4. ETTP Environmental Monitoring Programs

The East Tennessee Technology Park (ETTP), formerly known as the Oak Ridge Gaseous Diffusion Plant or K-25 Site, was originally built as part of the Manhattan Project. Uranium was enriched for weapons and nuclear reactor fuel elements and included recycling of reactor return fuel elements. Other activities included research and support operations. After the enrichment operations ceased in 1985, the primary focus of the plant shifted to environmental restoration, reindustrialization, and reuse of the facilities.

Environmental monitoring remains a major activity on the ETTP. Environmental monitoring encompasses two activities: effluent monitoring and environmental surveillance. Effluent monitoring consists of the collection and analysis of samples or measurements of liquid or gaseous effluents at their emission points to determine and quantify contaminants released. Environmental surveillance consists of the collection and analysis of samples of air, water, soil, vegetation, biota, and other media from the ETTP and its surroundings. External direct radiation is also measured. Data from environmental monitoring activities are used to assess exposures to members of the public and the environment, to assess the effects of ETTP operations on the public and the environment, to help plan remediation projects, and to evaluate the efficacy of these projects.

In 2003, the emissions of radionuclides from ETTP operations were well within the allowable derived concentration guides published in DOE Order 5400.5, and were similar in most respects to 2002 emissions. Potential direct radiation to the public from uranium hexafluoride cylinder storage yards and the K-770 scrap metal yard at ETTP remained below the requirements in DOE orders. Nonradiological emissions were also within limits, and compliance with permit limits was better than 99%.

4.1 ETTP RADIONUCLIDE AIRBORNE EFFLUENT MONITORING

In order to demonstrate compliance with DOE Order 5400.5 and Tennessee Rule 1200-3-11-.08, "Emission Standards for Emission of Radionuclides Other than Radon from Department of Energy Facilities," i.e., the National Emission Standards for Hazardous Air Pollutants (NESHAP), all airborne radionuclide emissions from DOE sources at ETTP must be determined for purposes of estimating dose to the most exposed member of the public.

Locations of airborne radionuclide point sources at the ETTP are shown in Fig. 4.1. Radionuclide emission information for these release points is compiled under the direction of Bechtel Jacobs Company LLC from operators subject to NESHAP regulations. For 2003, other prime contractors working directly for DOE at ETTP were also subject to NESHAP; data were obtained from the applicable sources and are reported here. Point sources shown in Fig. 4.1 include both individual point sources and grouped point sources, such as laboratory hoods. Radionuclide emissions data were determined from either EPA-approved sampling results or EPA-approved calculation methods.

4.1.1 Radionuclide Emissions Monitoring Approach

4.1.1.1 Minor sources

The number of minor sources in 2003 varied from the previous year's total because of fluctuations in site operations. For this reporting period, a total of four point sources and four grouped minor sources subject to NESHAP regulations operated. Minor sources are grouped if they have similar characteristics (e.g., general location, type of activity, or type of control) and provided that any one group does not have potential radionuclide emissions that would cause a dose in excess of 0.1 mrem/year effective dose equivalent (EDE) as defined under the rule. An example of a minor source is the TSCA Incinerator tank farm with 15 emission points.

Emissions from the various minor sources located at the ETTP were estimated by means of one of the following EPA-approved methods:

- radionuclide inventory (i.e., material balance)—four point sources and three grouped sources,

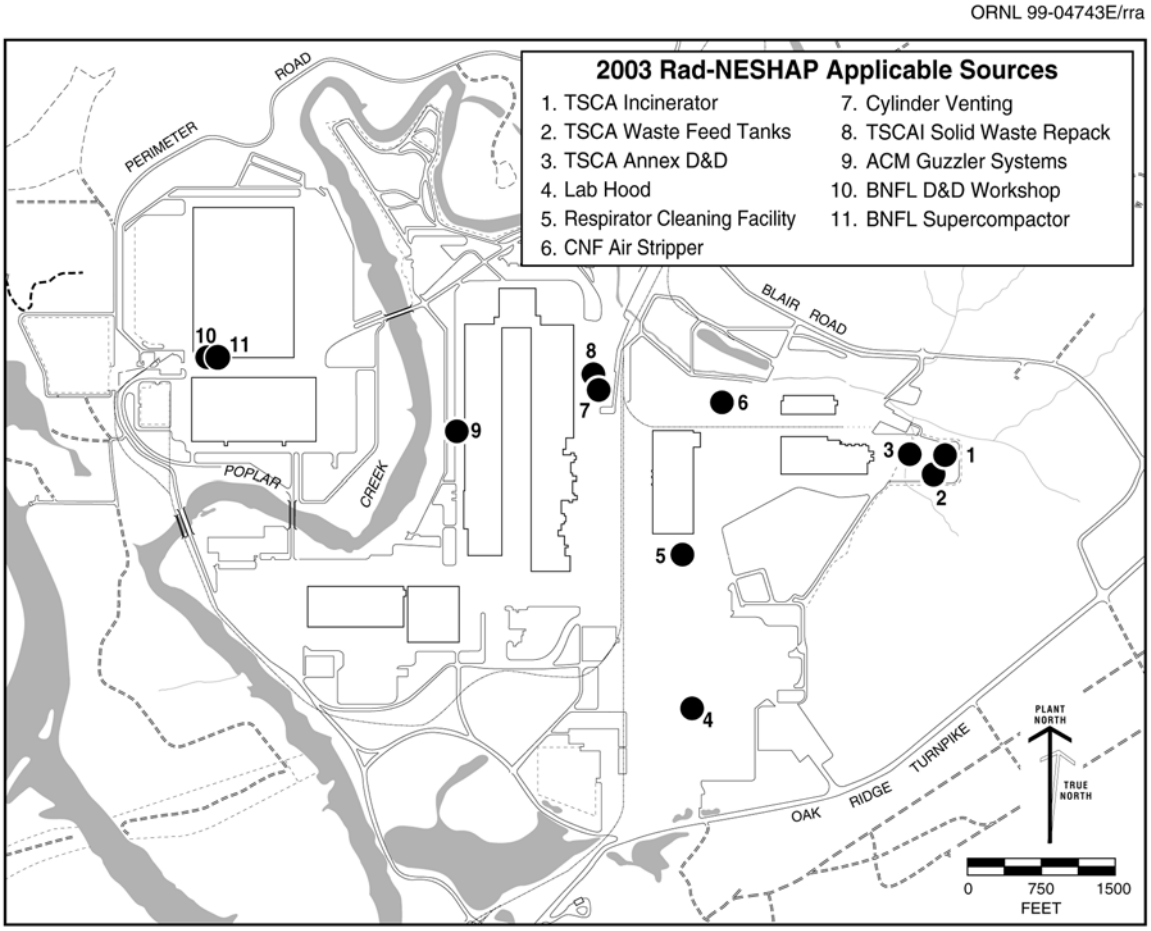

Fig. 4.1. Locations of airborne radionuclide point sources at the ETTP.

- health physics air measurements where room ventilation emissions exceeded 10% of derived air concentration worker protection guidelines—no sources,
- surrogate emission data from similar sources—one point source, and
- evaporative emissions—one grouped source.

All techniques are conservative methods of estimating emissions based on the physical form of the radionuclides and the maximum operating temperature of the process or activity.

Any remaining emissions were classified as major sources or diffuse/fugitive sources that are spatially distributed in nature or that were not emitted with forced air from a stack, vent, or other confined conduit. Typical examples of diffuse/fugitive sources include

- emissions from shutdown buildings;
- resuspension of contaminated soils, debris, or other materials;
- unventilated tanks;
- wastewater treatment systems;
- outdoor storage and processing areas;
- emissions from piping, valves, or other piping equipment and pump components; and
- decontamination and demolition activities.

Fugitive emission sources are monitored by way of the ORR and ETTP ambient air surveillance programs.

4.1.1.2 Major sources

Three ETTP major sources operated during 2003. Radionuclide emission measurements from the TSCA Incinerator were determined by means of a continuous stack-sampling system. The system is designed to automatically adjust sample flow rate to maintain near-isokinetic sampling conditions at the stack. The effluent is passed through filter media to collect particulate matter and through

impingers with absorbing and adsorbing media to collect gaseous radionuclides. Measurements of TSCA Incinerator emissions were based on monthly composites of weekly stack samples.

BNFL, Inc., operated two sources in the K-33 building requiring the continuous monitoring of radiological emissions. The decontamination and decommissioning workshop has two identical atmospheric release points, each equipped with a particulate filtration system and a continuous sampling device. The supercompactor vent continuous sampling system is the same design as the decontamination and decommissioning workshop units.

4.1.2 Results

The ETTP 2003 radionuclide emissions from the major and minor emission sources are shown in Table 4.1. Additionally, Figs. 4.2 and 4.3 show a comparison of the total discharges of uranium with those of previous years. The total curies and mass of uranium discharged to the air can vary from year to year. The variations are attributable to changes in project activities and source process rates. The resulting airborne dose from all ETTP radionuclide emissions was less than the reservation maximum limit of 10 mrem/year.

4.2 ETTP NONRADIOLOGICAL AIRBORNE EMISSIONS MONITORING

Under an application shield granted by the Tennessee Department of Environment and Conservation (TDEC) Division of Air Pollution Control, the ETTP has eight major air emission sources listed as subject to Tennessee Title V Major Source Operating Permit program rules. In addition, ETTP has a general fugitive air emissions permit for minor sources.

No direct monitoring of airborne emissions is required for nonradionuclide air contaminants from permitted sources. Instead, monitoring of key process and air pollution control device parameters is performed to ensure compliance with all permitted emission limits.

The ETTP is required to pay a major source emission fee each year for all regulated pollutants, excluding carbon monoxide and pollutants from exempt emission sources. To verify the air emission fee that is based on a combination of permitted allowable and actual emissions for air pollutants, an inventory of regulated emissions from the permitted sources at the ETTP is updated annually. Table 4.2 shows the results of the annual inventory of emissions of criteria pollutants from ETTP operations for the past 5 years. Beginning in 1999, the ETTP steam plant was transferred to the Community Reuse Organization of East Tennessee (CROET) and is no longer included in the ASER. The ETTP paid an annual fee in 2003 amounting to $13,800.50 based on the fee rate of $17.50 per ton of emissions during this period. Table 4.3 shows the inventoried regulated emissions during 2003 from the ETTP.

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 inventoried with respect to determining the ETTP annual fee. A comparison of actual and allowable TSCA Incinerator emissions is presented in Table 4.4. All other permitted sources have emissions inventoried based on permit allowable limits.

4.3 LIQUID DISCHARGES—ETTP RADIOLOGICAL MONITORING SUMMARY

The ETTP conducts radiological monitoring of liquid effluent and storm water discharges to determine compliance with applicable dose standards. It also applies the “as low as reasonably achievable” (ALARA) process to minimize potential exposures to members of the public.

4.3.1 Sample Collection and Analytical Procedure

The ETTP monitored the treated effluent from the K-1407-J Central Neutralization Facility (Outfall 014). Weekly samples were collected from the Central Neutralization Facility and were composited into monthly samples. These samples were then analyzed for radionuclides. Results of these sampling efforts were compared with the derived concentration guides (DCGs) listed in DOE Order 5400.5.

Table 4.1.ETTP radionuclide air emission totals, 2003 (Ci)[a]

Radionuclide	Total major	TSCAI (major)[b]	Total minor	Total ETTP
^{228}Ac	–	–	1.03E–08	1.03E–08
^{241}Am	–	–	3.31E–08	3.31E–08
^{243}Am	–	–	2.40E–10	2.41E–10
^{212}Bi	–	–	7.34E–09	7.34E–09
^{214}Bi	–	–	8.07E–09	8.07E–09
^{14}C	1.52E–05	1.52E–05	1.10E–05	2.62E–04
^{137}Cs	1.15E–04	1.15E–04	5.09E–06	1.20E–04
^{57}Co	–	–	2.20E–09	2.20E–09
^{60}Co	–	–	2.66E–07	2.66E–07
^{244}Cm	–	–	7.34E–10	7.34E–10
^{152}Eu	–	–	7.34E–10	7.34E–10
^{154}Eu	–	–	4.25E–07	4.25E–07
^{131}I	–	–	5.21E–08	5.21E–08
^{85}Kr	1.41E–03	1.41E–03	1.48E+06	1.41E-03
^{210}Pb	–	–	6.51E–08	6.51E–08
^{212}Pb	–	–	7.34E–09	7.34E–09
^{214}Pb	–	–	6.63E–09	6.63E–09
^{237}Np	3.98E–07	3.98E–07	1.56E–07	5.53E–07
^{95}Nb	–	–	7.34E–10	7.34E–10
^{238}Pu	2.75E–07	2.75E–07	6.60E–08	3.41E–07
^{239}Pu	3.28E–07	3.28E–07	1.06E–07	4.33E–07
^{242}Pu	–	–	2.23E–09	2.23E–09
^{40}K	–	–	2.71E–07	2.71E–07
^{231}Pa	–	–	3.57E–10	3.57E–10
^{233}Pa	–	–	5.14E–09	5.14E–09
^{234}Pa	–	–	1.31E–07	1.31E–07
^{234m}Pa	7.18E–03	7.18E–03	3.71E–05	7.22E–03
^{226}Ra	–	–	2.53E–07	2.53E–07
^{228}Ra	–	–	7.34E–10	7.34E–10
^{89}Sr	2.94E–06	2.94E–06	–	2.94E–06
^{90}Sr	–	–	1.08E–06	1.08E–06
^{99}Tc	9.44E–04	9.44E–04	2.73E–05	9.71E–04
^{208}Tl	–	–	2.94E–09	2.94E–09
^{228}Th	8.31E–06	8.31E–06	4.85E–08	8.36E–06
^{230}Th	6.44E–05	6.44E–05	9.07E–08	6.45E–05
^{231}Th	–	–	1.47E–09	1.47E–09
^{232}Th	3.45E–05	3.45E–05	5.32E–08	3.45E–05
^{234}Th	3.23E–03	3.23E–03	2.63E–05	3.26E–03
^{3}H	7.35E+00	7.35E+00	1.34E–02	7.37E+00
^{233}U	–	–	3.35E–06	3.35E–06
^{234}U	1.94E–04	1.94E–04	3.79E–05	2.32E–04
^{235}U	8.27E–04	8.27E–04	2.22E–06	8.29E–04
^{236}U	–	–	5.18E–07	5.18E–07
^{238}U	3.30E–04	3.28E–04	2.73E–05	3.67E–04
Totals	7.37E+00	7.37E+00	1.36E-02	7.38E-00

[a]1 Ci = 3.7E+10 Bq.
[b]Toxic Substances Control Act Incinerator.

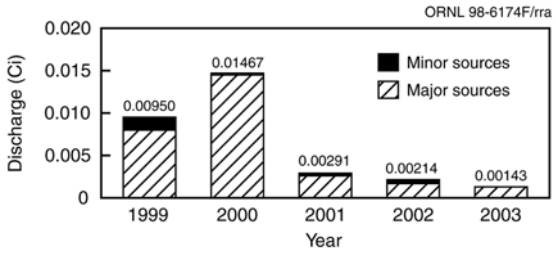

Fig. 4.2. Total curies of uranium discharged from the ETTP to the atmosphere, 1999–2003.

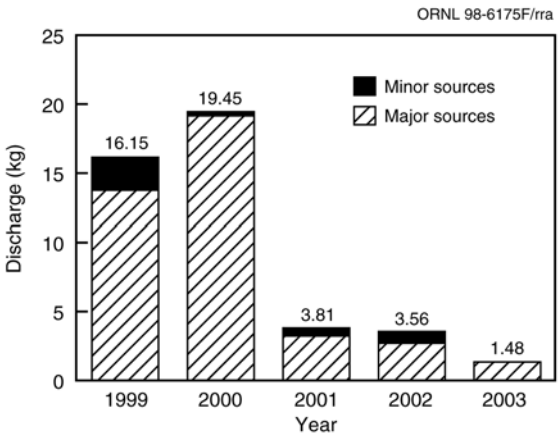

Fig. 4.3. Total kilograms of uranium discharged from the ETTP to the atmosphere, 1999–2003.

Table 4.2. Allowable emissions of criteria pollutants from the ETTP, 1999–2003

Pollutant	Allowable emissions (tons/year)				
	1999	2000	2001	2002	2003
Particulate matter	13	13	13	13	13
Volatile organic compounds	14	14	14	14	14
Sulfur dioxide	39	39	39	39	39
Nitrogen oxides	20	20	20	20	20
Carbon monoxide	20	20	19	19	19
Hazardous air pollutants	21	21	20	21	21
Miscellaneous	0	0	0	0	0
Total	127	127	125	126	126

Table 4.3. Actual emissions of criteria pollutants from permitted ETTP sources, 2003

Pollutant	Actual emissions	
	lb/year	tons/year
Particulate matter	232.5	0.116
Volatile organic compounds	254.1	0.127
Sulfur dioxide	3.2	0.002
Nitrogen oxides	8,429	4.21
Carbon monoxide	2,120	1.06

Table 4.4. Actual vs allowable air emissions from the Toxic Substances Control Act Incinerator at the ETTP, 2003

Pollutant	Emissions (tons/year)		Percentage of allowable
	Actual[a]	Allowable	
Lead	0.009	0.575	1.5
Beryllium	0.00002	0.00037	4.7
Mercury	0.002	0.088	2.3
Hydrogen fluoride	0.001	2.98	<0.1
Hydrogen chloride	0.050	16.12	0.3
Sulfur dioxide	0.002	38.5	<0.1
Particulate matter	0.116	13.1	0.9

[a]Actual emissions based on removal efficiencies measured during the permit-required air emission test conducted during 2000 with the exception of hydrogen fluoride, which is based on the CY 1995 test.

The Storm Water Pollution Prevention Program, which is described in more detail in Sect 4.5, included sampling for gross alpha and beta radioactivity as well as specific radionuclides at selected storm water outfalls. Results were used to estimate the total discharge of each radionuclide from ETTP via the storm water discharge system. Fig. 4.4 shows the location of the major National Pollutant Discharge Elimination System (NPDES) outfalls.

4.3.2 Results

The sum of the fractions of the DCGs at the Central Neutralization Facility was calculated at 8.4% for 2003, down from 18.8% in 2002. Table 4.5 lists radionuclides discharged from the ETTP Central Neutralization Facility to off-site surface waters in 2003. Total uranium discharges from the Central Neutralization Facility were 0.0058 Ci in 2003. Total discharge of transuranics was 0.0000385 Ci, which is more than two orders of magnitude less than the contribution from uranium.

In terms of total activity of the discharges, ^{3}H, ^{14}C, and ^{99}Tc were the greatest contributors. However, the allowable DCGs for these isotopes are greater than for the uranium isotopes, so their contribution to the sum of the fractions of the DCGs is relatively small. Uranium discharges from the Central Neutralization Facility during a 5-year period were investigated to observe their trend (Fig. 4.5). Uranium isotopes were the major contributors to the fraction of the DCG, contributing three quarters of the sum of the fraction of the DCG (Fig. 4.6). Thorium-230 was only detected in two of the samples, but due to the low DCG for this isotope, these ^{230}Th results contributed approximately 1% of the DCGs for this outfall. All of the remaining isotopes cumulatively accounted for approximately 1% of the allowable DCG. TSCA Incinerator wastewater, which is sent to the Central Neutralization Facility for treatment before being discharged at Outfall 014, is a major contributor of uranium; other operations contribute smaller amounts.

4.4 NONRADIOLOGICAL LIQUID DISCHARGES—ETTP SURFACE WATER EFFLUENTS

The current ETTP NPDES permit (Permit Number TN0002950) 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 Central Neutralization Facility, 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 included 2 process outfalls and 136 storm water outfalls during 2003. Compliance with the permit for the last 5 years is summarized in Fig. 4.7. Table 4.6 details the permit requirements and compliance records for all of the outfalls that discharged during 2003. The table provides a list of the discharge points, effluent analytes, permit limits, number of noncompliances, and the percentage of compliance for 2003. Samples from these outfalls are collected and analyzed as specified in the NPDES permit.

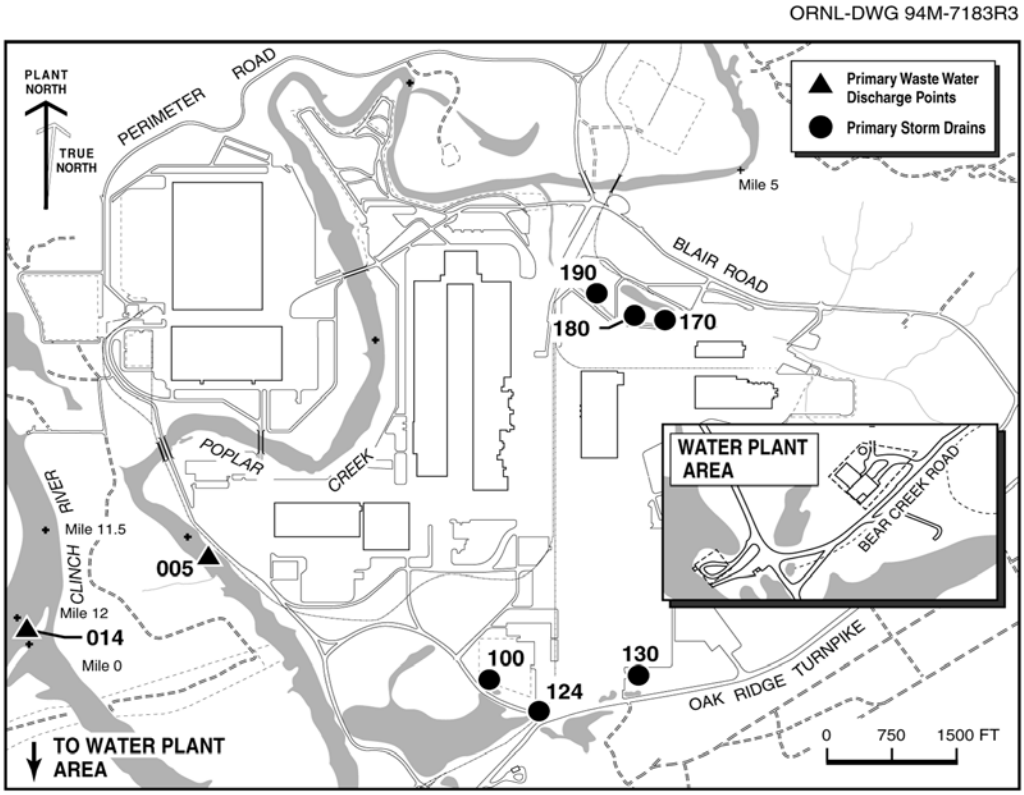

Fig. 4.4. ETTP National Pollutant Discharge Elimination System major outfalls and Category IV storm water outfalls.

Table 4.5. Radionuclides released to off-site surface waters from the ETTP, 2003

Effluent discharge location: Central Neutralization Facility

Radionuclide	Amount (Ci)[a]	Radionuclide	Amount (Ci)[a]
^{241}Am	3.7E-6	^{90}Sr	3.5E-5
^{14}C	4.2E-2	^{99}Tc	5.5E-2
^{137}Cs	4.0E-4	^{228}Th	3.3E-7
^{60}Co	2.7E-5	^{230}Th	5.5E-4
^{3}H	2.5E-2	^{234}Th	2.9E-3
^{40}K	9.8E-5	^{234}U	1.9E-3
^{237}Np	2.1E-6	^{235}U	2.0E-4
^{238}Pu	-7.1E-7	^{236}U	1.3E-4
^{239}Pu	-1.8E-7	^{238}U	3.6E-3

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

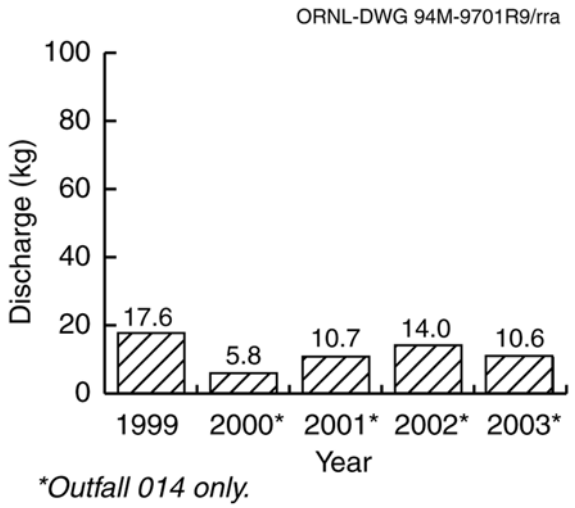

Fig. 4.5. Five-year trend of uranium releases to surface waters from the ETTP (Outfalls 005 and 014).

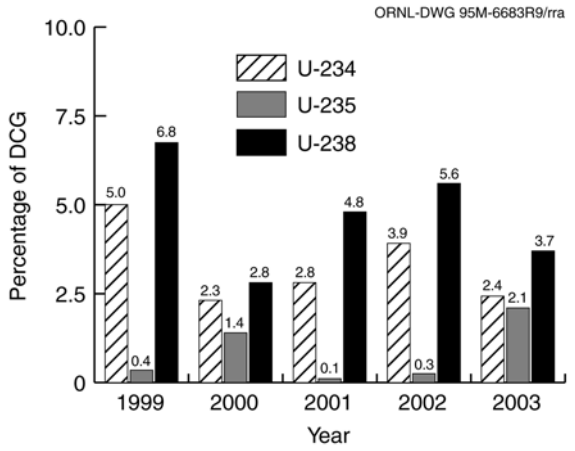

Fig. 4.6. Percentage of DOE derived concentration guides for uranium isotopes from K-1407-J (Outfall 014).

The two permitted outfalls at the ETTP during part of 2003 were Outfall 005, the permitted outfall for discharge of treated effluent from the K-1203 Sewage Treatment Plant to Poplar Creek, and Outfall 014, the permitted outfall for the discharge of effluent from the Central Neutralization Facility to the Clinch River. Individual NPDES permits with new outfall numbers were issued for each of these facilities during 2003.

The current ETTP NPDES Permit expired on September 29, 1997. An application for its renewal was submitted to TDEC in March 1997. To facilitate the transfer of ownership and

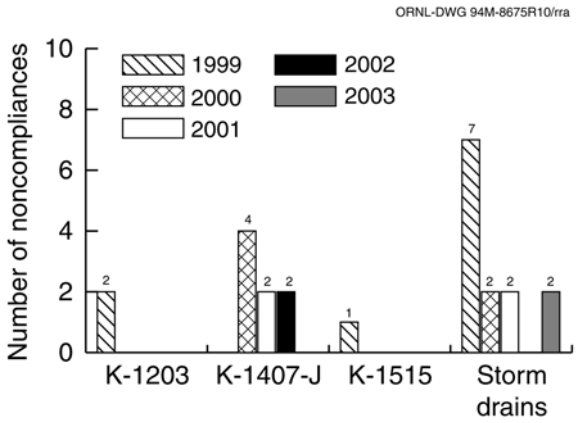

Fig. 4.7. ETTP National Pollutant Discharge Elimination System compliance history by source of noncompliance.

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. A general NPDES permit (TN0074233) for former outfalls 009 (K-1515 Sanitary Water Plant) and 013 (K-1513 Sanitary Water Intake Backwash Filter) was issued on January 14, 2000, and became effective on March 1, 2000. An NPDES permit (TN0074241) for former outfall 005 (K-1203 Sewage Treatment Plant) was issued on July 1, 2003, and became effective on August 1, 2003. An NPDES permit (TN0074225) for former outfall 014 (Central Neutralization Facility) was issued on October 7, 2003, and became effective on November 1, 2003. The issuance of these three permits allowed outfalls 005, 009, 013, and 014 to be removed from ETTP NPDES Permit Number TN0002950.

4.4.1 Results

The ETTP had two NPDES noncompliances in 2003 under NPDES Permit No. TN0002950; both were unpermitted discharges through storm water outfalls. On January 21, 2003, a diesel pickup truck belonging to a vendor for an ETTP site lessee leaked about half a gallon of diesel fuel onto a parking lot and roads within the ETTP during storm conditions. The spilled fuel quickly entered the storm drain system, and a small quantity discharged through permitted storm water outfall 100, causing an oil sheen in one area of the

Table 4.6. National Pollutant Discharge Elimination System compliance at the ETTP, 2003

Discharge point	Effluent parameter	Effluent limits				No. of noncompliances	Percentage of compliance
		Monthly avg[a]	Daily max[a]	Monthly avg (lb/day)	Daily max (lb/day)		
Outfall 005 (K-1203 Sewage Treatment Facility)	Ammonia nitrogen	5	7	27	38		100
	Biochemical oxygen demand	15	20	81	109		100
	Chlorine, total residual	0.14	0.24				100
	Dissolved oxygen		5[b]				100
	Fecal coliform, col/100 mL	200[c]	1,000				100
	LC_{50}, *Ceriodaphnia*, %		14.6[d]				100
	LC_{50}, *Pimephales*, %		14.6[d]				100
	NOEL,[e] *Ceriodaphnia*, %		4.2[d]				100
	NOEL,[e] *Pimephales*, %		4.2[d]				100
	pH, standard units		6.0–9.0				100
	Settleable solids, mL/L		0.5				100
	Suspended solids	30	45	27	244		100
Outfall 014 (K-1407-J Central Neutralization Facility to the Clinch River	Benzene		0.005				100
	Cadmium	0.18	0.69				100
	Carbon tetrachloride	0.5	0.5				100
	Chloride, total	35,000	70,000				100
	Chlorine, total residual		1.0				100
	Chloroform	0.5	0.5				100
	Chromium	1.71	2.77				100
	Copper	1.34	2.15				100
	Ethylbenzene		0.01				100
	Lead	0.38	0.69				100
	Nickel	2.38	3.98				100
	Oil and grease		30				100
	PCB	0.00022	0.00045				100
	Petroleum hydrocarbons		0.1				100
	pH, standard units		6.0–9.0				100
	Silver	0.24	0.43				100
	Suspended solids		40				100
	Tetrachloroethylene		0.7				100
	Toluene		0.01				100
	Total toxic organics		2.13				100
	Trichloroethylene	0.5	0.5				100[f]
	Vinyl chloride	0.2	0.2				100[f]
	Zinc	1.48	2.61				100[f]
Category I storm drains	pH, standard units		4.0–9.0				100
Category II storm drains	pH, standard units		4.0–9.0				100
Category III storm drains	pH, standard units		4.0–9.0				100
	Unpermitted discharge	*f*	*f*			1	*f*
Category IV storm drains (to Poplar Creek)	Chlorine, total residual		0.14				100
	pH, standard units		6.0–9.0				100
	Unpermitted discharge	*f*	*f*			1	*f*
Category IV storm drains (to Mitchell Branch)	Chlorine, total residual		0.019				100
	pH, standard units		6.0–9.0				100

[a]Units are mg/L unless otherwise stated.
[b]Daily minimum.
[c]Geometric mean.
[d]Toxic if LC_{50} <14.6% effluent or no observed effect level < 4.2%.
[e]No observable effect level.
[f]Not applicable.

K-1007-P1 Pond. Containment and cleanup efforts prevented spilled fuel from reaching Poplar Creek. The vehicle was repaired and was hauled from the site on a flatbed truck.

On July 29, 2003, an operator discovered a grayish discharge bubbling out of a sanitary sewer line clean-out port outside the K-1423 building break room. The grayish water was entering a nearby storm drain catch basin that discharges through storm water outfall 200 into Mitchell Branch. The catch basin was isolated, and a hose was inserted in the clean-out port to pump the gray water to a lift station. The amount of gray water discharged through the storm drain system could not be determined, but there was no evidence of any impact in Mitchell Branch. The sanitary sewer line was determined to have blockage; it was later excavated and repaired.

4.5 STORM WATER POLLUTION PREVENTION PROGRAM

4.5.1 Storm Water Monitoring Strategy

Development and implementation of the ETTP Storm Water Pollution Prevention Program is required by Part IV of ETTP NPDES Permit No. TN0002950. The objective of the program is to minimize the discharge of pollutants in storm water runoff from the ETTP.

The purpose of the ETTP Storm Water Pollution Prevention Program is to assess the quality of storm water discharges from ETTP, determine potential sources of pollutants affecting storm water, and provide effective controls to reduce or eliminate these pollutant sources. It provides a means whereby sources of pollutants that are likely to affect the quality of storm water discharges are identified, best management practices to control the entry of pollutants into storm water discharges are developed, and methods for implementing pollution prevention practices are devised.

Based on knowledge of past processes and activities at the ETTP, only parameters of particular concern were monitored during 2003. These parameters include gross alpha radioactivity, gross beta radioactivity, polychlorinated biphenyls (PCBs), mercury, metals, and volatile organic compounds. Gross alpha and gross beta radioactivity were monitored at those storm drain outfalls where they were detected at levels above screening criteria during more than one previous sampling effort. PCBs were monitored at those storm drain outfalls where they were detected above the detection limit of the analytical method. Metals were monitored at those locations where they were detected in amounts exceeding the screening criteria during more than one previous sampling effort and that may have received runoff from cooling tower areas. Volatile organics were monitored at those storm drain locations that are potentially affected by contaminated groundwater plumes and at locations where they were detected in amounts exceeding the screening criteria during more than one previous sampling effort.

As part of the 2003 Storm Water Pollution Prevention Program and in association with the ETTP Water Quality Project monitoring program, surface water samples were also collected at locations that are exit pathways for contaminants from ETTP. These locations have a direct discharge or potential for direct discharge to Poplar Creek or the Clinch River.

Storm drain water samples were also collected during 2003 to support remedial actions, decontamination and decommissioning activities, the ETTP Water Quality Project, and the NPDES permit renewal process.

4.5.2 Storm Water Monitoring Results

4.5.2.1 Radiological Monitoring of Storm Water Discharges

In the ETTP Storm Water Pollution Prevention Program, levels of 15 pCi/L for gross alpha activity and 50 pCi/L for gross beta activity are used as radiological screening levels. These screening levels correspond to the National Primary Drinking Water Standards established by the Safe Drinking Water Act. The screening level for a specific radionuclide is equal to 4% of the DCG for that radionuclide in water, as listed in U.S. DOE Order 5400.5. The screening levels for uranium isotopes are 20 pCi/L for ^{234}U and ^{236}U, and 24 pCi/L for ^{235}U and ^{238}U. The screening level for ^{99}Tc is 4,000

pCi/L. The screening levels for ^{237}Np, ^{238}Pu, and $^{239/240}$Pu are 1.2, 1.6, and 1.2 pCi/L, respectively.

ETTP storm water outfall monitoring results obtained in 2003 that exceeded radiological screening levels are shown in Table 4.7. Maximum exceedances at each outfall are shown.

Sampling for gross alpha radiation, gross beta radiation, ^{234}U, ^{236}U, ^{235}U, ^{238}U, ^{99}Tc, ^{237}Np, ^{238}Pu, and $^{239/240}$Pu was also performed at several other storm water outfalls in addition to those listed in the table. No radiological screening levels were exceeded for any of these outfalls.

Table 4.7. Maximum exceedances of radiological screening criteria for each storm water outfall, 2003 (pCi/L)[a]

Storm water outfall	Alpha	Beta	$^{233/234}$U	^{238}U
158	98.8	97.5		
180	19.4			
190	46.9		29.2	
292	38.3			
350	195	68.3	74.3	57.4
382	20.3			
490		84.2		
724	118	70.6	46.5	33.8
730	40.3	198	21.0	
740	106	72.9	69.3	48.2
750	47.1	67.3	28.2	
760	137	76.1	73.5	44.8

[a]Screening levels are 15 pCi/L alpha radiation, 50 pCi/L beta radiation, 20 pCi/L ^{234}U, 24 pCi/L ^{235}U, and 24 pCi/L ^{238}U.

Table 4.8 provides an estimate of the total activity of radionuclides discharged from ETTP storm water outfalls in 2003.

4.5.2.2 Nonradiological Monitoring of Storm Water Discharges

Grab samples were collected at storm water outfalls 100, 124, 170, 180, 190, 200, 210, 220, 230, 280, 292, 294, 490, 724, 730, 740, 750, 760, and 890 as part of the Storm Water Pollution Prevention Program storm water sampling effort, and they were analyzed for PCBs to a detection level of 0.5 µg/L. No detectable PCBs were found in samples from any of these locations except outfall 292, where one result for Aroclor-1260 was 0.5 µg/L.

Table 4.8. Radionuclides released to off-site surface waters from the ETTP storm water system, 2003

Radionuclide	Amount (Ci)[a]	Radionuclide	Amount (Ci)[a]
^{237}Np	-2.0E-5	^{234}U	1.5E–2
^{238}Pu[b]	6.3E–5	^{235}U	7.7E–4
^{239}Pu	8.6E-6	^{236}U	1.7E–4
^{99}Tc	6.1E–2	^{238}U	5.1E–3

[a]1 Ci = 3.7E+10 Bq. [b]All results less than or equal to laboratory error values.

Storm water from a number of outfalls contained metals and/or volatile organics at concentrations above applicable screening levels. These results are shown in Table 4.9.

Table 4.9. Maximum exceedances of nonradiological screening criteria for each storm water outfall (µg/L)

Outfall	Parameter	Monitoring Result	Criteria
100	Zinc	129	104
170	Aluminum	900	100
180	Trichloroethene	16	5
190	1,1-Dichloroethane	23	5
190	Barium	119	100
190	Boron	126	100
190	Nickel	115	100
190	Trichloroethene	41	5
190	Vinyl chloride	190	2
430	Trichloroethene	15	5
490	Trichloroethene	7	5
710	Copper	217	100
710	Zinc	549	100
724	Aluminum	280	100
750	Copper	118	100

4.5.2.3 Sump Data

No gross alpha or gross beta contamination above the screening levels was detected in water samples collected from any of the twelve sumps that were included in the 2003 Storm Water Pollution Prevention Program. In addition, no levels of transuranics or isotopic uranium exceeding 4% of the DCG level were detected in samples from any of the sumps sampled in 2003.

Trichloroethene was detected in water samples from three sumps in buildings K-1210 and K-731 at concentrations that exceeded the Tennessee water quality criteria for domestic water supply, which is 5 µg/L. No other volatile organics were detected at levels above the Tennessee water quality criteria at any of the other sumps sampled in 2003. Aroclor-1254 was detected in water samples from three sumps in building K-731 and Aroclor-1260 from one sump in building K-761 at concentrations that exceeded the detection level. PCBs were not found in detectable concentrations in any of the other sumps that were sampled as part of the 2003 Storm Water Pollution Prevention Program.

4.5.2.4 Sediment Monitoring at Storm Drains and Oil/Water Separators

As part of the 2003 Storm Water Pollution Prevention Program sampling effort, sediment samples were collected and analyzed for PCBs at seven oil/water separators that are part of the storm drainage system at ETTP. Aroclor-1260 was detected in each separator, and Aroclor-1254 was detected in three of the separators. No other aroclors were detected. The results of this sediment sampling effort are given in Table 4.10.

Table 4.10. PCBs detected in sediment from oil/water separators

Separator	Aroclor	Results (µg/g)
K-897	1254	1.1
	1260	0.7
K-897-B	1254	2.8
	1260	1.2
K-897-C	1260	0.5
K-897-D	1260	0.9
K-897-E	1260	2.3
K-897-F	1260	1
K-897-G	1254	0.7

4.6 ETTP TOXICITY CONTROL AND MONITORING PROGRAM

The NPDES permit requires that biannual toxicity testing be performed at Outfall 005 (the Sewage Treatment Plant). Operations Management International currently manages the water treatment plant and the Sewage Treatment Plant as well as some aspects of the storm drain network. The results of the toxicity tests of wastewaters conducted during 2003 are given in Table 4.11, which also provides the wastewater's no-observed-effect concentration (NOEC) and lethal concentration for 50% of the test organisms (LC_{50}) or the inhibition concentration for 25% of the organisms (IC_{25}) for fathead minnows (*Pimephales promelas*) and *Ceriodaphnia dubia* for each test. Average water quality measurements obtained during each toxicity test are shown in Table 4.12.

Effluent from Outfall 005 was tested two times during 2003 with fathead minnows and *Ceriodaphnia*. In all tests, samples did not reduce survival, growth, or reproduction. Thus all NOEC and the LC_{50} results were within the permit limits.

4.7 ETTP BIOLOGICAL MONITORING AND ABATEMENT PROGRAM

The Biological Monitoring and Abatement Program (BMAP) is a requirement of the NPDES permit. Its purpose is to assess the ecological health of the ETTP's receiving streams and ponds. The BMAP consists of four tasks: (1) toxicity monitoring, (2) bioaccumulation monitoring, (3) ecological surveys of instream communities (both fish and

Table 4.11. ETTP National Pollutant Discharge Elimination System Outfall 005 Permit Number TN 0002950/TN 0074241 toxicity test results, 2003

Test date	Species	NOEC[a] (%)	LC_{50}[b]	IC_{25}[c](%)	IWC[d] (%)
April–May	Fathead minnow	4.2	>14.6		3.
	Ceriodaphnia	4.2	>14.6		33.3
August	Fathead minnow	NA		>75.2	2.
	Ceriodaphnia	NA		>75.2	62.6

[a]No-observed-effect concentration
[b]96-h lethal concentration for 50% of the test organisms
[c]Inhibition concentration for 25% of the test organisms
[d]Instream waste concentration (based on critical low flow of Poplar Creek)

Table 4.12. ETTP average water quality parameters measured during toxicity tests of Outfall 005 effluent, 2003
Values are averages of full-strength wastewater for each test (N = 6 or 7)

Test date	pH (standard units)	Conductivity (µS/cm)	Alkalinity (mg/L $CaCO_3$)	Hardness (mg/L $CaCO_3$)
April–May	8.2	210	68	140
August	7.4	350	85	150

benthic macroinvertebrates), and (4) waterfowl monitoring. The BMAP is conducted by the ORNL Environmental Sciences Division under the direction of the ETTP Environmental Compliance and Protection Organization.

4.7.1 Toxicity Monitoring

The toxicity monitoring task for the BMAP includes tests of effluent from storm water outfalls 170, 180, and 190 concurrently with surface water from six ambient sites in Mitchell Branch [Mitchell Branch kilometer (MIK) 0.12, MIK 0.45, MIK 0.54, MIK 0.71, MIK 0.78, and MIK 1.43]. (The number following "MIK" indicates the distance in kilometers from the mouth of Mitchell Branch on Poplar Creek.) *Ceriodaphnia dubia* were used to evaluate effluent from stormwater outfalls 170 and 190, and the ambient monitoring location for toxicity four times during 2003. Survival and growth tests using fathead minnows (*Pimephales promelas*) were conducted on effluent from storm water outfall 190 at the same time as the *Ceriodaphnia dubia* tests. These tests were conducted in February and March, June, August, and December. Effluent from storm water outfall 180 was evaluated for toxicity two times in 2003 (in February and March, and again in August).

Results of the toxicity tests are presented in Table 4.13. In the tests on the ambient locations, only one test exhibited toxicity, but it exhibited toxicity at three locations (three locations at and downstream from MIK 0.54), in the form of reduced *Ceriodaphnia* reproduction. In *Ceriodaphnia* tests on effluent from storm water outfall 170, reproduction or survival was reduced in three of the four tests. However, none of the tests on effluent from storm water outfall 180 exhibited toxicity. In all four *Ceriodaphnia* tests, effluent from storm water outfall 190 reduced reproduction and/or survival. Fathead minnows were not significantly affected in any of the 2003 tests. Thus, the overall trend is one of consistent toxicity to *Ceriodaphnia* from storm water outfall 190, slightly less toxicity from storm water outfall 170, and no toxicity from storm water outfall 180. Although it was not possible to positively identify the source of the problem, the data gathered indicated that groundwater was percolating through waste in the K-1070-B Classified Burial Ground and leaching out small quantities of metals. Some of this groundwater was then flowing into the storm drain system and causing the toxicity. Nickel and zinc are present in water collected from the storm drain system near K-1070-B at levels that have been shown to be toxic to *Ceriodaphnia*.

Table 4.13. Mitchell Branch and associated storm water outfall toxicity test results, 2003[a]

Test	MIK 1.43	MIK 0.78	SD 170	MIK 0.71	SD 180	MIK 0.54	SD 190	MIK 0.45	MIK 0.12
First quarter, February–March									
Ceriodaphnia survival	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ceriodaphnia reproduction	NR	NR	NR	NR	NR	NR	R	NR	NR
Pimephales survival							NR		
Pimephales growth							NR		
Second quarter, June									
Ceriodaphnia survival	NR	NR	NR	NR	*b*	NR	R	NR	NR
Ceriodaphnia reproduction	NR	NR	R	NR	*b*	NR	R	NR	NR
Pimephales survival							NR		
Pimephales growth							NR		
Third quarter, August									
Ceriodaphnia survival	NR	NR	NR	NR	NR	NR	R	NR	NR
Ceriodaphnia reproduction	NR	NR	R	NR	NR	R	R	R	R
Pimephales survival							NR		
Pimephales growth							NR		
Fourth quarter, December									
Ceriodaphnia survival	NR	NR	NR	NR	*b*	NR	R	NR	NR
Ceriodaphnia reproduction	NR	NR	R	NR	*b*	NR	R	NR	NR
Pimephales survival							NR		
Pimephales growth							NR		

[a]NR: No significant reduction compared with the control population.
R: Significant reduction compared with the control population.
[b]SD 180 is only sampled twice per year.

4.7.2 Bioaccumulation Studies

In June and July, 2003, caged clams *(Corbicula fluminea)* were placed at several locations around ETTP, including five oil-water separators. The clams were allowed to remain in place for four weeks, then were analyzed for uptake of PCBs. Clams from all of the ETTP monitoring locations accumulated some level of PCBs; results of monitoring in 2003 were generally similar to the 2002 results. As before, the primary source of PCBs to the environment remains Storm Water Outfall 100. Both Mitchell Branch and the K-1007-P1 Pond receive effluent from other storm water outfalls that contain smaller amounts of PCBs. Levels in clams from Mitchell Branch progressively increase with the distance downstream. The PCBs in Mitchell Branch clams were primarily Aroclor 1254, while in the K-1007-P1 Pond clams both Aroclors 1248 and 1254 were present. As before, the concentration of PCBs in K-901-A clams was significantly lower than the concentration found in clams from K-1007-P1 Pond and Mitchell Branch. Clams were also placed in selected oil/water separators and in selected building sumps.

Fish were collected from Mitchell Branch, K-1007-P1 Pond, and K-901-A Pond in April 2003. Largemouth bass were collected from the pond sites, and redbreast sunfish were collected from Mitchell Branch. Game fish of a size large enough to be taken by sportsfishermen were selected to provide accurate data of potential human health concerns and to reduce the amount of variation in contamination levels in the individual fish due to age and size differences. Fillets were taken from each game fish and analyzed for PCBs. Table 4.14 gives a synopsis of the results. As in previous years, the fish from the K-1007-P1 pond contained the highest concentrations of PCBs, while those from Mitchell Branch contained smaller concentrations, and the fish from K-901-A contained the lowest concentrations. Average levels at all sites were within historic ranges for the respective locations, although compared with last year's monitoring results, the averages had increased slightly in fish from K-901-A and decreased slightly in fish from Mitchell Branch. The maximum concentration was found in a bass from K-1007-P1 Pond (33.7 µg/g, wet weight), where both the average and the maximum values in 2003 were slightly lower than in 2002.

4.7.3 Ecological Surveys of Instream Communities

In April 2003, the benthic macroinvertebrate community at four Mitchell Branch locations (MIK 0.45, 0.71, 0.78, and 1.43) were sampled. MIK 1.43 serves as the reference location. Except for a short-term impact at MIK 0.45 and 0.71 following construction of the interceptor trench, the benthic macroinvertebrate community at all locations in lower Mitchell Branch has generally increased in species richness and numbers of pollution-intolerant species over approximately the last ten years. (Figs. 4.8, 4.9, and 4.10). The results from this year's sampling show declines in species richness and richness of the pollution-intolerant species at MIK 0.45, 0.71, and 0.78 compared with 2002, suggesting that some level of stress remains. The results to date indicate that, although past ETTP operations had adversely affected the communities of Mitchell Branch, the institution of best management practices and remediation efforts has resulted in gradual, but more or less continuous, improvement of conditions in the stream.

Fish communities in Mitchell Branch (MIK 0.45 and 0.71) were sampled in April, and reference streams were sampled in April and June. Species richness, density, and biomass were examined. The community at MIK 0.45 showed a drastic drop in species richness, density, and biomass. In 2002, species richness, density, and biomass at MIK 0.45 were at the highest levels ever recorded since monitoring began, so the opportunity for a large decrease this year was increased. In the spring of 2003, some of the highest flows on record for the area were recorded, and many of the smaller individuals and eggs may have been washed out of the stream. The combination of these two factors may account for much of the decrease. The community at MIK 0.71 continues to show some improvements from 1998, when that area was extensively disturbed by the groundwater intercept trench project, but it still has not reached the levels existing prior to that disturbance.

Table 4.14. PCB concentrations in biota at ETTP, 2003

Location	Species	Mean Concentration (ppm)	Range	No.>1ppm/N
MIK 0.2	Redbreast sunfish (*Lepomis auritus*)	3.48	0.82-6.1	5/6
K-1007-P1	Largemouth bass (*Micropterus salmoides*)	17.02	5.93-33.7	6/6
K-901-A	Largemouth bass (*Micropterus salmoides*)	0.77	0.32-1.5	2/6
Hinds Creek (reference)	Redbreast sunfish (*Lepomis auritus*)	<0.01	<0.01	0/6
MIK 0.78	Asiatic clams (*Corbicula fluminea*)	0.08	N/A	N/A
MIK 0.71(SD170)	Asiatic clams (*Corbicula fluminea*)	0.14	N/A	N/A
MIK 0.54(SD180)	Asiatic clams (*Corbicula fluminea*)	0.17	N/A	N/A
MIK 0.45 (SD190)	Asiatic clams (*Corbicula fluminea*)	0.92	N/A	N/A
MIK 0.2	Asiatic clams (*Corbicula fluminea*)	2.1	N/A	N/A
SD100	Asiatic clams (*Corbicula fluminea*)	3.85	N/A	N/A
SD120	Asiatic clams (*Corbicula fluminea*)	0.79	N/A	N/A
SD124	Asiatic clams (*Corbicula fluminea*)	0.17	N/A	N/A
SD480	Asiatic clams (*Corbicula fluminea*)	0.7	N/A	N/A
K-1007-B	Asiatic clams (*Corbicula fluminea*)	1.71	N/A	N/A
K-901-A	Asiatic clams (*Corbicula fluminea*)	0.17	N/A	N/A
Little Sewee Creek (reference)	Asiatic clams (*Corbicula fluminea*)	0.03	N/A	N/A

4.7.4 Waterfowl Surveys

Waterfowl surveys were conducted each month. One state-listed species, the great egret (*Ardea alba*) was observed. One "in need of management" species, the vesper sparrow (*Pooecetes gramineus*) was also observed. Other interesting species found at ETTP include the osprey (*Pandion haliateus*), double-crested cormorant (*Phalacrocorax auritus*), and the Canada goose (*Branta canadensis*). During the last several years, the number of species of waterfowl, as well as the number of individuals, has fluctuated. It is not clear at this time whether or not the fluctuations represent a temporary plateau on the route to recovery, or whether the avian community has more or less reached a steady state for the current conditions.

4.8 ETTP AMBIENT AIR MONITORING

DOE Order 450.1 requires surveillance of ambient air to assess the impact of DOE operations on air quality. In addition, airborne radionuclide monitoring is required for compliance with radionuclide NESHAP regulatory agreements. DOE Order 5400.5 also specifies requirements for airborne radionuclide surveillance. The ETTP ambient air monitoring program is designed to monitor selected air contaminants for the ongoing monitoring of the impact of plant operations on the immediate environment. Specific locations were selected to determine air contaminant concentrations in the prevailing directions, upwind and downwind of the site, and to obtain airborne radiological measurements in the direction of both the nearest and most exposed member of the public. The current locations of these monitoring stations are shown in Fig. 4.11. The ETTP ambient air monitoring program complies with all requirements of DOE orders.

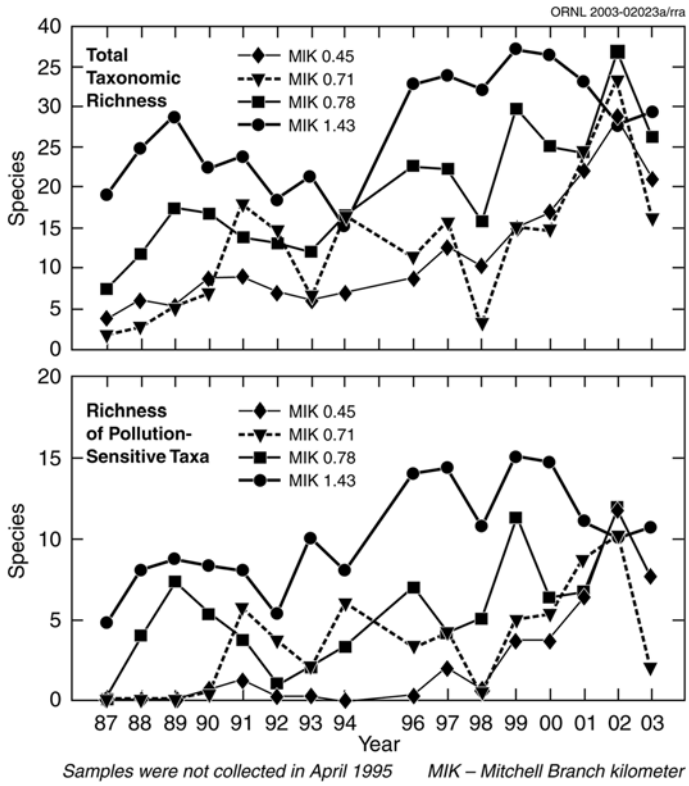

Fig. 4.8. Total taxonomic richness of pollution-sensitive taxa.

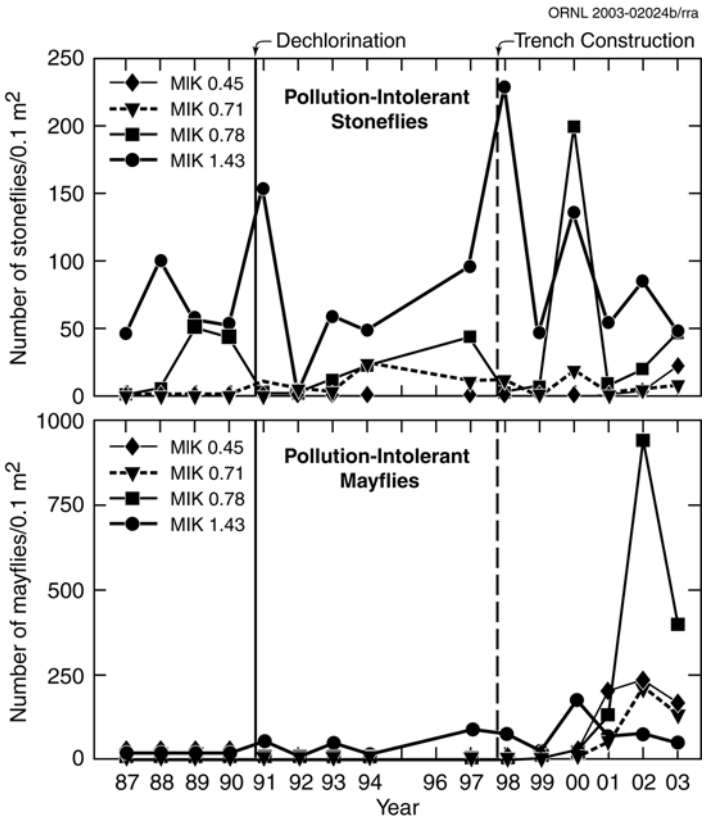

Fig. 4.9. Density of pollution-intolerant and pollution-tolerant species in Mitchell Branch.

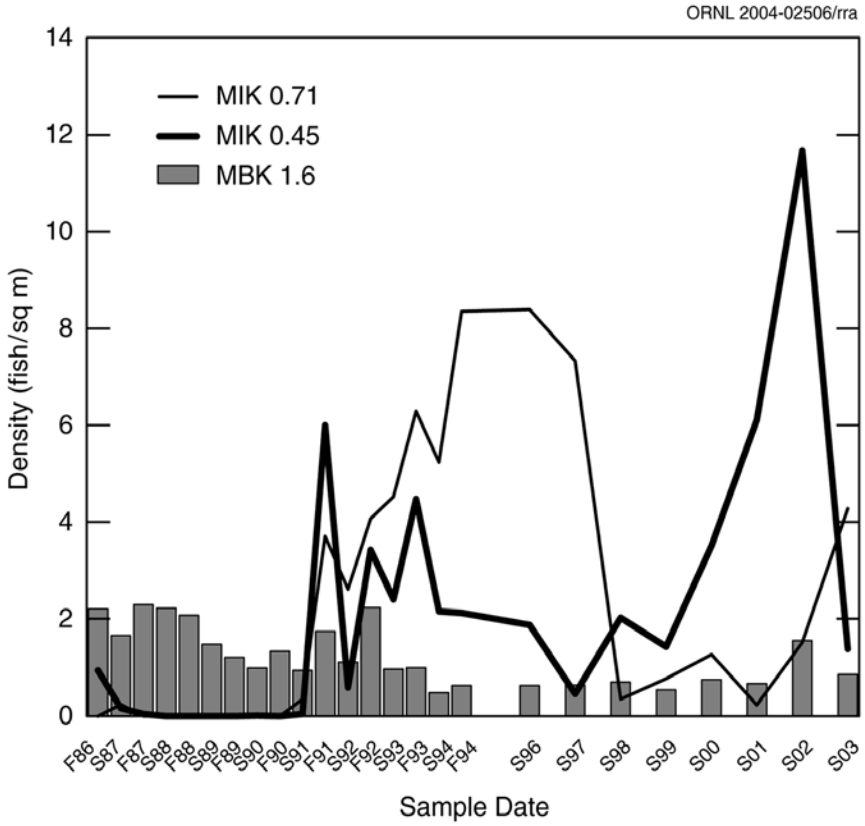

Fig. 4.10. Temporal trend in fish density in Mitchell Branch.

National ambient air quality standards are referenced by DOE orders as guidance with respect to ambient air concentrations of certain air contaminants. These regulations specify 24-h, quarterly, and annual standards for specific or criteria pollutants. Additionally, results are compared with any applicable risk-specific dose and reference air concentration listed in 40 CFR 266, Subpart H.

The ambient air sampling schedule and monitored parameters are listed in Table 4.15. All parameters were chosen with consideration of existing and proposed regulations and the nature of operations in and around the ETTP. Changes in emissions, wind profile, site activities, or any other parameter that may alter the potential impact of ETTP activities on nearby communities or the environment may warrant periodic changes of air contaminants measured, number of stations, or relocation of existing stations. The principal parameters monitored during 2003 were arsenic, beryllium, cadmium, chromium, lead, and uranium. Uranium was analyzed by both inorganic and radiochemical methods. Radiochemical analyses included isotopes of uranium (^{234}U, ^{235}U, ^{236}U, and ^{238}U), ^{99}Tc, ^{228}Th, ^{230}Th, ^{232}Th, ^{237}Np, ^{238}Pu, and ^{239}Pu.

During this reporting period, the ambient air monitoring network was modified with respect to ETTP operations. Station K11 was removed from service during 2002 concurrent with the completion of K-1070-A Burial Ground Remediation activities requiring this sampler. Sampling at Station K10 was discontinued at the end of May 2003. This coincided with the completion of building demolition activities that required the sampler. No other sampling procedures or locations were changed from the previous year. Samples were collected weekly from the following stations: K2, K6, K9, K10, and perimeter air monitors 35 and 42.

4.8.1 Results

No standards were exceeded, and, with the exception of uranium levels, there were no significant variations of annual pollutant concentrations

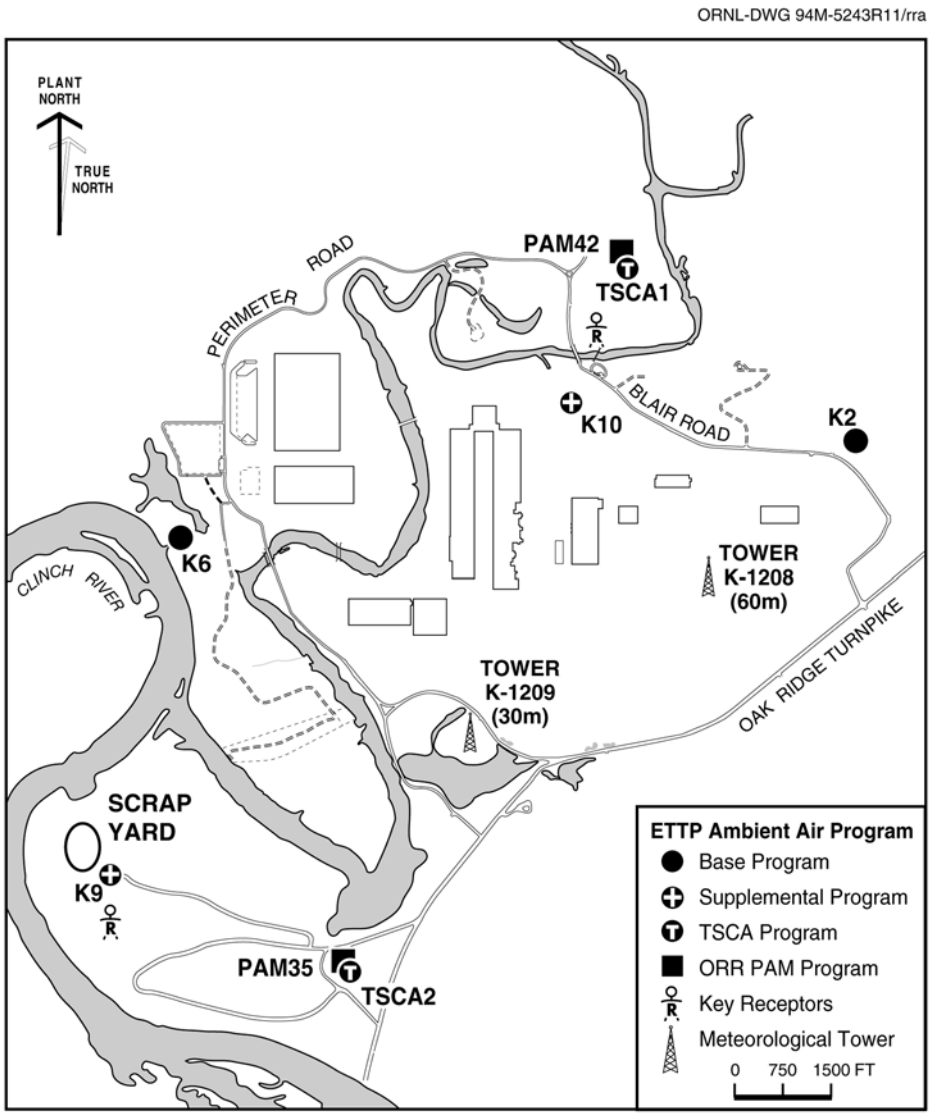

Fig. 4.11. Locations of ambient air monitoring stations at the ETTP.

associated with site operations when compared with data from the previous year. Sampling results assessing the impact of specific site activities on air quality show that the ETTP, including project-specific measurements, did not have any impact of concern on local air quality. Also, radiochemical analyses of ambient air samples confirm low radiological emissions from the ETTP.

4.8.2 Criteria Pollutant Levels

Quarterly lead results were determined from analyses of monthly composites of continuous weekly samples from station K10 and quarterly composites from stations K2, K6, and K9. The total mass quantities of lead for each sample were determined by the inductively coupled plasma mass spectrometry (ICP-MS) analytical technique. Lead analytical results are summarized in Table 4.16 and are compared with the Tennessee and national quarterly ambient air quality standard of 1.5 $\mu g/m^3$. There are no 24-h, monthly, or annual ambient air quality standards for lead. The maximum individual lead result was 0.0022 $\mu g/m^3$. This value was only 0.15% of the quarterly standard for lead. No lead concentrations of environmental concern were measured (see Fig. 4.12 for 5-year lead trend).

Table 4.15. Summary of types and frequencies of samples collected at ETTP perimeter ambient air monitoring stations, 2003

Parameter	Sampling locations	Sampling period	Collection frequency	Analysis frequency[a]
	Criteria pollutants			
Lead	K2, K6, K9	Continuous	Weekly	Quarterly
	K10[b]			Monthly
	Hazardous air pollutants carcinogen metals			
Arsenic	K2, K6, K9	Continuous	Weekly	Quarterly
Beryllium	K2, K6, K9	Continuous	Weekly	Quarterly
Cadmium	K2, K6, K9	Continuous	Weekly	Quarterly
	K10			Monthly
Chromium	K2, K6, K9	Continuous	Weekly	Quarterly
	Organic compounds			
Polychlorinated biphenyls	TSCAI[c] 1, 2	*d*	*d*	*d*
Furan	TSCAI 1, 2	*d*	*d*	*d*
Dioxin	TSCAI 1, 2	*d*	*d*	*d*
Hexachlorobenzene	TSCAI 1, 2	*d*	*d*	*d*
	Radionuclides(by inorganic analysis)			
Uranium (total)	K2, K6, K9	Continuous	Weekly	Quarterly
	K10			Monthly
	PAM 35, 42	Continuous	Weekly	Quarterly
	TSCAI 1, 2	*d*	*d*	*d*
	Radionuclides(by radiochemical analysis)			
^{99}Tc, ^{237}Np, $^{238,239}Pu$, $^{234,235,236,238}U$	K2, K6, K9	Continuous	Weekly	Quarterly
$^{234,235,236,238}U$	K10	Continuous	Weekly	Monthly

[a] Monthly and quarterly frequencies are composite sample analyses of all weekly samples collected over the identified period.

[b] Temporary sampling station discontinued operation in May 2003.

[c] Toxic Substances Control Act (TSCA) Incinerator.

[d] Stations are activated automatically only if a TSCA Incinerator operational upset occurs. Identified samples are then immediately submitted for analysis.

Table 4.16. Lead concentrations in ambient air at the ETTP, 2003

Annual average for all stations = 0.000736 μg/m^3

Station	Quarterly averages of monthly composites(μg/m^3)				Max quarterly result(μg/m^3)	Max percent of quarterly standard[a,b]
	1	2	3	4		
K2	0.000876	0.000342	0.000497	0.000531	0.000876	0.06
K6	0.000796	0.000350	0.000462	0.000654	0.000796	0.05
K9	0.000460	0.000310	0.000712	0.000573	0.000712	0.05
K10	0.002242	0.000140	*c*	*c*	0.002242	0.15
Quarterly avg	0.001094	0.000286	0.000557	0.000586	0.001094	0.07
Quarterly max	0.002242	0.000350	0.000712	0.000654	0.002242	0.15

[a] Tennessee and national air quality standard for lead is 1.5 μg/m^3 quarterly arithmetic average.

[b] Conservative comparison of the maximum individual monthly result with the quarterly standard.

[c] Temporary sampling station discontinued operation in May, 2003.

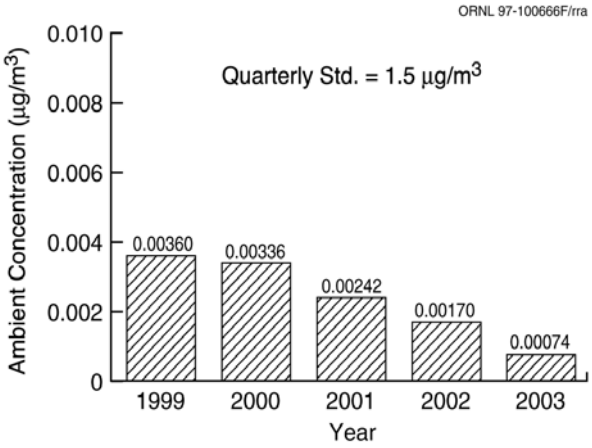

Fig. 4.12. Ambient air monitoring 5-year trend results for lead at the ETTP.

4.8.3 Hazardous Air Pollutant Carcinogenic Metal Levels

Analyses of hazardous air pollutant carcinogenic metals (arsenic, beryllium, cadmium, and chromium) were performed on quarterly composite samples of continuous weekly samples from stations K2, K6, and K9. All monthly composite samples from K10 were only analyzed for cadmium. Total mass of each selected metal was determined by the ICP-MS analytical technique. There are no Tennessee or national ambient air quality standards for these hazardous air pollutant carcinogenic metals. However, comparisons have been made against risk-specific doses and reference air concentrations.

The annual average arsenic concentration for all measurement sites was 0.00017 µg/m^3, well below the risk-specific dose of 0.0023 µg/m^3. The individual maximum measured result was 0.00027 µg/m^3. Annual beryllium measurements were at or near the minimum detectable concentrations of the analytical method, orders of magnitude below the risk-specific dose of 0.0042 µg/m^3. The combined beryllium average for all sites was <0.000002 µg/m^3 with the individual maximum result of <0.000003 µg/m^3. The maximum cadmium concentration result was 0.00037 µg/m^3. The cadmium annual average was 0.00008 µg/m^3. Both results are well below the risk-specific dose of 0.0056 µg/m^3. Individual chromium measurements ranged from approximately 0.00014 to 0.00065 µg/m^3. The annual average result for chromium was 0.00007 µg/m^3, well below the risk-specific dose of 0.00088 µg/m^3 for chromium VI. The form of chromium was not determined, and therefore the most conservative risk-specific dose (chromium VI) was used. A summary of the hazardous air pollutant carcinogenic metals measurements is presented in Table 4.17.

4.8.4 Radionuclide Levels

Total uranium metal was measured as a monthly composite of continuous weekly samples from station K10 and quarterly composites from stations K2, K6, and K9. Quarterly composites of weekly continuous samples were analyzed from perimeter air monitoring stations 35 and 42. The total uranium mass for each sample was determined by the ICP-MS analytical technique. The uranium annual averages and maximum individual concentration measurements for all sites are presented in Table 4.18. Results ranged from a minimum of approximately 0.00004 to 0.00023 µg/m^3. The highest result was measured at Station K10, which is in one of the prevailing wind directions from the K-1070-A Burial Ground Remediation activity. The annual average value for all stations due to uranium was 0.00009 µg/m^3. The ICP-MS results are compared with a dose based on the DCG for natural uranium. (The DCG is based on an annual air concentration exposure that would give a dose of 100 mrem.) The sampling location with the highest annual average concentration of uranium was at station K10. The annual result was only 0.00014 µg/m^3, which corresponds to 0.1% of the DCG (see Fig. 4.13 for 5-year uranium trend).

The highest recorded monthly uranium concentration for CY 2003 was measured at station K10, located in the K-1070-A area. The K10 sample result of 0.00023 µg/m^3, if assumed to be the annual average concentration, would equate to only 0.2% of the DCG for an individual located at that station for the entire year. Fig. 4.14 shows a comparison of monthly trends of total uranium data from K2 and TSCA Incinerator stack emission data. The intent of this figure is only to show the relative trend of each measurement result. A significant factor that can affect a comparison between the two data sets is the meteorology during each month. Shorter

Table 4.17. Hazardous air pollutant concentrations in ambient air at the ETTP, 2003

Parameter	Ambient air concentration (μg/m³)			Percentage of standard[a]
	Annual avg	Monthly max	Max location	
Arsenic	0.000165	0.000274	K2	7.6
Beryllium	<0.000002	<0.000003	K10	<0.1
Cadmium	0.000083	0.000365	K10	1.5
Chromium	0.000066	0.000099	K9	
Cr-III				<0.1
Cr-VI				7.5

[a]There are no Tennessee or national ambient air quality standards; however, annual averages are compared to risk–specific doses for As, Be, Cd, and Cr–VI and the reference air concentration for Cr–III as listed in 40 CFR 266.

Table 4.18. Total uranium in ambient air by inductively coupled plasma mass spectrometry analysis at the ETTP, 2003

Station	Samples	Concentration[a]				Percent of DCG[b](%)	
		(μg/m³)		(μCi/mL)			
		Avg	Max[c]	Avg	Max[c]	Avg	Max[c]
K2	6	0.000037	0.000184	2.45E–17	1.23E–16	0.02	0.12
K6	6	0.000106	0.000179	7.09E–17	1.19E–16	0.07	0.12
K9	6	0.000035	0.000082	2.36E–17	5.46E–17	0.02	0.05
K10	5	0.000144	0.000273	9.59E–17	1.82E–16	0.10	0.18
PAM35	3	0.000100	0.000175	6.68E–17	1.16E-16	0.07	0.12
PAM42	3	0.000121	0.000146	8.05E–17	9.72E–17	0.08	0.10
ETTP total	29	0.000091	0.000273	6.04E–17	1.82E–16	0.06	0.18

[a]Mass-to-curie concentration conversions assume a natural uranium assay of 0.717% ^{235}U.

[b]DOE Order 5400.5 Derived Concentration Guide (DCG) for naturally occurring uranium is an annual concentration of 1E–13 μCi/mL, which is equivalent to a 100 mrem annual dose.

[c]Maximum individual sample analysis result with dose calculations conservatively, assuming the value to be an annual concentration.

reporting periods increase the potential that the plume from the incinerator may not be in the direction of K2 when operating. Another factor is the sensitivity of the analytical methods at these low levels of pollutants, which can introduce increased uncertainty in the data. The data show that K2 can detect airborne uranium during periods of waste incineration. All emission sources were operating within permitted limits and within all emission standards.

Periodic radiochemical analyses were initiated during 2000 on selected monthly composite samples collected at Stations K2, K6, K9, and K10. For 2003, analyses were based on quarterly composite samples from these stations. The selected isotopes of interest were ^{237}Np, ^{238}Pu, ^{239}Pu, ^{99}Tc, and isotopic uranium (^{234}U, ^{235}U, ^{236}U, and ^{238}U). The resulting annual concentrations for all nuclides measured are presented in Table 4.19. Different averaging techniques were used to establish annual results. This was due to measurement results that were for differing periods of sampling time during the year. Results

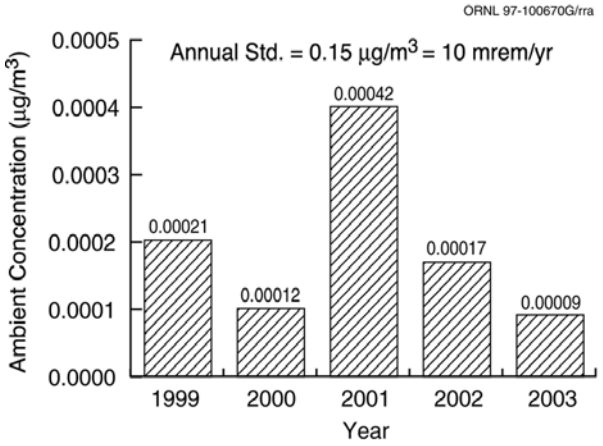

Fig. 4.13. Ambient air monitoring 5-year trend results for uranium at the ETTP.

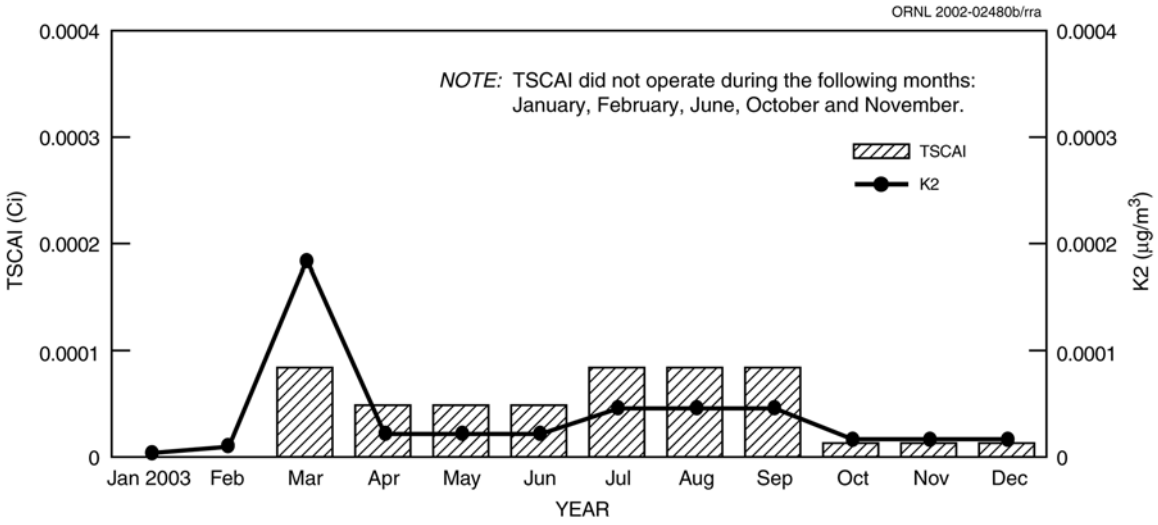

Fig. 4.14. Ambient air monitoring at ETTP Station K2 by ICP/MS vs TSCA Incinerator stack sampling results by radiochemistry.

Table 4.19. Radionuclides in ambient air by radiochemistry at the ETTP, 2003

	Concentration (µCi/mL)[a]											
Station	^{237}Np	^{238}Pu	^{239}Pu	^{99}Tc	^{228}Th	^{230}Th	^{232}Th	^{234}U	^{235}U	^{236}U	^{238}U	Total U
K2	1.84E−18	1.26E−18	8.25E−18	1.00E−15	*b*	*b*	*b*	1.22E−16	2.29E−17	1.38E−17	9.73E−17	2.56E−16
K6	3.76E−18	1.75E−18	9.70E−18	3.71E−15	*b*	*b*	*b*	5.24E−16	4.27E−17	1.95E−17	2.25E−16	8.11E−16
K9	7.53E−18	1.12E−17	2.14E−17	2.40E−15	*b*	*b*	*b*	1.74E−16	1.56E−17	8.94E−18	7.61E−17	2.75E−16
K10	*b*	*b*	*b*	*b*	*b*	*b*	*b*	9.48E−17	1.49E−17	8.17E−18	7.50E−17	1.93E−16

[a]K2, K6, K9 results are the average of four monthly composite analyses and assumed to represent an annual average value. K10 results are the average of the 12 monthly composite analyses.

[b]Data not available or sample not taken.

from stations K2, K6, and K9 are averages of four quarterly composite sample analyses and represent an annual average for this report. Station K10 sample results are based on 5 monthly composite analyses and are assumed to represent an annual average. For comparison, the total uranium results associated with ICP-MS analyses of composite samples are comparable with the uranium results determined by radiochemical techniques.

4.8.5 Organic Compound Levels

Currently, measurements of selected semivolatile organics are performed only during an operational upset of the TSCA Incinerator. There were no events that required the activation of sampling systems for organic pollutants in the ambient air during this reporting period. In the event that an unplanned release occurred, ambient air sampling stations would be activated automatically or manually.

4.8.6 Five-Year Trends

Five-year summaries of ETTP ambient air monitoring data are shown in Figs. 4.12 and 4.13 for lead and uranium, respectively. Variations of lead measurements were insignificant and most likely reflect background concentration variations of air quality. Uranium levels reflect typical levels that can be associated with normal ETTP operations.

Arsenic, beryllium, and cadmium measurements were initiated in 1993, and chromium measurements were initiated in 1986. Over the last 5 years, arsenic, cadmium, and chromium have been typically indistinguishable from background levels except during specific projects that have included major demolition activities. All beryllium measurements, historical and current, have been at or near analytical minimum detectable concentrations. During the 5-year period, no ambient air measurements have indicated any level of concern based on comparisons with any applicable standards.

4.9 ETTP SURFACE WATER MONITORING

Surface water surveillance is currently conducted at eight locations at the ETTP (Fig. 4.15). Stations K-1710 and MIK 1.4 provide information on conditions upstream of the ETTP. Stations K-716 and Clinch River kilometer (CRK) 16 are located downstream from most ETTP operations and provide information on the cumulative effects of the ETTP activities as well as those upstream. The remaining sampling locations are at points where drainage in the major surface water basins converges before discharging to Poplar Creek (Stations K-1007-B and K-1700) or to the Clinch River (Station K-901-A).

At most surveillance stations, semiannual sampling and analyses for radionuclides and field readings (dissolved oxygen, temperature, and pH) are conducted. At CRK 16, samples for radionuclides, volatile organic compounds, and selected metals are collected and analyzed on a monthly basis. Quarterly sampling for volatile organics, in addition to radionuclides and field readings, is conducted at the K-1700 and MIK 1.4 locations. Radionuclide results are compared with the DCGs. Nonradiological results are compared with Tennessee water quality standards for fish and aquatic life. The water quality standards use the numeric values given in the Tennessee general water quality criteria, which are a subset of the water quality standards.

In most instances, results of the monitoring for nonradiological parameters are well within the applicable standards. Heavy metals were often detected at CRK16, K-901-A, and K-1700 (barium was the most common heavy metal detected), and certain volatile organics (primarily trichloroethane, vinyl chloride, and 1,2-dichloroethane) were regularly detected at K-1700, but in all instances the results were below the applicable water quality standard. Dissolved oxygen measurements at MIK 0.4 fell below the minimum water quality standard during one summer sampling event due to elevated temperatures and the influence of groundwater and storm water at this location. Water bodies in the vicinity of the ETTP are regularly inspected for signs of stress on aquatic organisms during these periods. For the remaining analyses, results were within the reference standards or below

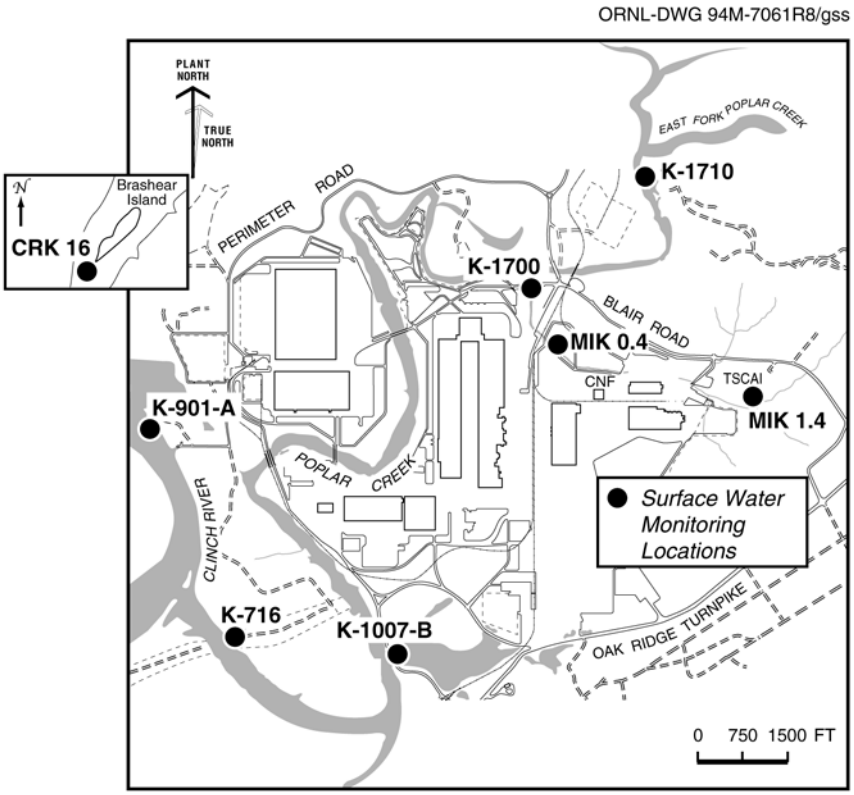

Fig. 4.15. Monitoring locations for surface water at the ETTP.

detection limits for the instrument and method. Moreover, analytical results for samples collected upstream of the ETTP were chemically similar in most respects to those collected below the ETTP.

The sum of the fractions of the DCGs for most stations remained below 1% of the DCG values for ingestion (Fig. 4.16). The highest sum of the fractions, 5.6% of the DCGs, was reported for sampling location CRK 16, with the second highest sum at K-1700 (1.1%). The results at the other surface water surveillance locations are all below 1% of the DCGs. These data are consistent with the historical results. Due to this stasis, monitoring at the surveillance locations will continue to be maintained at the reduced frequency until significant changes are detected or until ETTP operations change to include activities with the potential to affect discharges.

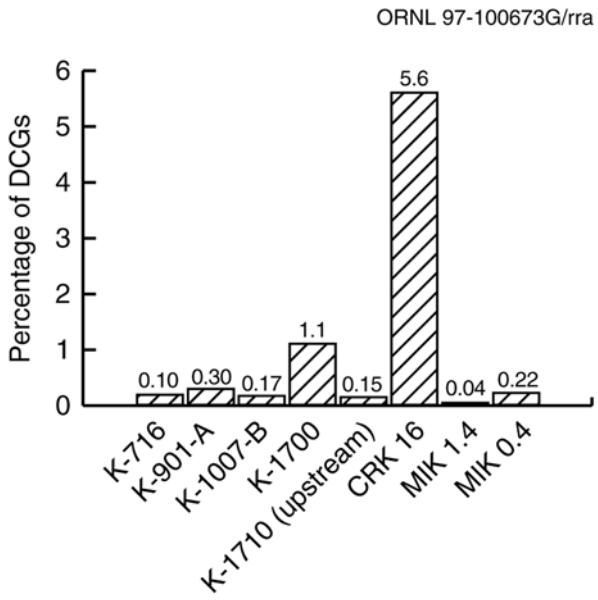

Fig. 4.16. Percentage of DOE derived concentration guides for ETTP surface water monitoring locations.

4.10 ETTP SOIL AND SEDIMENT MONITORING

In 2001, soil monitoring was reinstated at ETTP. Due to the possibility of aerial deposition of contaminants, the soil monitoring locations are co-located with ambient air monitoring stations

(K2, K6, K9, K10, and perimeter air monitors 35 and 42). Samples are collected and analyzed annually for selected radionuclides and metals. Results from the 2003 sampling indicate that ETTP operations have made some impacts on the environment, and comparison with ambient air monitoring results show that these impacts are ongoing. However, the results to date do not indicate that environmentally significant impacts are occurring at this time (for example, radionuclides other than ^{99}Tc and uranium were undetectable in the 2003 soil samples).

Currently, most sediment monitoring is conducted by the Water Resources Restoration Program in association with CERCLA remedial actions. Sediment monitoring is conducted both to provide a baseline for current conditions and to help gauge the effectiveness of the remedial actions. The ETTP Environmental Monitoring Program also conducts sediment monitoring at one location, just upstream of the K1700 weir on Mitchell Branch. Monitoring at this location in 2003 indicates that the sediment contains approximately 0.0038 mg/kg PCBs, 0.36 mg/kg beryllium, 43 mg/kg lead, 0.75 mg/kg mercury, 30 mg/kg chromium, and 134 mg/kg nickel. Results from the sediment monitoring conducted in association with CERCLA activity are described in the *2003 Remediation Effectiveness Report* (DOE 2003a).

4.11 ETTP GROUNDWATER MONITORING

Groundwater monitoring at the ETTP is focused primarily on investigating and characterizing sites for remediation under CERCLA. As a result of the Federal Facility Agreement and certification of closure of the K-1407-B and K-1407-C Ponds, the principal driver at the ETTP is CERCLA.

The cleanup strategy described in *Accelerating Cleanup: Paths to Closure,* (DOE 1999a) has been developed to accelerate the transition of areas of concern from characterization to remediation by making decisions at the watershed scale based on recommended land use. The watershed is a surface-drainage basin that includes an area of concern or multiple areas of concern to be investigated and/or remediated. This approach allows for the systematic monitoring and evaluation of contaminant sources and migration through the use of integrated surface-water and groundwater monitoring.

ETTP Groundwater Protection Program requirements are incorporated into the Water Resources Restoration Program. The Water Resources Restoration Program, which was established to provide a consistent approach to watershed monitoring across the ORR, is responsible for conducting groundwater surveillance monitoring at the ETTP, including exit pathway monitoring wells. Groundwater discharges into Poplar Creek, the Clinch River, and the three main surface water bodies at ETTP (the K-901 Pond, K-1007 Pond, and Mitchell Branch). Many of the contaminants at ETTP migrate toward one of these surface water bodies, which are monitored by the ETTP Environmental Monitoring Plan surface water surveillance program. The *2003 Remediation Effectiveness Report* (DOE 2003a) includes summaries of groundwater monitoring actions required for individual cleanup actions at the ETTP, along with recommendations to modify any requirements that would further ensure protection of human health and the environment.

4.12 ETTP DIRECT RADIATION

The UF_6 cylinder storage yards and K-770 Scrap Yard at ETTP may be sources of potential gamma and neutron direct radiation exposure to the public. Measured exposure rates and a hypothetical model of a maximally exposed individual were used to calculate theoretical doses. The calculated EDEs were based on gamma and neutron dose rates measured at the K-1066-J and K-1066-E Cylinder Yards along the near bank of Poplar Creek, the parking lot adjacent to the K-1066-K Cylinder Yard, and the near bank of the Clinch River in the vicinity of the K-770 Scrap Yard. The dose levels to the public calculated from the measured exposure rates noted in the discussion that follows are less than the 100-mrem/year limit established by DOE Order 5400.5.

Gamma and neutron dose rates from each area were measured in March or April 2003 with tissue-equivalent dose rate meters. The neutron dose rate meter used in 2003 was upgraded to

provide digital counts, and this allowed lower neutron dose rates to be reported than in previous years. Background readings were established at the ambient air monitoring stations north and northeast of ETTP off Blair Road, south and southwest of ETTP in the Powerhouse Area, and west of ETTP at the K-901 pumping station. The average gamma background was 0.005 mrem/h. Neutron background was not measured in 2003; therefore, the average neutron background of 0.006 mrem/h measured in February 2004 was used.

The potential maximally exposed individual model used for exposure from the K-1066-J or K-1066-E Cylinder Yard is a hypothetical fisherman who was assumed to have spent 250 h/year near the point of average exposure. This hypothetical individual could have received an EDE above background of about 1.00 mrem from gamma radiation and 0 mrem from neutron radiation along the bank of Poplar Creek near the K-1066-J Cylinder Yard, or 1.25 mrem from gamma radiation and 0.75 mrem from neutron radiation along the bank of Poplar Creek near the K-1066-E Cylinder Yard during 2003. This section of the creek runs through the ETTP plant and is used at times by fishermen; however, it is very unlikely that anyone would fish this stretch of Poplar Creek for 250 h/year.

General area dose rates were recorded in the vicinity of the K-770 Scrap Yard, along the near bank of the Clinch River. The average gamma dose rate was equivalent to the background level of 0.005 mrem/h; however, the average neutron dose rate was 0.01 mrem/h. A hypothetical Clinch River fisherman who was assumed to have spent 250 h/year near the point of average exposure could have received an EDE above background of about 1.00 mrem from neutron radiation attributable to the K-770 Scrap Yard during 2003.

The parking lot adjacent to the K-1066-K Cylinder Yard is used by workers and the public; therefore, it was included in the survey. This parking lot is intended for employees and has no public facilities. A potential maximally exposed individual is someone assumed to have spent 30 min per work day (125 h/year) waiting in the parking lot at the point of average exposure along the edge closest to the K-1066-K Cylinder Yard. This hypothetical individual could have received an EDE above background of about 1.75 mrem from gamma radiation and 3.00 mrem from neutron radiation during 2003.

4.13 MODERNIZATION AND REINDUSTRIALIZATION

The DOE Oak Ridge Operations Office (DOE-ORO) established the Reindustrialization Program in 1996 as an innovative way to address some of the environmental and financial challenges left at the end of the Cold War. Under this program, transfers of underutilized land and facilities are made available. The goal is to accelerate cleanup by reducing costs, while allowing for the productive use of these assets by the private sector. This process helps to offset negative impacts on the community caused by DOE downsizing, facility closeouts, and workforce restructuring. DOE-ORO worked with local officials and business leaders to establish the Community Reuse Organization of East Tennessee (CROET). Through CROET, the Reindustrialization Program has successfully leased land and facilities at the ETTP. DOE-ORO has transitioned to an accelerated cleanup of ETTP in preparation for its closure as a DOE site. ETTP will then be available for use as a private sector industrial park. As part of this accelerated process, the emphasis is on facility transfer of ownership (title transfer).

In 2003, DOE-ORO completed a “finding of no significant impact” to allow the transfer of property to Horizon Center LLC. The property, in the past known as Parcel ED-1, only consists of the portions suitable for development. The remainder of the property, known as the Natural Area, will continue to be leased by Horizon Center LLC and owned by DOE.

DOE is working with the state of Tennessee to grant the state an indefinite-term conservation easement of approximately 3000 acres to be located on the west end of the Oak Ridge Reservation. This action is the result of an agreement-in-principle related to the Natural Resources Damage Act affecting the Oak Ridge Reservation.