4. Effluent Monitoring

S. M. Adams, S. Baloga, D. C. Bonner, D. S. Cicerone, M. L. Coffey, E. T. Collins, L. L. Cunningham, J. M. Eaton, J. W. Evans, M. S. Greeley, Jr., L. V. Hamilton, K. G. Hanzelka, W. R. Hill, L. A. Kszos, D. M. Maguire, J. F. McCarthy, H. B. McElhoe, M. J. Peterson, W. K. Roy, M. G. Ryon, M. Salmons, E. M. Schilling, R. S. Sherles, B. A. Shoemaker, B. E. Skaggs, J. G. Smith, G. R. Southworth, A. J. Stewart, and L. F. Wicker

Abstract

Effluent monitoring is a major activity on the ORR. Effluent monitoring is the collection and analysis of samples or measurements of liquid and gaseous effluents to determine and quantify contaminants and process-stream characteristics, assess any chemical or radiological exposures to members of the public, and demonstrate compliance with applicable standards.

4.1 AIRBORNE DISCHARGES

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

Radionuclide NESHAP regulations limit the annual radioactive dose from air emissions to the most exposed member of the public. In December 1989, radionuclide NESHAP regulations were reissued. Negotiations between EPA and DOE were initiated to bring the ORR into full compliance with the new regulations. As a result of those negotiations, an FFCA was signed in May 1992 by the DOE-ORO manager and was implemented at the ORR facilities. The ORR fulfilled all of its FFCA commitments and came into compliance with the regulations by December 1992. On March 26, 1993, EPA Region 4 certified that DOE-ORO had completed all actions required by the FFCA and was considered to be in full compliance with radionuclide NESHAP regulations. An updated Radionuclide NESHAP Compliance Plan was sent to EPA Region 4 in May 1994.

In addition to federal regulations, DOE requirements for airborne emissions are established in DOE Order 5400.1, DOE Order 5400.5, and the *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991). The criteria in NESHAP regulations and DOE orders define major radionuclide effluent sources as emission points that have the potential to discharge radionuclides in quantities that could cause an EDE of 0.1 mrem/year or greater to the nearest member of the public. Calculations of potential emissions from a source do not take into account efficiencies of pollution control equipment where the source is otherwise operating normally.

Each ORR facility has a comprehensive air regulation compliance assurance and monitoring program to ensure that airborne discharges meet all regulatory requirements and therefore do not adversely affect ambient air quality. Common air pollution control devices employed at the three Oak Ridge facilities include exhaust gas scrubbers, baghouses, and other exhaust filtration systems designed to remove contaminants from exhaust gases before their release to the atmosphere. Process modifications and material substitutions are also made to minimize air emissions. In addition, administrative control plays a role in regulating emissions.

4.1.1 Y-12 Plant Radiological Airborne Effluent Monitoring

The release of radiological contaminants, primarily uranium, into the atmosphere at the Y-12 Plant occurs almost exclusively as a result of plant production, maintenance, and waste management activities. NESHAP regulations for radionuclides require continuous emission sampling of major sources (a "major source" is considered to be any emission point that potentially can contribute >0.1 mrem/year EDE to an off-site individual). During 1997, 46 of the Y-12 Plant's 58 stacks were judged to be major sources. Seven of these sources were not operational in 1997 because of work in progress on process or stack modifications. Twenty of the stacks having the greatest potential to emit significant amounts of uranium are equipped with alarmed breakthrough detectors, which alert operations personnel to process-upset conditions or to a decline in filtration-system efficiencies, allowing them to investigate and correct the problem before a significant release occurs.

As of January 1, 1997, the Y-12 Plant had a total of 58 stacks, 51 active and 7 temporarily shut down. During 1997, one stack was permanently shut down. Thus, 50 active stacks were being monitored at the end of 1997.

Uranium and other radionuclides are handled in millicurie quantities at facilities within the boundary of the Y-12 Plant as part of ORNL and Y-12 Plant laboratory activities. In addition, in 1996 an Analytical Services Organization (ASO) laboratory was relocated from the DOE Y-12 Plant to a location approximately 1/3 mile east of the Y-12 Plant on Union Valley Road. The laboratory is operated in a leased facility that is not within the ORR boundary. The emissions from the ASO Union Valley laboratory are included in the Y-12 Plant source term. The releases from these laboratories are minimal, however, and have negligible impact on the total Y-12 Plant dose.

Emissions from Y-12 Plant room ventilation systems are estimated from radiation control data collected on airborne radioactivity concentrations in the work areas. Areas where the monthly average concentration exceeded 10% of the DOE derived air concentration (DAC) worker protection guidelines are included in the annual emission estimate.

Emissions from unmonitored process and laboratory exhausts, categorized as minor emission sources, are estimated according to EPA-approved calculation methods. In 1997, 54 minor emission points were identified from unmonitored radiological processes and laboratories. Twenty-eight minor emission points were identified from ORNL laboratory activities at facilities within the boundary of the Y-12 Plant. Three minor emission points were identified at the ASO Union Valley laboratory. No areas were identified in 1997 where room ventilation emissions exceeded 10% of the DAC worker protection guidelines

4.1.1.1 Sample Collection and Analytical Procedure

Uranium stack losses were measured continuously on 58 process exhaust stacks in 1997. Particulate matter (including uranium) was filtered from the stack sample; filters at each location were changed routinely, from one to three times per week, and analyzed for total uranium. In addition, the sampling probes and tubing were removed quarterly and washed with nitric acid; the washing was analyzed for total uranium. At the end of the year, the probe-wash data were included in the final calculations in determining total emissions from each stack.

4.1.1.2 Results

An estimated 0.013 Ci (6.0 kg) of uranium was released into the atmosphere in 1997 as a result of Y-12 Plant activities (Table 4.1). The specific activity of enriched uranium is much greater than that of depleted uranium, and about 78% of the curie release was composed of emissions of enriched uranium particulate, even though less than 3% of the total mass of uranium released was enriched material (Figs. 4.1 and 4.2).

Table 4.1. Y-12 Plant airborne uranium emission estimates, 1997

Source of emissions	Quantity emitted	
	Ci[a]	kg
Enriched uranium		
Process exhaust (monitored)	0.01	0.153
Process and laboratory exhaust (unmonitored)	0.00015	0.002
Room exhaust (from health physics data)	0.00	0.00
Depleted uranium		
Process exhaust (monitored)	0.0026	4.8
Process and laboratory exhaust (unmonitored)	0.0005	1.0
Room exhaust (from health physics data)	0.00	0.0
Total	0.013	6.0

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

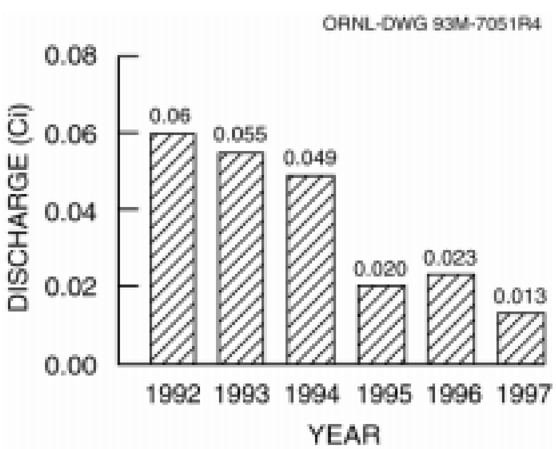

Fig. 4.1. Total curies of uranium discharged from the Y-12 Plant to the atmosphere, 1992–97.

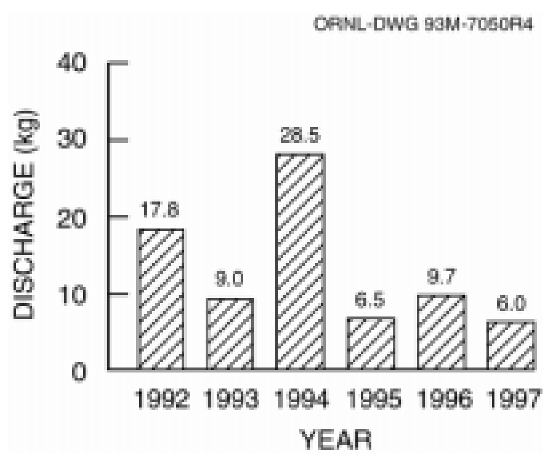

Fig. 4.2. Total kilograms of uranium discharged from the Y-12 Plant to the atmosphere, 1992–97.

4.1.2 ORNL Radiological Airborne Effluent Monitoring

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, then filtered with high-efficiency particulate air (HEPA) and/or charcoal filters before discharge to ensure that any radioactivity released is as low as possible. Radiological gaseous emissions from ORNL consist of solid particulates, adsorbable gases (e.g., iodine), tritium, and nonadsorbable gases. The major radiological emission point sources for ORNL consist of the following four stacks located in Bethel and Melton valleys (Fig. 4.3):

ORNL-DWG 88M-7048R5

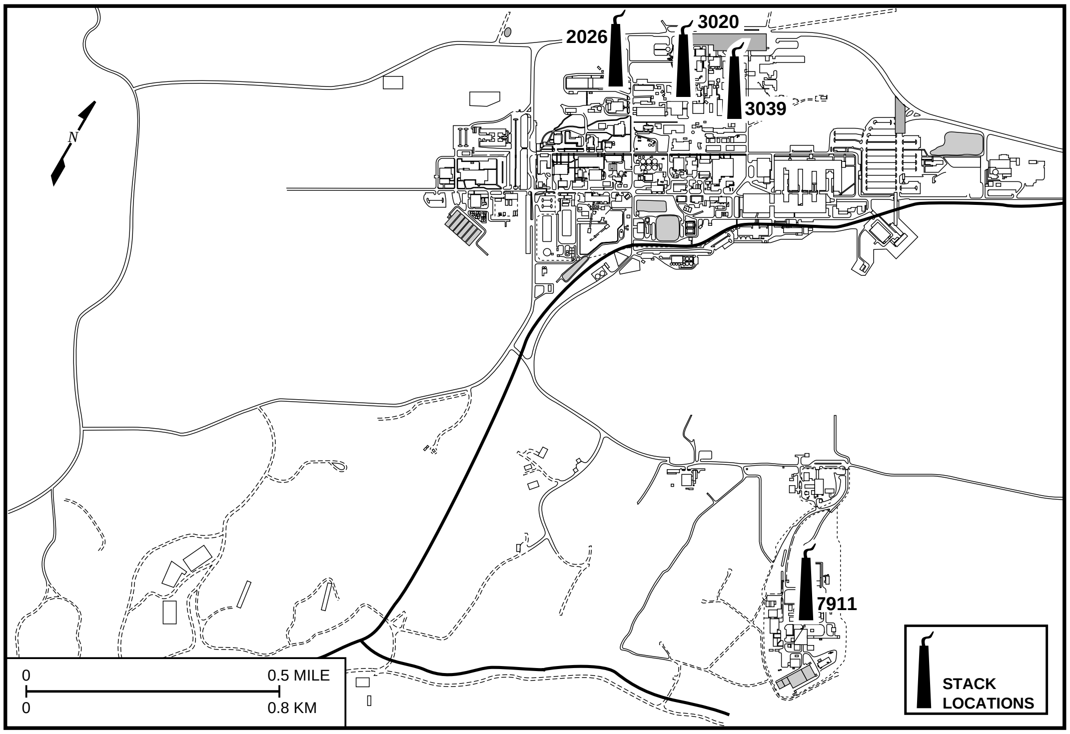

Fig. 4.3. Locations of major stacks (rad emission points) at ORNL.

- 2026 High Radiation Level Analytical Laboratory;
- 3020 Radiochemical Processing Plant;
- 3039 central offgas and scrubber system, which includes 3500 and 4500 areas cell ventilation system, isotope solid state ventilation system, and 3025 and 3026 areas cell ventilation system; and
- 7911 Melton Valley complex, which includes the High Flux Isotope Reactor (HFIR) and the Radiochemical Engineering Development Center (REDC).

In 1997, there were 21 minor point/group sources, and emission calculations/estimates were made for each of these sources. Three of these sources are continuously sampled.

4.1.2.1 Sample Collection and Analytical Procedure

Each of the four major point sources is equipped with a variety of surveillance instrumentation, including radiation alarms, near real-time monitors, and continuous sample collectors. Only data resulting from analysis of the continuous samples are used in this report because the other equipment does not provide data of sufficient accuracy and precision to support the quantitation of emission source terms. All ORNL in-stack source sampling systems comply with American National Standards Institute N 13.1 (ANSI 1969) criteria. 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 (i.e., ^{41}Ar) present in the effluent stream. To ensure that all radioactive particulates are accounted for, end-of-the-year samples are collected and analyzed by cleaning the in-stack sampling probes. This program requires annual removal, inspection, and cleaning of sample probes.

Velocity profiles are performed quarterly following the criteria in EPA Method 2 at all major and at 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. Minor sources are composed of any ventilation systems or components such as vents, laboratory hoods, room exhausts, and stacks that do not meet the criteria for a major source but are located in or vent from a radiological control area. A variety of methods are used to determine the emissions from the various minor sources. All methods used for minor source emission calculations comply with criteria agreed upon by EPA and/or are included in the NESHAP Compliance Plan for the ORR. These minor sources are evaluated on a 1- to 3-year basis, depending on the source type. All 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. 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 quantified the adsorbable gases. Analysis is performed weekly. 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 filters are then composited quarterly and analyzed for alpha-, beta-, and gamma-emitting isotopes. Compositing provides a better opportunity for quantification of these low-concentration isotopes. At the end of the year, each sample probe is rinsed, and the rinsate is collected and submitted to the laboratory 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.

4.1.2.2 Results

Annual radioactive airborne emissions for ORNL major sources in 1997 are presented in Table 4.2. All data presented were determined to be significantly different from zero at the 95% confidence level. Any number not statistically different from zero was not included in the emission calculation. Historical trends for ^{3}H and ^{131}I are presented in Figs. 4.4 and 4.5, respectively.

The tritium emissions for 1997 totaled approximately 148 Ci (Fig. 4.4), which is down significantly from previous years. The ^{131}I emission for 1997 is 0.055Ci, which is lower than that of the past years (Fig. 4.5). Emissions from the HFIR have increased in 1997. The major contributor to off-site dose is ^{41}Ar, which totaled 10,000 Ci in 1997 (Fig. 4.6).

4.1.3 ETTP Radiological Airborne Effluent Monitoring

Locations of airborne radionuclide point sources at the ETTP are shown in Fig. 4.7. These locations include both individual point sources and grouped point sources, such as laboratory hoods. Radioactive emissions data were determined from either EPA-approved sampling results or EPA-approved calculation methods.

4.1.3.1 Sample Collection and Analytical Procedure

Radionuclide emission measurements from the TSCA Incinerator were determined using a continuous stack sampling system. Radionuclide emission measurements were also determined from the K-1775 TVS, a new source, using a continuous stack sampling system. Measurements of TSCA Incinerator emissions were based on

Table 4.2. Major sources of radiological airborne emissions at ORNL, 1997 (in curies)[a]

Isotope	Stack			
	2026	3020	3039	7911
^{3}H			2.3E+001	6.9E+001
^{7}Be	5.9E-007	2.2E-007	2.6E-005	3.8E-007
^{41}Ar				1.0E+004
^{141}Ce				1.3E-006
^{144}Ce				3.2E-007
^{60}Co			1.8E-005	
^{203}Hg			5.3E-004	
^{85}Kr				1.1E+002
^{85m}Kr				1.5E+000
^{87}Kr				5.6E+001
^{88}Kr				5.9E+001
^{89}Kr				6.0E+000
Total Sr	1.0E-006	1.9E-006	1.4E-005	1.2E-005
^{129}I				2.3E-005
^{130}I				1.8E-006
^{131}I			1.6E-004	5.5E-002
^{132}I				1.4E-001
^{132m}I				5.1E-001
^{133}I	3.2E-007		2.2E-003	2.3E-001
^{134}I				4.0E-002
^{135}I			8.7E-003	9.4E-001
^{192}Ir			6.4E-004	
^{105}Ru				5.0E-002
^{133}Xe			3.5E-006	6.8E-003
^{135}Xe		4.7E-007	3.1E-004	1.0E+002
^{135m}Xe				6.1E+001
^{137}Xe				1.2E+002
^{138}Xe				3.4E+002
^{137}Cs	5.7E-006	2.8E-006	1.2E-004	2.9E-006
^{138}Cs				1.7E+003
^{139}Ba				6.7E-003
^{140}Ba				5.6E-005
^{191}Os			2.2E-001	3.2E-006
^{212}Pb	1.5E-001	4.9E-001	9.0E-001	2.6E-001
^{228}Th	1.8E-007	1.3E-007	1.2E-009	6.4E-009
^{230}Th		1.2E-009		2.7E-009
^{232}Th	1.0E-009			8.8E-010
^{234}U	3.6E-007	2.4E-007	2.2E-007	5.6E-008
^{235}U	2.6E-008	3.2E-008	8.3E-008	1.7E-008
^{238}U	1.9E-008	3.8E-008	7.6E-008	1.9E-008
^{238}Pu	8.6E-008	2.0E-008	3.1E-009	
^{239}Pu	2.9E-007	3.2E-007	2.3E-007	1.7E-009
^{241}Am	3.2E-008	6.3E-008	7.4E-008	1.4E-005
^{244}Cm	2.9E-007		8.6E-008	1.6E-008
^{152}Eu			1.2E-006	
^{154}Eu			5.8E-007	
^{140}La				1.6E-004

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

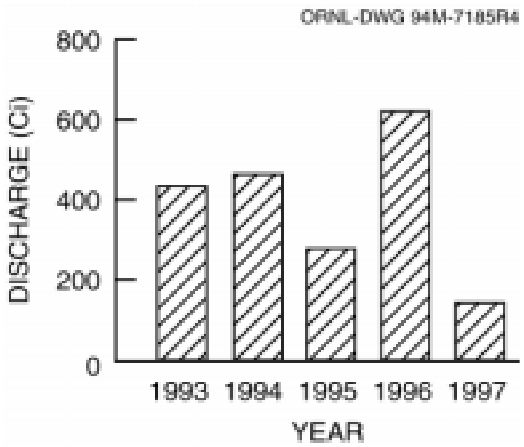

Fig. 4.4. Total discharges of ^3H from ORNL to the atmosphere, 1993–97.

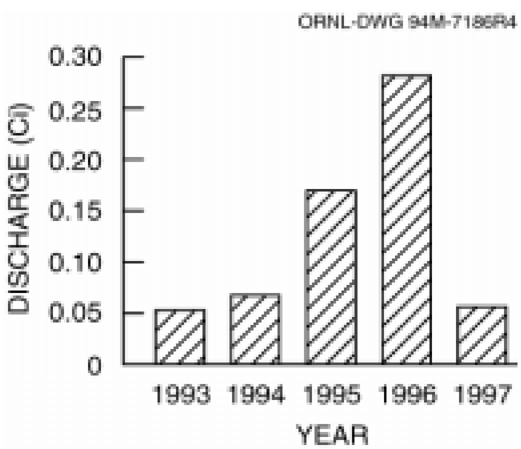

Fig. 4.5. Total discharges of ^{131}I from ORNL to the atmosphere, 1993–97.

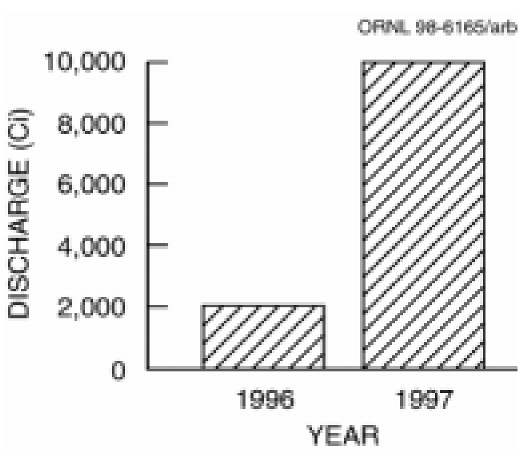

Fig. 4.6. Total discharges of ^{41}Ar from ORNL to the atmosphere, 1996–97.

monthly composites of weekly stack samples. Measurements of TVS emissions were not based on composite samples.

Other techniques were used to determine all other radiological point source emissions. Material balance calculations were used to generate emission estimates for the UF_6 Cylinder Program, Deposit Removal Project, and K-1004-A through D laboratories. The remaining active sources were calculated using surrogate sample techniques as described in the EPA-approved NESHAP compliance plan or from emission factors specified in 40 CFR 61, Appendix D. Both techniques are conservative methods of estimating emissions based on the physical form of the radionuclides and the maximum operating temperature of the process.

The K-1775 TVS began operation on low-level mixed waste in 1997. One new minor point source was approved for operation in 1997. A project for the UF_6 Cylinder Refurbishment Program was evaluated and approved for operation. The project includes controlled venting of cylinders containing depleted uranium hexafluoride. The controlled venting is performed to minimize the potential of uncontrolled releases caused by overpressurization of breached cylinders during repairs.

The following minor sources were reactivated during 1997: the K-304-5 Deposit Removal Project activities to mechanically remove solidified deposits of radiological material from the interior of cascade components; K-1423 drum crushing of radiologically contaminated empty drums; and a HEPA vacuum cleaning facility located in K-1310-DC for servicing vacuum cleaners containing potentially contaminated debris.

4.1.3.2 Results

The ETTP 1997 radionuclide emissions from the TSCA Incinerator, the TVS, and minor emission sources are shown in Table 4.3. Additionally, Figs. 4.8 and 4.9 show a comparison of the total 1997 discharges of uranium with those of previous years. The total curies and mass of uranium discharged have decreased from previous years.

ORNL-DWG 94M-7066R4

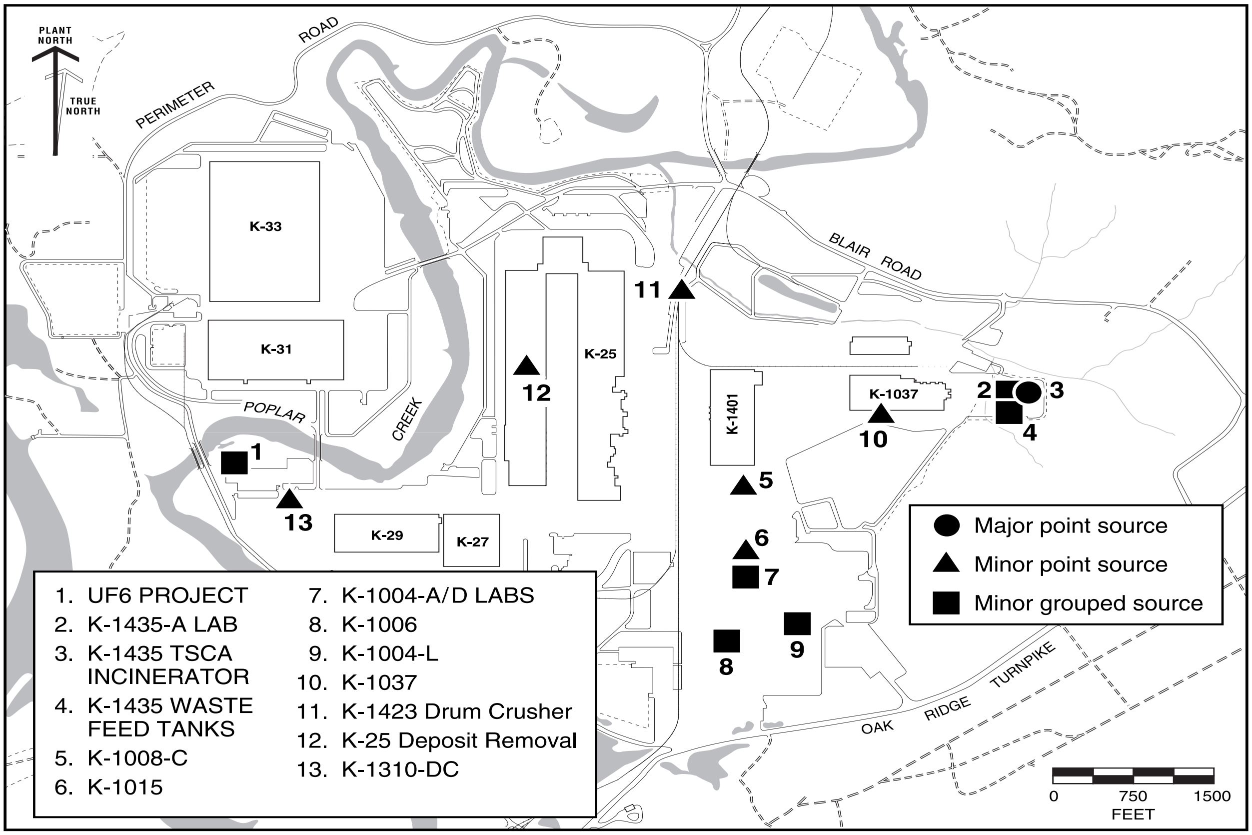

Fig. 4.7. ETTP active point sources of airborne radioactivity.

Variations are typically caused by changing levels of activities, waste burning, and uranium assay from year to year.

4.1.4 Y-12 Plant Nonradiological Airborne Emissions Monitoring

The release of nonradiological contaminants into the atmosphere at the Y-12 Plant occurs as a result of plant production, maintenance, and waste management operations and steam generation. Most process operations are served by ventilation systems that remove air contaminants from the workplace. In 1997, a major effort was expended preparing the Y-12 Plant's first-ever major source (Title V) operating permit application for these sources. This application implements the significant changes resulting from the 1990 Clean Air Act Amendments (Sect. 2.2.14.2) and replaces more than 50 individual emission source permit applications prepared in the early and mid-1990s. The nearly 1000-page application was submitted to TDEC in July 1997. The timely submission of the application allows the Y-12 Plant to continue to operate air emission sources under existing permits until a new permit is issued.

The 1997 Y-12 Plant annual emission fee was calculated based on 10,033 tons per year of allowable emission of regulated pollutants, with an annual emission fee of $158,521.40, as defined in TDEC regulations, Chapter 1200-3-26-.02(9)(i). In calculating the annual emission fee, Schedule III of Chapter 26 was used, in which the adjusted emissions equal the total emissions minus carbon monoxide and exempt emissions and a 4000-ton cap is imposed for SO_2 and NO_x. The emission fee rate was based on $15.80 per ton of regulated pollutant allowable emissions. The actual emis-

Table 4.3. ETTP radionuclide air emission totals, 1997 (in curies)[a]

Radionuclide	TSCA incinerator	TVS	Minor
^{3}H	3.85E–01	–	2.01E–04
^{14}C	–	–	1.19E–04
^{40}K	5.52E–05	1.20E–07	1.67E–05
^{51}Cr	–	–	–
^{57}Co	–	–	8.33E–07
^{60}Co	–	1.96E–07	2.15E–06
^{85}Kr	–	–	2.18E–03
^{90}Sc	–	–	1.12E–06
^{99}Tc	3.98E–03	4.64E–06	1.43E–03
^{106}Ru	–	–	1.01E–07
^{109}Cd	–	–	7.52E–06
^{131}I	–	–	2.05E–05
^{137}Cs	5.40E–04	–	4.22E–06
^{143}Ce	–	–	4.06E–06
^{210}Pb	–	–	7.95E–06
^{203}Hg	–	–	9.00E–09
^{237}Np	3.60E–07	7.47E–10	5.48E–06
^{238}Pu	8.83E–07	–	8.59E–06
^{239}Pu	9.45E–08	–	2.10E–06
^{228}Th	1.27E–07	5.22E–09	5.75E–06
^{230}Th	5.28E–07	–	8.08E–05
^{232}Th	1.11E–07	4.71E–10	5.70E–06
^{234}Th	1.01E–02	–	2.05E–03
^{234m}Pa	1.62E–02	–	4.67E–03
^{233}U	–	–	9.48E–07
^{234}U	1.36E–04	4.33E–09	6.18E–04
^{235}U	2.14E–07	–	6.42E–05
^{236}U	–	–	8.07E–06
^{238}U	7.70E–04	–	1.09E–03
^{242}Am	–	–	2.53E–07
Totals	4.17E–01	4.97E–06	1.26E–02

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

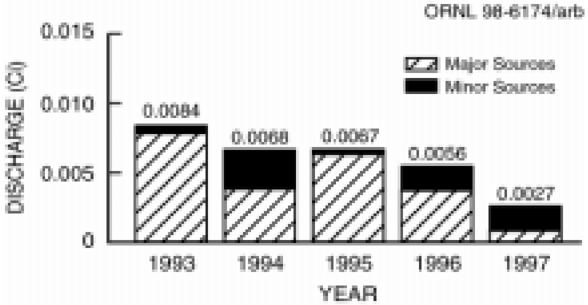

Fig. 4.8. Total curies of uranium discharged from the ETTP to the atmosphere, 1993–97.

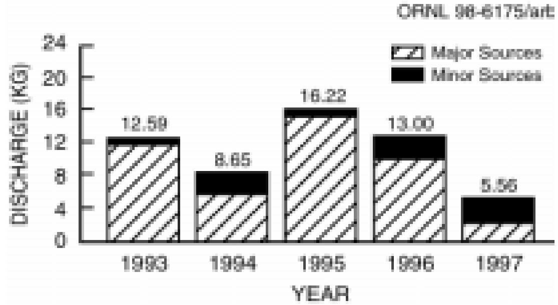

Fig. 4.9. Total kilograms of uranium discharged from the ETTP to the atmosphere, 1993–97.

sions are much lower than the allowable amount; however, major sources are required to pay their annual emission fee based on allowable emissions until the issuance of the major source operating permit.

The level of pollutant emissions is expected to decline in the future because of the changing mission of the Y-12 Plant and downsizing of production areas. More than 90% of the pollutants are attributed to the operation of the Y-12 Steam Plant. Nonradiological airborne emissions of materials have been estimated and are provided in Table 4.4.

Planning for continued compliance with anticipated and newly issued requirements under Title VI of the CAA amendments is a major effort. In accordance with the Y-12 Plant CAA implementation plan, a stratospheric ozone protection plan has been issued outlining current and historical actions necessary to comply with the new limitations on the release of ozone-depleting chemicals and with the 1995 production ban on these chemicals. An annual status report is prepared regarding these activities (*Y-12 Plant Stratospheric Ozone Protection Plan*, Y/TS-1179/R1).

The Y-12 Plant Environmental Compliance Organization personnel and refrigeration maintenance personnel successfully implemented work practices required to minimize releases of ozone-

Table 4.4. Y-12 Plant nonradiological airborne emissions, 1997

Chemical	Quantity released		Major release source	Basis of estimate
	lb	kg		
SARA 313 chemicals[a]				
Hydrochloric acid	98,100	44,591	Chemical processing aid	Engineering calculation
Lead	1,392	633	Ancillary	Engineering calculations
Methanol	32,405	14,730	Cleaning/cooling	Engineering calculation
Nitric acid	545	246	Chemical processing aid	Engineering calculation
Tetrachloroethene	0	0	Storage	Engineering calculation
Other large-inventory chemicals[b]				
Freon 11	890	405	Refrigerant	Quarterly report
Freon 12	248	113	Refrigerant	Quarterly report
Freon 22	3,358	1,526	Refrigerant	Quarterly report
Freon 13	1	0.5	Refrigerant	Quarterly report
Freon 502	3	1	Refrigerant	Quarterly report
Steam plant emissions (all calculated emissions)[c]				
Particulates	74,000	33,636	Stack emission	Engineering calculations based on emission facts
SO_x	5,714,000	2,597,273	Stack emission	Engineering calculations based on emission facts
Carbon monoxide	44,000	20,000	Stack emission	Engineering calculations based on emission facts
Volatile organic compounds	4,000	1,818	Stack emission	Engineering calculations based on emission facts
NO_x	2,816,000	1,280,000	Stack emission	Engineering calculations based on emission facts

[a]Superfund Amendments and Reauthorization Act, Title III, Section 313.
[b]Fugitive emissions.
[c]Point-source emissions.

depleting refrigerants to the atmosphere. Requirements for refrigeration-system and motor-vehicle air-conditioner maintenance compliance are being met. To accommodate the production ban on ozone-depleting chemicals, studies are proceeding to find suitable replacements, and plant refrigeration equipment is being modified as needed. Funding was received and design work implemented on a line-item project, Retrofit Heating, Ventilating, and Air-Conditioning (HVAC) Systems and Chillers for Ozone Protection. This project will eliminate the use of chlorofluorocarbon (CFC) refrigerants in chillers, direct expansion air conditioners, and process coolers, either by direct replacement with new equipment that operates with "ozone-friendly" refrigerants or by retrofit of existing equipment with new components to operate on "ozone-friendly" refrigerants. In addition, two general plant projects were completed to retrofit low-pressure chillers with high-efficiency purge units and pressurization/leak-detection units to reduce CFC emissions to the atmosphere. Figure 4.10 illustrates the five-year trend of fugitive CFC emissions as reported by the Y-12 Plant. Table 4.4 includes the 1997 estimated emissions of these ozone-depleting substances as a result of Y-12 Plant activities.

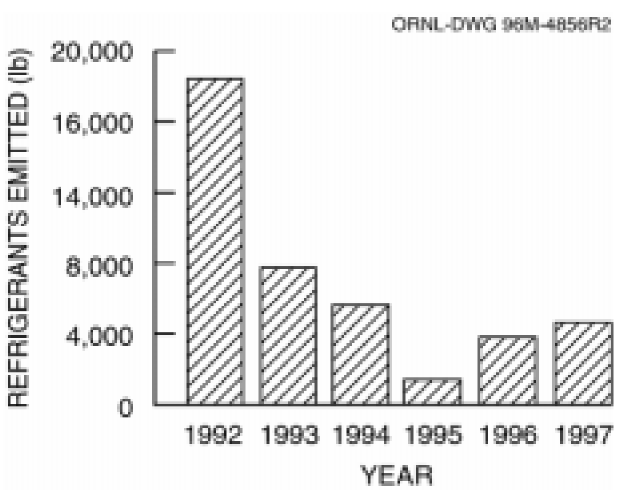

Fig. 4.10. Y-12 Plant CFC emissions, 1992–1997.

4.1.4.1 Sample Collection and Analytical Procedure

The two Y-12 Steam Plant exhaust stacks are each equipped with Lear Siegler RM41 opacity-monitoring systems. Under the current operating permit, the opacity-monitoring systems are required to be fully operational for at least 95% of the operational time of the monitored units during each month of a calendar quarter.

4.1.4.2 Results

The east and west Y-12 Steam Plant stack opacity monitors were each operational more than 99% of the time in 1997. Both systems were taken out of service for annual calibration/recertification by Spectrum Systems Engineering, Inc., on April 22 and 23, 1997. The annual opacity calibration error test reports were submitted to TDEC in July 1997.

During 1997, there were a total of 14 six-minute periods of excess emissions and 7 occasions where the monitors were out of service. Quarterly opacity reports of the operational status of the Y-12 Steam Plant are submitted to personnel at TDEC within 30 days after the end of each calendar quarter to comply with the current air permit.

Table C.4 in Appendix C is a record of excess emissions and out-of-service conditions for the east and west stack opacity monitors for 1997.

4.1.5 ORNL Nonradiological Airborne Emissions Monitoring

ORNL operates 21 permitted air emission sources. Most of these sources are small-scale activities and result in very low emission rates. TDEC air permits for ORNL sources do not require stack sampling or monitoring; however, an opacity monitor is used at the steam plant to ensure compliance with visible emissions. The steam plant and two small oil-fired boilers are the largest emission sources at ORNL and account for 98% of all allowable emissions.

For the period from July 1, 1996, through June 30, 1997, ORNL paid $82,333 in annual emission fees to TDEC. These fees are based on allowable emissions (actual emissions are lower than allowable emissions). During 1997, TDEC inspected all permitted emission sources. They were all found to be in compliance.

The ORNL 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. TDEC anticipates that the ORNL Title V permit will be issued in 1999.

Actions have been implemented to comply with the prohibition against releasing ozone-depleting substances under Title VI. Also, service requirements for refrigeration systems (including motor vehicle air conditioners), technician certification requirements, and labeling requirements have been implemented. ORNL has taken actions to phase out the use of Class I ozone-depleting substances. The most significant challenge, the replacement or retrofit of large chiller systems that require Class I refrigerants, is progressing on schedule.

4.1.5.1 Results

The primary sources of nonradioactive emissions at ORNL include the steam plant, on the main ORNL site, and two small boilers located in the 7600-area complex. These units use fossil fuels, and therefore criteria pollutants are emitted. A listing of actual vs allowable emissions from these sources is included in Table 4.5. Actual emissions were calculated from fuel usage and EPA emission factors. The steam plant and the 7600-area boilers operated in compliance with visible emission standards during 1997.

4.1.6 ETTP Nonradiological Airborne Emissions Monitoring

Under an application shield granted by the TDEC Division of Air Pollution Control, the ETTP operates 12 major air emissions sources which are subject to Tennessee Title V Major Source Operating Permit Program Rules. No direct monitoring of airborne emissions is required for nonradionuclide emissions from permitted sources. Instead, monitoring of key process parameters is done to ensure compliance with all permitted emission limits.

The ETTP is required to pay annual major source emission fees. To verify the annual air emission fee assessment, based on the ETTP's allowable limits for air pollutants, an inventory of allowable emissions from the permitted sources at the ETTP is updated annually. Table 4.6 shows the allowable emissions of criteria pollutants from ETTP operations for the past 5 years. The ETTP paid annual emission fees based on allowable emissions in 1997 amounting to $14,630. An inventory of actual emissions from all permitted sources in operation at the ETTP was also completed for 1997. Table 4.7 shows actual 1997 emissions from the ETTP.

Title VI of the CAA amendments addresses stratospheric ozone protection. EPA has promulgated a number of regulations to phase out the production and to eliminate the intentional release of regulated ozone-depleting substances to the atmosphere. Ozone-depleting substances are used at the ETTP primarily for office comfort cooling. All Class I CFC-11 comfort cooling units at the site were replaced in 1996 with Class II HCFC-22 units. Recovered CFC-11 from the replaced units (~1600 lb) plus a large inventory of new CFC-11 (~14,000 lb) was sent to Portsmouth and Paducah Gaseous Diffusion Plants for use at those facilities.

4.1.6.1 Results

The major sources of criteria air pollutants at the ETTP are the three remaining steam-generating units in operation at the K-1501 Steam Plant. These remaining units use natural gas as their primary fuel source, with No. 2 fuel oil used as backup during curtailment of natural gas supplies. Table 4.8 presents the actual and allowable emissions from the steam plant for 1997.

Table 4.5. Actual vs allowable air emissions from ORNL steam production, 1997

Pollutant	Emissions (tons/year) Actual	Emissions (tons/year) Allowable	Percentage of allowable
Particulate	2	441	0.5
Sulfur dioxide	1072	9062	11.8
Nitrogen oxides	103	531	19.4
Volatile organic compounds	1	3	33.3
Carbon monoxide	82	336	24.4

Table 4.6. Allowable emissions of criteria pollutants from the ETTP, 1993–97

Pollutant	Allowable emissions (tons/year)				
	1993	1994	1995	1996	1997
Particulate matter	180	141	296	247	194
Volatile organic compounds	166	153	167	150	120
Sulfur dioxide	429	429	428	428	428
Nitrogen oxides	226	226	224	224	224
Carbon monoxide	157	157	157	157	157
Miscellaneous	291	145	149	0	0
Total	1449	1251	1421	1206	1122

Table 4.7. Actual emissions of criteria pollutants from the ETTP, 1997

Pollutant	Actual emissions (tons/year)
Particulate matter	6.16
Volatile organic compounds	3.70
Sulfur dioxide	5.53
Nitrogen oxides	23.14
Carbon monoxide	26.48

The TSCA Incinerator is permitted as a major source of air emissions from the ETTP. Emissions from the incinerator are controlled by extensive exhaust-gas treatment. Thus, actual emissions from the incinerator are significantly less than the permitted allowable emissions (Table 4.9).

4.2 LIQUID DISCHARGES

4.2.1 Radiological Liquid Discharges

DOE Order 5400.5 sets annual dose standards to members of the public, as a consequence of routine DOE operations, of 100 mrem through all exposure pathways and 4 mrem from the drinking water pathway. Effluent monitoring results are a major component in the determination of compliance with these dose standards.

DOE Order 5400.5 also established DCGs for radionuclides in water. (See Appendix A for a list of radionuclides and their half-lives.) The DCG is the concentration of a given radionuclide for one exposure pathway (e.g., drinking water) that would result in an EDE of 100 mrem (1 mSv) per year to reference man, as defined by the Interna-

Table 4.8. Actual vs allowable air emissions from the K-1501 Steam Plant at the ETTP, 1997

Pollutant	Emissions (tons/year)		Percentage of allowable
	Actual	Allowable	
Particulate matter	1.74	143	1.2
Sulfur dioxide	1.53	389	0.4
Nitrogen oxides	16.06	191	8.4
Volatile organic compounds	1.07	9	11.9
Carbon monoxide	24.71	135	18.3

Table 4.9. Actual vs allowable air emissions from the TSCA Incinerator at the ETTP, 1997

Pollutant	Emissions (tons/year)		Percentage of allowable
	Actual	Allowable	
Lead	0.0012	0.575	0.2
Beryllium	0.000004	0.00037	1.1
Mercury	0.0024	0.088	2.7
Fluorine	0.0009	2.82	0.03
Chlorine	0.019	15.68	0.1
Sulfur dioxide	0.036	38.54	0.09
Particulate	0.006	13.14	0.05

tional Commission on Radiological Protection (ICRP) publication 23 (ICRP 1975). The consumption of water is assumed to be 730 L/year at the DCG level. DCGs were calculated using methodologies consistent with recommendations found in ICRP publications 26 (ICRP 1977) and 30 (ICRP 1978). DCGs are used as reference concentrations for conducting environmental protection programs at DOE sites, as screening values for considering best available technology for treatment of liquid effluents, and for making dose comparisons. Using radiological data, percentages of the DCG for a given isotope are calculated. In the event that a sum of the percentages of the DCGs for each location ever exceeds 100%, an analysis of the best available technology to reduce the sum of the percentages of the DCGs to less than 100% would be required as specified in DOE Order 5400.5.

4.2.1.1 Y-12 Plant Radiological Monitoring Summary

At the Y-12 Plant, a Radiological Monitoring Plan is in place to address compliance with DOE orders and the NPDES permit (TN002968). The permit, issued in 1995, required that the Y-12 Plant reevaluate its RMP and submit results from the monitoring program quarterly, as an addendum to the NPDES Discharge Monitoring Report. There were no discharge limits set by the NPDES permit for radionuclides; the requirement is only to monitor and report. A revised plan (*Radiological Monitoring Plan for the Y-12 Plant: Surface Water*, LMES 1995a) was fully implemented in 1995. The RMP was expanded at that time to allow sufficient collection of data such that an assessment of alpha, beta, and gamma emitters could be made. The intent was to more appropriately identify parameters to be monitored and establish analytical detection limits necessary for dose evaluations.

Based on an analysis of operational history, expected chemical and physical relationships, and historical monitoring results, the plan was updated again in October 1997 (*Radiological Monitoring Plan for the Oak Ridge Y-12 Plant: Surface Water*, Y/TS-1704). Under the monitoring program, effluent monitoring is continued at three types of locations: (1) treatment facilities, (2) other point and area source discharges, and (3) instream locations. One new outfall will be added to the monitoring progam in 1998 (outfall 551, the Central Mercury Treatment Facility), and two outfalls were discontinued during 1997.

Monitoring at Outfall 142 was discontinued for lack of flow, and Station 8, because of its close proximity to Outfall 200, was deemed to be unnecessary. Routine gamma spectometry was discontinued in 1997 because sufficient gamma information has been collected and reported to TDEC as required by the 1995 plan.

Operational history and past monitoring results have provided a basis for monitoring parameters routinely under the plan (Table 4.10).

The RMP also addresses monitoring of the sanitary sewer. The Y-12 Plant is permitted to discharge domestic wastewater to the city of Oak Ridge POTW under Industrial and Commercial User Wastewater Discharge Permit No. 1-91. Radiological monitoring of this discharge is also conducted and is reported to the city of Oak Ridge. Potential sources of radionuclides discharging to the sanitary sewer have been identified in previous studies at the Y-12 Plant as part of an initiative to meet the ALARA goals of the Y-12 Plant. These data show that levels of radioactivity are orders of magnitude below levels established in DOE orders and are not thought to pose a safety or health risk. The radiological monitoring needs for the sanitary sewer were reviewed and summarized in the 1997 update to the RMP (Y/TS-1704).

The following parameters are monitored routinely:

alpha, beta, and gamma activity;
plutonium (^{238}Pu and $^{239/240}$Pu); and
uranium (^{234}U, ^{235}U, ^{236}U, ^{238}U, total uranium, and percentage of ^{235}U).

Furthermore, radiological monitoring of storm water is required by the NPDES permit, and a comprehensive monitoring plan has been designed to fully charactize pollutants in storm-water runoff. The most recent revision of this plan was issued in May 1997, *Storm Water Pollution Prevention Plan for the Oak Ridge Y-12 Plant* (Y/TS-1180/R2), and this plan incorporates the

Table 4.10. Radiological parameters monitored at the Y-12 Plant in 1997

Parameters	Specific isotopes	Rationale for monitoring
Uranium isotopes	^{238}U, ^{235}U, ^{234}U, total U, weight % ^{235}U	These parameters reflect the major activity, uranium processing, throughout the history of the Y-12 Plant and are the dominant detectable radiological parameter in surface water.
Fission and activation products	^{90}Sr, ^{3}H, ^{99}Tc, ^{137}Cs	These parameters reflect a minor activity at Y-12, processing recycled uranium from reactor fuel elements, from the early 60s to the late 80s and will continue to be monitored as tracers for beta and gamma radionuclides although their concentrations in surface water are low.
Transuranium isotopes	^{241}Am, ^{237}Np, ^{238}Pu,$^{239/240}$Pu	These parameters are related to recycle uranium processing. Monitoring continued because of their half-lives and presence in groundwater.
Other isotopes of interest	^{232}Th, ^{230}Th, ^{228}Th, ^{226}Ra, ^{228}Ra	These parameters reflect historical thorium processing and natural radionuclides necessary to characterize background radioisotopes.

radiological monitoring requirements. The NPDES permit requires characterization of a minimum of 25 storm-water outfalls per year, including both grab and composite sampling.

Results

RMP locations sampled in 1997 are noted in Fig. 4.11 (Outfall 142 and Station 8 monitoring was discontinued in 1997). Table 4.11 identifies the monitored locations, the frequency of monitoring, and the sum of DCG percentages for radionuclides measured in 1997. Radiological data for all locations were well below the allowable DCGs. The highest summed percentage of DCGs was from the in-stream location at Station 8. Radium (^{228}Ra) and Uranium (^{238}U) were the major contributors of radioactivity there, contributing 6.2, and 1.1%, respectively, to the total 8.3% of the sum of the percentages of the DCGs.

The Central Pollution Control Facility (Outfall 501) is the only treatment facility that has exceeded maximum allowable DCGs in the past; however, improvements in the treatment process since 1989 have resulted in effluent data consistently well below DCGs. This improvement can be seen in Fig. 4.12, which shows ^{238}U concentrations since 1989.

In 1997, the total mass of uranium and associated curies released from the Y-12 Plant at the easternmost monitoring station, Station 17 on UEFPC, and the westernmost monitoring station, at BCK 4.55 (former NPDES Outfall 304), was 383 kg, or 0.214 Ci (Table 4.12). Figure 4.13 illustrates an 8-year trend of these releases. The total release is calculated by multiplying the average concentration (grams/liter) by the average flow (million gallons/day). Converting units and multiplying by 365 days/year yields the calculated discharge.

The City of Oak Ridge Industrial and Commercial User Wastewater Discharge Permit allows the Y-12 Plant to discharge wastewater to be treated at the Oak Ridge POTW through the East End Sanitary Sewer Monitoring Station (EESSMS), also identified as SS-6 (Fig. 4.11). Compliance samples are collected at this location.

No single radionuclide in the Y-12 Plant contribution to the sanitary sewer exceeded 1% of the DCG listed in DOE Order 5400.5. Summed percentages of DCGs calculated from the Y-12 Plant contribution to the sewer are essentially

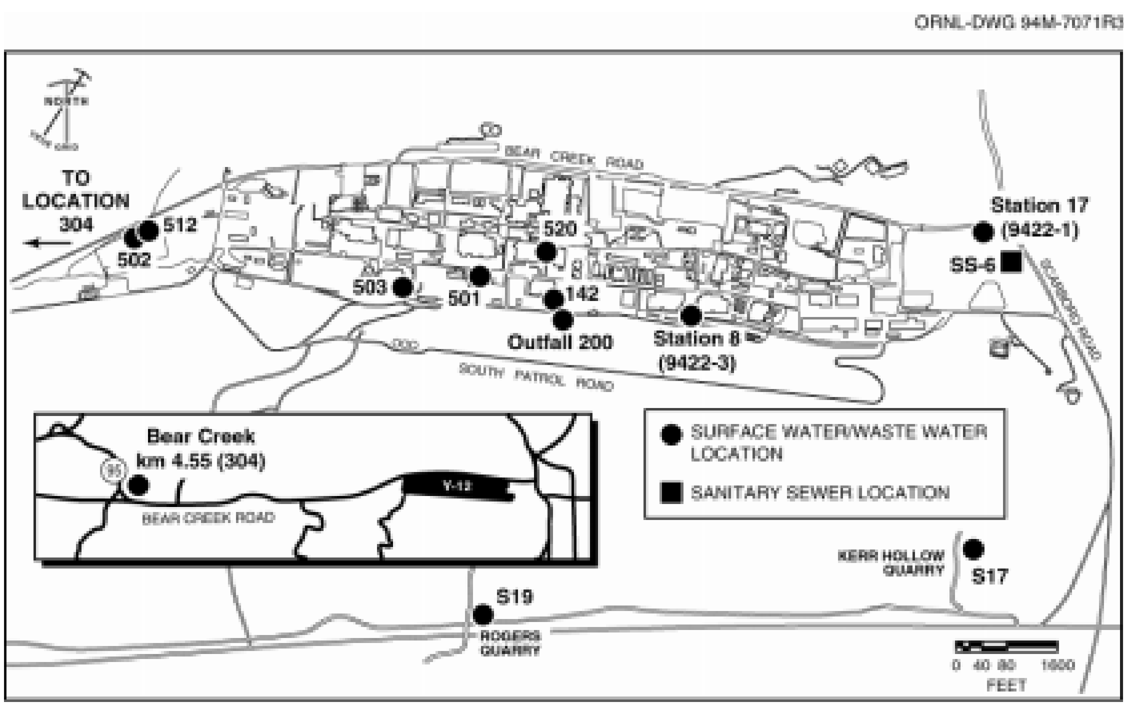

Fig. 4.11. Surface water and sanitary sewer radiological sampling locations at the Y-12 Plant.

Table 4.11. Summary of Y-12 Plant radiological monitoring plan sample requirements

Outfall No.	Location	Sample frequency	Sample type	Sum of DCG percentage
	Y-12 Plant wastewater treatment facilities			
501	Central Pollution Control Facility	1/week	Composite during batch operation	3.4
502	West End Treatment Facility	1/week	24-hour composite	2.4
503	Steam Plant Wastewater Treatment Facility	1/week	24-hour composite	No flow
512	Groundwater Treatment Facility	1/week	24-hour composite	4.2
520 (402)[a]	Steam condensate	1/week	Grab	No flow
	Other Y-12 Plant point and area source discharges			
142[b]	Isotope separation process	1/month	24-hour composite	No flow
S17 (301)[a]	Kerr Hollow Quarry	1/month	24-hour composite	1.1
S19 (302)[a]	Rogers Quarry	1/month	24-hour composite	1.6
	Y-12 Plant instream locations			
BCK 4.55 (304)[a]	Bear Creek, plant exit (west)	1/week	7-day composite	6.7
Station 17	East Fork Poplar Creek, plant exit (east)	1/week	7-day composite	2.9
Station 8[b]	East Fork Poplar Creek, plant site	1/week	7-day composite	8.3
200	North/south pipes	1/week	24-hour composite	6.5

[a]Outfall identifications were changed by the NPDES permit effective July 1, 1995. Former outfall identifications are shown here in parentheses.

[b]Monitoring at this location discontinued in 1997.

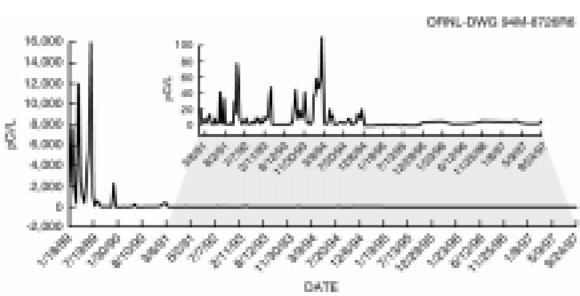

Fig. 4.12. Concentrations of ^{238}U at the Y-12 Plant Outfall 501, January 1989 through December 1997. The allowable DCG for ^{238}U is 600 pCi/L.

zero. Results of radiological monitoring were reported to the city of Oak Ridge with the quarterly monitoring report and are summarized for 1997 in Table 4.13. Figure 4.14 illustrates the 5-year trend of total uranium discharges from the Y-12 Plant Sanitary Sewer.

Radiological monitoring of storm water is consistent with past years results. Uranium is the dominant constituent and increases during storm flow, likely because of surface sources as well as from increased groundwater flow. Some parameters are not present at specific outfalls, and grab samples have not provided useful data. Composite samples generally exhibit higher (i.e., detectable) results. Thus a request to discontinue grab sampling of storm-water runoff for radiological analyses was made to TDEC in late 1997. With TDEC approval, the next revision to the Storm Water Monitoring Plan will reflect this change.

4.2.1.2 ORNL Radiological Monitoring Summary

To meet a permit requirement of the new NPDES permit, ORNL submitted to TDEC a revised RMP; approval of the RMP was received from TDEC on July 1, 1997. Under the revised

Table 4.12. Release of uranium from the Y-12 Plant to the off-site environment as a liquid effluent, 1991–97

Year	Quantity released	
	Ci[a]	kg
	Station 17	
1991	0.162	235
1992	0.087	130
1993	0.081	134
1994	0.11	185
1995	0.069	143
1996	0.135	215
1997	0.098	184
	Outfall 304	
1991	0.082	159
1992	0.060	110
1993	0.094	167
1994	0.13	236
1995	0.066	105
1996	0.149	259
1997	0.116	199

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

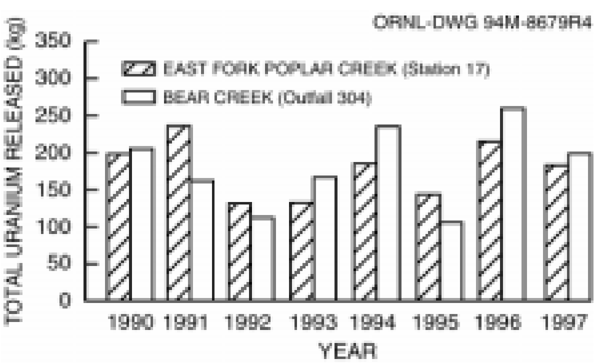

Fig. 4.13. Eight-year trend of Y-12 Plant release of uranium to surface water.

RMP, monitoring of radioactivity is required at three treatment facilities: the Sewage Treatment Plant (STP), the Coal Yard Runoff Treatment Facility (CYRTF), and the Nonradiological Wastewater Treatment Facility (NRWTF), as well as at three instream locations: X13 on Melton Branch, X14 on White Oak Creek, and X15 at White Oak Dam. Additional sites that were monitored under the previous RMP, namely, First Creek, Fifth Creek, Northwest Tributary, 7500 Road Bridge, Raccoon Creek, White Oak Creek Headwaters, and Melton Hill Dam (Fig. 4.15), continued to be monitored by the NPDES program through the remainder of 1997 to ensure continuity of data during transition to another monitoring program. Data for those sites are included with all the other ORNL radiological monitoring results. An assessment of radiological liquid effluents, including numerous category outfalls, was conducted in the summer of 1997. Data gathered during the assessment will be used to complete another revision of the RMP in 1998.

DOE DCGs are used as a means of standardized comparison for effluent points with different isotope signatures. The average concentration is expressed as a percentage of the DCG when a DCG exists and when the average concentration is significantly greater than zero. The calculation of percentage of the DCG for ingestion of water does not imply that effluent points or ambient water sampling stations at ORNL are sources of drinking water.

Results

For 1997, only three radionuclides had an average concentration greater than 4% of the relevant DCG; they were total radioactive strontium (^{89}Sr + ^{90}Sr) with the highest value at NRWTF (24% of the DCG, down from 43% in 1996); ^{3}H with the highest value at monitoring station MB1 (23% of the DCG, down from 34% in 1996), and ^{137}Cs at NRWTF (13% of the DCG, up from 12% in 1996) (Fig. 4.16). Following guidelines given in DOE Order 5400.5, fractional DCG values for the radionuclides detected at each monitoring point are summed to determine whether radioactivity is within acceptable levels. In 1997, the sum of DCG percentages at each effluent point and ambient water station was less than 100% and therefore within acceptable levels. The largest sum of DCG percentages was 42.9%

Table 4.13. Y-12 Plant Discharge Point SS6, Sanitary Sewer Station 6 (1/1/97–12/31/97)

Parameter	Number of samples	Concentration pCi/L						Standard error	Percentage of DCG	Total curies
		Max	+/–	Min	+/–	Median	+/–			
Alpha activity	56	44.0[a]	56	–1.1[a]	3.2	3.9	*b*	0.96	*b*	5.43E–03
Beta activity	56	290.0[a]	100	0.57[a]	3.6	7.5	*b*	6.2	*b*	2.05E–02
Gamma activity	56	300.0	45	–8.0[a]	30	17.0	*b*	6.5	*b*	3.52E–02
^{238}Pu	1	–0.066[a]	0.076	–0.066[a]	0.076	–0.066[a]	0.076	*b*	–0.16	–6.88E–05
$^{239/240}$Pu	1	–0.087[a]	0.088	–0.087[a]	0.088	–0.087[a]	0.088	*b*	–0.29	–9.07E–05
^{234}U	56	8.3	1.4	1.2	0.58	3.2	*b*	0.18	0.64	3.62E–03
^{235}U	57	6.4[a]	15	–0.73[a]	0.15	0.11[a]	0.16	0.11	0.018	2.23E–04
^{236}U	19	0.17[a]	0.24	–0.016[a]	0.031	0.054[a]	0.11	0.012	0.011	5.93E–05
^{238}U	56	5.1	1.0	1.2	0.42	1.85	*b*	0.14	0.31	2.33E–03

[a]Result was below the minimum detectable activity.
[b]Not applicable.

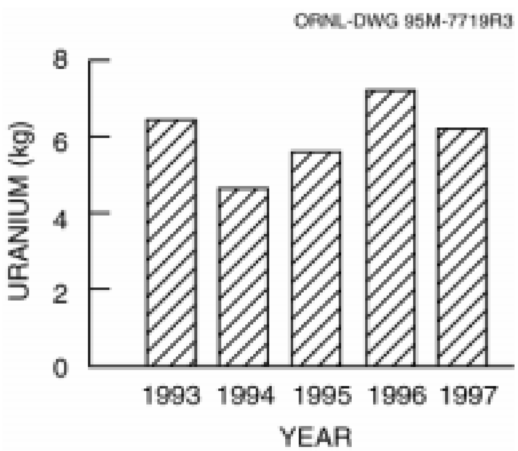

Fig. 4.14. Five-year trend of total uranium discharges from the Y-12 Plant Sanitary Sewer.

at NRWTF (down from 59.9% at NRWTF in 1996).

Amounts of radioactivity released at WOD are calculated from concentration and flow. As shown in Figs. 4.17, 4.18, 4.19, 4.20, 4.21, and 4.22, the total discharges (or amounts) of radioactivity released at WOD during the past 5 years have remained in the same range of values.

4.2.1.3 ETTP Radiological Monitoring Summary

The ETTP conducts radiological monitoring of liquid effluent to determine compliance with applicable dose standards. It also applies the ALARA process to maintain potential exposures to members of the public as low as is reasonably achievable.

Sample Collection and Analytical Procedure

The ETTP monitored two major effluent discharge points for radiological parameters: the K-1203 STP discharge (Outfall 005) and the treated effluent from the K-1407-J Central Neutralization Facility (CNF) (Outfall 014) (Fig. 4.23). Weekly samples were collected from the CNF. The weekly samples were composited into monthly samples. A single monthly 24-h composite sample is collected at K-1203. These samples are then analyzed for radionuclides. Results of these sampling efforts were compared with the DCGs.

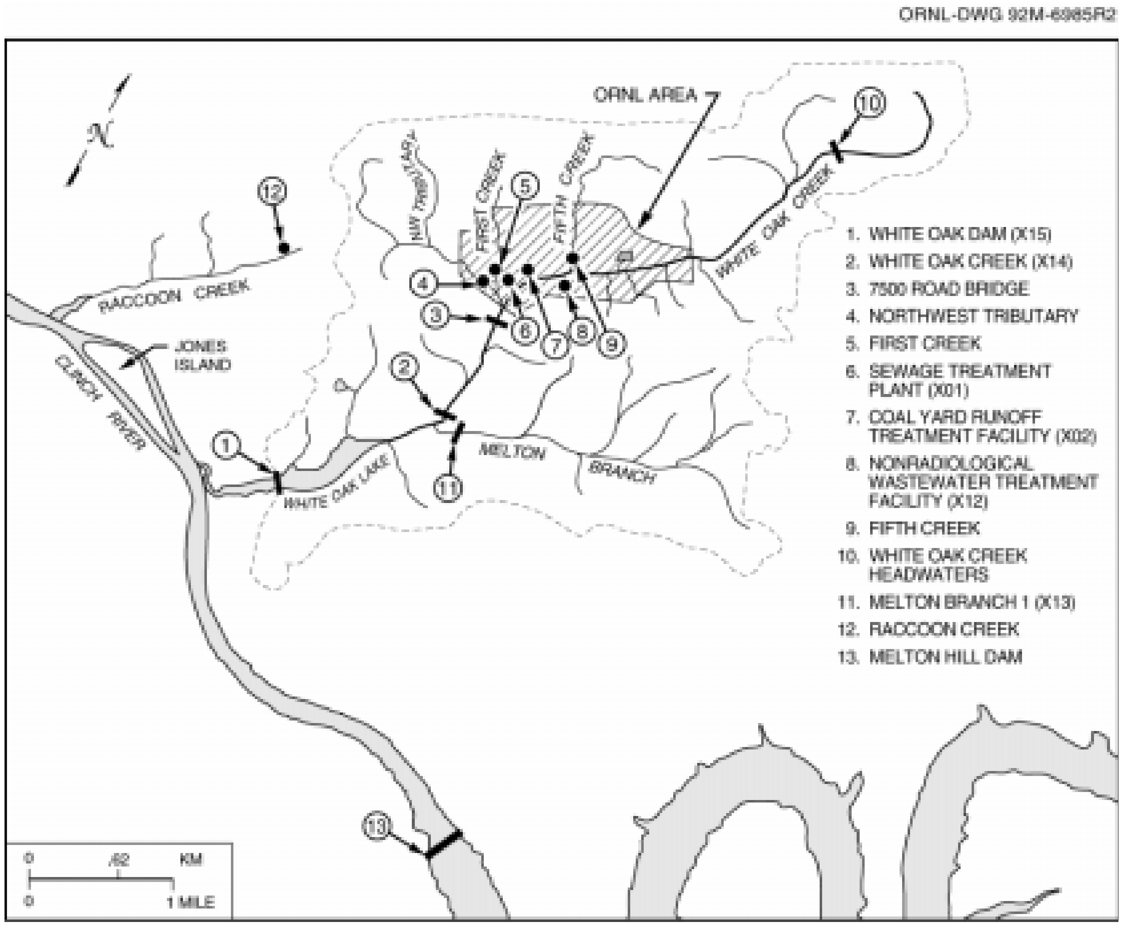

Fig. 4.15. ORNL surface water, NPDES, and reference sampling locations. Bars (**I**) indicate sampling locations that have weirs.

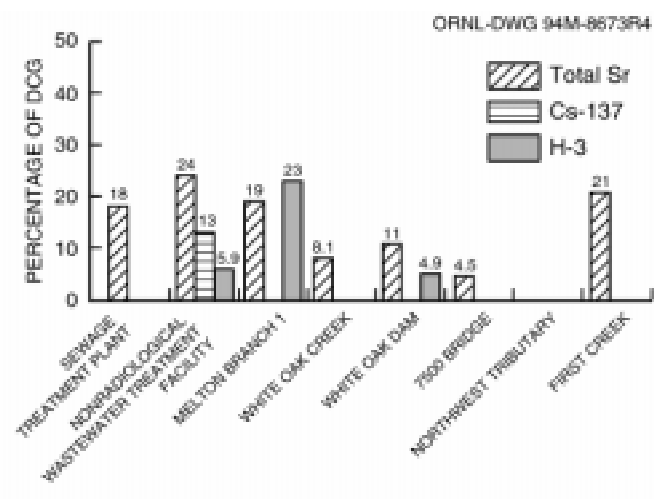

Fig. 4.16. Radionuclides at ORNL sampling sites having average concentrations greater than 4% of the relevant derived concentration guides in 1997.

Results

The sum of the fractions of the DCGs at K-1407-J was calculated at 31.4% for CY 1997, up from 18% for CY 1996. The increase was determined to be caused by changes in TSCA Incinerator feed material. The sum of the fractions of the DCGs for effluent location K-1203 was less than 1%. Table 4.14 lists radionuclides discharged from the ETTP to off-site surface waters in 1997.

Uranium discharges to surface waters during a 5-year period were investigated to observe their trend (Fig. 4.24). The effluent point having the greatest DCG percentage was the K-1407-J outfall. Uranium isotopes were the major contri-

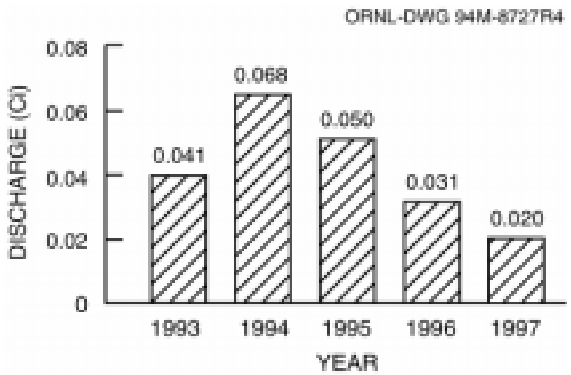

Fig. 4.17. Cobalt-60 discharges at White Oak Dam, 1993–97.

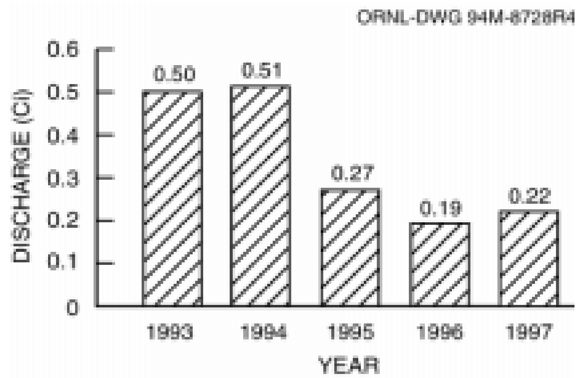

Fig. 4.18. Cesium-137 discharges at White Oak Dam, 1993–97.

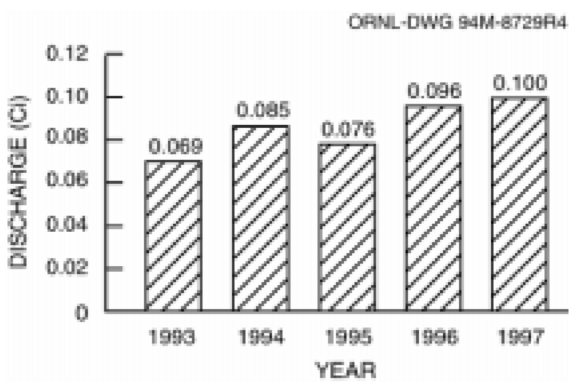

Fig. 4.19. Gross alpha discharges at White Oak Dam, 1993–97.

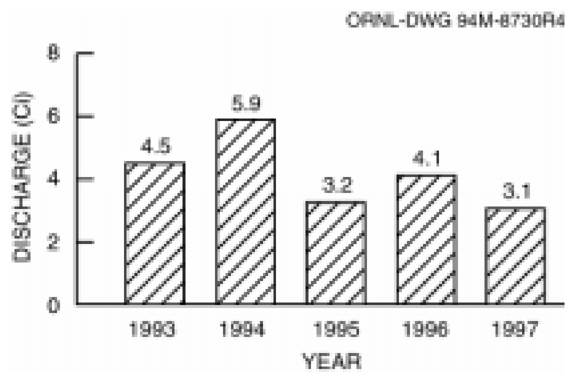

Fig. 4.20. Gross beta discharges at White Oak Dam, 1993–97.

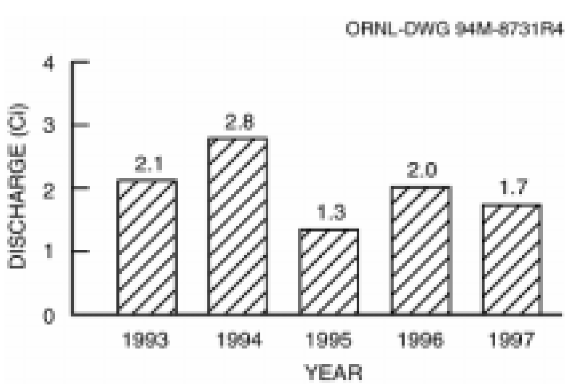

Fig. 4.21. Total radioactive strontium discharges at White Oak Dam, 1993–97.

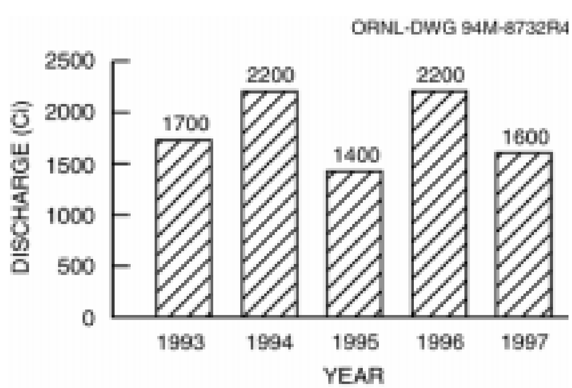

Fig. 4.22. Tritium discharges at White Oak Dam, 1993–97.

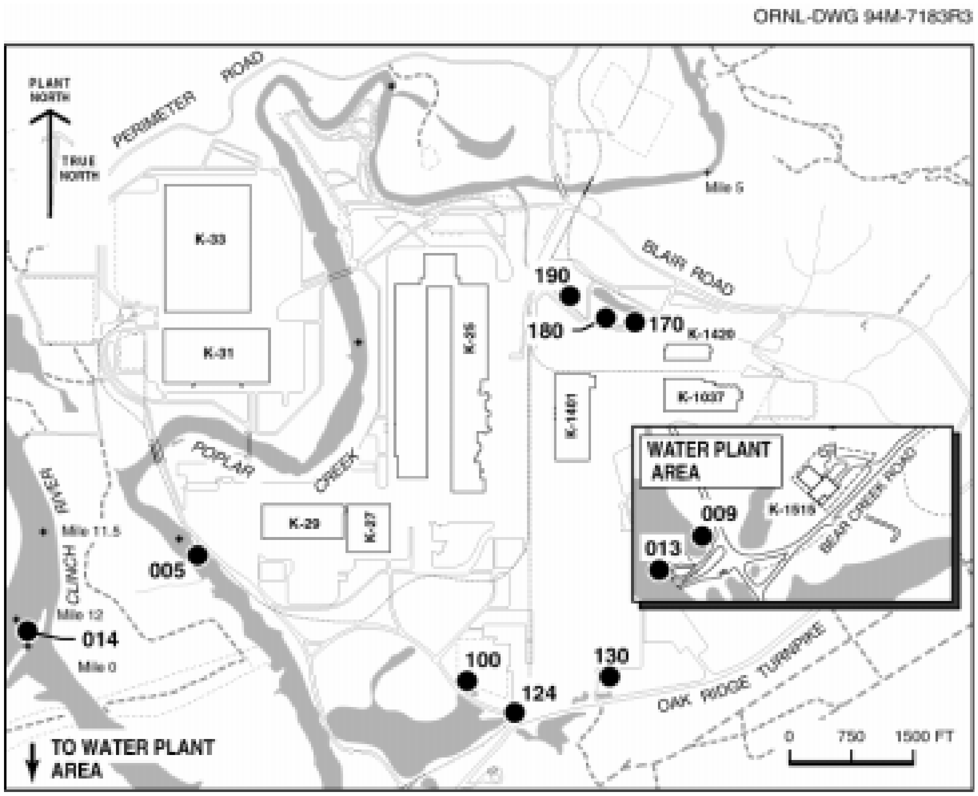

Fig. 4.23. ETTP NPDES major outfalls and Category I storm drain outfalls.

Table 4.14. Radionuclides released to off-site surface waters from the ETTP, 1997
Effluent discharge locations K-1203 and K-1407-J

Isotope	Amount (Ci)[a]	Isotope	Amount (Ci)[a]
^{137}Cs	9.5E–4	^{234}Th	2.1E–3
^{237}Np	2.3E–5	^{234}U	6.4E–3
^{238}Pu	6.7E–4	^{235}U	4.8E–4
^{239}Pu	1.2E–5	^{236}U	8.4E–4
^{99}Tc	6.0E–2	^{238}U	1.1E–2

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

butors (Fig. 4.25). The fluctuation in uranium discharges is attributed to TSCA Incinerator wastewater, which is sent to the CNF for treatment before discharging at K-1407-J (Outfall 014).

4.2.2 Nonradiological Liquid Discharges

The Federal Water Pollution Control Act and its amendments, more commonly known as the CWA, were the culmination of almost a century of litigation and political debates about water pollution. The two main goals of the CWA are (1) to attain a level of water quality that provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water and (2) to eliminate the discharge of pollutants into waters of the United States.

The CWA requires that EPA establish limits on the amounts of specific pollutants that may be discharged to surface waters. The standards,

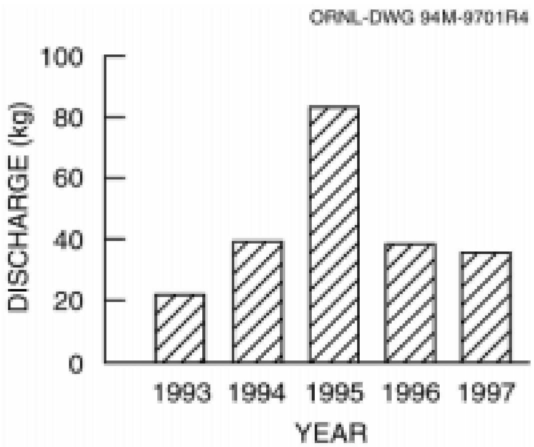

Fig. 4.24. Five-year trend of uranium releases to surface waters from the ETTP. Analysis includes discharge locations K-1203 and K-1407-J.

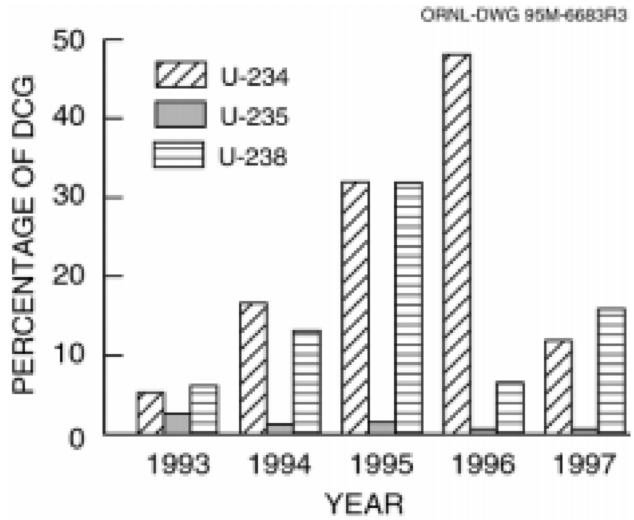

Fig. 4.25. Percentage of DCG for uranium isotopes from K-1407-J.

called effluent limitations, are written into NPDES permits issued to all municipal and industrial dischargers. The Y-12 Plant, ORNL, and the ETTP are each required to monitor discharges at frequencies specified in their permits to ensure compliance with the NPDES effluent limitations. The TDEC Division of Water Pollution Control has the authority to issue NPDES permits and to monitor compliance with the permits in the state of Tennessee under the Tennessee Water Quality Control Act and according to the rules and regulations of the Tennessee Water Quality Control Board. DOE wastewater treatment facilities have formal wastewater acceptability control and surveillance programs that ensure the protection of the facilities and the proper treatment of wastes. Among other things, these programs define pretreatment requirements and waste acceptance criteria. Discharges are regulated under NPDES permits.

The CWA also created the Federal Pretreatment Program to regulate industrial discharges to sanitary sewer systems, which are also referred to as POTWs. Under the Federal Pretreatment Program, industries are required to monitor and regulate their discharges to a POTW. The state of Tennessee has created the Tennessee Pretreatment Program, which requires municipalities to develop their own municipal POTWs for their local industries. Municipal POTWs issue permits to industries, spelling out the responsibilities of the industries for pretreatment and compliance with the sewer-use ordinance. These responsibilities include monitoring their waste streams to determine pollutant concentration limits.

Sanitary wastewater from the Y-12 Plant is discharged to the city of Oak Ridge POTW. Both ORNL and the ETTP have on-site sewage treatment plants.

4.2.2.1 Y-12 Plant Surface Water and Liquid Effluents

The current Y-12 Plant NPDES permit, issued on April 28, 1995, and effective on July 1, 1995, requires sampling, analysis, and reporting at approximately 100 outfalls. The number is subject to change as outfalls are eliminated or consolidated or if permitted discharges are added. In 1997, one outfall (Outfall 066) was physically eliminated. During the previous several years, approximately 100 outfalls were eliminated as part of a program to remove or consolidate outfall pipes on EFPC. Currently, the Y-12 Plant has outfalls and monitoring points in the following water drainage areas: EFPC, Bear Creek, and several unnamed tributaries on the south side of Chestnut Ridge. These creeks and tributaries eventually drain to the Clinch River.

At the end of 1997, there were 60 outfalls discharging various types of wastewater (condensate, cooling water, groundwater, water from building sumps, treated process wastewaters, and other wastewaters) to EFPC. Of the 60 outfalls, 9 discharge storm water only, 3 discharge steam condensate only, 2 discharge groundwater only, and 2 are potable water blowdowns. Twenty-seven other storm water outfalls are actually instream monitoring locations throughout the Y-12 Plant area. Seven internal monitoring points are used to monitor the effluent from wastewater treatment facilities.

Discharges to surface water allowed under the permit include storm drainage, cooling water, cooling tower blowdown, and treated process wastewaters, including effluents from wastewater treatment facilities. Sumps that collect groundwater inflow in building basements are also permitted for discharge to the creek. The monitoring data collected by the sampling and analysis of permittted discharges are compared to NPDES limits where a limit exists for each parameter. Some parameters are “monitor only,” with no limits specified.

The water quality of surface streams in the vicinity of the Y-12 Plant is affected by current and past operations. Discharges from Y-12 Plant processes affect water quality and flow in EFPC before the water enters Lake Reality at the eastern end of the Y-12 Plant and eventually flow through the city of Oak Ridge to Poplar Creek and into the Clinch River. In past years, discharge of coal bottom ash slurry to the McCoy Branch from the Y-12 Steam Plant occurred. This practice has been stopped, and coal ash is currently collected dry and is being used for recycle or for filler to support landfill operations. Bear Creek water quality is affected by area source runoff and groundwater discharges, and only storm water runoff is monitored under the NPDES permit (see Chap. 7 for details on groundwater).

Nineteen ninety-seven was the second full calendar year the Y-12 Plant operated under the permit that had been issued in 1995. The effluent limitations contained in the permit are based on the protection of water quality in the receiving streams. The permit places emphasis on storm water runoff and biological, toxicological, and radiological monitoring. Some of the more significant requirements in the permit and the status of compliance are as follows:

- toxicity limitation for the headwaters of EFPC (see Sect. 4.3.1)
- quarterly toxicity testing at the wastewater treatment facilities (see Sect. 4.3.1)
- a compliance schedule to reduce mercury in EFPC (see Reduction of Mercury in Plant Effluent in Sect. 4.2.2.2)
- a compliance schedule for chlorine limitations at outfalls containing cooling water (complete)
- chlorine limitations based on water quality criteria at the headwaters of EFPC (monitoring ongoing, chlorine limits are being met)
- a compliance schedule for correction of elevated ammonia concentrations discharged to EFPC from a groundwater spring (complete)
- a requirement to manage the flow of EFPC such that a minimum flow of 7 million gal/day is guaranteed by adding raw water from the Clinch River to the headwaters of EFPC (complete)
- sampling of storm water at a minimum of 25 locations per year (in second year of monitoring)
- a storm water pollution plan (plan updated in 1997), and
- instream pH limitations on tributaries to Bear Creek and various other tributaries on the south side of Chestnut Ridge (monitoring ongoing)

Sanitary Wastewater

Sanitary wastewater from the Y-12 Plant is discharged to the city of Oak Ridge POTW under Industrial and Commercial Users Wastewater Permit Number 1-91. A revision to the permit was issued August 25, 1997, by the city of Oak Ridge. A number of allowable discharge concentrations were modified in the new permit. Monitoring is conducted under the terms of the permit for a variety of organic and inorganic pollutants. During 1997, the wastewater flow in this system averaged about 754,000 gal/day (2,850,000 L/day).

Compliance sampling is conducted at the EESSMS (SS-6, Fig. 4.11) on a weekly basis. In addition, throughout 1997 mercury composite samples were obtained daily, Monday through Thursday, and a 3-day composite was obtained for the weekend (Friday through Sunday). This monitoring station is also used for 24-hour flow monitoring. As part of the city of Oak Ridge pretreatment program, city personnel also use this monitoring station to perform compliance monitoring as required by pretreatment regulations.

Storm Water

The development and implementation of a Storm Water Pollution Prevention Plan for the Y-12 Plant is required by Part IV of the NPDES permit. The objective of the plan is to minimize the discharge of pollutants in storm water runoff at the Y-12 Plant by assessing the quality of storm water discharges from the site, determining potential sources of pollutants affecting storm water, and providing effective controls to reduce or eliminate these pollutant sources. The plan is reviewed at least annually and updated, as necessary, to reflect changes in plant operations and incorporate revised monitoring strategies based on data from past years. The most recent revision of this plan was issued in May 1997, *Storm Water Pollution Prevention Plan for the Oak Ridge Y-12 Plant*, (Y/TS-1180/R2). The NPDES permit requires sampling of a minimum of 25 storm water outfalls per year, including both grab and composite sampling. Each year approximately 1500 chemical analyses are conducted on storm water samples at the Y-12 Plant.

4.2.2.2 Results and Progress in Implementing Corrective Actions

In 1997, the Y-12 Plant reduced NPDES excursions from ten in 1996 to seven in 1997. The seven excursions were attributed to following: an oil sheen on EFPC from a diesel fuel spill during filling of an underground tank, a high pH reading from a discharge from the Central Pollution Control Facility (CPCF), two exceedences of the permit limit for mercury from bypass of the East End Mercury Treatment Facility during a hundred-year flood event, two exceedences of the permit limit for nitrates from the discharge of the CPCF, and one excursion for low flow (monthly average) at Station 17. Additional detail on all Y-12 Plant NPDES permit excursions recorded in 1997 and the associated corrective action are summarized in Appendix F, Table F.1. As in the past year, none of the Y-12 Plant NPDES excursions were attributable to administrative errors such as missing analytical sample holding times, loss of a sample, or improper sample preservation. Table 4.15 lists the NPDES compliance monitoring requirements and the 1997 compliance record.

During 1997, the Y-12 Plant experienced three exceedences of the Industrial and Commercial Users Wastewater Permit for discharge of sanitary wastewater to the city of Oak Ridge POTW. The exceedences were for iron, copper, and cyanide. Although no specific cause could be determined, there are a number of construction activities involving the sanitary sewer that may have contributed to these exceedences. The construction activities are part of an ongoing multimillion-dollar sanitary sewer upgrade project that is expected to continue through FY 1999. Table 4.16 summarizes Y-12 Plant monitoring of the discharge to the sanitary sewer during 1997.

Review of storm water data from past years has established that some pollutants are not present at specific outfalls. It also has been established that for some parameters, grab and composite sample results are very similar. For these reasons, and with TDEC approval, the Storm Water Monitoring Plan will be revised to reflect reduced storm water monitoring in 1998.

East Fork Poplar Creek Dechlorination and Fish Kill Summary

During 1997, as in the past 4 years, instream levels of total residual chlorine were about 0.01 mg/L (outfall discharge levels prior to 1993 were about 0.3 to 1.0 mg/L). This reduction is a result of two dechlorination systems and 42 tablet

Table 4.15. NPDES compliance monitoring requirements and record for the Y-12 Plant, January through December 1997

Discharge point	Effluent parameter	Effluent limits: Daily av (lb/d)	Effluent limits: Daily max (lb/d)	Effluent limits: Daily av (mg/L)	Effluent limits: Daily max (mg/L)	Percentage of compliance	No. of samples
Outfall 066	pH, standard units			*a*	9.0	100	3
Outfall 068	pH, standard units			*a*	9.0	100	12
Outfall 117	pH, standard units			*a*	9.0	100	12
Outfall 073	pH, standard units			*a*	9.0	100	11
	Total residual chlorine				0.5	100	12
Outfall 077	pH, standard units			*a*	9.0	100	12
	Total residual chlorine				0.5	100	13
Outfall 122	pH, standard units			*a*	9.0	*b*	0
	Total residual chlorine				0.5	*b*	0
Outfall 133	pH, standard units			*a*	9.0	*b*	0
	Total residual chlorine				0.5	*b*	0
Outfall 125	pH, standard units			*a*	9.0	100	14
	Total residual chlorine				0.5	100	12
Category I outfalls (Storm water, steam condensate, cooling tower blowdown, and groundwater)	pH, standard units			*a*	9.0	100	60
Category I outfalls (Outfalls S15 and S16)	pH, standard units			*a*	10.0	100	5
Category II outfalls (cooling water, steam condensate, storm water, and groundwater)	pH, standard units			*a*	9.0	100	108
	Total residual chlorine				0.5	100	68
Category II outfalls (S21, S22, S25, S26, S27, S28, and S29)	pH, standard units			*a*	10.0	100	26
Outfall S19 (Rogers Quarry)	pH, standard units			*a*	9.0	100	14

Table 4.15 (continued)

Discharge point	Effluent parameter	Effluent limits: Daily av (lb/d)	Effluent limits: Daily max (lb/d)	Effluent limits: Daily av (mg/L)	Effluent limits: Daily max (mg/L)	Percentage of compliance	No. of samples
Category III outfalls (storm water, cooling water, cooling tower blowdown, steam condensate, and groundwater)	pH, standard units			*a*	9.0	100	157
	Total residual chlorine				0.5	100	130
Outfall 201 (below the North/South pipes)	Total residual chlorine			0.011	0.019	100	157
	Temperature, °C			*a*	30.5	100	157
	pH, standard units		8.5	*a*		100	157
Outfall 200 (North/ South pipes)	Oil and grease			10	15	100	159
Outfall 021	Total residual chlorine			0.080	0.188	100	157
	Temperature, °C			*a*	30.5	100	158
	pH, standard units				9.0	100	159
Outfall 017	pH, standard units			*a*	9.0	100	54
	Ammonia as N			32.4	64.8	100	54
Outfall 055	pH, standard units			*a*	9.0	100	103
	Mercury				0.004	98	108
	Total residual chlorine				0.5	100	103
Outfall 55A	pH, standard units			*a*	9.0	b	0
	Mercury				0.004	b	0
Outfall 550	pH, standard units			*a*	9.0	100	52
	Mercury			0.002	0.004	100	52
Outfall 551	pH, standard units				9.0	100	52
	Mercury				0.004	100	52
Outfall 051	pH, standard units			*a*	9.0	100	103
Outfall 501 (Central Pollution Control Facility)	pH, standard units			*a*	9.0	94	18
	Total suspended solids			31.0	40.0	100	16
	Total toxic organics				2.13	100	1
	Oil and grease			10	15	100	16
	Cadmium	0.16	0.4	0.075	0.15	100	16
	Chromium	1.0	1.7	0.5	1.0	100	16
	Copper	1.2	2.0	0.5	1.0	100	16
	Lead	0.20	0.4	0.1	0.2	100	16
	Nickel	1.4	2.4	2.38	3.98	100	16
	Nitrate/Nitrite				100	88	16
	Silver	0.14	0.26	0.05	0.05	100	16
	Zinc	0.9	1.6	1.48	2.0	100	16
	Cyanide	0.4	0.72	0.65	1.20	100	16
	PCB				0.001	100	1

Table 4.15 (continued)

Discharge point	Effluent parameter	Effluent limits: Daily av (lb/d)	Daily max (lb/d)	Daily av (mg/L)	Daily max (mg/L)	Percentage of compliance	No. of samples
Outfall 502 (West End Treatment Facility)	pH, standard units			*a*	9.0	100	35
	Total suspended solids	18.6	36.0	31.0	40.0	100	35
	Total toxic organics				2.13	100	5
	Nitrate/nitrite			100	150	100	35
	Oil and grease		10		15	100	35
	Cadmium	0.16	0.4	0.075	0.15	100	35
	Chromium	1.0	1.7	0.5	1.0	100	35
	Copper	1.2	2.0	0.5	1.0	100	35
	Lead	0.26	0.4	0.10	0.20	100	35
	Nickel	1.4	2.4	2.38	3.98	100	35
	Silver	0.14	0.26	0.05	0.05	100	35
	Zinc	0.9	1.6	1.48	2.0	100	35
	Cyanide	0.4	0.72	0.65	1.2	100	35
	PCB				0.001	100	5
Outfall 503 (Steam Plant Wastewater Treatment Facility)	pH, standard units			*a*	9.0	*b*	0
	Total suspended solids	125	417	30.0	40.0	*b*	0
	Oil and grease	62.6	83.4	10	15	*b*	0
	Iron	4.17	4.17	1.0	1.0	*b*	0
	Cadmium			0.075	0.15	*b*	0
	Chromium	0.83	0.83	0.20	0.20	*b*	0
	Copper	4.17	4.17	0.20	0.40	*b*	0
	Lead			0.10	0.20	*b*	0
	Zinc	4.17	4.17	1.0	1.0	*b*	0
Outfall 512 (Groundwater Treatment Facility)	pH			*a*	9.0	100	147
	Iron				1.0	100	147
	PCB				0.001	100	12
Outfall 520	pH, standard units				9.0	*b*	0
Outfall 05A	pH				9.0	100	4

[a]Not applicable.
[b]No discharge.

dechlorinators that were brought on line from 1992 through 1995. While reduced chlorine levels have contributed to ecological recovery of EFPC, a large, accidental release of a dechorination chemical on July 24, 1997, killed approximately 24,000 fish in UEFPC.

Most of these fish were central stonerollers (*Campostoma anomalum*) and blacknose dace (*Rhinichthys atratulus*). Other species killed included striped shiners (*Luxilus chrysocephalus*) and redbreast sunfish (*Lepomis auritus*). The fish kill was caused by an excess amount of dechlorinating chemical—sodium bisulfite—that was added to the creek, reacted with the water, reduced oxygen levels, and killed the fish. The problem followed heavy flooding during the night of July 22. A storm cell associated with Hurricane Danny released approximately 6 in. of rain on the Y-12 Plant in approximately 1½ hours. The dechlorinating system, and the raw water line

Table 4.16. Y-12 Plant Discharge Point SS6, Sanitary Sewer Station 6, nonradiological summary (1/1/97–12/31/97)

Parameter	Number of samples	Concentration[a]			Reference value[b]	Number of values exceeding reference
		Max	Min	Avg		
Flow, gpd[c]	365	1814831.0	456418.0	754190.7	*d*/1.4	*d*
pH, std unit	54	7.9	7.0	*d*	9/6(*e*)	0
Silver	53	0.011	0.0014	<0.0066	0.1/0.1	0
Arsenic	53	<0.042	<0.003	<0.03	0.1/0.0045	0
Boron	53	0.47	<0.02	<0.04	*d*/*d*	*d*
Benzene	13	0.01	0.005	0.008	0.87/0.015	0
Biochemical oxygen demand	53	90.0	11.0	39.2	300/300	0
Cadmium	53	<0.004	<0.0015	<0.003	0.004/0.0045	0
Chemical oxygen demand	8	103.0	41.0	71.4	*d*/*d*	*d*
Chromium	53	<0.006	0.0013	<0.005	0.44/0.075	0
Chromium, hexavalent	8	<0.01	<0.01	<0.01	0.01/*d*	0
Copper	53	0.217	0.007	0.03	0.04/0.092	1
Cyanide	13	0.015	<0.01	<0.01	0.01/0.062	1
Iron	53	1.91	0.34	0.61	1.5/15	1
Mercury	248	0.013	0.0003	0.002	0.035/0.035	0
Kjeldahl nitrogen	53	20.0	0.34	9.6	90/90	0
Methylene chloride	13	0.01	0.005	0.008	0.22/0.041	0
Manganese	53	0.085	0.031	0.056	1/*d*	0
Nickel	53	<0.008	<0.003	<0.008	0.1/0.032	0
Oil and grease	53	20.1	2.2	<6.2	50/50	0
Lead	53	<0.02	<0.003	<0.02	0.02/0.074	0
Phenols—total recoverable	22	0.032	<0.005	<0.02	5/0.5	0
Selenium	53	<0.1	<0.003	<0.1	*d*/*d*	*d*
Suspended solids	58	85.5	<5.0	<55	300/300	0
Toluene	13	0.01	0.005	0.008	5.35/0.02	0
Trichloroethene	13	0.002	0.001	0.002	0.045/0.027	0
Zinc	53	0.37	0.07	0.1	2/0.75	0
Uranium	56	0.014	0.0026	0.006	*d*/*d*	*d*
^{235}U, weight %	56	2.2	0.38	0.80	*d*/*d*	*d*

[a]Units in mg/L unless otherwise indicated.
[b]Sanitary sewer permit limits prior to August 25/ limits effective August 25 or after.
[c]Flow during operations and/or discharging.
[d]Not applicable.
[e]Maximum value/minimum value.

from the Clinch River that supplements the flow in EFPC, were shut off after the rainfall. Even though the dechlorinating system was shut off, an elevated tank allowed some of the chemical to bleed through a pump line into a mixing box. When the system was restarted on July 24, the excess chemical in the box was released to the creek. The malfunctioning feed system has been modified to prevent similar incidents.

Flow Management (or Raw Water) Project

Because of concern about maintaining water quality and stable flow in the upper reaches of EFPC, the NPDES permit requires addition of Clinch River water to the headwaters of EFPC (North/South Pipe-Outfall 200 area) so that a minimum flow of 7 million gal/day (26.5 million L/day) is maintained at the point where EFPC leaves the reservation (Station 17). The permit required that this project be implemented by March 1997, but the work was completed ahead of schedule (August 1996). With the completion of this project, instream water temperatures decreased approximately 5°C (from approximately 26°C at the headwaters). During September 1997, the monthly average daily flow at Station 17 was 6.9 million gallons per day. This was a result of a drier (less rainfall) than normal month and the unavailability of one of two raw water feed lines because of needed repair. A funding request has been made for repair to the second raw water line.

Drain Modifications and Reroutes

Extensive drain surveys conducted prior to 1993 identified building drains that were incorrectly connected to either the sanitary or storm sewers. Most of these drains were administratively closed at that time. Permanent and physical changes to provide correct drain routings have been completed for 29 buildings. In addition, a project to survey all the remaining and previously unsurveyed building drains at the Y-12 Plant was completed in early 1995. Incorrectly routed drains were identified for closure or correction, and many drains were corrected or eliminated. A validation project was initiated in 1996 to confirm the status of building floor drains. Any drains found to be open are required to be plugged or "permitted" open by an internal process. New building drain maps and drain status records are being generated. This work is planned for completion in 1998.

Reduction of Mercury in Plant Effluent: Phase II

The legacy of contamination resulting from use and storage of mercury at the Y-12 Plant has prompted a series of remedial measures. These efforts are directed toward meeting the NPDES permit requirements of 5 g/day from the Y-12 Plant by December 31, 1998. To date, six projects (four building source elimination efforts and two treatment units) have been completed under the Reduction of Mercury in Plant Effluent (RMPE) II program to reduce mercury contamination to UEFPC.

Additional work continued in 1997, which included development of a treatment approach for Outfall 51 (a mercury-contaminated spring), evaluation of stannous chloride additive to enhance air stripping of mercury, evaluation of several potential mercury-removing media in small-scale column tests, and a temporary, dry-weather bypass test of Lake Reality.

Although Lake Reality tends to trap sediment during storm events, it appears to have been a source of contaminants during dry weather, and anaerobic conditions in the lake generate methyl mercury. During dry weather there was a mercury increase across the lake (inlet to outlet) of approximately 5 grams per day. During the bypass test, mercury levels, as measured at Station 17, were approximately the same as at the lake inlet, thus reflecting an approximate 5-gram reduction as a result of the bypass. Because of these positive results achieved with a temporary bypass, a permanent bypass configuration is planned for 1998 where all flow, except for the most significant storm flows, will bypass the lake. However, the configuration will maintain the capability to divert flow to Lake Reality to capture a spill from within the plant if necessary.

Additional work in 1998 will consider treatment of Outfall 51 and redirection of some small volume of mercury-contaminated drainage to treatment. Future long-range mercury remediation for EFPC will be driven by the CERCLA process and the record of decision (ROD) for UEFPC Characterization area.

4.2.2.3 ORNL NPDES Summary

NPDES Permit Monitoring

ORNL NPDES Permit TN0002941 was renewed on December 6, 1996, and became effective on February 3, 1997. Data collected for the NPDES permit are submitted to the state of Tennessee in the monthly *Discharge Monitoring Report*. The renewed permit includes 164 separate outfalls and monitoring points.

ORNL's 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. 4.15). Under the renewed permit, numeric and aesthetic effluent limits have been placed on the following locations:

- X01- Sewage Treatment Plant;
- X02-Coal Yard Runoff Treatment Facility;
- X12-Nonradiological Wastewater Treatment Facility;
- 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;
- 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 and water condensate, cooling water, and cooling tower blowdown);
- Category IV outfalls (storm drains, water discharged under best management practices, groundwater, steam and water condensate, cooling water, and cooling tower blowdown); and
- Cooling systems (cooling water, cooling tower blowdown).

Permit limits and compliance statistics are shown in Table 4.17. Permit limit exceedences in 1997 are shown in Fig. 4.26. Most permit limit excursions in 1997 involved exceedence of chlorine limits at cooling water and cooling tower blowdown outfalls. Dechlorination systems have been upgraded to guard against recurrence.

ORNL Outfall X01, the STP, experienced a daily maximum concentration and a daily maximum loading exceedence of the carbonaceous biochemical oxygen demand (CBOD) limit on October 9, 1997. As a corrective measure, the dechlorination system feed was modified at the STP. There were no additional instances of nonconformance after the one on October 9, 1997.

One Category IV outfall, 302, experienced one pH limit exceedence (pH of 9.1 measured on November 17, 1997). Corrective actions to mitigate the exceedence included identifying and repairing an underground leak in a waste treatment system component.

Under the renewed NPDES permit, ORNL has initiated several new monitoring plans and programs. These include the RMP, the Chlorine Control Strategy (CCS), and the Storm Water Pollution Prevention (SWPP) Plan. Each of these is discussed in the following sections.

Radiological Monitoring Plan

To meet a permit requirement of the new NPDES permit, ORNL submitted to TDEC a revised RMP. Approval of the RMP was received from TDEC July 1, 1997. Under the revised RMP, monitoring of radioactivity is required at three treatment facilities, STP, CYRTF, and NRWTF, and at three instream locations, X13 on Melton

Table 4.17. 1997 NPDES compliance at ORNL (NPDES permit effective Feb. 3, 1997)

Discharge point	Effluent parameters	Permit limits: Monthly av (kg/d)	Permit limits: Daily max (kg/d)	Permit limits: Monthly av (mg/L)	Permit limits: Daily max (mg/L)	Permit limits: Daily min (mg/L)	Permit compliance: Number of noncompliances	Permit compliance: Number of samples	Permit compliance: Percentage of compliance[a]
X01 (Sewage Treatment Plant)	96-hour LC_{50} for *Ceriodaphnia* (%)					41.1	0	3	100
	96-hour LC_{50} for fathead minnows (%)					41.1	0	3	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	64	100
	Carbonaceous biochemical oxygen demand	8.7	13.1	10	15		2	143	99
	Dissolved oxygen					6	0	144	100
	Fecal coliform (col/100 mL)			1000	5000		0	144	100
	No-observed-effect conc. for *Ceriodaphnia* (%)					12.3	0	3	100
	No-observed-effect conc. for fathead minnows (%)					12.3	0	3	100
	Oil and grease	8.7	13.1	10	15		0	144	100
	pH (std. units)				9	6	0	144	100
	Total residual chlorine			0.038	0.066		2	147	99
	Total suspended solids	26.2	39.2	30	45		0	143	100
X02 (Coal Yard Runoff Treatment Facility)	96-hour LC_{50} for *Ceriodaphnia* (%)					4.2	0	4	100
	96-hour LC_{50} for fathead minnows (%)					4.2	0	4	100
	Copper, total			0.07	0.11		0	22	100
	Iron, total			1.0	1.0		0	22	100
	No-observed-effect conc. for *Ceriodaphnia* (%)					1.3	0	2	100
	No-observed-effect conc. for fathead minnows (%)					1.3	0	2	100
	Oil and grease			10	15		0	48	100
	pH (std. units)				9.0	6.0	0	48	100
	Selenium, total			0.22	0.95		0	22	100
	Silver, total				0.008		0	22	100
	Total suspended solids				50		0	48	100
	Zinc, total			0.87	0.95		0	22	100

Table 4.17 (continued)

Discharge point	Effluent parameters	Permit limits: Monthly av (kg/d)	Daily max (kg/d)	Monthly av (mg/L)	Daily max (mg/L)	Daily min (mg/L)	Permit compliance: Number of noncompliances	Number of samples	Percentage of compliance[a]
X12 (Nonradiological Wastewater Treatment Facility)	96-hour LC_{50} for *Ceriodaphnia* (%)					100	0	4	100
	96-hour LC_{50} for fathead minnows (%)					100	0	4	100
	Cadmium, total	0.79	2.09	0.008	0.034		0	48	100
	Chromium, total	5.18	8.39	0.22	0.44		0	48	100
	Copper, total	6.27	10.24	0.07	0.11		0	48	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	48	100
	Nickel, total	7.21	12.06	0.87	3.98		0	48	100
	No-observed-effect conc. for *Ceriodaphnia* (%)					30.9	0	4	100
	No-observed-effect conc. for fathead minnows (%)					30.9	0	4	100
	Oil and grease	30.3	45.4	10	15		0	48	100
	pH (std. units)				9.0	6.0	0	144	100
	Silver, total	0.73	1.3		0.008		0	48	100
	Temperature (°C)				30.5		0	144	100
	Total toxic organics		6.45		2.13		0	11	100
	Zinc, total	4.48	7.91	0.87	0.95		0	48	100
Instream chlorine monitoring points	Total residual oxidant			0.011	0.019		2	242	99
Steam condensate outfalls	pH (std. units)				9.0/8.5	6.0/6.5	0	17	100
Groundwater/ pumpwater outfalls	pH (std. units)				9.0/8.5	6.0/6.5	0	8	100

Table 4.17 (continued)

Discharge point	Effluent parameters	Permit limits					Permit compliance		
		Monthly av (kg/d)	Daily max (kg/d)	Monthly av (mg/L)	Daily max (mg/L)	Daily min (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[a]
Cooling tower blowdown outfalls	pH (std. units)				9.0	6.0	0	2	100
Category I outfalls	pH (std. units)				9.0	6.0	0	13	100
Category II outfalls	pH (std. units)				9.0	6.0	0	15	100
Category III outfalls	pH (std. units)				9.0	6.0	0	63	100
Category IV outfalls	pH (std. units)				9.0	6.0	1	296	100
Cooling tower blowdown/ cooling water outfalls	pH (std. units)				9.0	6.0	0	44	100
	Total residual oxidant			0.011	0.019		12	53	77

[a]Percent compliance = 100 – [(number of noncompliances/number of samples) * 100].

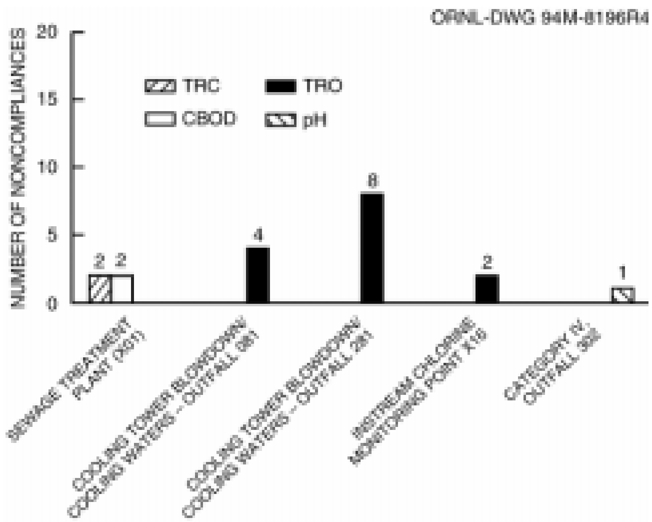

Fig. 4.26. ORNL NPDES permit limit exceedences in 1997 (total = 19).

Branch, X14 on White Oak Creek, and X15 at White Oak Dam (see Fig. 4.15). Additional sites that were monitored under the previous RMP, namely, First Creek, Fifth Creek, Northwest Tributary, 7500 Road Bridge, Raccoon Creek, White Oak Creek Headwaters, and Melton Hill Dam (Fig. 4.15), continued to be monitored under the NPDES program through the remainder of 1997 to ensure continuity of data while those sites were transitioned to another monitoring program. An assessment of radiological liquid effluents, including numerous category outfalls, was conducted in the summer of 1997. Data gathered during the assessment will be used to complete another revision of the RMP in 1998. Results for the 1997 monitoring are presented in the ORNL Radiological Monitoring Summary section, Sect. 4.2.1.2.

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 (TRO) mass-loading action levels on outfalls, depending on the outfall's location and volume of its discharge. At ORNL, TRO measurements may include both chlorine and bromine residuals. Most outfalls with TRO mass-loading action levels are monitored quarterly under the Chlorine Control Strategy in dry-weather conditions; five outfalls are monitored weekly in dry-weather conditions. These outfalls have a mass-loading action level for TRO that requires ORNL to reduce or eliminate TRO in the discharge if it exceeds the action level. The action level is 1.2 grams per day (g/d) and is calculated by multiplying the instantaneous measured concentration by the instantaneous flow rate of the outfall. During 1997, 74 outfalls had one or more measurable dry-weather flows and 20 outfalls exceeded the TRO action level one or more times. Corrective actions have been fully implemented at 11 outfalls by either rerouting or eliminating the chlorinated discharge or by installing dechlorination systems. Sources or corrective actions for the remaining outfalls are under investigation.

Storm Water Pollution Prevention Plan

The SWPP requires (1) assessment of storm water quality at ORNL, (2) characterization of storm water by monitoring, (3) training of employees, and (4) implementation of measures to minimize storm water pollution in areas of ORNL that may be affected. These four components of the plan were initiated in 1997 at ORNL. Monitoring for this program will begin in 1998.

Mercury and PCBs in the Aquatic Environment

The mercury and PCB monitoring programs at ORNL were conducted to comply with the ORNL NPDES permit issued in 1986. The new permit requires neither mercury nor PCB monitoring programs; monitoring of mercury and PCBs is continued as a requirement of the ORNL BMAP. Mercury found at the ORNL site was a result of spills that occurred from 1954 through 1963. Because processes using mercury are no longer in operation and analytical results of aquatic samples have consistently indicated concentrations well below the reference value established by the Tennessee Water Quality Criteria for the protection of fish and aquatic life, monitoring for mercury in the aquatic environment at ORNL was terminated in 1997. Monitoring for PCBs in water samples was terminated in 1992 because analytical values were consistently below analytical detection limits. Monitoring for PCBs in sediment was continued through 1996 and then terminated. Results for most samples in 1996 were below analytical detection limits or were estimated by the laboratory as at or below the detection level.

4.2.2.4 ETTP Surface Water Effluents

The current ETTP NPDES permit went into effect on October 1, 1992, and a major modification was issued effective June 1, 1995. The modification included removal of inactive outfalls, addition of effluent limits for new treatment technologies at the CNF, addition of new storm drains, and clarification of various requirements. In accordance with the NPDES permit, the ETTP is authorized to discharge process wastewater, cooling water, storm water, steam condensate, and groundwater to the Clinch River, Poplar Creek, and Mitchell Branch. The permit currently includes 4 facility outfalls and 136 storm water outfalls. Compliance with the permit for the last 5 years is summarized by the major effluent locations in Fig. 4.27. Table 4.18 details the permit requirements and compliance records for all of the outfalls that discharged during 1997. The table provides a list of the discharge points,

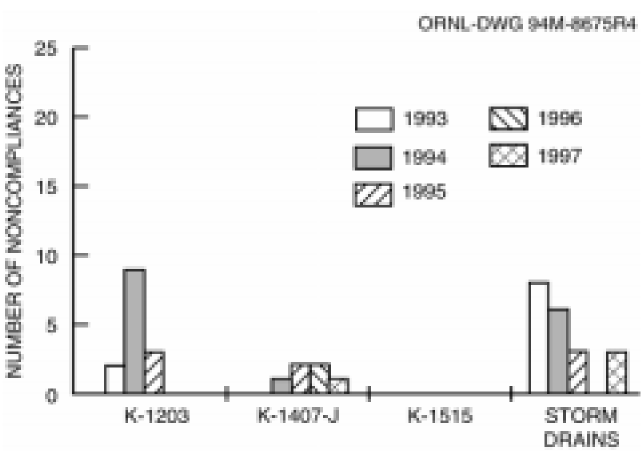

Fig. 4.27. ETTP NPDES compliance history by source of noncompliance.

effluent analytes, permit limits, number of noncompliances, and the percentage of compliance for 1997. Samples from these outfalls are collected and analyzed as specified in the NPDES permit.

The following are the four permitted major outfalls at the ETTP (Fig. 4.23):

- 005 (K-1203 Sewage Treatment Plant),
- 009 (K-1515 Sanitary Water Treatment Facility),
- 013 (K-1513 Sanitary Water Intake Backwash Filter), and
- 014 (K-1407-J CNF discharge to the Clinch River).

Although no monitoring is required at Outfall 013, routine inspections are conducted to ensure that no unsightly debris or scum is discharged through this point as the result of backwash operations at the K-1513 sanitary intake filter. Outfall 014 is a permitted outfall for the discharge of effluent from the CNF to the Clinch River.

Results

Outfall 005 is the discharge point for the ETTP STP, which is an extended aeration treatment plant having a rated capacity of 2.3 million L/d [0.6 million gallons per day (Mgd)] and a current use of about 1.4 million L/d (0.36 Mgd). Treated effluent from the main plant is discharged into Poplar Creek through this outfall. This facility had no NPDES permit noncompliances during 1997.

Outfall 009 is the discharge point for the K-1515 sanitary water plant, which provides sanitary water to the ETTP to be used for drinking, fire protection, and other purposes. It also provides water to two industries in the Bear Creek Road Industrial Park through an arrangement with the city of Oak Ridge. Raw water is taken from the Clinch River and treated at K-1515. The K-1515 sanitary water plant exhibited 100% compliance with the ETTP NPDES permit during 1997.

Table 4.18. NPDES compliance at the ETTP, 1997

Discharge point	Effluent parameter	Effluent limits: Monthly av[a]	Daily max[a]	Monthly av (lb/day)	Daily max (lb/day)	No. of noncompliances	Percentage of compliance
005 (K-1203 Sewage Treatment Facility)	Ammonia nitrogen	5	7	12	17		100
	Biochemical oxygen demand	15	20	37	49		100
	Chlorine, total residual	0.14	0.24				100
	Dissolved oxygen		5[b]				100
	Fecal coliform, col/100 mL	200[c]	1,000				100
	Flow, Mgd	*d*	*d*				100
	LC_{50}, *Ceriodaphnia*, %		14.6[b]				100
	LC_{50}, *Pimephales*, %		14.6[b]				100
	NOEL,[e] *Ceriodaphnia*, %		4.2[b]				100
	NOEL,[e] *Pimephales*, %		4.2[b]				100
	pH, standard units		6.0–9.0				100
	Settleable solids, mL/L		0.5				100
	Suspended solids	30	45	74	111		100
	Unpermitted discharge	*f*	*f*	*f*	*f*		*f*
009 (K-1515-C Sanitary Water Plant)	Aluminum	1.0	2.0				100
	Chlorine, total residual		1.0				100
	Flow, Mgd	*d*	*d*				100
	pH, standard units		6.0–9.0				100
	Settleable solids, mL/L		0.5				100
	Suspended solids	30	40				100
	Unpermitted discharge	*f*	*f*	*f*	*f*		*f*
013 (K-1513 Sanitary water intake and backwash filter	Visual inspection of receiving stream						
014 (K-1407-J Central Neutralization Facility to Clinch River)	1,1,1-Trichloroethane	*d*	*d*				100
	Acetone	*d*	*d*				100
	Acetonitrile	*d*	*d*				100
	Benzene	*d*	0.005				100
	Bromoform	*d*	*d*				100
	Cadmium	0.18	0.69				100
	Carbon tetrachloride	0.5	0.5				100
	Chemical oxygen demand	*d*	*d*				100
	Chloride, total	35,000	70,0000				100
	Chlorine, total residual		1.0				100
	Chlorodibromomethane	*d*	*d*				100
	Chloroform	0.5	0.5				100
	Chromium	1.71	2.77				100
	Copper	1.34	2.15				100
	Dichlorobromemethane	*d*	*d*				100
	Flow, Mgd	*d*	*d*				100
	Ethylbenzene	*d*	0.01				100
	Gross alpha, pCi/L	*d*	*d*				100
	Gross beta, Pci/L	*d*	*d*				100
	Lead	0.38	0.69				100
	Methyl ethyl ketone	*d*	*d*				100
	Methylene chloride	*d*	*d*				100
	Naphthalene	*d*	*d*				100
	Nickel	2.38	3.98				100
	Oil and grease		30				100
	PCB	0.00022	0.00045				100
	Petroleum hydrocarbons	*d*	0.1			1	91.7
	pH, standard units		6.0–9.0				100

Table 4.18 (continued)

Discharge point	Effluent parameter	Effluent limits: Monthly av[a]	Daily max[a]	Monthly av (lb/day)	Daily max (lb/day)	No. of noncompliances	Percentage of compliance
014 (continued)	Silver	0.24	0.43				100
	Suspended solids		40				100
	Tetrachloroethylene		0.7				100
	Toluene	*d*	0.01				100
	Total toxic organics		2.13				100
	Trichloroethylene	0.5	0.5				100
	Unpermitted discharge	*f*	*f*	*f*	*f*		*100*
	Uranium, total	*d*	*d*				100
	Vinyl chloride	0.2	0.2				100
	Zinc	1.48	2.61				100
Category I storm drains	Flow, Mgd	*d*	*d*				100
	pH, standard units		4.0–9.0				100
	Missed sample	*f*	*f*	*f*	*f*	1	50
Category II storm drains	Flow, Mgd	*d*	*d*				100
	pH, standard units		4.0–9.0				100
	Suspended solids	*d*	*d*				100
	Unpermitted discharge	*f*	*f*	*f*	*f*		*f*
Category III storm drains	Flow, Mgd	*d*	*d*				100
	Oil and grease	*d*	*d*				100
	pH, standard units		4.0–9.0				100
	Suspended solids	*d*	*d*				100
	Unpermitted discharge	*f*	*f*	*f*	*f*		*f*
Category IV storm drains (to Poplar Creek)	Chlorine, total residual		0.14			1	98
	Flow, Mgd	*d*	*d*				100
	Oil and grease	*d*	*d*				100
	pH, standard units		6.0–9.0				100
	Suspended solids	*d*	*d*				100
	Unpermitted discharge	*f*	*f*	*f*		1	*f*
Category IV storm drains (to Mitchell Branch)	Chlorine, total residual		0.019				100
	Flow, Mgd	*d*	*d*				100
	Oil and grease	*d*	*d*				100
	pH, standard units		6.0–9.0				100
	Suspended solids	*d*	*d*				100
	Unpermitted discharge	*f*	*f*	*f*	*f*		*f*

[a]Units are mg/L unless otherwise stated.
[b]Daily minimum.
[c]Geometric mean.
[d]Nonlimited parameter.
[e]No-observed-effect limit.
[f]Not applicable.

The ETTP CNF, Outfall 014, has provisions for treatment of nonhazardous and hazardous wastes. Nonhazardous flow entering the CNF consists of steam plant effluents and various small-quantity or infrequent streams from waste disposal requests. Hazardous streams include effluents from the TSCA Incinerator, the steam plant hydrogen softener waste stream, and various small-quantity or infrequent streams from waste disposal requests.

To begin treatment of waste streams contaminated with various organics, the CNF was upgraded in 1996 to include pressure filters, carbon adsorption, and air stripping. These upgrades were approved by TDEC, and construction was completed in April 1996. Operational testing was completed in June 1996, and the new organics treatment system went on line in July 1996. The CNF had one NPDES noncompliance in 1997.

The CNF experienced an exceedence of the NPDES permit limit for total petroleum hydrocarbons (TPH) in March 1997. The Outfall 014 permit limit of 0.1 mg/L for TPH was established as a technology-based limit contingent upon the upgrade of the CNF to include organics waste treatment capabilities. On March 17, 1997, the TPH concentration in a routine sample collected on effluent from Outfall 014 at the CNF was measured at 1.64 mg/L. This concentration exceeded the maximum permitted level of 0.1 mg/L for TPH at this outfall. Previous samples collected at the CNF after installation of the organic treatment unit in 1995 had shown no detectable levels of TPH. In addition, TPH concentrations in all influent streams to CNF were within the waste acceptance criteria guidelines for the CNF. Although an extensive investigation, which included close scrutiny of operating records and analytical procedures, was conducted, no definitive source of the elevated TPH concentration was identified.

The ETTP NPDES permit includes 136 storm water outfalls that are grouped into four categories based on their potential for pollutants to be present in their discharge. Category I storm water outfalls have intermittent flow and drain storm water runoff from areas remotely associated with plant activities and subsurface runoff; Category II storm water outfalls have intermittent flow and drain storm water runoff from building roof drains and paved areas associated with plant activities; Category III storm water outfalls have intermittent flow and drain storm water runoff from areas associated with concentrated storage areas, roof drains, coolant systems, and parking lots; and Category IV storm water outfalls have continuous flow and drain cooling water discharges and runoff from industrial areas. Monitoring at storm water outfalls is conducted semiannually, quarterly, monthly, or weekly for Categories I through IV, respectively, with those outfalls that have the highest potential for pollution being sampled most frequently.

The remaining three ETTP NPDES noncompliances for 1997 occurred at storm water outfalls. These noncompliances occurred at Outfall 100, Outfall 124, and Outfall 500.

On September 24, 1997, a routine weekly sample collected at storm water outfall SD-124 resulted in a total residual chlorine (TRC) measurement of 0.18 mg/L. This measurement exceeded the maximum permitted level of 0.14 mg/L for TRC at this outfall. A thorough investigation was conducted to determine the source of the elevated TRC. Buildings, paved areas and grassy areas that drain to SD-124 were walked down to identify potential TRC sources. Smoke testing was conducted at catch basins above SD-124 and maps and video tapes resulting from a storm drain video survey conducted in 1995 were reviewed. No TRC sources were identified. Dechlorination tablets were placed in a catch basin upstream of SD-124 as a precautionary measure, and daily surveillance of SD-124 was conducted to identify flow patterns. Sampling conducted at SD-124 since the September 24, 1997 incident have identified no presence of TRC.

On October 1, 1997, a liquid solution of an absorbent material was discovered entering the storm drain system via a catch basin outside a building being used by a private industrial firm. The catch basin is part of the storm drain network that discharges through storm drain outfall SD-100. The quantity of material that entered the storm drain system is unknown. The absorbent material is produced by the firm leasing the building, and although its exact formulation is proprietary, it is primarily composed of portland cement, attapulgite clay, and quartz. Best management practices to eliminate migration of the material into the storm drain system were recommended to the private industrial firm. No adverse environmental impacts were observed as a result of the incident.

During an October 2, 1997, administrative review of sampling records, it was discovered that NPDES Category I storm water outfall SD-500 had not been sampled during the semiannual reporting period of April 1, 1997, through September 30, 1997. An investigation was conducted to determine why SD-500 was not sampled and to identify corrective actions to prevent recurrence. Several contributing factors were identified, including physical relocation of sampling personnel, reductions in personnel in the sampling and program management departments, and access problems at SD-500 because of ongoing construction activities. The existing administrative systems for tracking outfall sampling progress were found to be satisfactory, and discussions emphasizing attention to detail were conducted with all staff involved in collecting samples.

The SWPP Program is another requirement of the NPDES permit. The purpose of the ETTP SWPP Program is to assess the quality of storm water discharges from the ETTP, determine potential sources of pollutants affecting storm water, and provide effective controls to reduce or eliminate these pollutant sources. The SWPP program provides a means whereby sources of pollutants that are likely to affect the quality of storm water discharges are identified, BMPs that can be used to control the entry of pollutants into storm water discharges are developed, and methods for implementing pollution prevention practices are devised.

As part of the 1996–97 SWPP sampling effort, storm water outfalls at the ETTP were grouped (as permitted under Part IV.C.4 of the ETTP NPDES permit), and storm water samples were collected from a representative outfall from each group. Storm water outfalls were placed in a group based on several criteria: (1) knowledge of drainage areas obtained from block plans and maps of the ETTP, (2) knowledge of various processes and functions conducted at the ETTP, and (3) information in the ETTP NPDES permit application. The individual outfall chosen to represent the group was selected based on the location of the outfall's storm drain network in relation to the other storm drain networks in the group, the representativeness of previously collected analytical data in relation to other outfalls in the group, the likelihood of the outfall having sufficient flow for sample collection to take place during a storm event, ease of access to the outfall during storm events, and categorization of the outfall in the ETTP NPDES permit.

Several of the storm water outfalls did not fit into groups and were therefore sampled individually. Screening criteria used to determine the outfalls that should be sampled individually were developed from the TDEC general water quality criteria for various uses, Part III.A.a. (Toxic Pollutants) criteria of the ETTP NPDES permit, discussions in NPDES permit rationale and addendums, and SDWA maximum contaminant levels. These criteria were applied to data collected under previous SWPP monitoring efforts. In general, the most stringent criterion was selected to be included in the overall screening criteria.

Analytical parameters that were monitored under this sampling and analysis (S&A) plan were selected based on the review of previous SWPP analytical data, historical knowledge of the ETTP, information obtained from the sitewide storm drain camera survey, data from sump discharge sampling efforts, and groundwater data from plant areas near drains where significant groundwater and surface water interactions are suspected. The previously mentioned screening levels were used to indicate the outfalls that may discharge pollutants at potentially significant levels.

The objectives of the 1996–97 SWPP sampling program were twofold: (1) to provide analytical data necessary for the ETTP NPDES permit renewal process and (2) to evaluate and characterize storm water runoff from the ETTP.

To facilitate the transfer of ownership/operation of ETTP facilities to other parties, it was determined that separate NPDES permits would be required for each of the ETTP treatment facilities. In addition, it was determined that a separate NPDES permit for the storm water drainage system would be necessary. The EPA 2F forms that must be completed as part of the application for the ETTP NPDES permit for the storm drainage system required a large quantity of analytical data that had not been collected during any previous storm drain sampling effort. Therefore, Phase I of the 1996–97 SWPP sampling effort was conducted to collect analytical data that would allow for completion of the NPDES permit application for the ETTP storm drainage system. Phase I sampling included collection of samples from specific storm drains during wet weather conditions and collection of samples from storm drains that flow on a continuous basis during dry weather conditions. Analytical data from both wet and dry weather conditions were required for completion of the 2F forms.

Because Phase I of the 1996–97 SWPP sampling effort was performed in an effort to obtain analytical data required by TDEC for completion of the ETTP NPDES permit renewal application, Phase I analytical data were not compared to the screening criteria.

Phase II sampling was conducted to further define the presence of contaminants in the storm drain system that have been detected during SWPP efforts conducted in 1993–94, 1994–95, and 1995–96. Analytical results from these past sampling efforts were compared to screening criteria that were developed from several sources. Parameters for which the analytical results exceeded these screening criteria were monitored as part of the 1996–97 SWPP sampling effort to determine the change in the levels of these contaminants over time, if any.

PCBs (Aroclor-1254) were detected at storm water Outfall 280 at a concentration of 0.88 µg/L. This storm water outfall is located at the north end of the K-1064 peninsula and drains a grassy and graveled area. Storm water Outfall 280 drains areas that are within the K-1064 Operable Unit. A remedial investigation of this unit will be conducted as part of the Environmental Restoration program.

Alpha activity was detected at levels of 58.6 pCi/L, 93.7 pCi/L, and 25.7 pCi/L at storm water outfalls 150, 158, and 382, respectively. All of these alpha activity levels were above the screening criteria level of 15 pCi/L, which is the maximum contaminant level (MCL) established for alpha activity in SWDA.

Trichloroethene was detected in concentrations above the applicable screening level at storm water outfalls 170 and 180. The screening level for trichloroethene is 5 µg/L, which is the limit for this compound found in the Tennessee Water Quality Criteria for domestic water supplies. Tricholorethene was detected at 16 µg/L and 130 µg/L at outfalls 170 and 180, respectively. In addition, vinyl chloride was detected in concentrations above the applicable screening level at storm water Outfall 190. The screening level for vinyl chloride is 2 µg/L, which is the limit for this compound found in the Tennessee Water Quality Criteria for domestic water supplies. Vinyl chloride was detected at Outfall 190 at 20 µg/L.

The presence of volatile organic compounds in these storm water outfalls is likely a result of the discharge of contaminated groundwater. The presence of a contaminated groundwater plume that discharges to Mitchell Branch via these outfalls is well documented. Currently, CERCLA remedial actions are being evaluated to construct trenches and extraction wells to intercept the plume. The contaminated groundwater would be collected and pumped to the K-1407 CNF, where it would be treated and discharged to the Clinch River via an NPDES-permitted outfall.

Metals concentrations above applicable screening levels were detected at several locations throughout the ETTP as part of the 1996–97 SWPP sampling effort. Metals commonly detected in storm water runoff included iron, magnesium, aluminum, copper, and zinc. However, the presence of these particular metals in storm water runoff in concentrations above screening levels is not believed to be problematic. All of these metals are commonly found in soils and sediments within this geographic region. Also, many of the elevated metals levels were associated with elevated levels of total suspended solids, which suggests that the source of the metals is more closely related to the amount of sediment being transported by the storm water runoff and not the storm water itself.

4.3 TOXICITY CONTROL AND MONITORING PROGRAM

4.3.1 Y-12 Plant Biomonitoring Program

In accordance with the 1995 NPDES permit (Part III-C, p. 39), a Biomonitoring Program that evaluates an EFPC instream monitoring location (Outfall 201), wastewater treatment system discharges, and locations in the storm sewer system is required. Table 4.19 is a summary of the results of biomonitoring tests conducted on effluent

Table 4.19. Y-12 Plant Biomonitoring Program summary information for wastewater treatment systems and storm sewer effluents for 1997[a]

Site/building	Test date	Species	48-h LC_{50}[b] (%)	IWC[c] (%)
Central Pollution Control Facility (Outfall 501)	1/8	*Ceriodaphnia*	>100	0.09
Groundwater Treatment Facility (Outfall 512)	1/8	*Ceriodaphnia*	43.0	0.23
9422-17 Storm Sewer	1/8	*Ceriodaphnia*	>100	*d*
Central Mercury Treatment System (Outfall 551)	1/15	*Ceriodaphnia*	>100	8.32
Storm Sewer Drain D2426	1/15	*Ceriodaphnia*	>100	*d*
Storm Sewer Drain D2426 (dechlorinated)	1/15	*Ceriodaphnia*	>100	*d*
Storm Sewer Drain D3321	1/15	*Ceriodaphnia*	70.7	*d*
Storm Sewer Drain E3305	1/15	*Ceriodaphnia*	>100	*d*
West End Treatment Facility (Outfall 502)	3/7	*Ceriodaphnia*	91.1	0.07
Central Pollution Control Facility (Outfall 501)	4/3	*Ceriodaphnia*	>100	0.10
Groundwater Treatment Facility (Outfall 512)	4/10	*Ceriodaphnia*	30.5	0.15
Central Mercury Treatment System (Outfall 551)	4/10	*Ceriodaphnia*	>100	23.73
Storm Sewer Drain D2426	4/10	*Ceriodaphnia*	56.0	*d*
Storm Sewer Drain D2426 (dechlorinated)	4/10	*Ceriodaphnia*	>100	*d*
Central Pollution Control Facility (Outfall 501)	4/11	*Ceriodaphnia*	>100	0.06
9422-17 Storm Sewer	4/15	*Ceriodaphnia*	Invalid[e]	Invalid[e]
Storm Sewer Drain D3321	4/15	*Ceriodaphnia*	17.1	*d*
Storm Sewer Drain E3306	4/15	*Ceriodaphnia*	>100	*d*
9422-17 Storm Sewer	5/1	*Ceriodaphnia*	>100	*d*
Storm Sewer Drain E3306	7/9	*Ceriodaphnia*	>100	*d*
Groundwater Treatment Facility (Outfall 512)	7/10	*Ceriodaphnia*	40.9	0.25
Central Mercury Treatment System (Outfall 551)	7/10	*Ceriodaphnia*	>100	0.15
Storm Sewer Drain D2426	7/10	*Ceriodaphnia*	70.7	*d*
Storm Sewer Drain D2426 (dechlorinated)	7/10	*Ceriodaphnia*	>100	*d*
Central Pollution Control Facility (Outfall 501)	7/12	*Ceriodaphnia*	73.8	0.11
9422-17 Storm Sewer	7/15	*Ceriodaphnia*	>100	*d*
Storm Sewer Drain D3321	7/15	*Ceriodaphnia*	>100	*d*
West End Treatment Facility (Outfall 502)	8/15	*Ceriodaphnia*	>100	0.11
Groundwater Treatment Facility (Outfall 512)	10/2	*Ceriodaphnia*	77.5	0.14
9422-17 Storm Sewer	10/2	*Ceriodaphnia*	>100	*d*
9422-10 Storm Sewer	10/3	*Ceriodaphnia*	14.7	*d*
9422-10 Storm Sewer (dechlorinated)	10/3	*Ceriodaphnia*	75.8	*d*
Storm Sewer Drain D3121	10/3	*Ceriodaphnia*	12.9	*d*
Storm Sewer Drain D3121 (dechlorinated)	10/3	*Ceriodaphnia*	81.6	*d*
Central Mercury Treatment System (Outfall 551)	10/7	*Ceriodaphnia*	>100	0.04
Outfall 135 Storm Sewer	10/7	*Ceriodaphnia*	>100	*d*
West End Treatment Facility (Outfall 502)	10/17	*Ceriodaphnia*	43.5	0.18

[a]Summarized are the effluents and their corresponding 48-h LC_{50}s and instream waste concentrations (IWCs). NOTE: Discharges from treatment facilities are intermittent because of batch operations.

[b]The concentration of effluent (as a percentage of full-strength effluent diluted with laboratory control water) that is lethal to 50% of the test organisms in 48 h.

[c]IWC = instream waste concentration. The IWC is based on actual flows at East Fork Poplar Creek kilometer 24.6 (Station 8).

[d]This point is in the storm sewer system; therefore, an IWC is not applicable.

[e]This test was invalid because of unacceptable survival of control organisms. This location was retested on May 1, 1997.

samples from wastewater treatment systems and storm sewer effluents. The results of the biomonitoring tests are expressed as the concentration of effluent that is lethal to 50% of the test organisms (LC_{50}) during a 48-hour period. Thus, the lower the value, the more toxic an effluent. The LC_{50} is compared to the effluent's calculated instream waste concentration (IWC) to determine the likelihood that the discharged effluent would be harmful to aquatic biota in the receiving stream. If the LC_{50} is much greater than the IWC, it is less likely that there is an instream impact. Table 4.20 is a summary of the no-observed-effect concentrations (NOECs) and 96-hour LC_{50}s for the instream monitoring location, Outfall 201. The NOEC is the concentration of effluent that does not reduce survival, growth, or reproduction of the biomonitoring test organisms. Thus, like the LC_{50}, the higher the value the less toxic an effluent.

Effluent from the CPCF was tested in January, twice in April, and in July using *Ceriodaphnia dubia*. In January and April, treated effluent from the CPCF had 48-hour LC_{50}s of >100%. In July, the effluent had a 48-hour LC_{50} of 73.8%. The calculated IWCs of the CPCF effluent were 0.09% in January, 0.10% and 0.06% in April, and 0.11% in July. Because the IWCs were less than the LC_{50}s, it is unlikely that treated effluent from that facility adversely affected the aquatic biota in EFPC.

Effluent from the Groundwater Treatment Facility (GWTF) was tested in January, April, July, and October using *Ceriodaphnia*. The effluent's 48-hour LC_{50}s were 43.0%, 30.5%, 40.9%, and 77.5%, respectively. The calculated IWCs (0.23%, 0.15%, 0.25%, and 0.14%, respectively) were below the LC_{50}s; therefore, it is unlikely that treated effluent from the GWTF adversely affected the aquatic biota in EFPC.

Effluent from the Central Mercury Treatment System (CMTS) was tested in January, April, July, and October using *Ceriodaphnia*. The 48-hour LC_{50}s were all >100%. The calculated IWCs were 8.32%, 23.73%, 0.15%, and 0.04%, respectively. Because the IWCs were less than the LC_{50}s, it is unlikely that treated effluent from the CMTS adversely affected aquatic biota in EFPC.

Table 4.20. Y-12 Plant Biomonitoring Program summary information for Outfall 201 for 1997[a]

Site	Test date	Species	NOEC[b] (%)	96-h LC_{50}[c] (%)
Outfall 201	1/8	*Ceriodaphnia*	100	>100
		Fathead minnow	100	>100
Outfall 201	4/9	*Ceriodaphnia*	100	>100
		Fathead minnow	100	>100
Outfall 201	7/9	*Ceriodaphnia*	100	>100
		Fathead minnow	100	>100
Outfall 201	10/1	*Ceriodaphnia*	100	>100
		Fathead minnow	100	>100

[a]Summarized are the no-observed effect concentrations and the 96-h LC_{50}s for the instream monitoring location, Outfall 201.

[b]No-observed-effect concentration (NOEC) as a percent of full-strength effluent from Outfall 201 diluted with laboratory control water. The NOEC must equal one of the test concentrations and is the concentration that does not reduce *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth.

[c]The concentration of effluent (as a percent of full-strength effluent diluted with laboratory control water) that is lethal to 50% of the test organisms in 96 h.

West End Treatment Facility (WETF) effluent was tested in March, August, and October using *Ceriodaphnia*. The effluent's 48-hour LC_{50}s were 91.1%, >100%, and 43.5%, respectively. The calculated IWCs (0.07%, 0.11%, and 0.18%, respectively) were below the LC_{50}s; therefore, it is unlikely that treated effluent from theWETF adversely affected aquatic biota in EFPC.

Toxicity testing of storm sewers was conducted at Drains D2426, D3121, D3321, E3305, and E3306 and at Outfall 135. Buildings 9422-10 and 9422-17, which are monitoring locations in the storm system as part of the SWHISS, were also tested. Water from Storm Sewer Drain D2426 was tested in January, April, and July using *Ceriodaphnia*. In January, water from Drain D2426 had a 48-hour LC_{50} of >100%. A portion of this water was treated by dechlorination before testing. The 48-hour LC_{50} of the dechlorinated water was >100%. In April, the 48-hour LC_{50} was 56.0%, and the 48-hour LC_{50} of dechlorinated water was >100%. In July, the 48-hour LC_{50} was 70.7%, and the 48-hour LC_{50} of dechlorinated water was >100%.

Water from Storm Sewer Drain D3121 was tested in October using *Ceriodaphnia*. The 48-hour LC_{50} was 12.9%, and the 48-hour LC_{50} of dechlorinated water was 81.6%. Water from Storm Sewer Drain D3321 was tested in January, April, and July using *Ceriodaphnia*. The 48-hour LC_{50}s were 70.7%, 17.1%, and >100%, respectively.

The storm sewer at Drain E3305 was tested in January using *Ceriodaphnia*. The 48-hour LC_{50} was >100%. The storm sewer at Drain E3306 was tested in April and July. The 48-hour LC_{50}s were both >100% for *Ceriodaphnia*.

The storm sewer at Outfall 135 was tested in October using *Ceriodaphnia*. The 48-hour LC_{50} was >100%. The storm sewer at Building 9422-10 was tested in October using *Ceriodaphnia*. The 48-hour LC_{50} was 14.7%, and the 48-hour LC_{50} for dechlorinated water was 75.8%.

The storm sewer at Building 9422-17 was tested in January, April, May, July, and October using *Ceriodaphnia*. In January the 48-hour LC_{50} was >100%. In April, the test was determined to be invalid because of unacceptable survival of control organisms. This location was retested in May, and the 48-hour LC_{50} was >100%. In July and October, the 48-hour LC_{50}s were >100%.

Water from the instream monitoring point, Outfall 201, was tested four times in 1997 using fathead minnow larvae and *Ceriodaphnia dubia*. For tests in January, April, July, and October, the NOECs were all 100% for both *Ceriodaphnia* and fathead minnows; the 96-hour LC_{50}s were all >100% for both *Ceriodaphnia* and fathead minnows.

4.3.2 ORNL Wastewater Biomonitoring

Under the ORNL NPDES permit, wastewaters from the STP, the CYRTF, and the NRWTF were evaluated for toxicity. The results of the toxicity tests of wastewaters from the three treatment facilities are given in Table 4.21. This table provides the NOEC and LC_{50} for fathead minnows and *Ceriodaphnia* for each wastewater stream and the month it was tested. The NOEC is the concentration that did not significantly reduce survival or growth of fathead minnows or survival or reproduction of *Ceriodaphnia*. The LC_{50} is the concentration of wastewater that kills 50% of the test organisms in 96 hours. Average water quality measurements obtained during each toxicity test are shown in Table 4.22. The NPDES permit effective February 3, 1997, defines the limits for the biomonitoring tests. For the X01 (STP) discharge, toxicity is demonstrated if more than 50% lethality of the test organisms occurs in 96 hours in 41.1% effluent (LC_{50}) or the NOEC is <12.3%. For the X02 discharge (CYRTF), toxicity is demonstrated if more than 50% lethality of the test organisms occurs in 96 hours in 4.2% effluent or the NOEC is <1.3%. Because of the batch mode of discharge at CYRTF, the limit for the NOEC only applies if the facility discharges for a sufficient length of time. For the X12 discharge (NRWTF), toxicity is demonstrated if more than 50% lethality of the test organisms occurs in 96 hours in 100% effluent (LC_{50}) or the NOEC is <30.9%. Prior to issuance of the renewed permit in 1997, there were no numeric limits for the biomonitoring tests.

Table 4.21. 1997 toxicity test results of ORNL wastewaters

Outfall	Test date	Test species	NOEC[a]	LC_{50}[b]
Sewage Treatment Plant (X01)	January	*Ceriodaphnia*	<6	70.7
	February[c]	*Ceriodaphnia*	50	>100
	April	*Ceriodaphnia*	100	>100
		Fathead minnow	100	>100
	September	*Ceriodaphnia*	32.9	>100
		Fathead minnow	100	>100
	November	*Ceriodaphnia*	41.1	>100
		Fathead minnow	100	>100
Coal Yard Runoff Treatment Facility (X02)	March	Fathead minnow	100	>100
		Ceriodaphnia	4.2	>100
	June	Fathead minnow	100	>100
		Ceriodaphnia	3.36	>100
	September	Fathead minnow	*d*	>100
		Ceriodaphnia	*d*	>100
	November	Fathead minnow	*d*	>100
		Ceriodaphnia	*d*	>100
Nonradiological Wastewater Treatment Facility (X12)	March	Fathead minnow	100	>100
		Ceriodaphnia	80	>100
	May	Fathead minnow	100	>100
		Ceriodaphnia	80	>100
	August	Fathead minnow	100	>100
		Ceriodaphnia	100	>100
	November	Fathead minnow	100	>100
		Ceriodaphnia	80	>100

[a]NOEC = No-observed-effect concentration [the concentration (as percent 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 percent of full-strength wastewater) that kills 50% of the test species in 96 h.

[c]Confirmatory test.

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

Table 4.22. 1997 average water quality measured during toxicity tests of ORNL wastewaters
Values are for full-strength wastewater for each test (n = 2 or 7)

Outfall	Test date	pH[a]	Conductivity[b]	Alkalinity[c]	Hardness[c]
Sewage Treatment Plant (X01)	January	7.71	476	93	167
	April	7.86	409	98	158
	September	7.92	425	89	154
	November	7.82	440	91	157
Coal Yard Runoff Treatment Facility (X02)	March	8.02	3980	31	2113
	June	7.53	3316	23	2029
	September	7.82	3350	25	840
	November	7.47	5110	26	700
Nonradiological Wastewater Treatment Facility (X12)	March	7.86	654	78	64
	May	8.08	549	79	83
	August	7.90	541	94	87
	November	7.92	502	88	79

[a]Standard units.
[b]µS/cm; corrected to 25°C.
[c]mg/L as $CaCO_3$.

During 1997, the STP, CYRTF, and NRWTF were tested four times each. The STP wastewater's NOECs ranged from <6 to 100%, and the LC_{50}s from 70.7 to >100%. A confirmatory test conducted following the low NOEC for *Ceriodaphnia* in January showed that the toxicity of the effluent was transient. The biomonitoring limits for STP in the renewed permit were not exceeded during the March–November biomonitoring tests. The CYRTF wastewater's NOECs ranged from 3.36 to 100%, and the LC_{50}s were always greater than 100%. The biomonitoring limits for the CYRTF in the renewed permit were not exceeded during the March–November biomonitoring tests. The NRWTF wastewater's NOECs ranged from 80 to 100%, and the LC_{50}s were always greater than 100%. The biomonitoring limits for NRWTF in the renewed permit were not exceeded during the March–November biomonitoring tests.

4.3.3 ETTP Toxicity Control and Monitoring Program

The ETTP NPDES permit requires that biannual toxicity testing be performed at Outfall 005 (K-1203, the Sewage Treatment Plant).The results of the toxicity tests of wastewaters conducted during 1997 are given in Table 4.23. This table provides the wastewater's NOEC and 96-hour LC_{50} for fathead minnows and *Ceriodaphnia* for each test. Average water quality measures obtained during each toxicity test are shown in Table 4.24.

Effluent from K-1203 was tested twice with fathead minnows and *Ceriodaphnia*. In both tests, full-strength samples did not reduce survival, growth, or reproduction. Thus the NOECs were 100% and the LC_{50}s were >100%.

Table 4.23. 1997 ETTP NPDES Permit Number TN 0002950 toxicity tests results

ETTP Outfall	Test date	Species	NOEC[a] (%)	LC_{50}[b] (%)	IWC[c] (%)
K-1203 (Outfall 005)	January	Fathead minnow	100	>100	2.45
		Ceriodaphnia	100	>100	2.45
	July	Fathead minnow	100	>100	2.5
		Ceriodaphnia	100	>100	2.5

[a]No-observable-effect concentration.
[b]96-hour lethal concentration for 50% of the test organisms.
[c]Instream waste concentration (based on critical low flow of Poplar Creek).

Table 4.24. 1997 ETTP average water quality parameters measured during toxicity tests of ETTP wastewaters
Values are averages of full-strength wastewater for each test (N = 6 or 7)

ETTP Outfall	Test date	pH (standard units)	Conductivity (µS/cm)	Alkalinity (mg/L $CaCO_3$)	Hardness (mg/L $CaCO_3$)
K-1203 (005)	January	8.12	365	107	158
	July	8.1	337	82	133

4.4 BIOLOGICAL MONITORING AND ABATEMENT PROGRAMS

The NPDES permits issued to the Y-12 Plant in 1995, the ETTP in 1992, and ORNL in 1996 mandate BMAPs with the objective of demonstrating that the effluent limitations established for each facility protect the classified uses of the receiving streams. The Y-12 Plant effluents discharge to EFPC; ETTP effluents discharge to Mitchell Branch, Poplar Creek, and the Clinch River; and ORNL effluents discharge to WOC and its tributaries. Each of the BMAPs is unique and consists of three or four major tasks that reflect different but complementary approaches to evaluating the effects of the effluent discharges on the aquatic integrity of the receiving streams. Tasks present in one or more of the BMAPs include (1) toxicity monitoring; (2) bioaccumulation studies; (3) biological indicator studies; (4) waterfowl surveys; and (5) ecological surveys of the periphyton, benthic macroinvertebrate, and fish communities.

4.4.1 Y-12 Plant BMAP

Two major changes initiated in the UEFPC watershed during 1996, flow management and a bypass of Lake Reality, continued to influence water quality and the biota of EFPC during 1997. Flow management, which was first fully implemented in the fall of 1996, operated except for short down-periods throughout 1997. The bypass of Lake Reality, testing for which did not begin until mid-December 1996, also continued throughout 1997.

The levels of exposure of EFPC biota to contaminants continued to decrease during 1997, at least partly as a result of these two management actions (flow management and the Lake Reality bypass). Y-12 Plant activities continued to have some adverse effects on the biota of EFPC, as evidenced by a major fish kill in UEFPC (see Sects. 4.2.2.2 and 4.4.1.4) as well as by the improving but still relatively poor state of fish and invertebrate communities in UEFPC in terms of species diversity. However, distinct increases in species richness and diversity at upstream locations, along with improving trends in a number of other BMAP indicators, suggests that the overall ecological health of EFPC continues to improve.

4.4.1.1 Toxicity monitoring

Toxicity monitoring uses EPA-approved methods with *Ceriodaphnia dubia* (an invertebrate "water flea") to assess the toxicity of stream water to aquatic life. Toxicity monitoring in the first quarter of 1997 was conducted monthly at several sites upstream of Bear Creek Road, including Lake Reality outlet or LR-o (EFK 23.8), LR inlet or LR-i (EFK 24.1), and Area Source Study Site 8 or AS-8 (EFK 24.6). Water samples from sites downstream of Bear Creek Road (EFKs 22.8, 21.9, 20.5, 18.2, 13.8, and 10.9) were tested once during the quarter. No evidence for toxicity was found during the first-quarter *Ceriodaphnia* tests.

As a result of the continuing absence of toxicity to *Ceriodaphnia* in ambient water samples from EFPC, the scope of the toxicity monitoring program was reduced beginning in the second quarter of 1997 under the revised BMAP sampling plan (YTS-1613). Testing of ambient sites downstream of Bear Creek Road were discontinued, and testing of sites upstream of Bear Creek Road were reduced to a quarterly frequency at two sites (EFK 23.8 and EFK 24.1). No evidence for toxicity was found during *Ceriodaphnia* tests conducted during the remainder of 1997.

4.4.1.2 Bioaccumulation studies

Elevated concentrations (relative to local reference sites) of mercury and PCBs in biota are associated with proximity to the Y-12 Plant. Redbreast sunfish (*Lepomis auritus*) were collected twice during 1997 from six sites along the length of EFPC to evaluate spatial and temporal trends in mercury and PCB contamination. Largemouth bass (*Micropterus salmoides*) were collected once from two sites in EFPC (Lake Reality and EFK 23.4) and analyzed for mercury and PCBs to provide an estimate of bioaccumulation in larger piscivorous fish. A forage fish species (the stoneroller, *Campostoma anomalum*) was also collected once in 1997 from one site in UEFPC (EFK 24.8) to evaluate metal contamination in the food of fish-eating wildlife. These collections reflected the deletion of one previously sampled site (EFK 2.2) from the redbreast sunfish monitoring program and two previously sampled sites (EFK 23.4 and EFK 18.2) from the forage fish monitoring program in 1997 under the revised Y-12 BMAP sampling plan.

In spring 1997, the mean mercury concentrations in sunfish sampled from EFPC ranged from 5 to 13 times higher than the average concentration in fish from the reference stream. Highest levels of contamination continued to occur upstream of Lake Reality, suggesting that Y-12 Plant discharges remain an important source of mercury in fish in the upper reaches of EFPC. However, mercury concentrations in fish have decreased in UEFPC over the last few years in parallel with decreases in water concentrations of mercury (Fig. 4.28).

PCB concentrations in sunfish sampled from EFPC during 1997 fell within ranges typical of past monitoring efforts at these sites. Mean PCB concentrations remain highest in Lake Reality and the reaches of EFPC above Lake Reality, indicating a source or sources within the Y-12 Plant (Fig. 4.29).

In an effort to identify the primary sources of PCBs to EFPC, semipermeable membrane devices (SPMDs) were deployed in UEFPC and in drains and outfalls discharging to UEFPC. SPMDs are passive sampling devices that provide a time-integrated measurement of dissolved (bioavail able) PCB concentrations. The use of these devices during 1997 led to the identification of several sources of PCBs entering UEFPC from outfalls and to the discovery that the majority of PCBs in UEFPC do not actually originate from such outfalls but instead come from unknown sources along two reaches of the stream (N/S Pipe to 109 Bridge and Station 8 Bridge to East Patrol

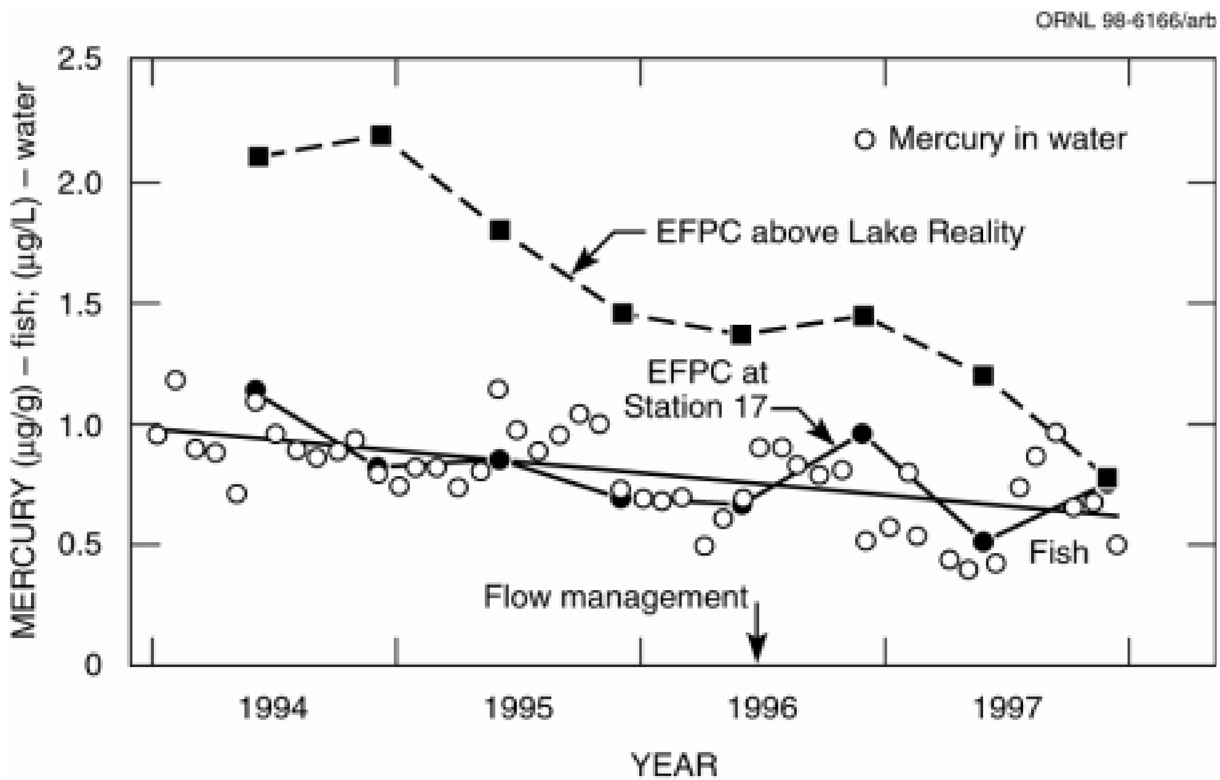

Fig. 4.28. Average mercury concentrations in fish and water above and below Lake Reality, 1994–97.

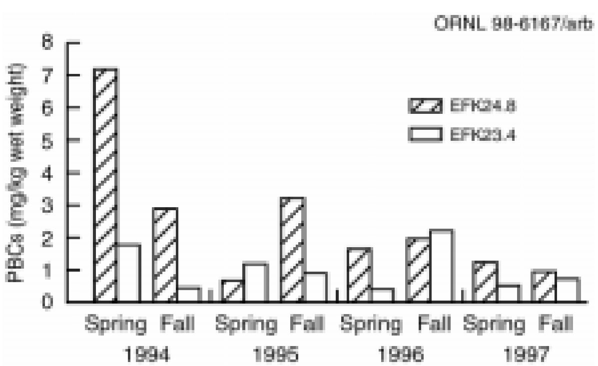

Fig. 4.29. PCB concentrations in fish above and below Lake Reality, 1994–97.

Road Bridge). This latter finding suggests that most of the PCBs exiting the Y-12 Plant originate from historical contamination in the vicinity of the stream bed and enter EFPC through shallow groundwater flow.

Kingfishers are highly piscivorus birds that consume up to half their body weight each day in fish or crayfish. For two years, the ORR ecological risk assessment (Sample et al. 1995, 1996) identified kingfishers as being highly at risk on all ORR streams. In 1996, BMAP researchers began to study kingfishers in the EFPC floodplain. Three birds (two females and one male) were regularly observed at Lake Reality and along EFPC upstream of Lake Reality, and a presumably mated pair were observed along LEFPC in the vicinity of EFK 13. However, only one nest site, in the Scarboro Bend area of Melton Hill Lake, was confirmed in 1997, and this belonged to the male using Lake Reality and UEFPC. No kingfisher burrows were found along EFPC after extensive searching, and little suitable habitat was identified for such burrows. Thus, despite the calculated risk to kingfishers from ORR contamination, further kingfisher monitoring along EFPC was considered unlikely to yield practical results, and the task was therefore deleted from the Y-12 BMAP during 1997.

4.4.1.3 Biological indicator studies

The biological indicator task is designed to evaluate the effects of water quality and other environmental variables on the health and reproductive condition of individual fish and fish populations in EFPC. Redbreast sunfish were sampled from four sites in EFPC (upstream of Lake Reality, EFK 23, EFK 19, and EFK 14) and from two reference streams (Brushy Fork and Hinds Creek) in the spring of 1997 prior to the onset of the breeding season. A formerly sampled site at EFK 6.3 was deleted from the bioindicator task because of improvements in the ecological condition of LEFPC. Physiological and biochemical indicators measured in these fish indicated that the health of individual sunfish in EFPC upstream of Bear Creek Road continues to differ significantly from fish at reference sites. However, temporal trends in several bioindicators indicate distinct improvement in overall fish health in UEFPC over the course of the last few years.

Fish reproductive health continued to be adversely impacted in UEFPC during 1997. Following a consistent trend established over the last decade, female sunfish had characteristically high incidences of oocyte atresia (death of immature eggs) at sites upstream of Bear Creek Road. However, atresia was much higher than expected at all sites sampled during 1997, including the reference sites, apparently because of a delayed spawn throughout the region because of an abnormally cool spring. This spawning delay was accentuated in EFPC by the extra chilling effect from the addition of cool Melton Hill water during flow management. The long-term effects of the shift toward cooler water temperatures in UEFPC are expected to be beneficial to the majority of fish species typically found in similar types of streams in the East Tennessee region but may have negative impacts on some of the current fish populations in EFPC in the short term.

Water sampled throughout the length of EFPC during 1997 remained toxic to developing fish embryos in the medaka test. The specific cause(s) for this toxicity have not yet been identified, but medaka embryos, like the embryos of many other species of fish, are quite sensitive to many chemical constituents originating within the Y-12 Plant, including various metals (particularly mercury), ammonia and other nitrogenous wastes, and apparently even the chemicals involved in, or the by-products of, chlorination/dechlorination water treatment procedures.

4.4.1.4 Ecological surveys and fish kill results

Periphyton monitoring in EFPC occurs four times a year. Algal biomass and photosynthetic rates measured during 1997 were generally within the range of measurements made over the past several years, remaining elevated in EFPC in comparison with reference streams (such as Brushy Fork). Concentrations of nutrients, including nitrate, ammonia, and phosphate, also continued to be much higher in EFPC than in reference streams, although levels decreased significantly at upstream sites (EFK 24.4 and EFK 23.4) from 1996 to 1997 in conjunction with the implementation of flow management. Flow management may also have been responsible for significant decreases from 1996 to 1997 at several EFPC sites in the periphyton concentrations of five metals (mercury, cadmium, chromium, copper, and zinc). However, metal concentrations continued to be relatively high during 1997 in EFPC periphyton, with a trend toward decreasing concentrations at downstream sites, supporting the existence of a source or sources of these metals at the Y-12 Plant. And remarkable similarities in the mercury concentrations of periphyton collected in September 1993 and April 1997 from three sites in EFPC (EFKs 24.4, 23.4, and 18.4) suggest that short-term changes in periphyton metal concentrations and similar ecological measurements need to be cautiously interpreted in light of possible overriding long-term trends and natural cyclicity.

The fish community task is responsible for conducting biannual estimates of the fish community at six EFPC sites and two reference stream sites and for investigating fish kills near the Y-12 Plant. Improvements in the fish communities of EFPC continued during 1997, although species richness and diversity in upstream locations remain much lower than in comparable reference streams (Fig. 4.30). Two sensitive species, the northern hog sucker and the snubnose darter, which were first observed at EFK 23.4 in 1996, were again found at this site in 1997. They were joined by another sensitive species, the greenside darter. Other sensitive species, including rock bass, redline darter, and spotted sucker, were collected at intermediate sites such as EFK 18.7 and EFK 13.8 where they had never previously occurred or been only rarely encountered. The new temperature regime in UEFPC now approximates that of other area streams and is no longer elevated to potentially stressful levels for sensitive fish species. However, whether many additional species will ever occur upstream of Lake Reality is questionable because of the difficulty of fish migration through the bypass arrangement used to shunt water around the lake.

Fish kill investigations are conducted in response to chemical spills and unplanned water releases or when dead fish are observed in EFPC. The basic procedure for fish kill investigations is a survey of UEFPC (above Bear Creek Road to the north-south pipes), during which numbers and locations of dead, dying, and stressed fish are recorded. In previous years, fish kills were often associated with the spawning period of stonerollers in EFPC. A total of 100 dead fish, including 91 central stonerollers, were found in daily surveys during April 7–14. Thereafter, the average dead per survey decreased to less than one fish, a value similar to background mortality levels.

In late July 1997, two events occurred in EFPC that had tremendous impacts on the fish communities in the vicinity of the Y-12 Plant and further downstream. In late July, a record rainfall occurred in a few hours and resulted in a pulsed flow that blasted through the EFPC watershed. In UEFPC, particularly inside the plant, fish were displaced, stranded, and killed by this pulse. Usually in July most of the fish have spawned and small young of the year (YOY) individuals are widespread in the shallow and backwater areas of the system. Because this pulse of water was so large, many of these YOY fishes may have been

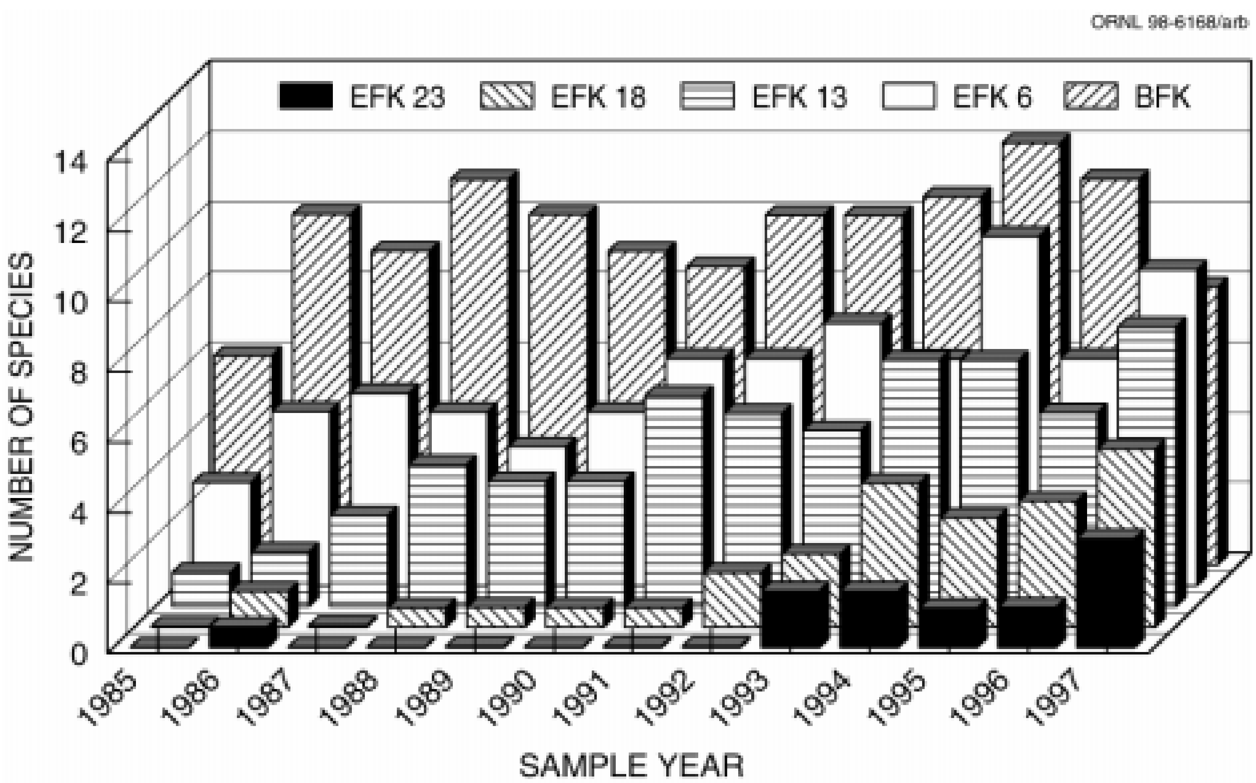

Fig. 4.30. Colonization of EFPC by sensitive fish species.

killed or displaced out of EFPC, even as far down as EFK 6.3. In addition to the record rainfall and partly as a result of the alterations to the flow management operations that were necessitated by the rain, an extremely large fish kill occurred in UEFPC on July 24, 1997. The kill was acute, based on zero or low dissolved oxygen conditions augmented by sodium bisulfide toxicity that affected the stream from just below the north-south pipes down to Lake Reality. The result was a fish kill with an estimated total of approximately 24,000 fish (see also Sect. 4.2.2.2). This was almost 5 times larger than any previous kill in UEFPC. The kill included all species and all size classes within that section of stream. Unlike most previous fish kills in this stream section, all of the mortality occurred within a few hours if not minutes on July 24. Conditions within the stream returned to normal and acceptable shortly after full flow was restored to the stream. Effects on future community assessments may be evident from these impacts, including lower species richness, density, and biomass during the next few sampling seasons.

Benthic macroinvertebrate communities are sampled from four sites in EFPC and from two reference streams in the fall and spring of each year. The macroinvertebrate communities at EFK 23.4 and EFK 24.4 remained significantly degraded through 1997 (Figs. 4.31 and 4.32). However, subtle but persistent increases in total richness and the richness of pollution-tolerant taxa at these sites indicate continuing improvement in water quality. The benthic macroinvertebrate communities at sites farther downstream (i.e., EFK 13.8) appear only minimally impacted relative to reference conditions.

4.4.2 ORNL BMAP

4.4.2.1 Toxicity Monitoring

Instream toxicity monitoring was terminated in 1997 because instream toxicity has not been detected for the past several years. However, wastewater is actively monitored for toxicity (Sect. 4.3.2).

4.4.2.2 Bioaccumulation studies

Monitoring of mercury contamination in sunfish and largemouth bass continued in 1997. Redbreast sunfish were collected in the spring (January through March) of 1997 from WOC (WCK 2.9), and bluegill sunfish (*Lepomis macrochirus*) and largemouth bass *(Micropterus salmoides)* were collected from White Oak Lake (WOL). Mercury concentrations (relative to local reference sites) in sunfish were highest in WOC proper; mercury concentrations in bluegill collected approximately 1.4 km downstream inWOL were not much different from reference stream values. The present level of mercury contamination in WOC sunfish is approximately 5 times higher than concentrations observed in fish from the reference stream. As expected, mercury concentrations in largemouth bass were higher than in sunfish collected at the same site because of their position in the food chain. Unlike past years, no fish in the WOC watershed in 1997 contained mercury concentrations in excess of 0.50 µg/g.

In 1997, monitoring of PCB contamination in sunfish was conducted at two WOC sites: WCK 2.9 and WOL. Monitoring of PCB contamination in largemouth bass was conducted at WOL. The mean PCB concentrations in sunfish from WCK 2.9 and WOL were 0.39 ± 0.10 and 0.69 ± 0.06 µg/g, respectively. These PCB levels are high for relatively short-lived, lipid-poor fish such as sunfish. Reference site sunfish analyzed at the same time averaged <0.02 µg/g PCBs. Largemouth bass, a species that achieves a large size, is at the top of the food chain, and contains relatively high levels of intramuscular lipids, were sampled in WOL to evaluate the maximum PCB concentrations likely in the WOC system. The mean PCB concentration in WCK 1.5 bass exceeded the Food and Drug Administration threshold limit of 2 µg/g. A high degree of variation was evident in the collection; the range of values was 0.43 to 3.80 µg/g. Five of eight bass exceeded the 2 µg/g FDA threshold limit. Since 1994, PCB concentrations in WOC sunfish and largemouth bass have remained approximately 2 to 3 times higher than concentrations reported in the early 1990s.

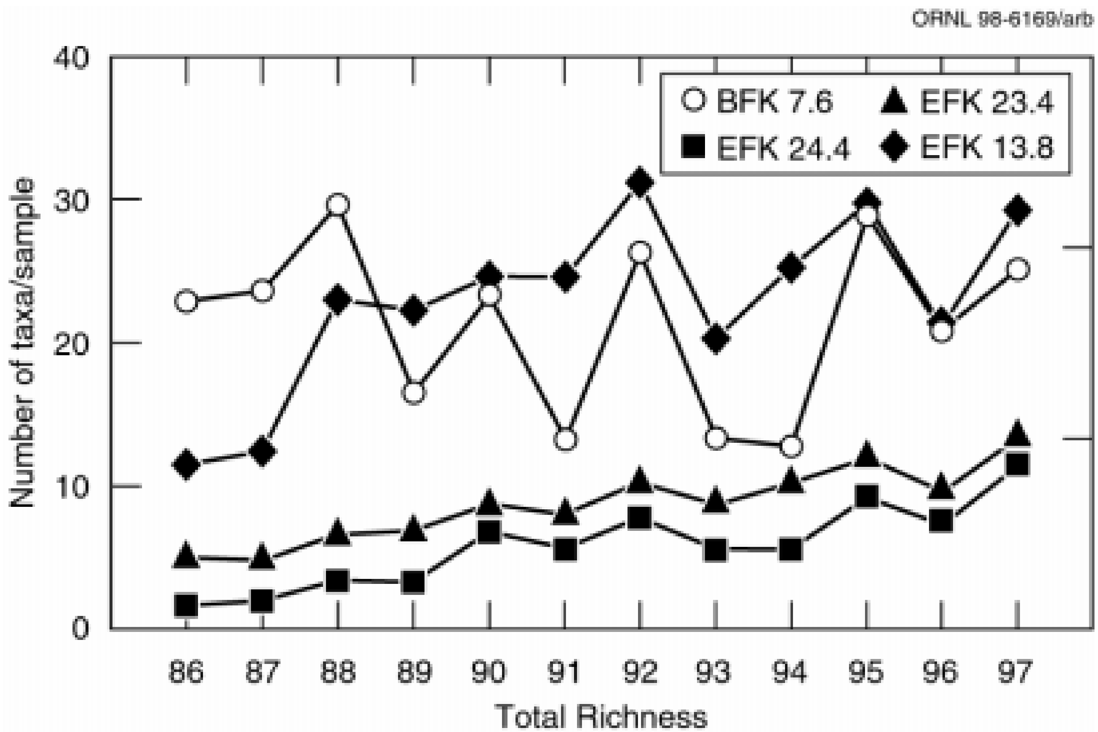

Fig. 4.31. Comparison of number of species in EFPC and Brushy Creek.

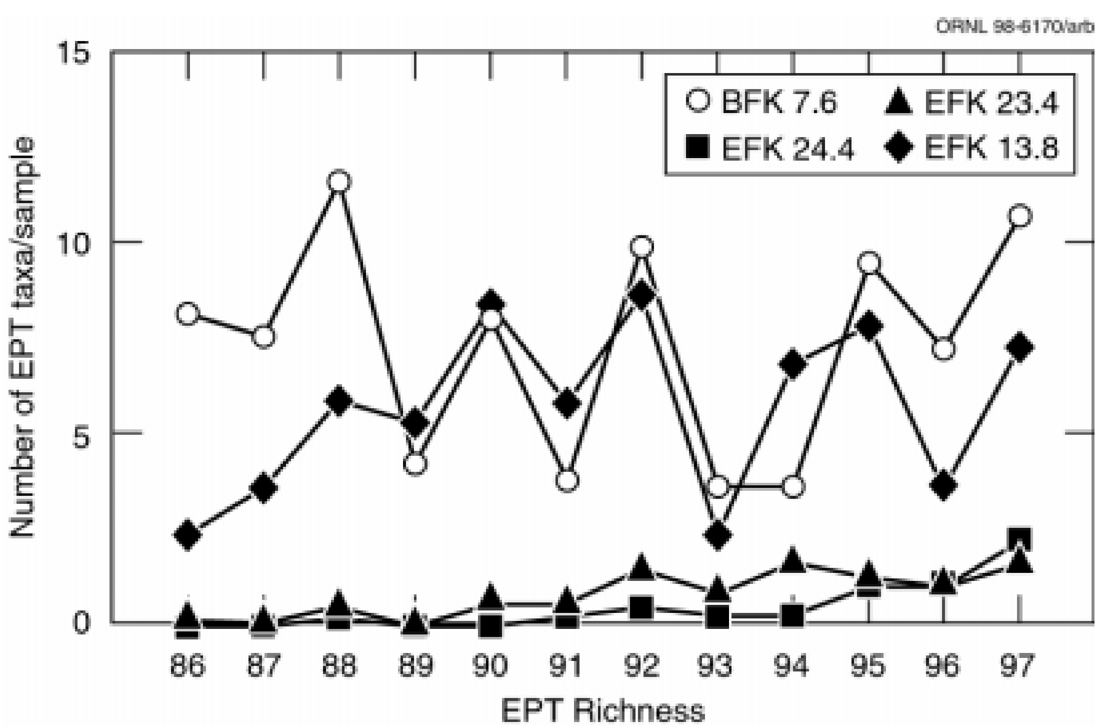

Fig. 4.32. Number of sensitive species in EFPC and Brush Creek.

Water samples were collected from White Oak Creek at four sites on November 25, 1997, and analyzed for total mercury by Lockheed Martin Energy Systems Analytical Services Organization using EPA Method 245.1 (low-level notification/reporting limit). Stream conditions were representative of base-flow (dry weather) conditions at the time of sampling. The mercury concentration in White Oak Creek at the weir upstream from ORNL (WCK 6.8) was 11 ng/L, typical of background or reference streams in East Tennessee. At WCK 3.5 (the flume upstream from the NRWTF (MS 3619), mercury concentrations were 520 and 540 ng/L in duplicate samples. The mercury concentration was 160 ng/L at WCK 2.9 (Melton Valley Road bridge) and 63 ng/L at the discharge of White Oak Dam.

4.4.2.3 Ecological surveys

Quantitative samples at established biomonitoring sites in the WOC watershed in the spring and fall of 1997 were collected under the fish community task. For spring 1997, total fish density at the downstream site on First Creek remained depressed from fall 1996. Estimated total density values at this site have generally been low since fall 1992. The majority of the decline in estimated total fish density is from the decline in blacknose dace (*Rhinichthys atratulus*) and western mosquitofish (*Gambusia affinis*) numbers. The sampling site downstream on Fifth Creek contains a stable population of central stoneroller (*Campostoma anomalum*), blacknose dace, and banded sculpin (*Cottus carolinae*). A single creek chub (*Semotilus atromaculatus*) was found at this site in fall 1997. Estimated total fish density at the lower site on Fifth Creek declined in 1995 and 1996 from a previous high in fall 1994. This decline was followed by a slight increase in spring 1997.

The fish community at two sites in the mid-reach of WOC (WCK 3.4 and WCK 3.9) have exhibited overall declines in estimated total fish density over the past 5 years. Estimated total fish density at WCK 3.4 increased overall from fall 1991 through spring 1995, from which time density has declined, with a slight increase in spring 1997. WCK 3.9 exhibited a similar pattern of an overall decline in estimated total fish density from peak values in fall 1992 through fall 1996, with a slight increase in density in spring 1997. Bluegill sunfish (*Lepomis macrochirus*) were absent at WCK 3.4 in the spring and the fall 1997 after being collected during every sampling period since August 1985.

The benthic macroinvertebrate communities were sampled at nine sites in the WOC watershed during the spring and fall of 1997. Results of the April sampling periods through 1996 continued to show that ORNL operations are impacting streams on the ORNL site. The average number of taxa and number of pollution sensitive taxa (i.e., Ephemeroptera, Plecoptera, and Trichoptera, or EPT) remain markedly lower downstream of ORNL effluent discharges in First Creek, Fifth Creek, and WOC. However, after two consecutive years of declines in the number of sensitive taxa (EPT taxa/sample) in First Creek at FFK 0.2 (i.e., 1994 and 1995), the number increased in 1996. This either demonstrates improvement after two consecutive years of declining conditions, may simply be a change associated with natural annual variation, or may be the slow result of a major dechlorination of ORNL outfalls in 1995–96. In Melton Branch, the total number of taxa/sample and the number of sensitive taxa/sample continue to be slightly lower downstream of the High Flux Isotope Reactor discharge tributary than at the reference site. This difference has persisted since 1992.

4.4.3 ETTP BMAP

4.4.3.1 Toxicity monitoring

The toxicity monitoring task for the ETTP BMAP includes tests of effluent from treatment facilities (see ETTP Toxicity Control and Monitoring Program, Sect. 4.3.3); effluent from storm drains SD170, SD180, and SD190; and surface water from six sites within Mitchell Branch. Effluent from SD170 and SD190 was evaluated for toxicity six times using *Ceriodaphnia dubia*. Full-strength effluent from SD170 reduced *Ceriodaphnia* survival or reproduction in four of six tests. Full-strength effluent from SD190 reduced *Ceriodaphnia* survival or reproduction in four of six tests. Effluent from SD180 was evaluated for toxicity two times in 1997; the effluent did not reduce *Ceriodaphnia* survival or reproduction in any test. Toxicity tests were conducted using ambient water from Mitchell Branch downstream of each storm drain. For each test period, the toxicity of the storm drain effluents was not reflected in reduced survival or reproduction of *Ceriodaphnia* in the corresponding Mitchell Branch samples.

4.4.3.2 Bioaccumulation studies

In July and August 1997, caged clams were used to evaluate potential PCB sources to ETTP waters. In Mitchell Branch, caged clam studies showed that SD190 and a site near the Mitchell Branch weir provide the highest influx of PCBs to downstream waters and that at the K-1007-P1 pond the highest PCB concentration was at the SD100 outfall (15.46 µg/g). The average PCB concentration in clams placed for four weeks at the K901-A outlet (0.20 µg/g) was approximately 20 times higher than reference clams but was relatively low compared with that at lower Mitchell Branch and the K-1007-P1 pond outlets to Poplar Creek (4.31 and 1.14 µg/g, respectively). The clam studies in 1997 indicate that Mitchell Branch and the K-1007-P1 pond are the major ETTP sources of PCBs to downstream waters.

4.4.4 Waterfowl Surveys

In conjunction with TWRA personnel, ORR personnel monitor waterfowl populations on the ORR, and geese are measured occasionally for gross radiological activity. A roundup of Canada geese was performed on June 24 and 25, 1997. Roundup participants included employees and students from Oak Ridge National Laboratory, the ETTP, Department of Energy, Tennessee Wildlife Resources Agency, Animal Damage Control (ADC, a division of the U.S. Department of Agriculture), Tennessee Department of Environment and Conservation, and Shaw University in North Carolina. A total of 140 geese were captured during the roundup, including 88 adults and 52 goslings. Twenty-two of the 88 adults were recaptures (previously leg-banded and/or neck-collared). Eighty-two of the 88 adult geese captured were subjected to live whole-body gamma scans.

Of the 83 geese analyzed, all but 2 had activity levels below 0.2 pCi/g of ^{137}Cs. The other two, both captured at the ORNL Swan Pond, had levels of 0.69 ± 0.09 pCi/g and 15 ± 1 pCi/g of ^{137}Cs. This latter goose was sacrificed because of the relatively high presence of ^{137}Cs.

The overall number and diversity of waterfowl observed on the ORR have increased in recent years, a pattern consistent with national trends.

4.4.5 Ecological Surveys

The benthic macroinvertebrate communities downstream of the main storm drains in Mitchell Branch continue to show impacts compared with the upstream reference site. The most affected site is MIK 0.45 (downstream of SD 190), where very few pollution-intolerant EPT (i.e., mayflies, stoneflies, and caddisflies) taxa exist, and the least affected site is MIK 0.78 (immediately upstream of SD 170). Since showing some recovery at MIK 0.45 and MIK 0.71 after the 1989 or 1990 sampling periods, "steady state" conditions appear to have been reached. Some slight increases in the EPT taxa at MIK 0.45 were found, indicating that slight improvements in conditions may be occurring at that location.

In April 1996, the fish communities were quantitatively sampled at sites MIK 0.71, MIK 0.45, and the reference site, Scarboro Creek. In general, fish community studies have shown that stream conditions have improved since the early 1990s, when fish populations first became established in Mitchell Branch. The estimated fish density decreased slightly from 1996 at MIK 0.71. Total estimated fish density also has shown an overall decline at MIK 0.45 from 1996. In comparison to the reference stream, Mitchell Branch is lacking stable populations of several fish species. Although some improvements have been observed in comparison to 1990 data, Mitchell Branch still exhibits signs of adverse impact.

4.4.6 BMAP Trends on the ORR

Several tasks were common to each of the three ORR BMAPs during 1997, and these provide some basis for examining trends in environmental quality for the ORR. Toxicity was consistently not demonstrated in standardized fish- and invertebrate-based tests of ambient water samples collected from the Y-12 Plant and the ETTP during 1997 (ambient samples were not collected near ORNL). However, water from EFPC (the only receiving stream tested by this procedure) continued to be toxic to fish embryos in themedaka embryo test. Mercury and PCB accumulation in fish continued to be a concern in 1997 at numerous ORR sites. Trends over time include decreased mercury concentrations in fish near the Y-12 Plant and increased PCBs in biota at some sites near the ETTP. Canada geese, which cross facility boundaries, averaged levels of gamma radiation comparable with those of geese collected at other sites in the area, although a few geese—all at ORNL—continued to show individual levels of elevated gamma radiation. Fish communities continued to improve to varying degrees during 1997 in streams draining all three facilities, although the fish communities remained largely degraded relative to reference streams. Invertebrate communities showed similar trends. Improvements were observed at some sites on the reservation; continuing significant degradation was observed elsewhere relative to reference sites.