Ce. Grout consisted of diatomaceous earth and cement.

Hydrofracture Experiment Site 2 is located about 0.8 km (0.5 mile) south of the 7500 (experimental reactor) area in WAG 8. The second hydrofracture experiment was designed to duplicate, in scale, an actual disposal operation; however, radioactive tracers were used instead of actual waste. Cement, bentonite, and water tagged with ^{137}Cs were used in formulating the grout.

The Old Hydrofracture Facility is located about 1.6 km (1.0 mile) southwest of the main ORNL complex, near the southwest corner of WAG 5. Commissioned in 1964, the facility was used to dispose of liquid radioactive waste in impermeable shale formations at depths of 800 to 1000 ft by hydrofracture methods. Wastes used in the disposal operations included concentrated LLLW from the gunite tanks in WAG 2, ^{90}Sr, ^{137}Cs, ^{244}Cm, transuranics, and other (unidentified) radionuclides.

The New Hydrofracture Facility, constructed to replace the Old Hydrofracture Facility, is located 900 ft southwest of the Old Hydrofracture Facility, on the south side of Melton Branch. Wastes used in the injections were concentrated LLLW and sludge removed from the gunite tanks, ^{90}Sr, ^{137}Cs, ^{244}Cm, transuranics, and other nuclides. Recent Environmental Management and Enrichment Facilities Program activities at WAG 10 are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2003a).

5.11.3.8 Melton Valley Exit Pathway Results

Ten monitoring wells are located on the groundwater exit pathway for Melton Valley. Four of these wells (1189, 1190, 1191, and 1192) are also part of the WAG 2 groundwater monitoring program and have been discussed in Sect. 5.11.3.1. Consequently, only six wells (860, 857, 858, 859, 1236, and 1239) will be discussed in this section. The six exit pathway wells were monitored for volatile organic compounds, metals, gross alpha and beta, tritium, total radioactive strontium, and gamma emitters during 2003. None of the concentrations of contaminants of concern in samples collected during 2003 from these six wells exceeded their respective reference values for contaminants of concern. (There were exceedances for iron and aluminum.)

Surface water is also sampled at White Oak Dam (monitoring station WCK 1.0) and is considered part of the exit pathway monitoring program. Gross beta activity exceeded its reference values during 2003. It most likely originated from legacy contamination associated with past waste disposal practices in the Melton Valley WAGs. Historical gross beta data accumulated through 2003 were analyzed, and exhibited a statistically significant decreasing trend throughout its monitoring history at a level of significance of 0.2.

5.11.4 White Wing Scrap Yard

5.11.4.1 White Wing Scrap Yard (WAG 11) Area

The White Wing Scrap Yard (WAG 11), a largely wooded area of about 30 acres, is located in the McNew Hollow area on the western edge of East Fork Ridge. It is 1.4 km (0.9 mile) east of the junction of White Wing Road and the Oak Ridge Turnpike. Geologically, the White Oak thrust fault bisects WAG 11. Lower-Cambrian-age strata of the Rome Formation occur southwest of the fault and overlie the younger Ordovician-age Chickamauga Limestone northeast of the fault. There is only one solid waste management unit in WAG 11.

The White Wing Scrap Yard was used for aboveground storage of contaminated material from ORNL, the ETTP, and the Y-12 Complex. The material stored at the site by ORNL consisted largely of contaminated steel tanks; trucks; earth-moving equipment; assorted large pieces of steel, stainless steel, and aluminum; and reactor cell vessels removed during cleanup of Building 3019. TDEC, EPA, and DOE agreed to an interim record of decision that required the removal of surface debris from the site. This work was completed in 1994.

The area began receiving material (primarily metal, glass, concrete, and trash with alpha, beta, and gamma contamination) in the early 1950s. Information regarding possible hazardous waste contamination has not been found. The precise dates of material storage are uncertain, as is the time when the area was closed to further storage. In 1966, efforts were begun to clean up the area by disposing of contaminated materials in SWSA 5 and by the sale of uncontaminated material to an outside contractor for scrap. Cleanup continued at least into 1970, and removal of contaminated soil began in the same year. Some scrap metal, concrete, and other trash are still located in the area. Numerous radioactive areas, steel drums, and PCB-contaminated soil were identified during surface radiological investigations conducted in 1989 and 1990 at WAG 11. The amount of material or contaminated soil remaining in the area is not known. Recent Environmental Management and Enrichment Facilities Program activities in WAG 11 are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2003a).

White Wing Scrap Yard (WAG 11) Results

Groundwater monitoring in WAG 11 was transferred to the Integrated Water Quality Program (now the Water Resources Restoration Program) in 1996. Any activities to be reported are published in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2003a).

5.12 WELL PLUGGING AND ABANDONMENT AT ORNL

The purpose of the ORNL well plugging and abandonment program is to remove unneeded wells and boreholes as possible sources of cross-contamination of groundwater from the surface or between geological formations. Because of the complex geology and groundwater pathways at ORNL, it has been necessary to drill many wells and boreholes to establish the information base needed to predict groundwater properties and behavior. However, many of the wells established before the 1980s were not constructed to serve current long-term monitoring requirements. Where existing wells do not meet monitoring requirements, they become candidates for plugging and abandonment.

5.12.1 Wells Plugged During 2003

During CY 2003 BJC completed plugging and abandonment of 29 hydrofracture-related wells.

To support closure activities included in the Melton Valley Record of Decision, BJC initiated well plugging and abandonment of nonhydrofracture wells in Melton Valley in September 2003 (DOE 2001a and BJC 2003a). During the months of September through December 2003, a total of 394 nonhydrofracture wells were plugged and abandoned.

5.12.2 Methods Used

Plugging and abandonment of wells are accomplished by splitting the existing well casing and filling the casing and annular voids with grout or bentonite to create a seal between the ground surface and water-bearing formations, and between naturally isolated water-bearing formations.

Splitting and abandoning the well casing in place minimizes the generation of waste that would be created if other methods were used. Specialized tools have been developed to split well casings of different sizes and compositions and are used when wells are plugged and abandoned at ORNL.

Detailed procedures have been developed and documented regarding the use of specific grout materials in different well environments. These procedures were tested and evaluated during the 1993 plugging and abandonment activities.

5.13 ORNL MODERNIZATION AND REINDUSTRIALIZATION ACTIVITIES

FY 2003 was a peak year for construction activities at ORNL associated with ORNL modernization activities. At the main ORNL campus, the private sector building construction was completed, and the laboratory and office complex is now fully operational. This upgrade added more than 40,000 ft^2 of new supercomputer space, more than 750 offices, more than 30 new wet/dry laboratories, and high bay space. Construction progress continued as well on the companion State of Tennessee Joint Institute for Computational Sciences and the DOE-sponsored Research Support Center (cafeteria and visitors' center) being built adjacent to the private sector facilities in the East Campus area. Both of those projects will be completed in FY 2004. Other modernization initiatives, including upgrades at the HFIR, construction of a new Advanced Materials Characterization Laboratory, significant removal of legacy materials and equipment, and deactivation of more than 500,000 ft^2 of excess space, were accomplished during FY 2003. The first phase of ORNL modernization will be completed by FY 2004, with plans under way for construction of additional state and private-sector facilities to begin again in FY 2005.

5.14 SPALLATION NEUTRON SOURCE

DOE prepared and issued a final environmental impact statement (SNS 1999a and 1999b) and a record of decision to construct and operate the SNS. This state-of-the-art pulsed-neutron facility is under construction on Chestnut Ridge at ORNL. A mitigation action plan was developed to document the goals and objectives by which the potential environmental impacts from construction and operation identified in the environmental impact statement will be mitigated. The SNS Project is on schedule and within budget, and in 2003 significant progress was made on the target building, accelerator tunnel, central laboratory and office complex, and site infrastructure. Construction of the SNS is currently approximately 80% complete, and technical components of the accelerator are being installed and commissioned. The facility will become operational in FY 2006.

On November 3, 2003, the TDEC Division of Water Pollution Control issued an NPDES permit that became effective on December 1, 2003. It authorized DOE to discharge cooling tower blowdown and heating, ventilation, and air conditioning condensate water from the SNS to a storm water detention pond that discharges to White Oak Creek at approximate stream mile 4.2 through Outfall 435. Furthermore, the pond emergency spillway, designated as Outfall 437, will discharge in large storm runoff situations to mile 0.6 of a tributary to White Oak Creek. The SNS began discharging blowdown waters to the detention pond in December 2, 2003. For December, 2003, the SNS was fully compliant with all permit limits.

Potential adverse impacts of SNS construction and operations were identified for wetlands, protected species, cultural resources, transportation infrastructure, and research projects in the Walker Branch Watershed. Mitigation measures were identified for each of the potential subjects.

Construction of the SNS access roads affected wetlands. Routes were evaluated, and improving the Chestnut Ridge Road was selected as the action affecting the smallest area of wetlands. Construction affected 0.055 acres, and careful attention to erosion control and equipment movement limited impacts to other nearby wetland areas. The SNS developed a wetlands mitigation plan to compensate for the impacts to the 0.055 acres by restoring 0.138 acres (a mitigation ratio of 2.511) of wetlands located in the same watershed. TDEC accepted the wetlands mitigation plan on June 29, 2000, and the 0.138 acres of wetlands were restored in August 2000. This mitigation action is complete, and the restored areas are routinely monitored to ensure the survival rate of the indigenous shrubs and vegetation planted in the restored area. No significant impacts on the wetlands have resulted from construction activities. The wetlands mitigation activities were evaluated and reported in 2002 and 2003. These reviews have found that the SNS mitigation wetland is functioning as a viable wetland community. The site has the necessary wetland vegetation, soils, and hydrology to be classified as a jurisdictional wetland.

No federally listed or proposed threatened or endangered species were identified in the site surveys of the SNS. However, construction and operation of the SNS could affect protected species that were not identified during the site surveys. Definitive surveys were conducted during three seasons (spring, summer, and fall) in 1999 to ensure that any protected species, including those that can be identified only during flowering, would be noted. No protected species were identified during these surveys, and this mitigation action is complete.

No prehistoric or historic sites listed on or eligible for inclusion on the *National Register of Historic Places* (National Park Service 2003) were identified on the SNS site. A survey of cultural resources was conducted for the access road rights-of-way, and no significant cultural resources were located or disturbed. This mitigation action is complete for the SNS roads and utility corridors. The TVA powerline upgrades associated with the SNS have been evaluated for cultural resources, and no issues were identified.

Increased traffic resulting from SNS construction and operation on local roads was evaluated by SNS staff. Traffic issues were also coordinated with other activities on the ORR. Improvements to Bethel Valley Road, including acceleration and deceleration lanes, marked turn lanes, lighting, and traffic signals, have been identified to reduce the effects on traffic flow in the vicinity of the SNS. Improvements to the roads, including widening and lane marking, were made in the spring of 2001. Traffic signals and lighting became operational in 2002. This mitigation action is complete.

Emissions of water vapor and CO_2 during construction and operation of the SNS could impact the research activities at the Walker Branch Watershed, located approximately 0.75 mile (1.2 km) east of the SNS on Chestnut Ridge. The emissions would affect a small amount of the data collected at Walker Branch Watershed, and a committee was established in 1999 to evaluate the impacts of the SNS. The committee reviewed the impacts and potential mitigation measures and determined that establishing a satellite monitoring location in an area not affected by SNS was the preferred solution. The satellite tower will be established before SNS operates to allow development of statistical correlations between the locations, thereby preserving the quality of the data. The location of the satellite tower was identified in FY 2001, and plans to develop the site are under way by the Walker Branch researchers. Funding for the tower and instruments has been provided to the researchers, and this corrective action is now closed.

Incorporating superconducting accelerator technology at SNS was evaluated in a supplement to the final environmental impact statement in 2000. The impacts of the technology on the Walker Branch Watershed were evaluated and were found to be not significant; the change to superconducting was determined to have no significant environmental impacts. Funding for the satellite tower has been provided by SNS, and this mitigation action is complete.