4. ETTP Environmental Monitoring Programs

Setting

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.

Update

In 2000, the emissions of radionuclides from ETTP operations were well within the allowable derived concentration guides (DCGs) published in DOE Order 5400.5, and were similar in most respects to 1999 emissions. Potential direct radiation to the public from uranium hexafluoride cylinder storage yards at ETTP remained well 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., 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 2000, other prime contractors working directly for DOE were also subject to NESHAP; data were obtained from the applicable sources and 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 2000 varied from the previous year's total because of fluctuations in site operations. For this reporting period, a total of six point and two 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

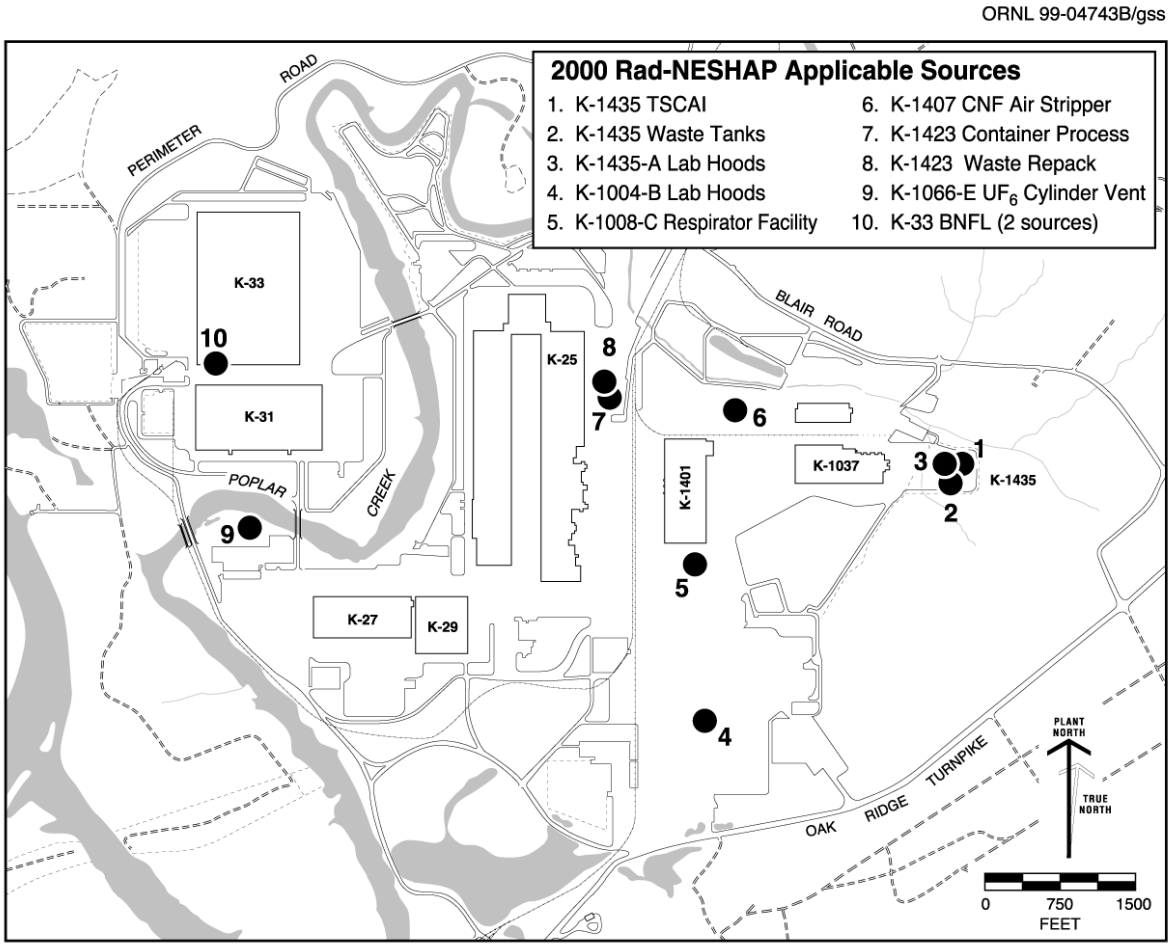

Fig. 4.1. Locations of airborne radionuclide point sources at the ETTP.

that would cause a dose in excess of 0.1 mrem/year effective dose equivalent (EDE) as defined under the rule. Laboratory hoods were grouped as 2 emission points, and the Toxic Substances Control Act Incinerator (TSCAI) tank farm as a group of 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:

1. radionuclide inventory (i.e., material balance)—six point and one grouped source,
2. health physics air measurements where room ventilation emissions exceeded 10% of derived air concentration (DAC) worker protection guidelines—no sources,
3. surrogate emission data from similar sources—one point source, and
4. 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 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

Two ETTP major sources operated during 2000. Radionuclide emission measurements from the TSCAI 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 TSCAI emissions were based on monthly composites of weekly stack samples.

British Nuclear Fuels, Ltd. (BNFL), operated one source in the K-33 building, and continuous monitoring of radiological emissions was required. This source had two identical atmospheric release points, each equipped with a particulate filtration system and a continuous sampling device.

4.1.2 Results

The ETTP 2000 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 were greater than 1999 amounts. This increase in uranium emissions was attributable to increased uranium contained in feed to the TSCAI. The resulting airborne dose from all ETTP radionuclide emissions was still less than the reservation maximum.

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 operated eight major air emission sources subject to Tennessee Title V Major Source Operating Permit program rules. 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 done to ensure compliance with all permitted emission limits.

The ETTP is required to pay annual major source emission fees for all regulated pollutants, excluding carbon monoxide and pollutants from exempt emission sources. 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 4.2 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 2000 amounting to $10,251.80. An inventory of actual emissions from all permitted sources in operation at the ETTP was also completed for 2000. Table 4.3 shows actual 2000 emissions from the ETTP.

The TSCAI 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 4.4).

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 is 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 (CNF) (Outfall 014) (Fig. 4.4). Weekly samples were collected from the CNF and were com-

Table 4.1. ETTP radionuclide air emission totals, 2000 (In curies)[a]

Radionuclide	Total major	TSCAI (major)	Total minor	Total ETTP
^{228}Ac	–		7.45E–09	7.45E–09
^{241}Am	–		1.95E–07	1.95E–07
^{133}Ba	–			
^{212}Bi	–		1.56E–08	1.56E–08
^{214}Bi	–		6.99E–12	6.99E–12
^{109}Cd	–		7.94E–10	7.94E–10
^{249}Cf	–			
^{14}C	5.71E–03	5.71E–03	3.94E–05	5.75E–03
^{143}Ce	–		5.20E–12	5.20E–12
^{144}Ce	–			
^{243}Cm	–		2.51E–14	2.51E–14
^{57}Co	3.69E–08	3.69E–08	2.86E–08	6.55E–08
^{58}Co	–			
^{60}Co	–		6.35E–08	6.35E–08
^{51}Cr	–		2.21E–09	2.21E–09
^{134}Cs	–		2.35E–11	2.35E–11
^{137}Cs	5.44E–04	5.44E–04	6.41E–07	5.45E–04
^{152}Eu	–		2.87E–12	2.87E–12
^{154}Eu	–		9.50E–13	9.50E–13
^{155}Eu	–		5.87E–12	5.87E–12
^{59}Fe	–			
^{3}H	5.81E+01	5.81E+01	3.16E–03	5.81E+01
^{131}I	–		1.24E–09	1.24E–09
^{40}K	–		2.16E–07	2.16E–07
^{85}Kr	–		2.81E–02	2.81E–02
^{54}Mn	–			
^{22}Na	–		5.18E–09	5.18E–09
^{95}Nb	–		3.02E–09	3.02E–09
^{237}Np	7.07E–07	7.07E–07	1.28E–06	1.99E–06
^{231}Pa	–			
^{233}Pa	–		1.58E–10	1.58E–10
^{234}Pa	–		1.08E–07	1.08E–07
^{234m}Pa	2.53E–04	2.53E–04	1.51E–04	4.05E–04
^{210}Pb	–		2.11E–10	2.11E–10
^{212}Pb	–		1.12E–08	1.12E–08
^{214}Pb	–		1.97E–11	1.97E–11
^{210}Po	–			
^{238}Pu	2.08E–06	2.08E–06	8.87E–08	2.17E–06
^{239}Pu	3.04E–06	3.04E–06	1.62E–07	3.20E–06
^{240}Pu	–			
^{226}Ra	–		2.08E–10	2.08E–10
^{228}Ra	–			
^{106}Ru	–		3.74E–09	3.74E–09

Table 4.1 (continued)

Radionuclide	Total major	TSCAI (major)	Total minor	Total ETTP
^{125}Sb	–		3.34E–12	3.34E–12
^{89}Sr	–		1.26E–08	1.26E–08
^{90}Sr	–		1.12E–05	1.12E–05
^{99}Tc	1.86E–03	1.86E–03	1.17E–05	1.87E–03
^{208}Tl	–		1.83E–08	1.83E–08
^{228}Th	5.48E–05	5.48E–05	9.23E–08	5.49E–05
^{230}Th	3.35E–04	3.35E–04	3.12E–07	3.35E–04
^{231}Th	–		1.46E–07	1.46E–07
^{232}Th	9.51E–05	9.51E–05	1.13E–07	9.52E–05
^{234}Th	1.52E–02	1.52E–02	4.04E–05	1.52E–02
^{233}U	–		4.44E–06	4.44E–06
^{234}U	7.71E–03	7.64E–03	9.65E–05	7.81E–03
^{235}U	3.69E–04	3.61E–04	3.08E–06	3.72E–04
^{236}U	–		8.08E–07	8.08E–07
^{238}U	6.39E–03	6.36E–03	1.01E–04	6.49E–03
^{65}Zn	–		2.11E–07	2.11E–07
^{95}Zr	–		5.44E–12	5.44E–12
Totals	5.82E+01	5.82E+01	3.17E–02	5.82E+01

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

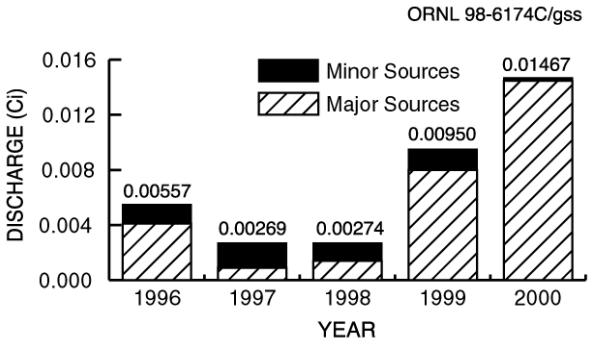

Fig. 4.2. Total curies of uranium discharged from the ETTP to the atmosphere, 1996–2000.

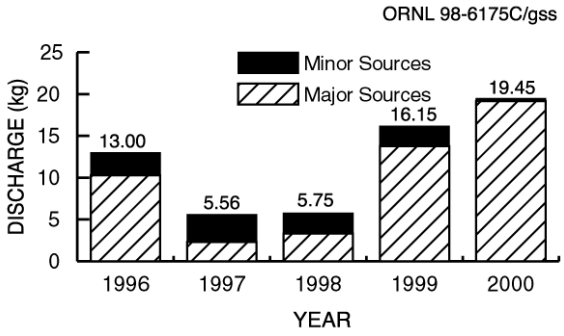

Fig. 4.3. Total kilograms of uranium discharged from the ETTP to the atmosphere, 1996–2000.

Table 4.2. Allowable emissions of criteria pollutants from the ETTP, 1996–2000

Pollutant	Allowable emissions (tons/year)				
	1996	1997	1998	1999	2000
Particulate matter	247	194	192	13	13
Volatile organic compounds	150	120	122	14	14
Sulfur dioxide	428	428	427	39	39
Nitrogen oxides	224	224	185	20	20
Carbon monoxide	157	157	147	20	19
Hazardous air pollutants	24	24	24	21	20
Miscellaneous	0	0	0	0	0
Total	1230	1147	1097	127	125

Table 4.3. Actual emissions of criteria pollutants from permitted ETTP sources, 2000

Pollutant	Actual emissions	
	lb/year	tons/year
Particulate matter	10.3	0.005
Volatile organic compounds	416.3	0.21
Sulfur dioxide	9.9	0.005
Nitrogen oxides	13,703	6.85
Carbon monoxide	3,426	1.71

Table 4.4. Actual vs allowable air emissions from the TSCA Incinerator at the ETTP, 2000

Pollutant	Emissions (tons/year)		Percentage of allowable
	Actual	Allowable	
Lead	0.003	0.575	0.5
Beryllium	0.000001	0.00037	0.3
Mercury	0.002	0.088	2.3
Hydrogen fluoride	0.001	2.98	0.03
Hydrogen chloride	0.01	16.12	0.1
Sulfur dioxide	0.005	38.5	0.01
Particulate	0.005	13.1	0.04

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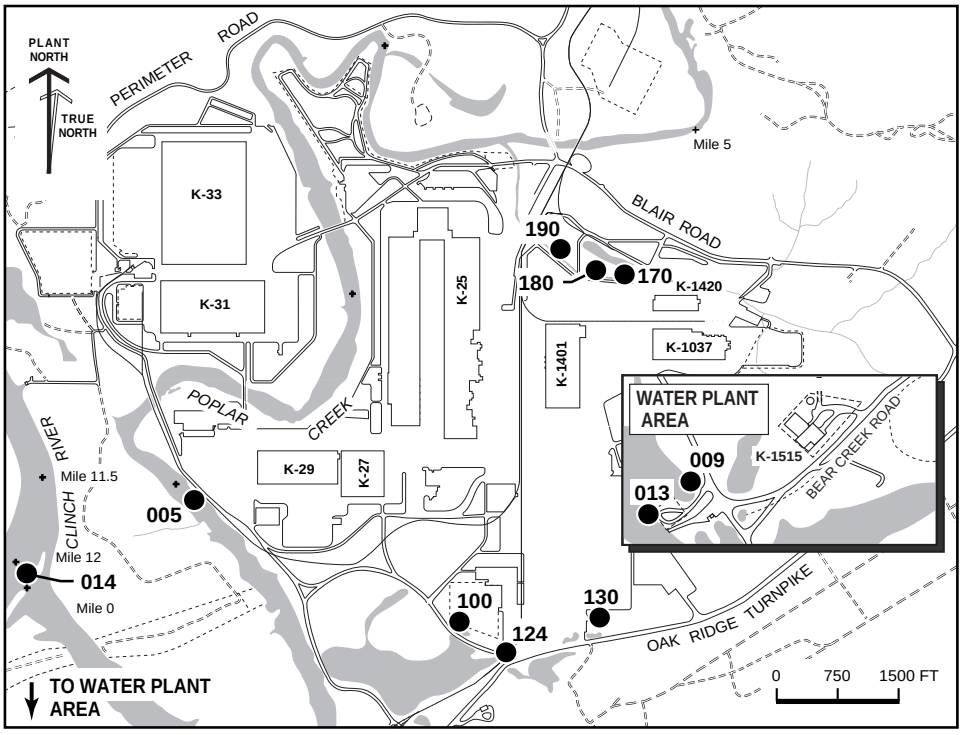

Fig. 4.4. ETTP NPDES major outfalls and Category IV storm drain outfalls.

posited into monthly samples. Due to contractual and management changes at the K-1203 Sewage Treatment Plant (005), the ETTP Surveillance Program did not conduct monitoring for radionuclides at Outfall 005 in 2000. These samples were then analyzed for radionuclides. Results of these sampling efforts were compared with the derived concentration guides (DCGs).

The Storm Water Pollution Prevention (SWPP) Plan, 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.

4.3.2 Results

The sum of the fractions of the DCGs at the CNF was calculated at 11.2% for 2000, down from 19.9% in 1999. The decrease was determined to be caused by changes in TSCAI feed material. Table 4.5 lists radionuclides discharged from the ETTP to off-site surface waters in 2000. Total uranium discharges from the CNF were 0.0047 Ci in 2000. Total discharge of transuranics from the CNF was 2.2×10^{-4} Ci, which is an order of magnitude less than the contribution from uranium.

Uranium discharges from the CNF 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, although ^{3}H accounted for the largest portion of the total activity discharged. This is because the allowable DCG for ^{3}H is much higher than the DCG for uranium (Fig. 4.6). TSCAI wastewater, which is sent to the CNF for treatment before discharging at CNF (Outfall 014), is the major contributor of uranium; other operations contribute a smaller amount. The radionuclides discharged from the ETTP storm water system in 2000 are listed in Table 4.6. Total uranium discharges from ETTP storm water outfalls were 0.012 Ci in 2000. Technetium accounted for the largest fraction of activity discharged from ETTP storm water outfalls in 2000.

Table 4.5. Radionuclides released to off-site surface waters from the ETTP, 2000
Effluent discharge locations, CNF

Radionuclide	Amount (Ci)[a]	Radionuclide	Amount (Ci)[a]
^{60}Co	2.2E–5	^{238}U	2.6E–3
^{137}Cs	4.6E–4	^{14}C	3.6E–2
^{237}Np	1.9E–4	^{3}H	1.6E–1
^{238}Pu	1.3E–5	^{234}U	1.8E–3
^{239}Pu	1.8E–5	^{235}U	1.3E–4
^{99}Tc	3.2E–2	^{236}U	9.1E–5

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

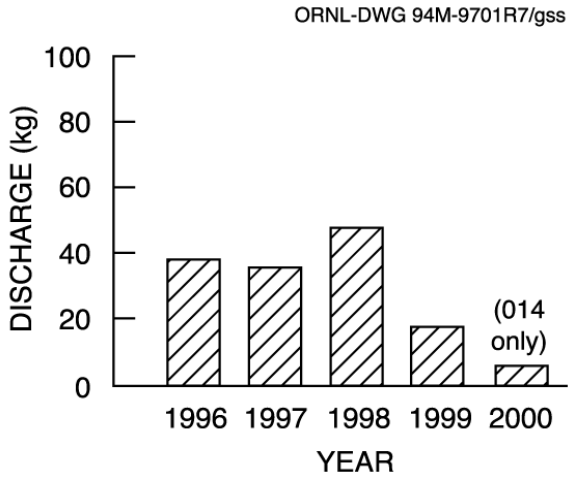

Fig. 4.5. Five-year trend of uranium releases to surface waters from the ETTP (Outfalls 005 and 014).

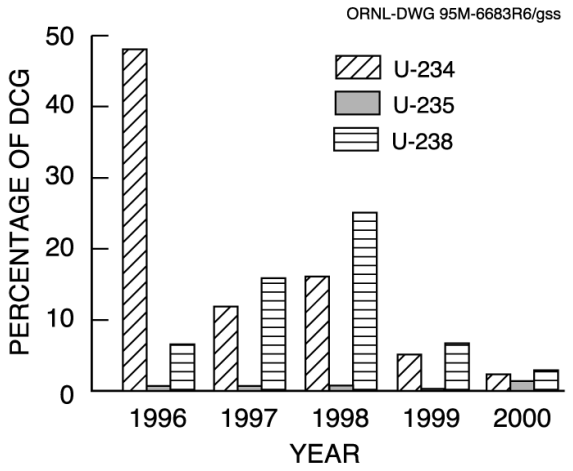

Fig. 4.6. Percentage of DCG for uranium isotopes from K-1407-J (Outfall 014).

Table 4.6. Radionuclides released to off-site surface waters from the ETTP storm water system, 2000

Radionuclide	Amount (Ci)[a]	Radionuclide	Amount (Ci)[a]
^{137}Cs[b]	6.0E–2	^{99}Tc	6.7E–2
^{237}Np[b]	4.6E–6	^{234}U	6.5E–3
^{212}Pb	3.4E–4	^{235}U	3.3E–4
^{238}Pu	9.2E–5	^{236}U	4.9E–5
^{239}Pu	7.3E–5	^{238}U	5.2E–3

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

[b]All results less than or equal to laboratory error values.

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 CNF, addition of new storm drains, and clarification of various requirements.

In accordance with this 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 2 process outfalls and 136 storm water outfalls. Compliance with the permit for the last 5 years is summarized by the major effluent locations in Fig. 4.7. Table 4.7 details the permit requirements and compliance records for all of the outfalls that discharged during 2000. The table provides a list of the discharge points, effluent analytes, permit limits, number of noncompliances, and the percentage of compliance for 2000. Samples from these outfalls are collected and analyzed as specified in the NPDES permit.

The following are the two permitted process outfalls at the ETTP (Fig. 4.4):

- Outfall 005 [K-1203 Sewage Treatment Plant (STP)], and
- Outfall 014 (CNF discharge to the Clinch River).

Outfall 005 is a permitted outfall for discharge of the treated effluent from the K-1203 STP to Poplar Creek. Outfall 014 is a permitted outfall for the discharge of effluent from the CNF to the Clinch River.

The current ETTP NPDES Permit expired on September 29, 1997. An application for renewal of this permit was submitted to TDEC in March 1997. 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. A general NPDES permit 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. The issuance of this permit (Permit Number TN0074233) allowed outfalls 009 and 013 to be removed from ETTP NPDES Permit Number TN0002950. The K-1203 STP, the CNF, and the ETTP storm water outfalls will continue to discharge under NPDES Permit Number TN0002950 until new NPDES permits for these outfalls are issued.

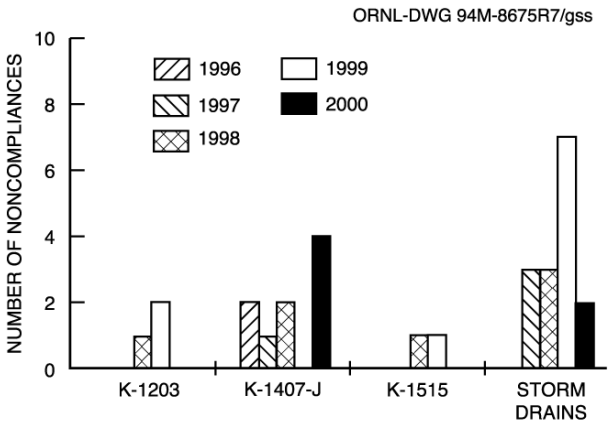

Fig. 4.7. ETTP NPDES compliance history by source of noncompliance.

Table 4.7. NPDES compliance at the ETTP, 2000

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	Ammonia nitrogen	5	7	27	38		100
(K-1203	Biochemical oxygen demand	15	20	81	109		100
Sewage	Chlorine, total residual	0.14	0.24				100
Treatment	Dissolved oxygen		5[b]				100
Facility)	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	27	244		100
Outfall 014	1,1,1-Trichloroethane	*d*	*d*				100
(K-1407-J	Acetone	*d*	*d*				100
Central	Acetonitrile	*d*	*d*				100
Neutralization	Benzene	*d*	0.005				100
Facility to	Bromoform	*d*	*d*				100
Clinch River)	Cadmium	0.18	0.69				100
	Carbon tetrachloride	0.5	0.5				100
	Chemical oxygen demand	*d*	*d*				100
	Chloride, total	35,000	70,000				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		0.1			3	75
	pH, standard units		6.0–9.0				100
	Silver	0.24	0.43				100
	Suspended solids		40			1	99.5
	Tetrachloroethylene		0.7				100
	Toluene	*d*	0.01				100
	Total toxic organics		2.13				100
	Trichloroethylene	0.5	0.5				100
	Uranium, total	*d*	*d*				100
	Vinyl chloride	0.2	0.2				100
	Zinc	1.48	2.61				100
Category I	Flow, Mgd	*d*	*d*				100
storm drains	pH, standard units		4.0–9.0				100
	Missed sample	*f*	*f*	*f*	*f*		100
Category II	Flow, Mgd	*d*	*d*				100
storm drains	pH, standard units		4.0–9.0				100
	Suspended solids	*d*	*d*				100

Table 4.7 (continued)

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)		
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
Category IV storm drains (to Poplar Creek)	Chlorine, total residual		0.14				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
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*	2	*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.

4.4.1 Results

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 TSCAI, 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 filtration, 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 four NPDES noncompliances in 2000. These are described below.

On March 24, 2000, CNF personnel were informed about an elevated measurement for total petroleum hydrocarbons (TPH) from a sample that was collected on March 7, 2000. The TPH result was 1.9 mg/L, which exceeds the ETTP NPDES permit limit of 0.1 mg/L for TPH. This result was validated by the analytical laboratory on March 27, 2000. However, a duplicate sample for TPH, collected on March 7, did not exceed the analytical reporting limit of 1.0 mg/L. Personnel from CNF began an investigation into the elevated TPH measurement upon receipt of the initial analytical result on March 24. Existing facility records were reviewed for potential causes of the elevated TPH result. In addition, log books, operating instructions, treatment log sheets, precipitation data, and daily flow totalizer readings were reviewed for the March 7 time period. The flows during this period were normal compared with recent volumes. No unusual events were noted in the logbooks, operating instructions, or treatment logs that would explain an increase in TPH concentrations. Rainfall amounts were determined to be normal. According to treatment log entries, all batches of wastewater were treated according to established procedures. According to existing facility records, all CNF treatment units were operating normally. No breakthrough of the carbon adsorption units was detected in monitoring data. No miscellaneous sources of wastewater were received or treated during this time and the

only sources of water in the CNF treatment system were the standard hard-piped influents, storm water, K-1407-E/F pond waters, and water used to clean coalescing tubes, none of which would be expected to contribute significant amounts of TPH to the treatment system. In addition, the finding of no detectable TPH above the analytical reporting limits in the duplicate sample results for March 7 indicated that there was no continuous discharge of detectable levels of TPH. CNF personnel were not able to identify a probable cause for the reported elevated TPH result.

On August 11, 2000, CNF personnel received notification of an elevated CNF effluent sample result. A sample collected on July 26 at 0830 as part of the semiannual control and surveillance program sampling event had a reported TPH concentration of 27.3 mg/L. This sample was an additional sample taken in July specifically for control and surveillance program purposes. The regularly scheduled TPH sample for compliance monitoring was collected on July 5. The July 5 sample contained no detectable TPH. Upon notification of the elevated July 26 sample result, CNF personnel immediately began a review of other available data and facility operations records to determine a potential cause for the elevated TPH sample result. Several relevant data points were discovered in the initial stages of this review: (1) All hard-piped influent wastewater streams to CNF were sampled on July 24 as part of the semiannual control and surveillance program sampling event. None of the sampled wastewater streams contained TPH above the established analytical reporting limit (<1 mg/L). (2) No miscellaneous wastewaters were received during this period. However, an operational sample of G-310B carbon adsorption unit effluent collected on July 26 at 0810 had a reported result of 2.0 mg/L for TPH concentration. This result indicated breakthrough of the lead carbon adsorption unit in a series configuration. A sample taken at the same sample point on June 27 contained no detectable TPH. Given the available data, breakthrough of the G-310B unit (the lead unit in a series configuration) was a possibility, but there did not appear to be a readily identifiable source of TPH in the influent to the unit. In any event, the reported CNF effluent TPH concentration of 27.3 mg/L on July 26 did not appear reasonable because the first indication of breakthrough for the first carbon adsorption unit in a series configuration did not appear until July 26. Both units in a series configuration do not typically experience breakthrough at the same time.

On August 15, 2000, CNF personnel received notification of an elevated CNF effluent sample result. A sample of CNF effluent collected on August 1 had a TPH concentration of 9.6 mg/L. CNF personnel were already investigating an elevated TPH result for an effluent sample collected on July 26. The August 1 sample result confirmed the presence of an unusual condition in the CNF process. Discharges of treated effluent were immediately suspended, and influents to CNF were diverted to sumps and tanks available for temporary storage. Additionally, activated carbon was ordered to recharge the G-310B carbon adsorption unit. This unit contained the oldest activated carbon in the treatment system. On August 16, the spent carbon was removed from the G-310B carbon adsorption unit, and the unit was recharged with approximately 6500 lb of virgin activated carbon. The carbon adsorption system was placed into service with the G-310A unit (oldest carbon) in lead and the G-310B (newest) unit in lag. CNF resumed discharge of treated effluent on the evening of August 16. The recharge of G-310B with new activated carbon was expected to prevent a recurrence of elevated TPH concentrations in the CNF effluent. Samples of the spent carbon were collected and analyzed for organic contaminants. A sample of the spent carbon from the bottom of the G-310B unit contained 300 mg/kg of recoverable hydrocarbons, 130 µg/kg of acetone, and 100 µg/kg of chloroform. A sample of the carbon from the bottom of the G-310A unit contained 500 mg/kg of recoverable hydrocarbons, 20 µg/kg of acetone, and 8 µg/kg of chloroform. On August 1, G-310B was the lead unit with G-310A as the lag unit. These results indicated the presence of more hydrocarbons in the lag unit than the lead unit. In a series configuration, the lead unit should adsorb most of organic contaminants. When the lead unit nears its adsorptive capacity, contaminants will be detected in the effluent of the lead unit. However, the lag unit should see very low concentrations of organic contaminants to that point. Therefore, the carbon in the lag unit should contain lower concentrations of organic contaminants than the lead unit. Based upon the available data, the lag unit in the CNF

system had the higher level of organic contaminants. Also, the reported elevated effluent concentrations are significantly higher than the concentrations typically found in the influents to CNF. Therefore, it is theorized that some compound is displacing the adsorbed petroleum hydrocarbons in the CNF carbon adsorption units. The new carbon in G-310B should prevent any immediate threat to the quality of the CNF effluent due to its high adsorptive capacity at this time. However, CNF personnel are continuing investigative activities to attempt to identify a root cause for the apparent displacement of adsorbed petroleum hydrocarbons. Finally, the G-310A unit may be taken out of service until the unit can be recharged.

CNF personnel received notification of a possible elevated NPDES sample result on Friday, October 13, 2000. The initial notification reported a result of 61 mg/L for total suspended solids (TSS) in a sample collected on September 13, 2000. The NPDES permit limit for TSS in CNF effluent is 40 mg/L. Upon notification of the elevated September 13 sample result, CNF personnel immediately began to attempt to verify the reported result. A request was made to the analytical laboratory to verify the validity of the reported result. In addition, a review of other available data and facility operations records to determine a potential cause for the elevated TSS sample result was initiated. On Tuesday, October 17, 2000, laboratory contractor personnel from Radian Corp. received an e-mail confirming that the laboratory's calculations were correct and that the reported result of 61 mg/L was valid. None of the facility records or data reviewed to date indicated a probable cause for the exceedence. There were no log entries or other records indicating any unusual facility conditions or treatment operations during the time of the exceedence. The effluent TSS results for the two days prior to the exceedence were 5 mg/L and 15 mg/L. The TSS results for the following day were 17 mg/L. In addition, the effluent-monitoring strip chart showed no spike in turbidity during the subject sample period. Therefore, CNF personnel have not identified a probable cause for the reported elevated TSS result.

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, and weekly for Categories I through IV, respectively, with those outfalls that have the highest potential for pollution being sampled most frequently.

Two NPDES noncompliances occurred at storm water outfalls during 2000. Storm water outfall 170 had both of the noncompliances, which are described below.

On November 29, 2000, a white milky discharge was observed coming from storm water outfall 170, which discharges into Mitchell Branch. An investigation of the source of the discharge was begun immediately after the observation was noted. The investigation indicated that the probable source of the milky discharge was a leak in a sanitary sewer line that connects the K-1501 Steam Plant to a nearby sewer collection system lift station. As part of the investigation, it was determined that paint rollers and brushes from a lessee operation had been washed out in a sink in building K-1501. The sink discharges to the sanitary sewer system. The paint washed from the painting equipment is believed to be the source of the milky discoloration in the discharge.

Dye tests conducted on November 30 confirmed that the sanitary sewer line was leaking to the storm drain system; however, a significant amount of flow was still being discharged to the sanitary sewer collection system. The exact location of the leak in the sanitary sewer line was identified, and the sanitary sewer line was excavated and repaired by the lessee organization that manages the ETTP utilities. The sewer system was dye-tested on December 6, 2000 to confirm the integrity of the repaired sanitary sewer line. No additional leakage from the sanitary sewer was

noted after the repairs were made. The sanitary sewer line was returned to active service after the dye testing was completed.

This event was categorized as an unpermitted discharge to the storm water drainage system, which constitutes a noncompliance under the ETTP NPDES Permit. Courtesy notifications of the event were provided to the National Response Center, TEMA, EPA Region 4, and the TDEC/DOE-O offices.

On December 13, 2000, personnel from the ORNL Environmental Sciences Division were collecting samples at storm water outfall 170 for routine toxicity testing. The sampling technicians observed that the flow from storm water outfall 170 was very turbid and cloudy. In addition, they observed several dead fish (2–4 in. in length) near the outfall discharge and in Mitchell Branch.

On-site environmental compliance and sampling services personnel at the ETTP were contacted and immediately began an investigation into the source of these observations. Upstream catch basins within the storm water outfall 170 drainage network were inspected in an effort to identify any unpermitted discharges to the storm drain system that might have caused the turbidity and fish kill. Near the northwest corner of Building K-1037, water was observed flowing across a paved area and into an open catch basin. This water appeared to be associated with a cooling tower located nearby, and the pH of the water was measured at 3.2. Facility personnel were notified, and the discharge was immediately valved off by the K-1037 facility manager.

The maintenance of the K-1037 cooling tower is the responsibility of the ETTP utility subcontractor to the Community Reuse Organization of East Tennessee. The utility operations staff were notified of this discharge, and it was determined that the cooling tower was being flushed with a sulfamic acid solution that is used to remove rust, scale, and other materials. The acid and the materials being flushed from the cooling tower had been discharged onto a paved area near the cooling tower that drained to a storm water catch basin. For future discharges, the utility subcontractor personnel were instructed to route the discharge into the sanitary sewer system or collect it for treatment at an approved facility.

Subsequent monitoring conducted on December 14, 2000, at storm water outfall 170 showed that the pH of the discharge was within expected limits and that the turbidity of the discharge had gradually subsided. A total of nine dead fish were observed at the storm water outfall 170 discharge point and in Mitchell Branch downstream of the storm drain discharge.

The test results from sampling conducted on December 13, 2000, showed high toxicity at storm water outfall 170 and at several points in Mitchell Branch downstream of this outfall. It is believed that the toxicity exhibited at these locations may be partly or wholly the result of the discharge of the sulfamic acid solution and/or the metals and other materials cleaned from the K-1037 cooling tower. Elevated toxicity was not observed at MIK 0.12 which is a reference point on Mitchell Branch above the discharge point into Poplar Creek. It is believed that the toxic material was diluted or neutralized through natural reactions prior to reaching this downstream reference location in Mitchell Branch.

No threat to human health and only minor impacts to aquatic life are believed to have occurred as a result of this incident. No areas other than the reach of Mitchell Branch between storm water outfall 170 and reference point MIK 0.45 are believed to have been affected by this discharge. A courtesy notification was made to TDEC on December 14, 2000.

4.5 STORM WATER POLLUTION PREVENTION PROGRAM

The development and implementation of the ETTP Storm Water Pollution Prevention (SWPP) Program is required by Part IV of the 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 SWPP 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 (BMPs) 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 the 1999–2000 SWPP Program. These parameters include gross alpha radioactivity, gross beta radioactivity, polychlorinated biphenyls (PCBs), mercury, metals, and volatile organic compounds (VOCs). Gross alpha and gross beta radioactivity were monitored at storm drain outfalls where they were detected at levels above screening criteria during more than one previous SWPP sampling effort. PCBs were monitored at storm drain outfalls where they were detected above the analytical method detection limit. Mercury was monitored at locations where it was detected in amounts exceeding the screening criteria during more than one previous SWPP sampling effort. Metals were monitored at locations that may have received runoff from cooling tower areas and where they were detected in amounts exceeding the screening criteria during more than one previous SWPP sampling effort. VOCs were monitored at 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 SWPP sampling effort.

Gross alpha radiation was detected at storm water outfall SD-350 at a level of 71 pCi/L. This level exceeds the screening criteria for gross alpha activity of 15 pCi/L, which is the maximum contaminant level established by the Safe Drinking Water Act.

Storm water outfall SD-350 carries storm water primarily from surface drainages, including the former location of the K-1066-D Cylinder Yard area. This area was once used for the storage and handling of uranium hexafluoride (UF_6) cylinders. In addition, SD-350 receives drainage from the K-1031 and K-1031-A buildings, which were once used to store wastes from uranium decontamination and recovery operations, including organic degreasers, uranium compounds, and trace quantities of transuranics. A portion of the SD-350 drainage network consists of an open, grass-lined ditch that has been roped off as a radioactively contaminated area. The area that drains to SD-350 will be addressed as part of the ETTP Sitewide Record of Decision.

Gross beta radiation was detected at storm water outfall SD-490 at a level of 74 pCi/L. This level exceeds the screening criteria for gross beta activity of 50 pCi/L, which is the maximum contaminant level established by the Safe Drinking Water Act.

Storm water outfall SD-490 drains a large area, including most of the southern end of the K-25 building, the K-1600 building, the K-601 building, and the eastern portion of the K-29 building. Several areas near the K-25 and K-29 buildings are known to be radioactively contaminated. Currently, no remedial actions are scheduled for the areas drained by storm water outfall SD-490.

Trichloroethene was detected in samples collected from storm water outfall SD-382 at a level of 33 µg/L. This level exceeds the screening criterion of 5 µg/L, which is the Tennessee Water Quality Criterion for Domestic Water Supply.

SD-382 flows on an almost constant basis, and is, therefore, believed to be a conduit for the discharge of groundwater. Sampling of groundwater wells near SD-382 has indicated the presence of a contaminated groundwater plume in the area. It is believed that the VOC contamination noted at SD-382 is due to the discharge of contaminated groundwater and not to the discharge of storm water contaminated with volatile organics. Remediation of groundwater contamination at ETTP will be addressed in the future by the Sitewide Record of Decision.

Metals concentrations above applicable screening criteria were detected at several of the locations sampled as part of the 1999–2000 SWPP Program sampling effort. Metals that were routinely detected in storm water runoff included aluminum, iron, magnesium, and manganese. However, the presence of these metals in storm water runoff in concentrations above screening criteria is not believed to be problematic. All of these metals are commonly found in soils and sediments within the geographic region of the ETTP. The source of the metals is most likely related to sediment and suspended solids being transported in storm water runoff. In addition, concentrations of these metals in storm water outfalls that flow on a constant basis are believed

to be attributable to the discharge of groundwater, which is known to occur at these storm water outfalls. Therefore, it is believed that the vast majority of detectable concentrations of metals found in storm water effluent from ETTP are due to the contact of storm water with the soil and/or the discharge of groundwater containing detectable metals concentrations.

In addition to the sampling effort, several storm water outfalls were smoke tested or dye tested as part of the 1999–2000 SWPP Program. This effort was conducted to reduce the number of storm water outfalls that are covered by the NPDES permit. As a result of this testing, it will be recommended that three storm water outfalls be removed from the new NPDES permit after it is issued by TDEC. The storm water outfalls cannot be removed from the current NPDES permit because it has expired, and regulations prohibit the modification of an expired permit.

4.6 ETTP TOXICITY CONTROL AND MONITORING PROGRAM

The 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 2000 are given in Table 4.8, which also provides the wastewater's no-observable-effect level (NOEL) and 96-h lethal concentration for 50% of the test organisms (LC_{50}) for fathead minnows and *Ceriodaphnia* for each test. Average water quality measurements obtained during each toxicity test are shown in Table 4.9.

Effluent from K-1203 was tested twice during 2000 with fathead minnows and *Ceriodaphnia*. In both tests, full-strength samples did not reduce survival, growth, or reproduction. Thus the NOELs were 100% and the LC_{50}(s) were >100%.

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 benthic macroinvertebrates), and (4) waterfowl monitoring.

Table 4.8. ETTP NPDES Permit Number TN 0002950 toxicity tests results, 2000

ETTP Outfall	Test date	Species	NOEC[a] (%)	LC_{50}[b] (%)	IWC[c] (%)
K-1203 (Outfall 005)	January	Fathead minnow	100	>100	2.2
		Ceriodaphnia	100	>100	2.2
	July	Fathead minnow	100	>100	2.3
		Ceriodaphnia	100	>100	2.3

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

Table 4.9. ETTP average water quality parameters measured during toxicity tests of ETTP wastewaters, 2000
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	7.9	360	89	150
	July	7.8	350	96	160

4.7.1 Toxicity Monitoring

The toxicity monitoring task for the BMAP includes tests of effluent from treatment facilities (see ETTP Toxicity Control and Monitoring Program, Sect. 4.6), and effluent from storm drains (SD170, SD180, and SD190), concurrently with surface water from six ambient sites (MIK 0.12, MIK 0.45, MIK 0.54, MIK 0.71, MIK 0.78, and MIK 1.43) on Mitchell Branch. The designation "MIK" indicates Mitchell Branch Kilometer, and the number indicates the number of kilometers from the mouth of Mitchell Branch on Poplar Creek. *Ceriodaphnia dubia* were used to evaluate effluent from SD170 and SD190 for toxicity six times during 2000. Full-strength effluent from SD170 reduced *Ceriodaphnia* survival or reproduction in three of six tests. Full-strength effluent from SD190 reduced *Ceriodaphnia* survival or reproduction in all six tests. Effluent from SD180 was evaluated for toxicity two times in 2000; the effluent did not reduce *Ceriodaphnia* survival or reproduction in either test. In selected tests, water samples from storm water outfall 190 have been treated to remove metals. This treatment has dramatically decreased toxic effects, indicating that the primary source of toxicity is from metals. An analysis of water from the storm drain 190 network has indicated that both nickel and zinc are present at levels that have been shown to be toxic to *Ceriodaphnia*. Toxicity tests of surface water from Mitchell Branch downstream of each storm drain were conducted six times in 2000. Reduction in *Ceriodaphnia* survival or reproduction occurred sporadically in these tests. However, half of the reductions can be traced to a single NPDES noncompliance that occurred in December 2000 when a cooling tower blowdown was inadvertently sent to the storm drain 170 network (see Sect. 4.4.1 for details).

4.7.2 Bioaccumulation Studies

In 2000, resident fish and caged clams in Mitchell Branch, the K1007-P1 pond, and the K901-A pond were monitored for PCB contamination. In Mitchell Branch, the mean PCB concentrations in redbreast sunfish increased steadily from less than 1 µg/g wet weight in 1993 to 2.35 µg/g wet weight in 2000 (although this was down slightly from 3.2 µg/g in 1998). Clam-monitoring results suggest that the observed increase was associated with SD190 with a smaller contribution from SD170 because PCB levels increased substantially over the last 7 years in clams placed below the SD190 discharge and near the weir in Mitchell Branch. PCBs in the clams upstream from SD190 were lower, but the levels in clams from the two locations downstream from SD 170 still registered an increase of about two times over the levels found in 1999. At the same time, levels from the site upstream from SD 170 remained very low.

In the K1007-P1 pond (Fig. 4.8), PCB concentrations in largemouth bass decreased from last year (an average of 21.8 µg/g and a maximum of 35.4 µg/g in 2000, up from 13.3 µg/g in 1999). Although there has been some variation, the overall levels of PCBs in the fish remain well above the human health risk guidelines. Sampling of caged clams at various flow inputs to the pond clearly indicated continuing inputs of PCBs. Although PCBs were detected in clams from several storm water outfalls entering the P1 pond, SD100 continued to be the most contaminated outfall, having an average concentration of 21.3 µg/g. PCB accumulation in clams at some of the monitoring locations (SD100, SD 120, and the P1 pond exit) in 2000 was greater than the levels observed in previous years. Levels indicate that SD 124 and SD 480 continue to contribute PCBs to the pond, but the levels at these discharges are similar to 1999 levels. The pattern of PCB levels indicates that the P1 pond is acting as a PCB sink, trapping much of the PCBs before they reach Poplar Creek.

Largemouth bass and caged clams from the K901-A pond were comparatively low [means of 0.94 µg/g, wet weight for largemouth bass (fillet samples) and 0.27 µg/g for clams] in PCBs. Although the levels for PCBs in the largemouth bass were the highest to date from K-901-A, they were still averaging near the historical concentrations in bass collected from this location. Clam studies indicate that the PCB flux from K-901-A is very modest compared with that from Mitchell Branch and K-1007-P1 pond.

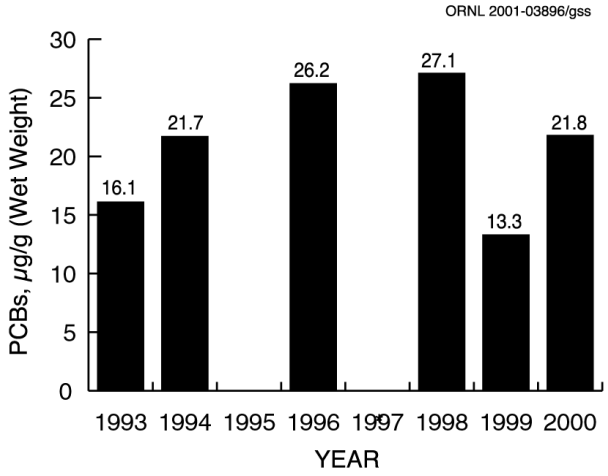

Fig. 4.8. Mean PCB concentrations in largemouth bass from the K-1007-P1 pond at the ETTP. Samples are fillets; N = 2–8 fish/year.

4.7.3 Ecological Surveys of Instream Communities

The benthic macroinvertebrate community downstream of the main storm drains in Mitchell Branch continued to show impacts compared with the upstream reference site. Results from 1998 show that construction of the interceptor trench adjacent to Mitchell Branch significantly impacted MIK 0.71 and MIK 0.78. In the 1999 and 2000 studies, however, there is evidence of a rapid recovery to preconstruction conditions although the rate of recovery appears to have slowed in 2000. In general, taxonomic richness (including the richness of the pollution-sensitive taxa Ephemeroptera, Plecoptera, and Trichoptera) has increased at all sites, with the most dramatic increase at MIK 0.71. The magnitude of the increases has been greater in those sites within the industrial portion of the ETTP, although the richness at these sites continues to lag behind that of the reference site (MIK 1.43). Thus, the evidence indicates that past industrial operations have adversely impacted the stream but that pollution abatement and remediation measures in the last decade have improved the overall quality of the stream.

Fish community data gathered at both MIK 0.45 and MIK 0.71 show that Mitchell Branch has been adversely impacted but that some recovery is taking place. Species richness at MIK 0.71 dropped slightly in 2000 compared with that observed in 1999, a reflection of the general instability of the fish community at that location. Measures of density, biomass, and species richness are greater at MIK 0.45 than at MIK 0.71, a continuation of the trend since the spring of 1998. Prior to the construction of the Mitchell Branch interceptor trench in the winter of 1997–1998, the community at MIK 0.71 was richer and more diverse than that at MIK 0.45. The most likely explanation is that the trench construction project removed much of the suitable habitat at MIK 0.71 and that many species will be slow to return to this section unless the habitat is reestablished.

4.7.4 Waterfowl Surveys

Seventeen waterfowl surveys were conducted on ETTP during 2000. The number of species recorded (36) was similar to the number observed in the recent years. Although no endangered species were observed, two threatened species; the osprey (*Pandion haliaetus*) and the bald eagle (*Haliaeetus leucocephalus*) were seen. The number of Canada geese continued to decline, a trend that has been apparent throughout the 1990s. The number of waterfowl species other than Canada geese has increased. One possible explanation for these trends is that changes in land management and use have reduced the amount of preferred habitat for the geese while the amount of habitat suitable for other waterfowl has increased.

No radioactively contaminated geese were found at ETTP during the waterfowl surveys.

4.8 ETTP AMBIENT AIR MONITORING

DOE Order 5400.1 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 contami-

nant 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 locations of these monitoring stations are shown in Fig. 4.9. The ETTP ambient air monitoring program complies with all requirements of DOE orders. 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 applicable risk-specific doses (RSDs) and reference air concentrations (RACs) as listed in 40 CFR 266, Subpart H.

The ambient air program sampling schedule and monitored parameters are listed in Table 4.10. All parameters are 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 are particulate matter less than 10 µm in diameter (PM10), also arsenic, beryllium, cadmium, chromium, lead, and total uranium. During the third quarter of 1999 radiochemical analyses were added that included isotopes of uranium (^{234}U, ^{235}U, and ^{238}U), ^{99}Tc, ^{237}Np, ^{238}Pu, and ^{239}Pu.

During this reporting period, the ambient air monitoring network was modified with respect to

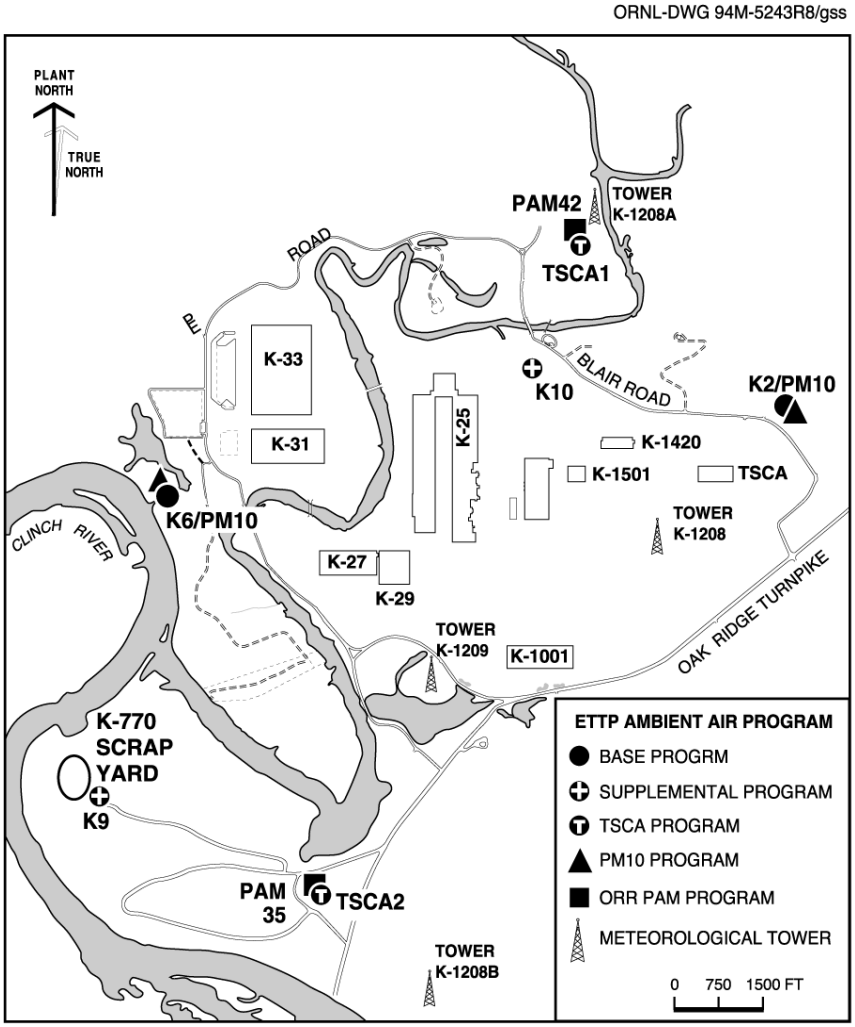

Fig. 4.9. Locations of ambient air monitoring stations at the ETTP, 2000.

Table 4.10. Summary of types and frequencies of samples collected at ETTP perimeter ambient air monitoring stations, 2000

Parameter	Sampling locations	Sampling period	Collection frequency	Analysis frequency[a]
		Criteria pollutants		
Lead	K2, K6, K9[b], K10[b]	Continuous	Weekly	Monthly
PM10	K2, K6	24 h	Every sixth day[c]	Weekly
		Hazardous air pollutants carcinogenic metals		
Arsenic	K2, K6, K9, K10	Continuous	Weekly	Monthly
Beryllium	K2, K6, K9, K10	Continuous	Weekly	Monthly
Cadmium	K2, K6, K9, K10	Continuous	Weekly	Monthly
Chromium	K2, K6, K9, K10	Continuous	Weekly	Monthly
		Organic compounds		
Dioxin	TSCAI 1, 2	*d*	*d*	*d*
Furan	TSCAI 1, 2	*d*	*d*	*d*
Hexachlorobenzene	TSCAI 1, 2	*d*	*d*	*d*
PCBs	TSCAI 1, 2	*d*	*d*	*d*
		Radionuclides (by inorganic analysis)		
Uranium (total)	K2, K6, K9, K10	Continuous	Weekly	Monthly
	PAM-35, -42	Continuous	Weekly	Quarterly
	TSCAI 1, 2	*d*	*d*	*d*
		Radionuclides (by radiochemical analysis)		
^{237}Np, ^{238}Pu, ^{239}Pu, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{99}Tc	K2, K6, K9	Continuous	Weekly	Monthly
^{234}U, ^{235}U, ^{236}U, ^{238}U	K10	Continuous	Weekly	Monthly

[a]Weekly frequency is analysis for each individual sample. Monthly and quarterly are composite sample analyses of all weekly samples collected over the identified period.

[b]Temporary sampling station.

[c]24-h sample every sixth day from midnight to midnight.

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

ETTP operations. Temporary on-site station K8 was deactivated during the fourth quarter of 1999. During the second quarter of 2000, a new temporary sampling station identified as K9 was activated at a location directly between the K-770 contaminated scrap metal yard and a new commercial lessee. This station is to confirm the dose to the lessee from possible fugitive emissions from the yard and the ETTP are within regulatory limits. A second temporary station (K10) was activated during the fourth quarter of 2000 with respect to decontamination and decommissioning (D&D) activities near the northern fence line of the ETTP. This location is between D&D activities and the nearest member of the public located at the Tennessee Valley Authority Roane Substation. These temporary stations supplement the ongoing sampling at stations K2, K6, PAM35, and PAM42.

4.8.1 Results

No standards were exceeded, and there were no statistically significant elevations of pollutant concentrations associated with site operations. 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. These data support the state classification of this

area, including the ETTP, as being in attainment with the Tennessee ambient air quality standard for particulate matter less than 10 µm in diameter (PM10). Also, radiochemical analyses of ambient air samples confirm low radiological emissions from the ETTP. Table 4.10 lists selected parameters measured during 2000.

4.8.2 Criteria Pollutant Levels

Gravimetric analyses were performed on all PM10 24-h samples. A summary of all PM10 measurements is presented in Table 4.11. For 2000, the 24-h PM10 concentrations ranged from 4.7 to 69.9 µg/m^3. The highest measured value was 46.6% of the Tennessee 24-h primary and secondary ambient air quality standards (i.e., 150 µg/m^3). These levels are not an environmental concern.

Annual PM10 arithmetic averages of 24-h measurements are presented in Table 4.11. The highest averaged PM10 annual result was 23.2 µg/m^3. This value was only 46.4% of the Tennessee and national annual primary and secondary ambient air quality standards for PM10 (i.e., 50 µg/m^3). Historical data show that this level is typical of annual measurements and is of no environmental concern (see Fig. 4.10 for 5-year PM10 trend).

Quarterly lead results were determined from analyses of monthly composites of continuous weekly samples from stations K2, K6, K9, and K10. The total mass quantities of lead for each sample were determined by the inductively coupled plasma mass spectrometry (ICP-MS) analytical technique. Lead-measurement results are summarized in Table 4.12 and are compared with the Tennessee and national quarterly ambient air quality standard of 1.5 µg/m^3. There are no 24-h, monthly, or annual ambient air quality standards for lead. The maximum individual lead result was 0.0063 µg/m^3. This value was only 0.4% of the quarterly standard for lead. No lead concentration levels of environmental concern were measured (see Fig. 4.11 for 5-year lead trend).

4.8.3 Hazardous Air Pollutant Carcinogenic Metal Levels

Analyses of hazardous air pollutant (HAP) carcinogenic metals (arsenic, beryllium, cadmium, and chromium) were performed on monthly composites of continuous weekly samples from stations K2, K6, and K9. Monthly composite samples from K10 were analyzed only 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 HAP carcinogen metals. However, comparisons have been made against RSDs and RACs. Individual arsenic concentration results for all measurement sites ranged from approximately 0.0005 to 0.0011 µg/m^3. No beryllium measurement was above minimum detectable concentrations of the analytical method. Cadmium concentration results ranged from approximately 0.0001 to 0.0015 µg/m^3. Individual chromium measurements ranged from approximately <0.0001 to 0.0010 µg/m^3. A summary of the HAP carcinogenic metals measurements is presented in Table 4.13.

Table 4.11. PM10 particulates in ambient air at the ETTP, 2000

Station	Number of Samples	Annual summary of PM10 concentrations (µg/m^3)			Max percentage of standard[a]	
		Annual avg	24-h max	24-h min	Annual	24-h
K2	57	23.2	69.9	5.0	46.4	46.6
K6	54	21.4	60.2	4.7	42.8	40.1
All stations	111	22.3	69.9	4.7	44.6	46.6

[a]PM10 Tennessee and national primary and secondary ambient air quality standards are 150 µg/m^3 per 24 h and 50 µg/m^3 per year arithmetic mean.

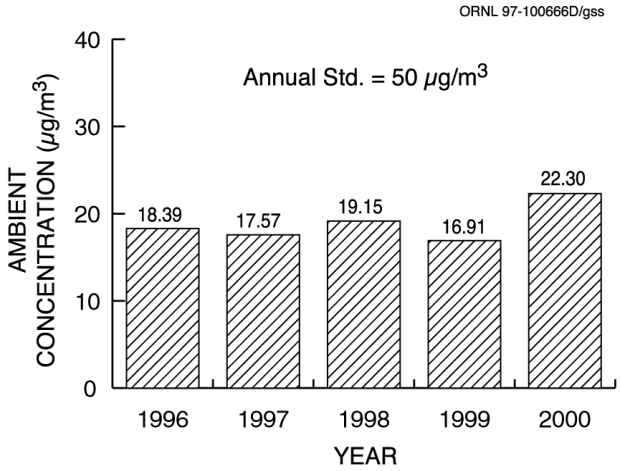

Fig. 4.10. Ambient air monitoring 5-year trend results for PM10 at the ETTP.

Table 4.12. Lead concentrations in ambient air at the ETTP, 2000

Station	Quarterly averages of monthly composites ($\mu g/m^3$)				Max quarterly result	Max monthly result	Max percent of quarterly standard[a,b]
	1	2	3	4			
K2	0.003445	0.002345	0.001821	0.003211	0.003445	0.003445	0.23
K6	0.003943	0.002686	0.002438	0.003668	0.003943	0.003943	0.26
K9[c]	0	0.006257	0.002699	0.003212	0.006257	0.006257	0.42
K10[d]	0	0	0	0.003573	0.003573	0.005404	0.24
Quarterly avg	0.003694	0.003763	0.002319	0.003416	0.003763	N/A	0.25
Quarterly max	0.003943	0.006257	0.002699	0.003668	0.006257	N/A	0.42
Annual average for all stations = 0.003365 $\mu g/m^3$							

[a]Tennessee and national air quality standard for lead is 1.5 $\mu g/m^3$ quarterly arithmetic average.
[b]Conservative comparison of the maximum individual monthly result with the quarterly standard.
[c]ETTP temporary station activated during the second quarter of 2000.
[d]ETTP temporary station activated during the fourth quarter of 2000.

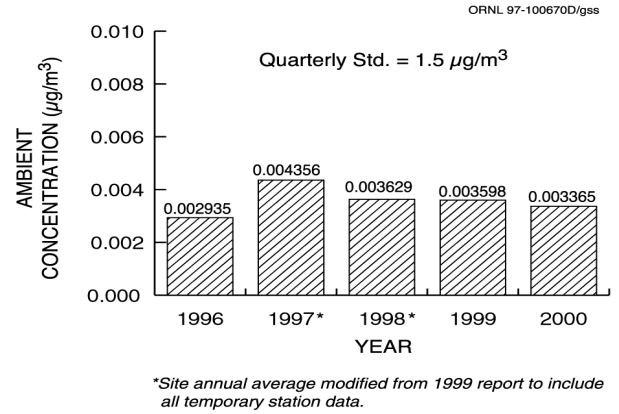

Fig. 4.11. Ambient air monitoring 5-year trend results for lead at the ETTP.

Table 4.13. HAP concentrations in ambient air at the ETTP, 2000

Parameter	Ambient air concentration ($\mu g/m^3$)			% of Standard[a]	
	Annual avg	Monthly max	Max location		
Arsenic	0.000668	0.001131	K6	29.0	
Beryllium	<0.000007	<0.000008	*b*	<0.2	
Cadmium	0.000363	0.001497	K9	6.5	
				Cr-III	*Cr-VI*
Chromium	0.000456	0.001007	K2	<0.1	51.8

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

[b]Results at all locations were at or near the minimum detectable concentration.

4.8.4 Radionuclide Levels

Total uranium metal was measured as a monthly composite of continuous weekly samples from stations K2, K6, K9, and K10 and as quarterly composites of weekly continuous samples from stations PAM35 and PAM42. 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 4.14. Results ranged from a minimum of approximately 0.00004, up to 0.00087 $\mu g/m^3$. The highest monthly result was measured at Station K2, which is in the prevailing downwind direction of the ETTP. The highest annual average value for all stations due to uranium was only 0.58 mrem/year (the annual standard is 10 mrem per year). No uranium concentration levels of environmental concern were measured (see Fig. 4.12 for 5-year uranium trend).

Periodic radiochemical analyses were initiated during 2000 on selected monthly composite samples collected at Stations K2, K6, K9 and K10. Note that stations K9 and K10 began operations in July and November 2000, respectively. 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 calculated dose contributions for each and all nuclides measured are presented in Table 4.15. For comparison, the total uranium dose associated with ICP-MS analyses of composite samples are compared with the uranium results determined by radiochemical techniques. The data show that results from the different analytical techniques demonstrate that airborne radionuclide emissions from the ETTP are low with respect to the annual standard of 10 mrem per year. Isotopes of uranium were the prominent contributors to dose at all stations. However, Station K2 had the highest ratio of transuranic isotopes.

4.8.5 Organic Compound Levels

Currently, measurements of selected semivolatile organics are performed only during an operational upset of the TSCAI. One unplanned release occurred during waste-burning operations in 2000. On August 2, 2000, a kiln surge vent event occurred at the TSCAI. By management decision, the TSCA ambient air station samples were not analyzed due to meteorological conditions at the time of the events. Conditions at the time of the event would not have carried any potential release in the directions of the two TSCA ambient air stations.

4.8.6 Five-Year Trends

Five-year summaries of ETTP ambient air monitoring data are shown in Figs. 4.10, 4.11, and 4.12 for PM10, lead, and uranium, respectively. Other measured pollutant trends are discussed in this section. Variations of PM10 and lead mea-

Table 4.14. Total uranium in ambient air by ICP/MS analysis at the ETTP, 2000

Station	No. of samples	Concentration[a]				% of DCG[b] (%)		EDE[c] (mrem)	
		μg/m³		μCi/mL					
		Avg	Max[d]	Avg	Max	Avg	Max	Avg	Max
K2	53	0.000143	0.000865	9.80E–17	5.97E–16	0.01	0.58	0.01	0.58
K6	53	0.000054	0.000093	3.68E–17	6.40E–17	0.04	0.06	0.04	0.06
K9	30	0.000048	0.000100	3.26E–17	6.86E–17	0.03	0.07	0.03	0.07
K10	8	0.000386	0.000525	2.65E–16	3.61E–16	0.26	0.35	0.26	0.35
PAM35	53	0.000041	0.000074	2.78E–17	5.07E–17	0.03	0.05	0.03	0.05
PAM42	53	0.000040	0.000066	2.71E–17	4.53E–17	0.03	0.04	0.03	0.04
Site total	250	0.000118	0.000865	8.13E–17	5.94E–16	0.08	0.58	0.08	0.58

[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 natural occurring uranium is an annual concentration of 1E–13 μCi/mL which is equivalent to a 100 mrem annual dose.

[c]Effective dose equivalent as defined in 40 CFR 61, Subpart H and calculated based on the dose limit of 10 mrem, which equates to an annual ambient air concentration of 0.015 μg/m³ per year, assuming a naturally occurring ^{235}U assay.

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

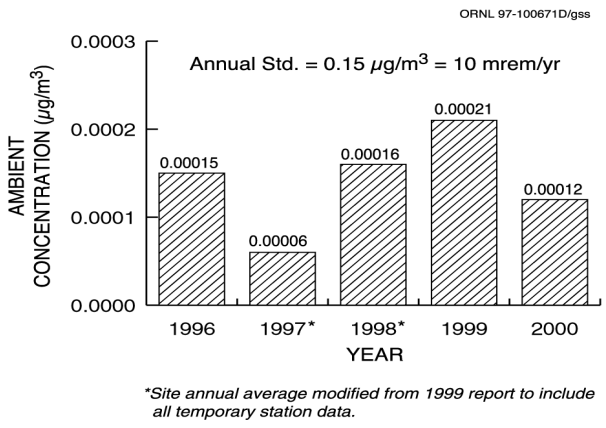

Fig. 4.12. Ambient air monitoring 5-year trend results for uranium at the ETTP.

surements 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 was 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 seven locations at the ETTP (Fig. 4.13). Stations K-1710 and MIK 1.4 provide information on conditions upstream of the ETTP. Stations K-716 and 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).

In the last quarter of 1999, at most surveillance stations, sampling was scaled back to semiannual sampling and analyses for radionuclides

Table 4.15. Radionuclides in ambient air by radiochemistry at the ETTP, 2000

Station	Effective dose equivalent (mrem/yr)										
	Total U[a] (ICP)	Total U[b] (alpha spec)	^{237}Np	^{238}Pu	^{239}Pu	^{99}Tc	^{234}U	^{235}U	^{236}U	^{238}U	Total EDE
K2	0.095	0.046	ND[c]	0.009	0.022	0.006	0.014	0.005	ND	0.027	0.084
K6	0.036	0.063	0.012	0.001	ND	0.008	0.028	0.004	ND	0.030	0.083
K9[d]	0.032	0.061	0.010	0.012	ND	0.005	0.023	0.007	ND	0.031	0.088
K10[d]	0.258[e]	0.094	*f*	*f*	*f*	*f*	0.053	0.001	0.001	0.039	0.094
35[d]	0.027	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*
42[d]	0.026	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*

[a]The calculated (annual) dose, due to uranium in the ambient air, is based on the annual average result of inorganic analyses for uranium assuming a naturally occurring ^{235}U assay.

[b]The annualized dose is based on radiochemistry analyses of monthly composite samples.

[c]"ND" indicates that the identified nuclide was not present at levels above the reported minimum detectable activity of the radiochemistry method.

[d]Station K9 sampling was initiated in June and Station K10 in November of this reporting period. Stations 35 and 42 results are based on inorganic analyses for uranium of ORR quarterly composite split samples assuming a naturally occurring assay.

[e]Results based on elevated minimum detection limits during analyses.

[f]Data not available or sample not taken.

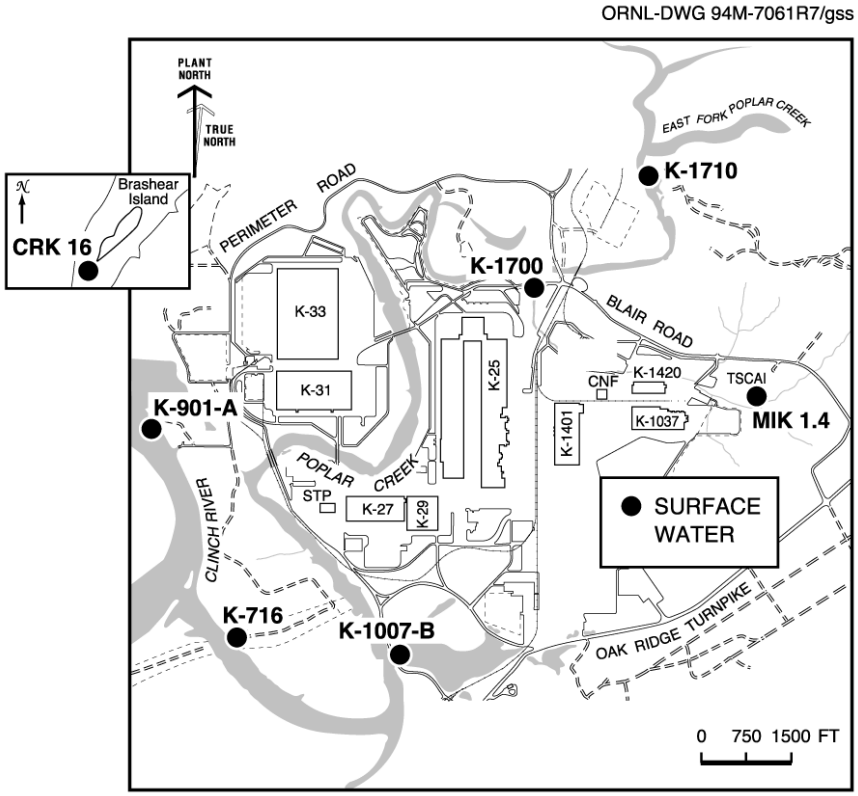

Fig. 4.13. Monitoring locations for surface water at the ETTP.

and field readings (dissolved oxygen, temperature, and pH). In February 2000, two locations that had been monitored by ORNL as part of the ORR monitoring effort were transferred to the ETTP monitoring program. At CRK 16, the parameters and frequency (monthly samples for radionuclides, VOCs, and selected metals) conducted by ORNL were retained. Quarterly sampling for VOCs was retained 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 (WQSs) for fish and aquatic life. The WQSs use the numeric values given in the Tennessee general water quality criteria (TWQC), which are a subset of the WQSs.

In most instances, results of the monitoring for nonradiological parameters are well within the applicable standards. Heavy metals were often detected at CRK16, and certain VOCs (primarily trichloroethane and 1,2-dichloroethane) were regularly detected at K-1700, but in all instances the results were well below the applicable WQS. Dissolved oxygen measurements regularly fall below the minimum WQS during the summer months because of increased temperature (and therefore lower solubility of the gas) and increased biological activity. Similarly, increased photosynthesis during the summer months causes an increase in the pH of area waterways, sometimes exceeding the maximum WQS. Water bodies in the vicinity of the ETTP are regularly inspected for signs of stress on aquatic organisms during these periods. For most of the remaining analyses, results are below detection limits for the instrument and method. Moreover, analytical results for samples collected upstream of the ETTP are chemically similar in most respects to those collected below the ETTP.

The sum of the fractions of the DCGs for all stations remained below the annual limit, as required by DOE Order 5400.5 (Fig. 4.14). The highest sum of the fractions, 51% of the allowable sum of the fractions of the DCGs, was reported for sampling location CRK 16. However, this was largely due to the contribution from two anomalous results for ^{226}Ra. Although the measured results were fairly low, ^{226}Ra has a very low DCG. This resulted in a relatively high fraction of the total allowable DCGs. These results are still well below the conservative limits established by the DOE order. The sums of the fractions of the DCGs at K-716 and K-1700 were 2.2% and 2.3%, respectively. The results at the other surface water surveillance locations are all at or below 1% of the allowable DCG. The data are consistent with the results found throughout the 1990s. 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.

4.10 ETTP SEDIMENT MONITORING

Currently sediment monitoring is conducted by the Integrated Water Quality Program (IWQP) in association with Comprehensive Environmental Response, Compensation, and Liability Act (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. Results from the sediment monitoring conducted in association with CERCLA activity are described in the *2001 Remediation Effectiveness Report/CERCLA Five Year Review for the U. S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE 2001).

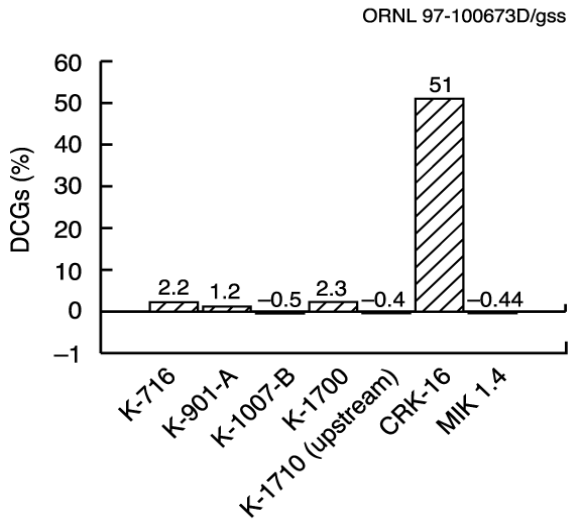

Fig. 4.14. Percentage of DCGs for ETTP surface monitoring locations.

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 FFA 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 *The Accelerating Cleanup: Paths to Closure, Oak Ridge Operations, Office* (DOE 1999b) 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 were incorporated into the IWQP in FY 1997 so that there is no longer a site-level program (DOE 1998e). The IWQP, which was established to provide a consistent approach to watershed monitoring across the ORR, is responsible for conducting groundwater surveillance monitoring at the ETTP. Although the groundwater monitoring program at ETTP had previously designated four wells as exit path monitoring wells, analysis of groundwater and subsurface geology data collected since that designation has determined that there are no discrete exit points for groundwater at ETTP. Groundwater discharges diffusely 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 contaminant sources at ETTP migrate toward one of these surface water bodies monitored for NPDES compliance. Because off-site releases need to be monitored more effectively, future editions of the FFA-required report, *Remediation Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, will include a summary of NPDES compliance. The current edition of this report 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 at ETTP may be sources of potential exposure to the public from gamma radiation from radionuclides in the cylinders. Measured exposure rates and a hypothetical model of a maximally exposed individual were used to calculate theoretical doses. The calculated effective dose equivalents (EDEs) were based on gamma 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 measured exposure rates indicate levels well below the requirements in DOE orders.

Gamma dose rates from each area were measured in February 2001 with a tissue-equivalent dose rate meter. Background readings were established at the ambient air monitoring stations north and northeast of ETTP off Blair Road. The average gamma background was 0.003 mrem/h, and all neutron background measurements were 0 mrem/h. Neutron dose rates for a count time of 1 min were 0 mrem/h at each of the monitoring locations.

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, maximally exposed individual could have received an EDE above background of about 0.25 mrem along the bank of Poplar Creek near K-1066-J Cylinder Yard, or 1.25 mrem along the bank of Poplar Creek near K-1066-E Cylinder Yard during 2000. 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.

In the vicinity of the K-770 Scrap Yard general area dose rates were recorded every 100 to

120 ft along the near bank of the Clinch River. The average gamma dose rate was equivalent to the background level of 0.003 mrem/h; therefore, a hypothetical Clinch River fisherman would not be expected to have received any EDE attributable to the K-770 Scrap Yard during 2000.

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. 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, maximally exposed individual could have received an EDE above background of about 1.25 mrem during 2000.