5. Environmental Surveillance

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Abstract

Annual environmental surveillance is a major activity on the ORR. Environmental surveillance consists of the collection and analysis of samples of air, water, vegetation, biota, and other media from the reservation and its surroundings. External radiation is also measured. Samples are analyzed for the presence of radioisotopes and for chemical content. Data collected from environmental surveillance activities are used to demonstrate compliance with applicable standards, to assess exposures to members of the public, and to assess effects on the local population and the environment.

5.1 ENVIRONMENTAL SURVEILLANCE PROGRAM CHANGES

In 1997, major revisions to the environmental surveillance program were implemented. These revisions were the result of an extensive review of each program component, conducted primarily because management authority for the ORR was divided between LMES and LMER. The modified surveillance program was developed in a cooperative effort between LMER and LMES in which both entities identified those monitoring activities necessary to meet all applicable requirements for the individual sites, as well as those applicable to the ORR. Consequently, many of the activities described in the following sections have changed significantly in terms of locations, parameters, and sampling frequencies from the environmental surveillance activities reported in the *Oak Ridge Reservation Annual Site Environmental Report for 1996.*

5.2 METEOROLOGICAL MONITORING

Seven meteorological towers provide data on meteorological conditions and on the transport and diffusion qualities of the atmosphere on the ORR. Data collected at the towers are used in routine dispersion modeling to predict impacts from facility operations and as input to emergency response atmospheric models used in the event of accidental releases from a facility. Data from the towers are also used to support various research and engineering projects.

5.2.1 Description

The seven meteorological towers, depicted in Fig. 5.1, consist of one 330-ft (100-m) tower (MT5) and one 200-ft (60-m) tower (MT6) at the Y-12 Plant, one 330-ft tower (MT2) and two 100-ft towers (MT3 and MT4) at ORNL, and one 200-ft tower (MT1) and one 100-ft (MT7) tower at the ETTP.

Data are collected at different levels to determine the vertical structure of the atmosphere and the possible effects of vertical variations on releases from facilities. At all towers, data are collected at the 32.8-ft level and at the top of the tower. At the 330-ft towers, data are collected at an intermediate 100-ft level as well. At each measuring level on each tower, temperature, wind speed, and wind direction are measured. Humidity and data needed to determine atmospheric stability (a measure of the dispersive capability of the atmosphere) are also measured at each tower. Barometric pressure is measured at one tower at each facility. Precipitation is measured at MT1 and MT7 at the ETTP and at MT2 at ORNL; solar radiation is measured at MT2.

Data from the towers at each site are collected by a dedicated control computer. The towers are polled, and the data are filed on disk. Fifteen-minute and hourly values are stored at each site

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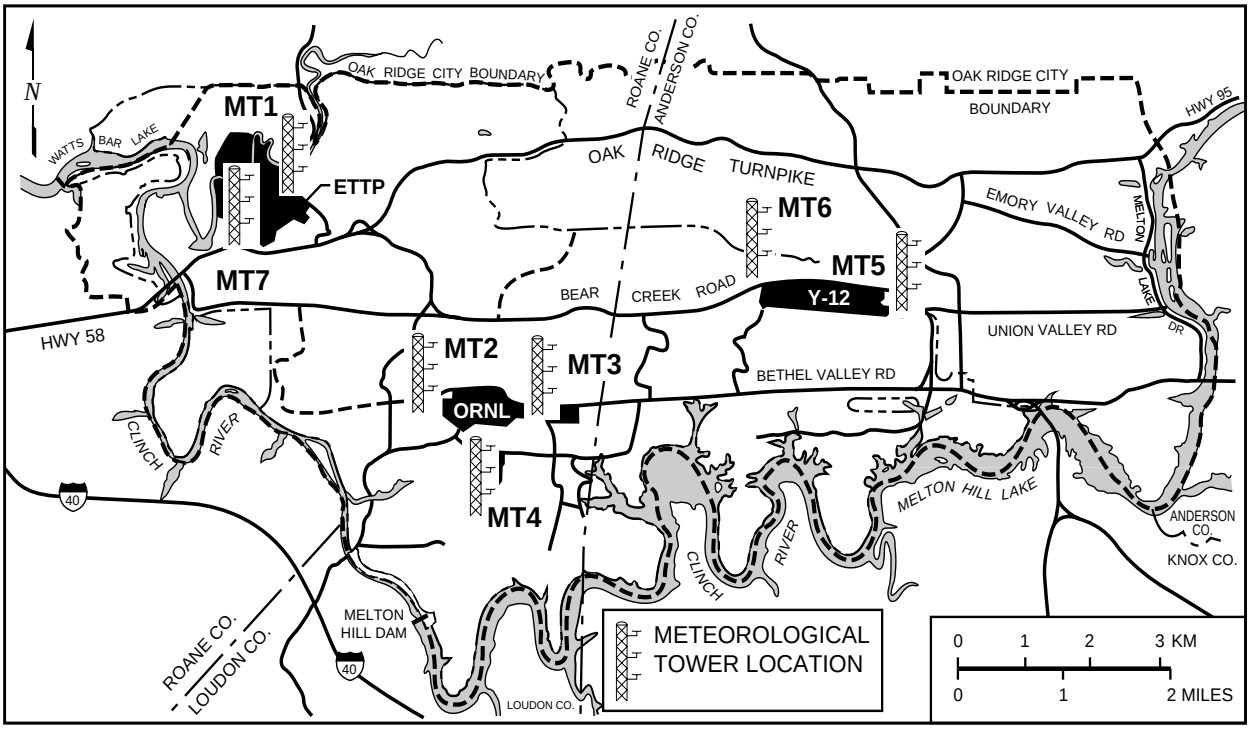

Fig. 5.1. The ORR meteorological monitoring network.

for a running 24-hour period, but only hourly data are routinely stored beyond 24 hours. The meteorological monitoring data from all towers are summarized quarterly at the Y-12 Plant and monthly at ORNL and the ETTP. Quarterly calibration of the instruments is conducted for each site by an outside contractor.

Fifteen-minute and hourly data are used directly at each site computer for emergency-response purposes such as input to dispersion models. Annual dose estimates are calculated from archived data (either hourly values or summary tables of atmospheric conditions). Data quality is checked continuously against predetermined data constraints, and out-of-range parameters are marked invalid and are not input to the dispersion models.

5.2.2 Results

Prevailing winds are generally up-valley from the southwest and west-southwest or down-valley from the northeast and east-northeast. This pattern is the result of the channeling effect of the ridges flanking the site. Winds in the valleys tend to follow the ridges, with limited cross-ridge flow. These conditions are dominant over the entire reservation, with the exception of the ETTP, which is located in a relatively open area that has a more varied flow. Weaker valley flows are noted in this area, particularly in locations near the Clinch River.

On the reservation, low-speed winds predominate at the surface level. This characteristic is noted at all tower locations, as is the increase in wind speed at the height at which measurements are made. This activity is typical of tower locations and is important when selecting appropriate data for input to dispersion studies.

The atmosphere over the reservation is dominated by stable conditions on most nights and in early morning hours. These conditions, coupled with the low wind speeds and channeling effects of the valleys, result in poor dilution of material emitted from the facilities. These features are captured in the data input to the dispersion models

and are reflected in the modeling studies conducted for each facility.

Precipitation data from tower MT2 are used in stream-flow modeling and in certain research efforts. The data indicate the variability of regional precipitation: the high winter rainfall amounts resulting from frontal storms and the uneven, but occasionally intense, summer rainfall associated with thunderstorms.

The average data recovery rate (a measure of acceptable data) across all locations and at the 16 tower levels was 96.3% in 1997. The maximum data recovery was 99.6% at ETTP MT1 at 60 m and at ORNL MT2 at both 10 and 30 m. The minimum data recovery rate was 74.5% at ETTP MT7 at 30 m.

5.3 EXTERNAL GAMMA RADIATION MONITORING

External gamma radiation measurements are made to determine whether routine radioactive effluents from the ORR are increasing external radiation levels significantly above normal background levels.

5.3.1 Data Collection and Analysis

External gamma measurements are recorded weekly at six ambient air stations from resident external gross gamma monitors (Fig. 5.2). Each consists of a dual-range, high-pressure ion chamber sensor and digital electronic count-rate meter and totalizer. Totalizing consists of multiplying the count rate by the time of exposure to obtain total dose. The doses are analyzed for average and median values, which are compared with national median values.

5.3.2 Results

Table 5.1 summarizes the data collected at each station during the year. The minimum, maximum, and average values reported in 1997 appear to differ significantly from the corresponding values in the 1996 ASER. These differences are actually the result of changes in the way the data are reported. The summary data for 1997 are based on average exposure rates for each measurement period, whereas the values summarized for 1996 were actual rates observed at the time of data collection. Averaging the total exposure over each measurement cycle provides more information about the entire period of interest and is more comparable to national median values used as reference information.

5.4 AMBIENT AIR MONITORING

In addition to exhaust stack monitoring conducted at the DOE Oak Ridge installations, ambient air monitoring is performed to measure radiological and other selected parameters directly in the ambient air adjacent to the facilities. Ambient air monitoring provides direct measurement of airborne concentrations of radionuclides and other hazardous pollutants in the environment surrounding the facilities, allows facility personnel to determine the relative level of contaminants at the monitoring locations during an emergency, verifies that the contributions of fugitive and diffuse sources are insignificant, and serves as a check on dose-modeling calculations.

The following sections discuss the ambient air monitoring networks for the ORR, the Y-12 Plant, ORNL, and the ETTP.

5.4.1 ORR Ambient Air Monitoring

The objectives of the ORR ambient air monitoring program are to perform surveillance of airborne radionuclides at the reservation perimeter and to collect reference data from a remote location not affected by activities on the ORR. The ORR perimeter air monitoring (PAM) network includes stations 35, 37, 38, 39, 40, 42, 46, and 48 (Fig. 5.3). Reference samples are collected from station 52 (Fort Loudoun Dam). Sampling was conducted at each ORR station during 1997 to

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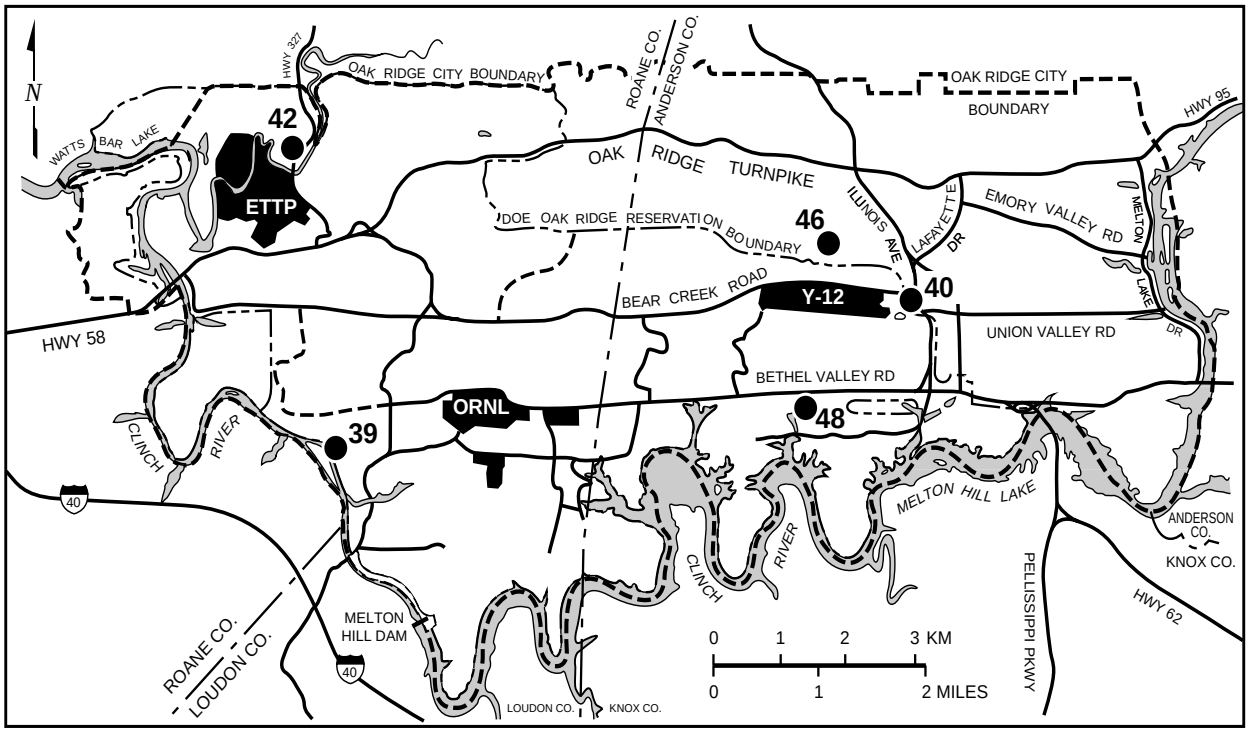

Fig. 5.2. External gamma radiation monitoring locations on the ORR. Location 52, at Fort Loudoun Dam, approximately 15 miles southwest of ORNL, is not shown on this map.

Table 5.1. External gamma averages, 1997

Location	Number of data values collected	Measurement (μR/h)[a]			Standard error of mean
		Min	Max	Mean	
39	51	0.02	6.8	5.8	0.0002
40	51	4.9	10.9	5.7	0.0002
42	52	4.6	14.7	5.2	0.0002
46	49	5.4	6.5	5.8	0.00003
48	49	1.2	6.5	4.9	0.0002
52	50	4.5	5.5	5.1	0.00004

[a]To convert microroentgens per hour (μR/h) to milliroentgens per year, multiply by 8.760.

quantify levels of alpha-, beta-, and gamma-emitting radionuclides and tritium.

Atmospheric dispersion modeling was used to select appropriate sampler locations. The locations selected are those most likely to be affected by routine releases from the Oak Ridge facilities. Therefore, it is predicted that no residence or business in the vicinity of the ORR would be affected by undetected releases of radioactive materials. To provide an estimate of background radionuclide concentrations, an additional station is located at a site not affected by releases from the ORR.

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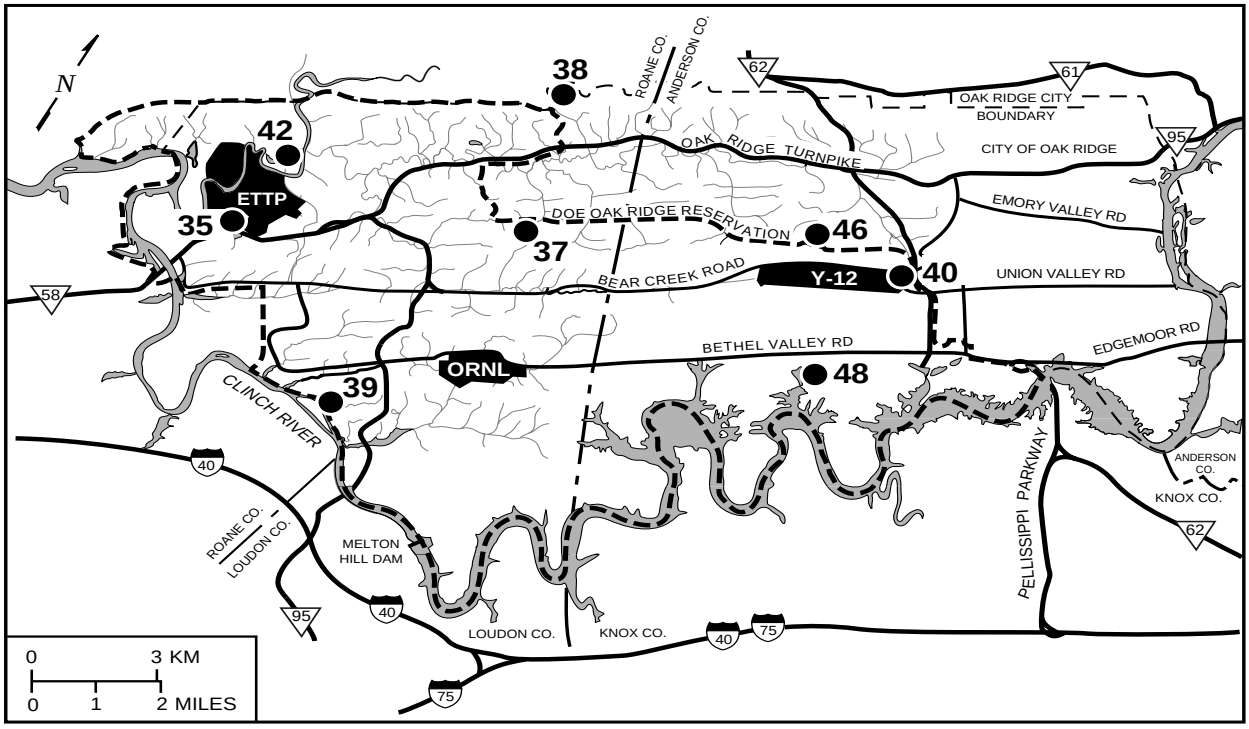

Fig. 5.3. Location of ORR perimeter air monitoring stations.

The sampling system consists of two separate instruments. The particulates are captured using a high-volume air sampler on glass fiber filters. The filters are collected weekly, composited quarterly, then submitted to the laboratory for isotopic analysis. The second system is designed to collect tritiated water vapor. The sampler consists of a prefilter followed by an adsorbent trap consisting of indicating silica gel. The samples are collected weekly or biweekly, composited quarterly, then submitted to the laboratory for tritium analysis.

The ORR PAM or ambient air network (Fig. 5.3) provides appropriate monitoring for all facilities within the reservation, which eliminates the necessity for site-specific ambient air programs. As part of the ORR network, an ambient air monitoring station located in the Scarboro Community of Oak Ridge (Station 46) measures off-site impacts of the Y-12 Plant operation and is located near the theoretical area of maximum public pollutant concentrations as calculated by air-quality modeling. Station 40 of the ORR network monitors the east end of the Y-12 Plant, and Station 37 monitors the overlap of the Y-12 Plant, ORNL, and ETTP emissions.

5.4.1.1 Results

Data from the ORR PAM stations are analyzed to assess the impact to air quality of operations on the entire reservation. The background station provides information on reference concentrations of radionuclides and gross parameters for the region. A comparison of ORR PAM station sampling data with those from the reference station at the 95% confidence level shows that there are no significant differences in the radionuclide concentrations from the ORR stations and the reference station (Table 5.2).

Table 5.3 represents the average concentration of three isotopes of uranium at each station for sampling years 1994, 1995, 1996, and 1997.

Table 5.2. Radionuclide concentrations at ORR perimeter air monitoring stations, 1997[a,b]

Station	^{7}Be	^{60}Co	^{137}Cs	^{40}K	^{3}H	^{234}U	^{235}U	^{238}U	Gross alpha	Gross beta
35	*c*	3.6E–17	1.0E–16	1.9E–15	*c*	4.0E–17	2.1E–18	4.6E–17	1.2E–15	2.7E–15
37	*c*	3.2E–17	3.4E–17	1.6E–15	*c*	5.3E–17	4.4E–18	5.4E–17	1.5E–15	2.6E–15
38	*c*	3.0E–17	1.2E–17	1.8E–15	*c*	5.3E–17	1.8E–18	4.4E–17	1.4E–15	2.7E–15
39	4.2E–14	1.7E–17	4.8E–18	1.6E–15	5.5E–11	4.6E–17	1.6E–18	6.1E–17	2.1E–15	3.3E–15
40	5.5E–14	8.4E–18	4.1E–18	1.7E–15	*c*	2.2E–16	5.8E–18	5.9E–17	1.5E–15	3.0E–15
42	*c*	5.2E–17	3.0E–17	2.2E–15	*c*	7.2E–17	6.2E–18	3.9E–17	2.0E–15	2.9E–15
46	6.3E–14	2.0E–17	2.0E–17	2.5E–15	*c*	1.0E–16	3.7E–18	4.7E–17	1.6E–15	3.8E–15
48	4.6E–14	2.3E–17	5.7E–18	1.8E–15	*c*	5.3E–17	4.3E–18	4.8E–17	1.6E–15	2.8E–15
52[d]	*c*	1.1E–17	2.3E–17	2.3E–15	*c*	4.1E–17	3.6E–18	3.7E–17	2.1E–15	4.0E–15

[a]All values are mean concentrations.
[b]Units are μCi/mL.
[c]Not detected at 95% confidence level
[d]Reference location.

5.4.2 Y-12 Plant Ambient Air Monitoring

In 1994, Y-12 Plant personnel issued *Evaluation of the Ambient Air Monitoring Program at the Oak Ridge Y-12 Plant* (MMES 1994) and worked with DOE and TDEC in reviewing the ambient air program for applicability and usefulness of the data. There are no federal regulations, state regulations, or DOE orders that require this monitoring. All ambient air monitoring systems at the Y-12 Plant are operated as a BMP. With the reduction of plant operations and improved emission and administrative controls, levels of measured pollutants have decreased significantly during the past several years. In addition, processes that result in emission of enriched and depleted uranium are equipped with stack samplers that have been reviewed and approved by EPA to meet requirements of the NESHAP regulations. ORR air sampling stations, operated by ORNL in accordance with DOE orders, are located around the reservation. Their locations ensure that areas of potentially high exposure to the public are monitored continuously for parameters of concern.

With agreement from TDEC personnel, the ambient air sampling program at the Y-12 Plant was significantly reduced, effective at the end of 1994. All fluoride, total suspended particulates (TSPs), and particulate matter less than 10 microns in diameter (PM10) sampling was discontinued, and all but 3 of the 12 uranium samplers were shut down. The mercury sampling program was continued to monitor ambient air level concentrations through 1997 but may be curtailed in the near future because of decreasing monitoring budgets.

In 1997, three low-volume uranium particulate monitoring stations and four mercury monitoring stations were operated by the Y-12 Plant. The locations of these monitoring stations are shown in Fig. 5.4.

Table 5.3. Uranium concentrations in ambient air on the ORR

Isotope	Concentration (10^{-15} µCi/mL)			
	1994	1995	1996	1997
		Station 35		
^{234}U	3.5E–02	1.5E–02	2.2E–02	4.0E–02
^{235}U	3.0E–03	4.4E–04	1.3E–03	2.1E–03
^{238}U	2.4E–02	1.8E–02	3.4E–02	4.6E–02
		Station 37		
^{234}U	3.5E–02	1.3E–02	2.0E–02	5.4E–02
^{235}U	3.0E–03	1.4E–03	7.2E–04	4.4E–03
^{238}U	1.9E–02	1.3E–02	2.1E–02	5.3E–02
		Station 38		
^{234}U	2.9E–02	1.1E–02	1.6E–02	5.3E–02
^{235}U	4.0E–03	2.7E–04	9.2E–04	1.8E–03
^{238}U	1.6E–02	1.1E–07	2.0E–02	4.4E–02
		Station 39		
^{234}U	2.7E–02	1.1E–02	1.4E–02	4.6E–02
^{235}U	5.0E–03	1.1E–03	6.2E–04	1.6E–03
^{238}U	9.0E–03	9.1E–03	1.2E–02	6.1E–02
		Station 40		
^{234}U	8.9E–02	5.1E–02	4.6E–02	2.2E–01
^{235}U	9.0E–03	3.4E–03	1.8E–03	5.8E–03
^{238}U	1.6E–02	1.6E–02	1.7E–02	5.9E–02
		Station 42		
^{234}U	1.9E–02	1.1E–02	1.8E–02	7.2E–02
^{235}U	2.0E–03	1.3E–03	1.3E–03	6.2E–03
^{238}U	1.5E–02	1.1E–02	2.0E–02	3.9E–02
		Station 46		
^{234}U	4.4E–02	2.6E–02	2.3E–02	1.0E–01
^{235}U	6.0E–03	1.7E–03	1.1E–03	3.7E–03
^{238}U	1.5E–02	1.1E–02	1.9E–02	4.7E–02
		Station 48		
^{234}U	2.3E–02	1.3E–02	2.8E–02	5.3E–02
^{235}U	1.0E–03	1.0E–03	6.9E–04	4.3E–03
^{238}U	1.1E–02	9.5E–03	1.3E–02	4.8E–02
		Station 52		
^{234}U	1.6E–02	1.2E–02	9.4E–03	4.1E–02
^{235}U	2.0E–02	2.2E–03	1.4E–03	3.6E–03
^{238}U	6.0E–03	8.9E–03	9.3E–03	3.7E–02

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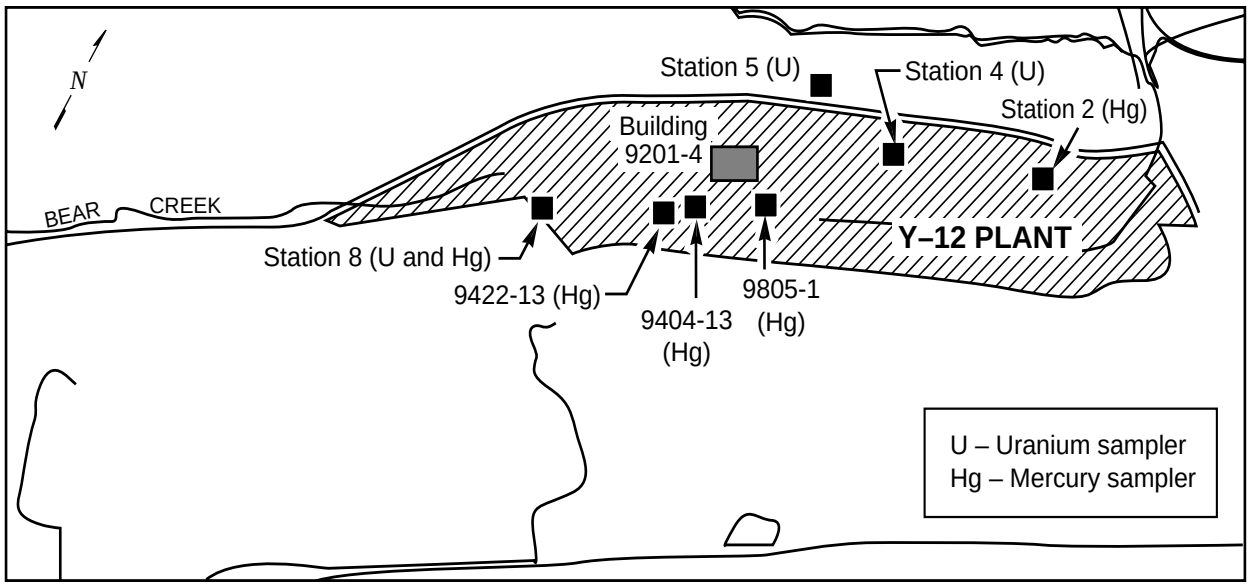

Fig. 5.4. Locations of ambient air monitoring stations at the Y-12 Plant.

5.4.2.1 Uranium

Samples for routine measurement of uranium particulate were collected by pulling ambient air through a 14-cm- (5.5-in.-) square filter, which was analyzed by the Y-12 Plant Analytical Services Organization for total uranium and for the percentage of ^{235}U. Prior to 1993, the samples were analyzed for gross alpha and beta and for activity levels of specific uranium isotopes; however, in 1993, the analysis program for radionuclides was revised as described in the EMP to obtain total uranium particulate and the percentage of ^{235}U. In this manner, uranium concentrations in ambient air could be better correlated to stack emission data, which are also measured as total uranium mass. For 1997, the average 7-day concentration of uranium at the three monitored locations ranged from a low of 0.0000062 $\mu g/m^3$ at Station 5 to a high of 0.00297 $\mu g/m^3$ at Station 4 (Table 5.4).

5.4.2.2 Mercury

The year 1997 represents the twelfth year of operation of the Oak Ridge Y-12 Plant monitoring program for measuring on-site mercury vapor concentrations in ambient air. Outdoor airborne mercury vapor at the Y-12 Plant is primarily the result of vaporization from mercury-contaminated soils, fugitive emissions from former mercury-use area buildings, and releases from coal burning at the Y-12 Steam Plant. The goals of the monitoring program have been to establish a historical data base of mercury concentrations in ambient air at the Y-12 Plant, identify spatial and temporal trends in mercury vapor concentrations at the Y-12 Plant, and demonstrate protection of the environment and human health from releases of mercury from the Y-12 Plant to the atmosphere.

Four outdoor ambient mercury monitoring stations (boundary stations) on the east and west ends of the plant and two stations near Building 9201-4, a former lithium isotope separation facility contaminated with mercury, were established at the Y-12 Plant in 1986. One of the original sites near Building 9201-4 was relocated in 1996 approximately 30 meters south and west of the old location to a site near Building 9422-13. A control or reference site was established in 1988 at Rain Gage No. 2 on Chestnut Ridge in the Walker Branch Watershed and monitored for a period of 20 months during 1988 and 1989 to establish background concentrations.

Table 5.4. Uranium mass in ambient air at the Y-12 Plant, 1997

Station No.	No. of samples	7-day concentration ($\mu g/m^3$)		
		Max	Min	Av
4	51	0.0029737	0.0000086	0.0001498
5	51	0.0011685	0.0000062	0.0000954
8	52	0.0007323	0.0000221	0.0000905

Because no established or EPA-approved method for measuring mercury vapor in ambient air existed when the program was initiated in 1986, staff of the ORNL Environmental Sciences Division developed a method to meet the needs of the monitoring program for the Y-12 Plant. At each of the monitoring sites, airborne mercury vapor is pulled through a Teflon filter and flow-limiting orifice before being adsorbed onto iodated charcoal packed in a glass sampling tube. The charcoal sampling tubes are routinely changed every 7 days. Average air concentration of mercury vapor for each 7-day sampling period is calculated by dividing the total quantity of mercury collected on the charcoal by the total volume of air pulled through the charcoal trap over the 7-day period.

During 1997, Tekran™ Model 2537A mercury vapor analyzers were operated at the two boundary locations, Ambient Station No. 2 and Ambient Station No. 8. The Tekran mercury vapor analyzers are self-calibrating, include mass-flow controllers, and can provide almost continuous analysis of mercury vapor in air at less than nanogram per cubic meter (sub-ng/m^3) levels at time intervals as short as 5 minutes, thus providing a means for determining the range and magnitude of short-term (i.e., minutes instead of days) mercury fluctuations. During 1997, the analyzers were operated at time intervals of 30 minutes, resulting in approximately 15,500 mercury concentration data points for Ambient Station No. 2 and over 10,000 data points for Ambient Station No. 8.

The Tekran analyzers at both Ambient Station No. 2 and Ambient Station No. 8 were run simultaneously throughout most of the year with the older monitoring system (i.e., the iodated charcoal traps) to verify comparability of the measurements. Figure 5.5 is a plot of mercury vapor concentrations recorded at 30-minute intervals by the Tekran analyzer at Ambient Station No. 2 during 1997. Overlain on top of it is the 7-day moving average of the Tekran data (comparable to the charcoal trap weekly results). The Tekran plot presents over 15,000 data points and provides important information on the magnitude of short-term fluctuations in mercury vapor concentration at Ambient Station No. 2. Figure 5.6 presents a plot of the charcoal trap results overlain on the Tekran 7-day moving average for the same time period (January through June 1997), illustrating good agreement between data collected by the two monitoring systems.

As reported in last year's annual ORR environmental report, analysis of data collected at the two Tekran sites has shown a strong correlation between wind direction and mercury vapor concentration, with peak mercury vapor concentrations measured at a site when the prevailing wind direction is from the former mercury-use areas at the Y-12 Plant. Data for 1997 continues to support this finding. Because the boundary sites are at opposite ends of the Y-12 Plant and opposite directions from the mercury-use areas, one would expect that when mercury vapor concentrations peak at one site, vapor concentrations would be low at the other boundary site. Tekran 30-minute interval results for the two sites support this (Fig. 5.7). Only mercury vapor concentrations greater than 0.01 $\mu g/m^3$ are shown in Fig. 5.7 so as to highlight differences between the two sites during periods when vapor concentrations are higher than average.

Annual average mercury vapor concentrations at the Y-12 Plant have declined since the early years of the monitoring program (1986 through 1988) with average concentrations at the two boundary sites currently comparable to those measured in 1988 and 1989 at the reference site (Table 5.5). Of the three sites operational since 1986, all three show significantly lower annual

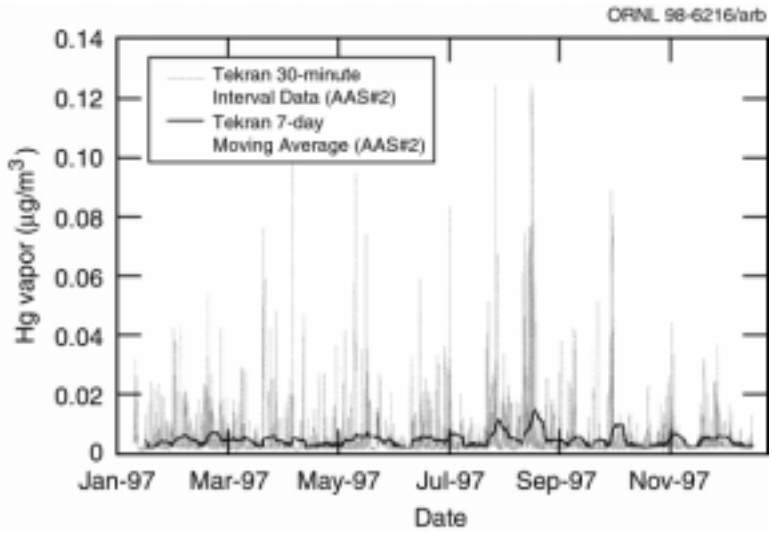

Fig. 5.5. Temporal trends in mercury vapor concentration at Ambient Station No. 2 from January through mid-December 1997 as measured by a Tekran Model 2537A mercury vapor analyzer. The 7-day moving average for the 15,444 data points overlays the 30-min Tekran data.

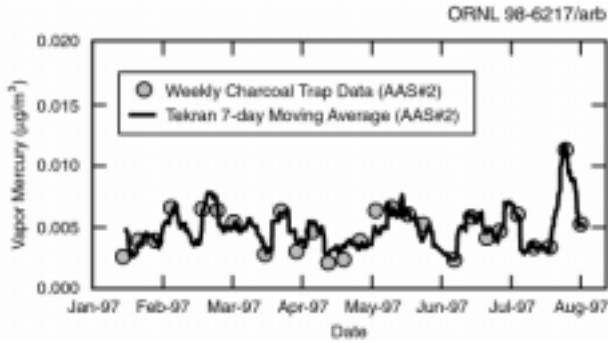

Fig. 5.6. Comparison of the Tekran 7-day moving average with the 7-day charcoal trap data for Ambient Station No. 2 during the first half of 1997.

averages (Student's *t*-test at the 1% level) for mercury vapor concentration when compared with the 1986 through 1988 average. Average mercury vapor concentrations in 1997 for the four sites currently monitored are comparable to those reported for the last two years in the annual environmental report (Table 5.5). The decrease in ambient vapor mercury recorded at the Y-12 sites since 1989 is thought to be related to the reductions in coal burning at the Y-12 Steam Plant beginning in 1989 and to the completion prior to 1989 of several major engineering projects [e.g., New Hope Pond closure, the Perimeter Intrusion Detection Assessment System (PIDAS), Reduction of Mercury in Plant Effluent (RMPE), and Utility Systems Restoration] that may have caused a temporary increase in mercury air concentrations because of disturbances to contaminated soil and sediment. More recently, mercury cleanup and closure activities have been conducted at several sites within the mercury-use areas including Building 9201-4.

Figure 5.8 illustrates temporal trends in mercury concentrations for the four active ambient air mercury monitoring sites since the inception of the program in 1986. Results for the newest site near Building 9422-13, which replaced the nearby site at Building 9404-13 in 1996, are overlain on the original plot for Building 9404-13. Seasonal increases in mercury concentrations in ambient air are recorded at all four sites during warm-weather months.

In 1997, although ambient mercury concentrations at the two monitoring sites near Building 9201-4 are still elevated above natural background, results indicate that concentrations of mercury vapor are well below the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value of 50 $\mu g/m^3$ (time-weighted average for 8-hour workday and 40-hour work week). Average concentrations at the two boundary monitoring sites located at the east and west end of the Y-12 Plant are comparable to levels measured at our reference site on Chestnut Ridge.

5.4.3 ORNL Ambient Air Monitoring

The objectives of the ORNL ambient air monitoring program are to collect samples at stations that are most likely to show impacts of airborne emissions from the operation of ORNL and to provide for emergency response capability.

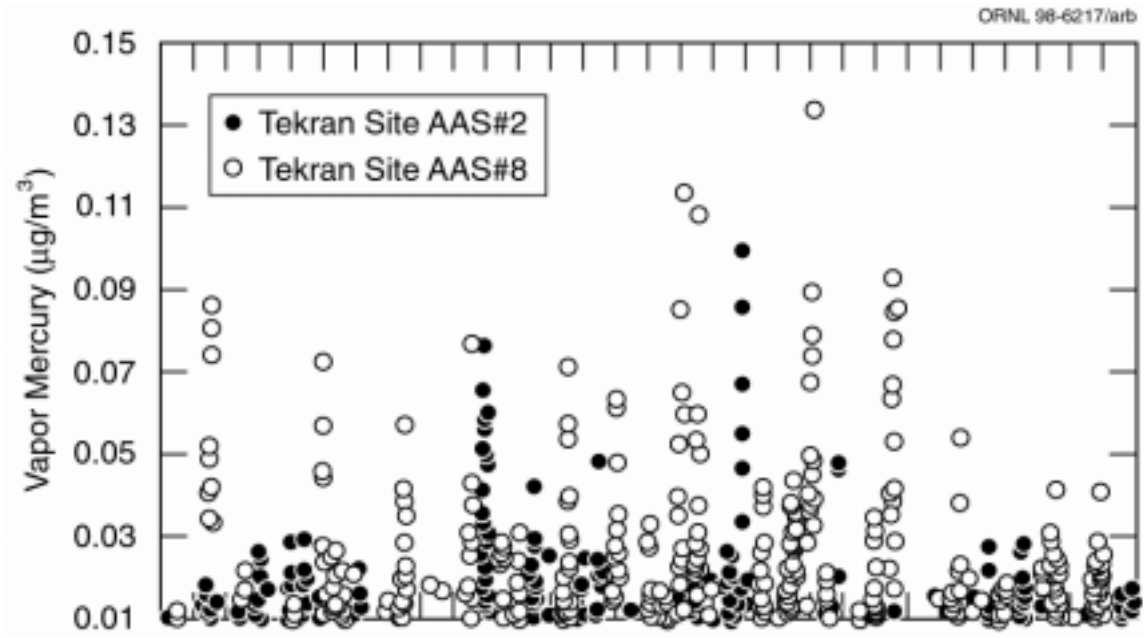

Fig. 5.7. Temporal comparison of peak (>0.01 µg/m³) mercury concentrations at Ambient Station No. 2 and Ambient Station No. 8 during a 2-month period in 1997.

Table 5.5. Results of the Y-12 Plant ambient air mercury monitoring program
The 1997 averages are calculated from results of both charcoal trap and Tekran monitoring

Ambient air monitoring site	Mercury vapor concentration (µg/m³)			
	1997 Average	1996 Average[a]	1995 Average[a]	1986–1988 Average[a]
Station No. 2 (east end of Y-12 Plant)	0.0048	0.004	0.005	0.010
Station No. 8 (west end of Y-12 Plant)	0.0065	0.006	0.007	0.033
Bldg. 9422-13 (SW of Bldg. 9201-4)	0.032[b]	0.030	N/A[c]	N/A[c]
Bldg. 9805-1 (SE of Bldg. 9201-4)	0.064[b]	0.058	0.066	0.099
Reference Site, Rain Gage No.2 (1988[d])	N/A	N/A	N/A	0.006
(1989[e])	N/A	N/A	N/A	0.005

[a]ACGIH 8-h workday/40-h work week threshold limit equals 50 µg/m³.
[b]Data for period from January 1 through September 30, 1997.
[c]Site established in late 1995.
[d]Data for period from February 9 through December 31, 1988.
[e]Data for period from January 1 through October 31, 1989.

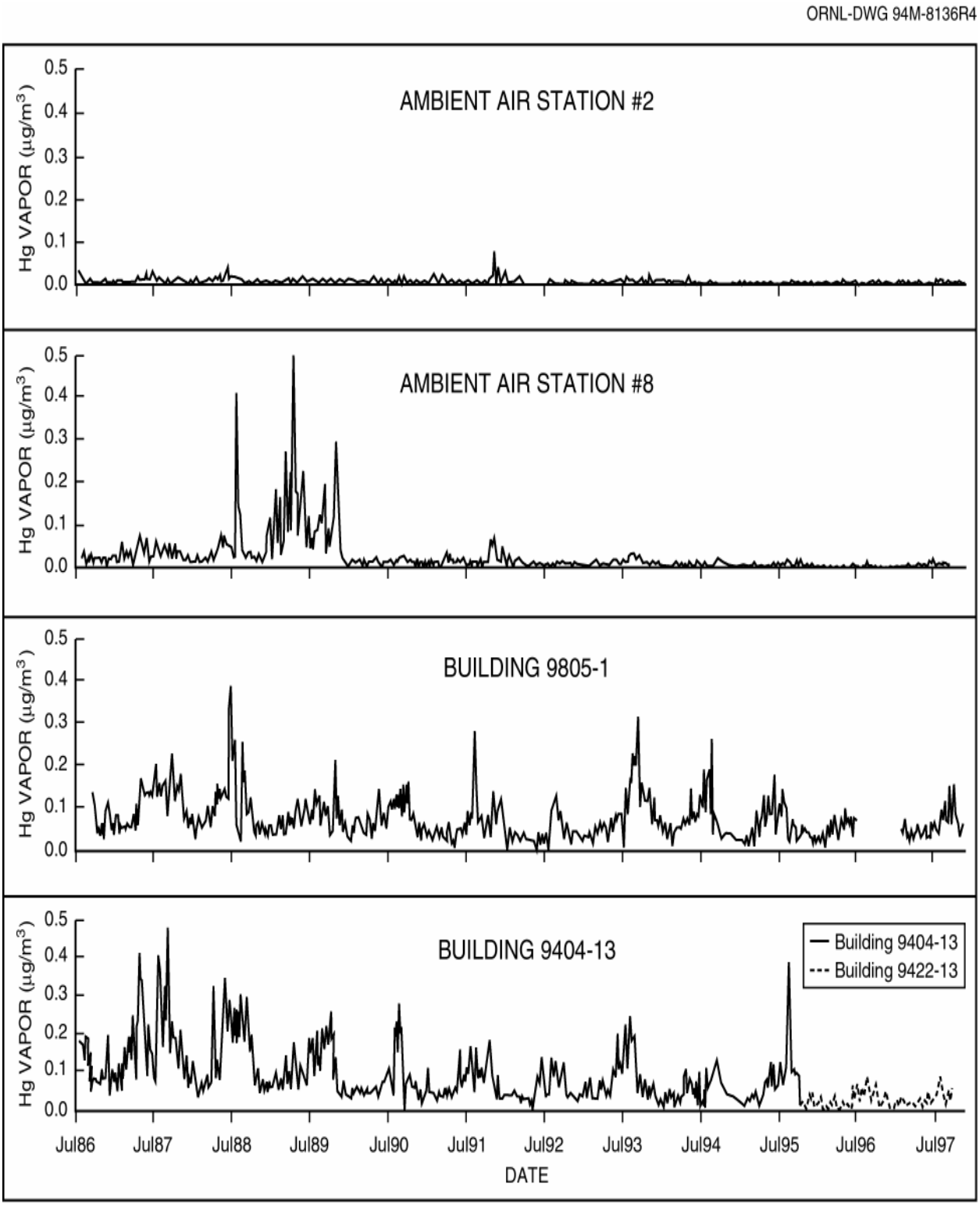

Fig. 5.8. Time trends in mercury vapor concentrations for the four active airborne mercury monitoring sites at the Oak Ridge Y-12 Plant (1986 through 1997). Note that the new site established in late 1995 at Building 9422-13 is overlain on the plot for Building 9404-13.

Four stations identified as stations 1, 2, 3, and 7 (Fig. 5.9) make up the ORNL network. Sampling is conducted at each ORNL station to quantify levels of adsorbable gases (e.g., iodine), and gross alpha-, beta-, and gamma-emitting radionuclides (Table 5.6).

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

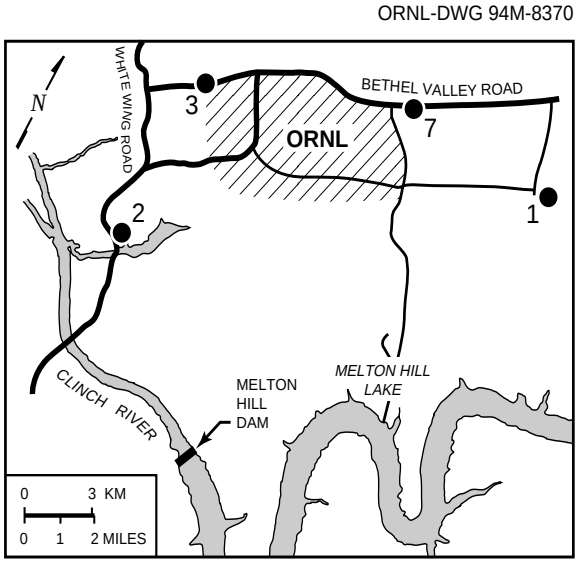

Fig. 5.9. Locations of ambient air monitoring stations at ORNL.

5.4.3.1 Results

The ORNL PAM stations are designed to provide data for collectively assessing the specific impact of ORNL operations on local air quality. Sampling data from the ORNL PAM stations (Table 5.6) is compared with air sampling data from the reference station (station 52) at Fort Loudoun.

5.4.4 ETTP Ambient Air Monitoring

DOE Order 5400.1 requires surveillance of ambient air to assess the impact of DOE operations on air quality off-site. In addition, airborne radionuclide monitoring is required for compliance with radionuclide NESHAP regulatory agreements. DOE Order 5400.5 also specifies locations for airborne radionuclide surveillance. The ETTP ambient air monitoring program is designed to monitor selected air contaminants for the ongoing monitoring of plant operations' impact 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 locations of these monitoring stations are shown in Fig. 5.10. 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-hour, quarterly, and annual standards for specific or criteria pollutants.

The ambient air program sampling schedule and monitoring capabilities for airborne particulate matter, uranium, and selected HAP metals are listed in Table 5.7. 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 enviroment may warrant periodic changes of air contaminants measured, number of stations, or relocation of existing stations.

During this reporting period, the network was modified with respect to ETTP operations. During the fourth quarter of 1997, a temporary high-

Table 5.6. Radionuclide concentrations measured at ORNL perimeter air monitoring stations, 1997 (µCi/mL)[a]

Parameter	Station				
	1	2	3	7	52[b]
^{7}Be	1.6E–14	1.0E–14	9.8E–15	9.9E–15	*c*
^{137}Cs	3.1E–17	2.0E–17	5.2E–17	2.1E–17	2.3E–17
^{60}Co	3.0E–17	*c*	1.6E–17	*c*	1.1E–17
^{3}H	*c*	7.8E–11	*c*	2.6E–12	c
^{131}I	8.5E–16	1.5E–15	2.4E–15	9.4E–16	*d*
^{133}I	*c*	2.3E–15	2.6E–15	3.7E–15	*d*
^{135}I	7.6E–15	5.6E–14	1.5E–14	*c*	*d*
^{40}K	8.3E–16	9.1E–16	1.2E–15	9.3E–16	2.3E–15
^{234}U	3.0E–17	3.6E–17	2.9E–17	4.0E–17	4.1E–17
^{235}U	3.5E–18	*c*	*c*	*c*	3.6E–18
^{238}U	2.9E–17	2.6E–17	3.3E–17	3.0E–17	3.7E–17
Gross alpha	5.3E–15	4.5E–15	4.2E–15	6.3E–15	
Gross beta	1.1E–14	1.1E–14	1.0E–14	1.1E–14	

[a]1 µCi = 3.7E+04 Bq.
[b]Reference location.
[c]Not detected.
[d]Not applicable.

volume (HV) sampling station was activated in response to a scheduled demolition of buildings not within the existing perimeter ambient air monitoring network. Station KAFaD was activated prior to the start of activities to establish background levels of the air pollutants as identified in Table 5.7. All sampling was continuous with all procedures and schedules identical to the ETTP ambient air monitoring network operations with the exception that individual weekly samples are analyzed. The location of station KAFaD project is identified in Fig. 5.10.

HV sampling for uranium continues at stations K6 and K2, representing samples in the prevailing site upwind and downwind directions, respectively. Additional uranium monitoring coverage is supplied by ORR PAM stations 35 and 42. The PAM locations represent coverage in the direction of the nearest and the most exposed individuals as defined by DOE Order 5400.5. Sampling for HAP carcinogen metals and lead continues at stations K2 and K6.

5.4.4.1 Results

No standards were exceeded, and there were no significant elevations of pollutant concentrations associated with site operations. Sampling results assessing specific site activities' impact on air quality show that the ETTP and the project-specific operations did not have a measurable impact on local air quality. These data also support the state classification of this area, including the ETTP, as in attainment for PM10. Table 5.7 lists selected parameters measured during 1997.

5.4.4.2 Criteria Pollutant Levels

Daily PM10 analyses were performed on all 24-hour samples. A summary of all PM10 mea-

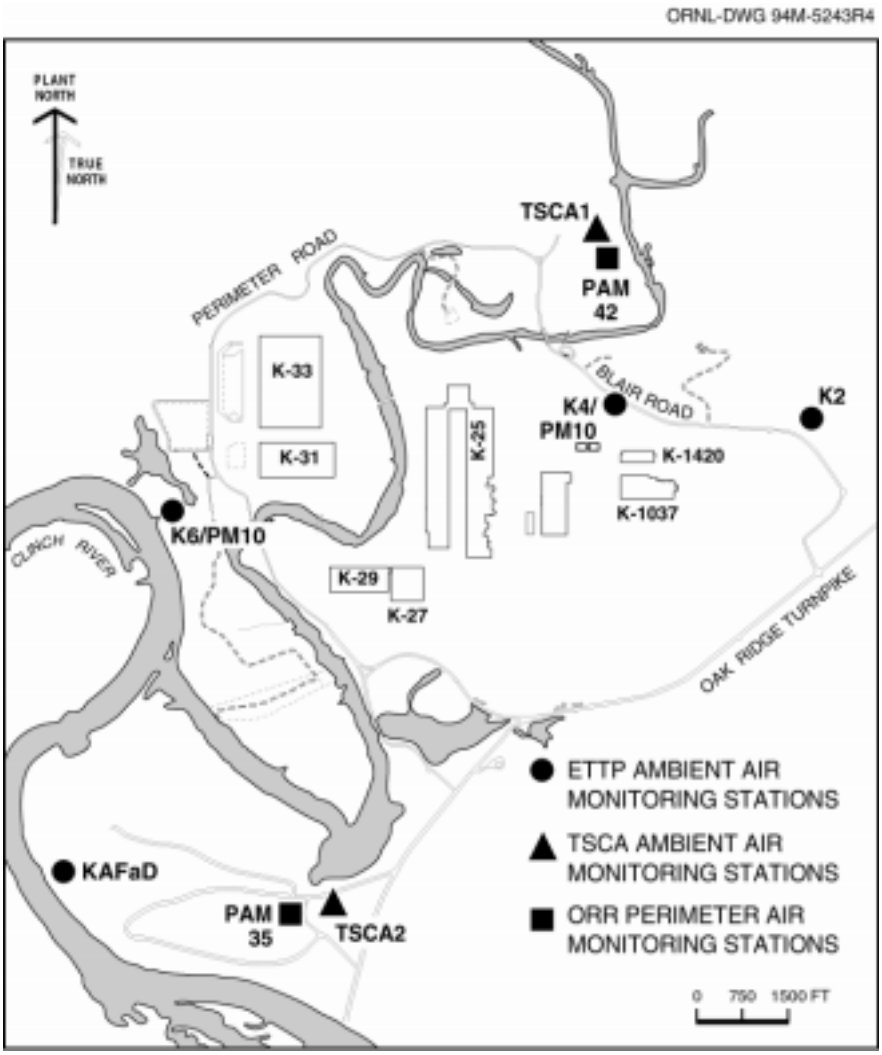

Fig. 5.10. Locations of ambient air monitoring stations at the ETTP.

surements is presented in Table 5.8. For 1997, the 24-hour PM10 concentrations ranged from 2.91 to 55.07 $\mu g/m^3$. The highest measured value was 36.7% of the Tennessee 24-hour primary and secondary standards (i.e., 150 $\mu g/m^3$). These levels are not an environmental concern.

Annual PM10 arithmetic averages of 24-hour measurements are presented in Table 5.8. The highest averaged PM10 annual result was 18.91 $\mu g/m^3$. This value was only 37.8% of the Tennessee and national annual primary and secondary standards for PM10 (i.e., 50 $\mu g/m^3$). Historical data show that this level is typical of annual measurements and is of no environmental concern (see Fig. 5.11 for 5-year PM10 trend).

Quarterly lead results were determined from analyses of both monthly composites of continuous weekly samples for stations K2 and K6 and weekly analyses of samples from the KAFaD project station. The total masses of lead were determined by the inductively coupled plasma mass spectrometry (ICP-MS) analytical technique. A summary of lead measurement results are presented in Table 5.9 and are compared with the Tennessee and national quarterly standard of 1.5 $\mu g/m^3$. There are no 24-hour, monthly, or annual ambient air criteria pollutant standards for lead. The maximum individual lead result was 0.008456 $\mu g/m^3$. This value was only 0.56% of the quarterly standard for lead. No lead concentration levels of environmental concern were measured (see Fig. 5.12 for 5-year lead trend).

5.4.4.3 Hazardous Air Pollutant Carcinogen Metal Levels

Analyses of HAP carcinogen metals (arsenic, beryllium, cadmium, and chromium) were performed on both monthly composites of continuous weekly samples from stations K2 and K6 and on each weekly sample from the KAFaD project station. The 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 HAP carcinogen metal. However, arsenic individual concentration results

Table 5.7. Summary of collection and analysis frequencies of samples collected at ETTP perimeter ambient air monitoring stations, 1997

Parameter	Sampling locations	Sampling period	Collection frequency	Analysis frequency[a]
		Criteria pollutants		
PM10	K4, 6	24 hour	Every sixth day[b]	Weekly
Lead	K2, 6	Continuous	Weekly	Monthly
	KAFaD[c]	Continuous	Weekly	Weekly
		Hazardous air pollutants carcinogen metals		
Arsenic	K2, 6	Continuous	Weekly	Monthly
	KAFaD	Continuous	Weekly	Weekly
Beryllium	K2, 6	Continuous	Weekly	Monthly
	KAFaD	Continuous	Weekly	Weekly
Cadmium	K2, 6	Continuous	Weekly	Monthly
	KAFaD	Continuous	Weekly	Weekly
Chromium (total)	K2, 6	Continuous	Weekly	Monthly
	KAFaD	Continuous	Weekly	Weekly
		Organic compounds		
PCBs	TSCA 1, 2	*d*	*d*	*d*
Furan	TSCA 1, 2	*d*	*d*	*d*
Dioxin	TSCA 1, 2	*d*	*d*	*d*
Hexachlorobenzene	TSCA 1, 2	*d*	*d*	*d*
		Radionuclides		
Uranium (total)	K2, 6	Continuous	Weekly	Monthly
	PAM-35, 42	Continuous	Weekly	Quarterly
	KAFaD	Continuous	Weekly	Weekly
	TSCA 1, 2	*d*	*d*	*d*

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

[b]24-hour sample every sixth day from midnight to midnight.

[c]Temporary sampling station during building demolition activities.

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

for all measurement sites ranges from 0.000475 to 0.001160 $\mu g/m^3$. No beryllium measurement was above the established minimum detection limits of the analytical method. Cadmium concentration results ranged from 0.000190 to 0.001804 $\mu g/m^3$. Individual chromium measurements ranged from 0.000324 to 0.000966 $\mu g/m^3$. A summary of the HAP carcinogen metals measurements are in Table 5.10.

5.4.4.4 Radionuclide Levels

Of the radionuclides, only uranium was measured both as a monthly composite of continuous weekly samples from stations K2 and K6 and weekly samples from station KAFaD. The total uranium mass for each sample was determined by the ICP-MS analytical technique. The uranium concentrations for all measurement sites are

Table 5.8. PM10 particulates in ambient air at the ETTP, 1997

Station	Number of samples	Annual summary of PM10 concentrations ($\mu g/m^3$)			Max percentage of standard[a]	
		Annual av	24-h max	24-h min	Annual	24-h
K4	61	16.24	46.13	2.91	32.5	30.8
K6	58	18.91	55.07	4.96	37.8	36.7
All stations	119	17.57	55.07	2.91	35.1	36.7

[a]PM10 Tennessee and national primary and secondeary standards are 150 $\mu g/m^3$ per 24 hours and 50 $\mu g/m^3$ per year arithmetic average.

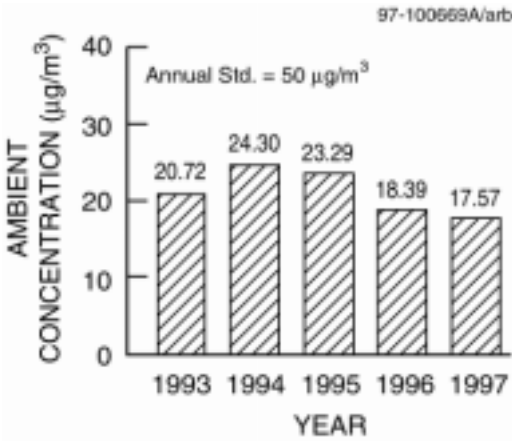

Fig. 5.11. Ambient air monitoring 5-year trend results for PM10 at the ETTP.

presented in Table 5.11 and ranged from a low of 0.000002 to 0.000621 $\mu g/m^3$. The highest results were measured at Station K2. Station K2 is in the prevailing downwind direction of the ETTP. The annual average values for all stations were less than 1% of the annual standard of 0.15 $\mu g/m^3$ (1.0E-1 pCi/m^3) for naturally occurring uranium. No uranium concentration levels of environmental concern were measured (see Fig. 5.13 for 5-year uranium trend).

5.4.4.5 Organic Compound Levels

Currently, measurements of selected semivolatile organics are performed only during an operational upset of the TSCA Incinerator. No upsets occurred during waste burning operations in 1997 that activated the TSCA ambient air stations.

5.4.4.6 Five-Year Trends

Five-year summaries of ETTP ambient air monitoring data are shown in Figs. 5.11, 5.12, and 5.13 for PM10, lead, and uranium. Other measured pollutant trends are discussed in this section. Variations of PM10 measurements were insignificant and most likely reflect background concentration variations of air quality. Lead measurement variations from 1993 to 1994 were primarily caused by changes in analytical techniques. The minor changes are most likely a result of typical background variations of lead concentrations. 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. Both arsenic and chromium measurement variations over the last 5 years have typically been indistinguishable from background levels except during the cooling tower demolition project activities in 1995 and 1996. All beryllium measurements, historical and current, have been at or near analytical detection limits. Cadmium concentration measurement variations have occurred coincidental to ground disturbance activities such as logging or bulldozing or in areas where large exposed earthen areas exist.

Table 5.9. Lead concentrations in ambient air at the ETTP, 1997

Station	Quarterly averages of monthly composites ($\mu g/m^3$)				Max individual result	Min individual result	Max percentage of quarterly standard[a,b]
	1	2	3	4			
K2	0.003653	0.004628	0.004523	0.003839	0.004628	0.003653	0.31
K6	0.003240	0.003318	0.003253	0.005670	0.005670	0.003240	0.38
KAFaD[c]				0.005038	0.008456	0.002437	0.56
Quarterly av	0.003446	0.003973	0.003888	0.004755	0.004755	0.003446	0.32
Quarterly max	0.003653	0.004628	0.004523	0.005670	0.005670	0.003653	0.38
Annual average for stations K2 and K6 = 0.004016 $\mu g/m^3$							

[a]Tennessee and national air quality standard for lead in 1.5 $\mu g/m^3$ quarterly arithmetic average.
[b]Conservative comparison of the maximum individual result (monthly or weekly) with the quarterly standard.
[c]K-25 Auxiliary Facility Demolition Project —Temporary station activated during the fourth quarter of 1997.

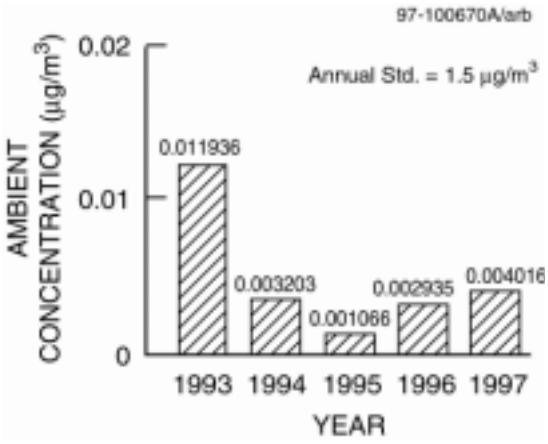

Fig. 5.12. Ambient air monitoring 5-year trend results for lead at the ETTP.

5.5 SURFACE WATER MONITORING

5.5.1 ORR Surface Water Monitoring

Under the ORR EMP, samples are collected and analyzed from 22 locations around the ORR to assess the impact of past and current DOE operations on the quality of local surface water. Sampling locations are on streams downstream of ORR waste sources, at reference points on streams and reservoirs upstream of waste sources, and at public water intakes (Fig. 5.14). Sampling locations include the following:

- Bear Creek downstream from Y-12 Plant inputs [Bear Creek kilometer (BCK) 0.6],
- Clinch River downstream from all DOE inputs [Clinch River kilometer (CRK) 16],
- water supply intake for the ETTP (CRK 23),
- Clinch River downstream from ORNL (CRK 32),
- water supply intake for Knox County (CRK 58),
- Melton Hill Reservoir above city of Oak Ridge water intake (CRK 66),
- Clinch River (Solway Bridge) upstream from all DOE inputs (CRK 70),
- EFPC prior to entering Poplar Creek [East Fork Poplar Creek kilometer (EFK) 0.1],
- EFPC downstream from floodplain (EFK 5.4),
- Melton Branch downstream from ORNL [Melton Branch kilometer (MEK) 0.2],
- Mitchell Branch upstream from the ETTP [Mitchell Branch kilometer (MIK) 1.4],
- WOL at WOD [White Oak Creek kilometer (WCK) 1.0],

Table 5.10. HAP carcinogen metals in ambient air[a] at the ETTP, 1997

Parameter	Summary of K2 and K6 monthly composites of 32 samples (µg/m³)			Summary of KAFaD weekly results of 11 samples (µg/m³)		
	Annual av[b]	Monthly max	Monthly min	Fourth quarter av[c]	Weekly max	Weekly min
Arsenic	0.000603	0.000814	0.000475	0.000611	0.001160	0.000275
Beryllium	<0.000015	<0.000015	<0.000014	<0.000028	<0.000028	<0.000028
Cadmium	0.000273	0.000342	0.000190	0.000777	0.001804	0.000207
Chromium	0.000795	0.000966	0.000490	0.000534	0.000831	0.000324

[a]There are no Tennessee or national ambient air quality standards; however, EPA has identified arsenic, beryllium, cadmium, and chromium as HAP carcinogen metals.
[b]Average of all station K2 and K6 composites of weekly measurements.
[c]Average of station KAFaD weekly measurements.

Table 5.11. Uranium in ambient air at the ETTP, 1997

Station	Number of samples	Summary of composite analyses (µg/m³)		
		Annual av[a]	Max[b]	Min
K2	51	0.000186	0.000621	0.000025
K6	51	0.000034	0.000055	0.000019
PAM35	51	0.000023	0.000027	0.000021
PAM42	51	0.000018	0.000027	<0.000002
All stations	204	0.000065	0.000621	<0.000002
		Summary of weekly analyses (µg/m³)		
		Fourth quarter av	Max	Min
KAFaD	11	<0.000034	0.000069	<0.000017

[a]The annual standard for naturally occurring uranium is 1E–01 pCi/m³, which is equivalent to 0.15 µg/m³.
[b]Maximum individual composite result.

- WOC downstream from ORNL (WCK 2.6),
- WOC upstream from ORNL (WCK 6.8),
- Walker Branch prior to entering CRK 53.4 [Walker Branch kilometer (WBK) 0.1],
- McCoy Branch prior to entering CRK 60.3 [McCoy Branch kilometer (MCCBK) 1.8],
- Grassy Creek upstream of SEG and IT Corp. at CRK 23 [Grassy Creek kilometer (GCK) 3.6],
- Ish Creek prior to entering CRK 30.8 [Ish Creek kilometer (ICK) 0.7],
- Raccoon Creek sampling station prior to entering CRK 31 [Raccoon Creek kilometer (RCK) 2.0],
- Northwest Tributary prior to entering CRK 31 [Northwest Tributary kilometer (NWTK) 0.1],

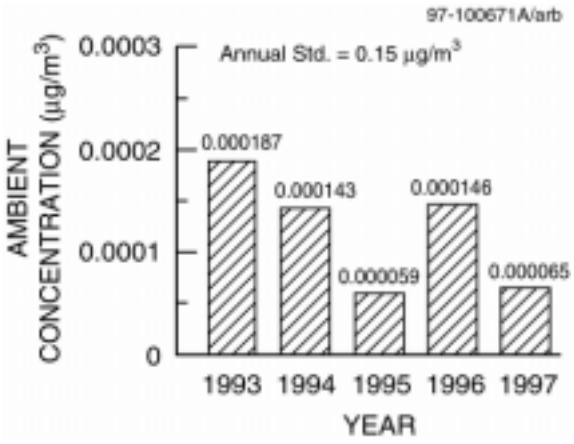

Fig. 5.13. Ambient air monitoring 5-year trend results for uranium at the ETTP.

- First Creek just upstream of NWT [First Creek kilometer (1STCK) 0.1], and
- Fifth Creek just upstream of White Oak Creek (ORNL) [Fifth Creek kilometer (FIFTHCK) 0.1].

Water quality measurements serve as guides to the general health of the environment. The sampling and analysis in this program are conducted in addition to requirements mandated in NPDES permits for individual ORR DOE facilities. Although there is some overlap of sampling sites in the NPDES and environmental monitoring plan programs, frequency and analytical parameters vary between the two programs.

Sampling frequency and parameters vary by site. Grab samples are collected and analyzed for general water quality parameters at all locations, and all are screened for radioactivity and analyzed for specific radionuclides when appropriate. A few sites also are checked for volatile organic compounds and/or PCBs. Table 5.12 lists the specific locations and their sampling frequencies and parameters.

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

Radionuclides were detected (statistically significant at a 95% confidence interval) at all of these surface water locations in 1997 except WBK 0.1 (Table D.3 in Appendix D). High levels of gross alpha, gross beta, and total radioactive strontium were detected at the First Creek (1STCK 0.1) location. Uranium isotopes, including ^{233}U, ^{234}U, ^{235}U, and ^{238}U were determined to be the primary alpha emitters. These phenomena are believed to be related to the findings at Corehole 8 and are being further investigated by Environmental Restoration. In June 1991, rock core drilling at Core Hole 8 revealed radiologically contaminated groundwater, referred to as the Core Hole 8 plume, in the uppermost portion of bedrock. The source of the plume was believed to be leakage to backfill and soil from underground radioactive waste storage Tank W-1A, which is located in the North Tank Farm within the main ORNL facilities complex. Because groundwater flows toward First Creek from the tank area, it is thought that radionuclides detected in those surface waters originate in soils surrounding Tank W-1A (DOE 1998a).

Considering the remaining 21 locations, the highest levels of gross beta, total radioactive strontium, and tritium were at Melton Branch downstream from ORNL (MEK 0.2), WOC at WOD (WCK 1.0), and WOC downstream from ORNL (WCK 2.6). These data are consistent with historical data and with the processes or legacy activities nearby or upstream from these locations.

The few locations that were checked for volatile organic compounds either did not have any detected or what little was detected were either common laboratory contaminants, also present in the associated laboratory blanks, or were detected at low, estimated levels. PCBs were detected in some of the sampling events at WOD at low levels.

Two locations, Northwest Tributary (NWTK 0.1) and Raccoon Creek (RCK 2.0), also had elevated levels of gross beta and total radioactive strontium. Both of these locations have been sampled only three times because they are new to the program and are sampled semiannually. The

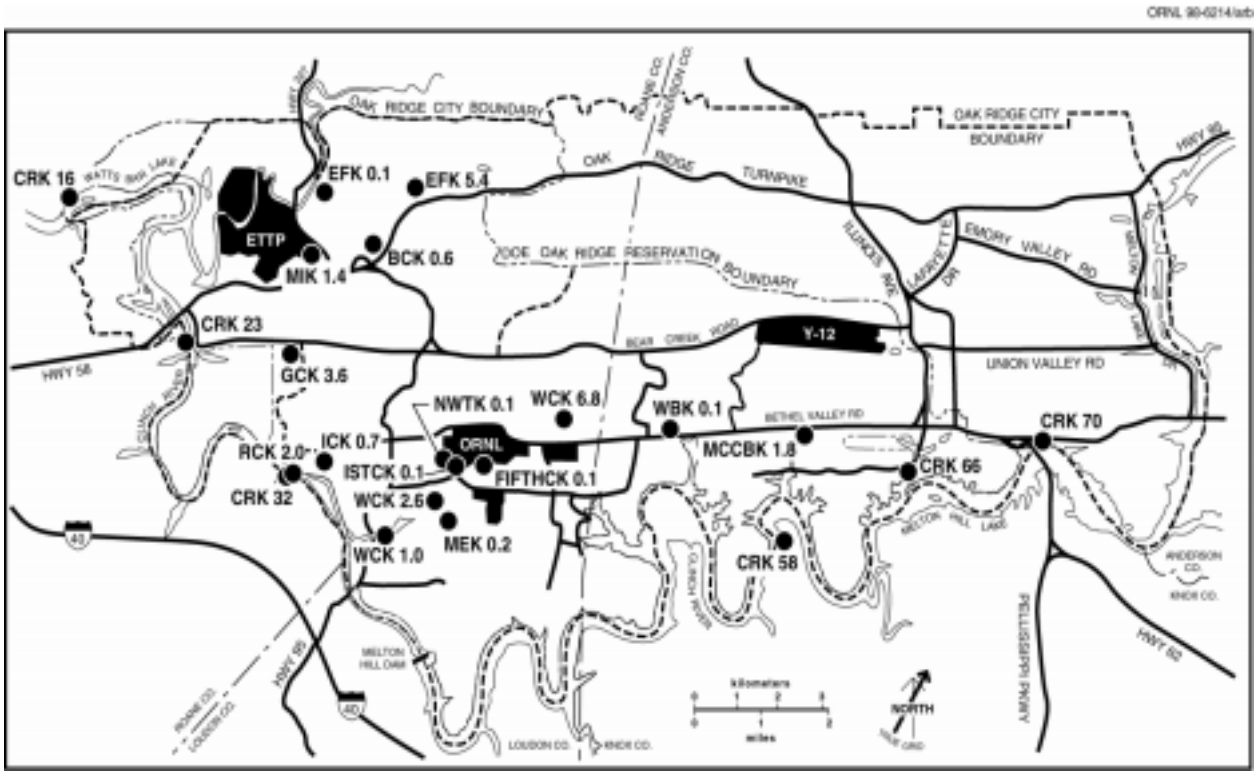

Fig. 5.14. Locations of ORR surface water surveillance sampling stations.

Raccoon Creek results appear to be seasonal, with the results from the two fall sampling events being higher than the one spring event. However, there are not enough data at this time to confirm this.

5.5.2 Y-12 Plant Surface Water Monitoring

Routine surface water surveillance monitoring, above and beyond that required by the NPDES permit, is performed as a BMP. (See Chap. 4 for results of radiological monitoring and NPDES monitoring at the Y-12 Plant.) The Y-12 Environmental Compliance Organization staff monitor the surface water as it exits from each of the three hydrogeologic regimes that serve as an exit pathway for surface water (Fig. 5.15). Modifications were made to the routine BMP program (sampling frequency and number of parameters) in the fall of 1996 to meet budget constraints.

Monitoring is conducted in EFPC at Station 17 (9422-1) near the junction of Scarboro and Bear Creek roads. The current sampling program consists of two 48-hour composites plus a 3-day weekend composite. These samples are analyzed for mercury, ammonia-N, inductively coupled plasma (ICP) metals, and total suspended solids (TSS).

Monitoring is conducted in Bear Creek at BCK 4.55 (former NPDES station 304), which is at the western boundary of the Y-12 Plant area of responsibility. A surveillance sample (a 7-day composite sample) is collected monthly for analysis for mercury, anions (sulfate, chloride, nitrate, nitrite), ICP metals, total phenols, and TSS.

The exit pathway from the Chestnut Ridge regime is monitored via NPDES location S19 (former NPDES station 302) at Rogers Quarry. S19 is an in-stream location of McCoy Branch and is sampled monthly (a 24-h composite) for ICP metals. The NPDES requirement for this location is to monitor and report metals data only. As part of the surface-water BMP surveillance activity, data from this location, as well as that from Station 17 and BCK 4.55, are compared with state water quality criteria.

Table 5.12. Surface water sampling locations, frequencies, and parameters

Location (K indicates kilometer)	Frequency	Parameters
BCK 0.6; Bear Creek downstream from Y-12 Plant inputs	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[a]
CRK 16; Clinch River downstream from all DOE inputs	Monthly	Volatiles, metals, gross alpha, gross beta, gamma scan, field measurements[a]
CRK 23; water supply intake for the ETTP	Monthly	Volatiles, metals, gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements[a]
CRK 32; Clinch River downstream from ORNL	Monthly	Gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements[a]
CRK 58; water supply intake for Knox County	Monthly	Gross alpha, gross beta, gamma scan, field measurements[a]
CRK 66; Melton Hill Reservoir above city of Oak Ridge	Monthly	Gross alpha, gross beta, gamma scan, field measurements[a]
CRK 70; Solway Bridge	Monthly	Volatiles, metals, gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements[a]
EFK 0.1; East Fork Poplar Creek prior to entering Poplar Creek	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[a]
EFK 5.4; East Fork Poplar Creek downstream from floodplain	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[a]
MEK 0.2; Melton Branch downstream from ORNL	Bimonthly (Jan, Mar, May, Jul, Sep, Nov)	Gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements[a]
MIK 1.4; Mitchell Branch upstream from the ETTP	Quarterly (Feb, May, Aug, Nov)	Volatiles, PCBs, gross alpha, gross beta, field measurements[a]
WCK 1.0; White Oak Lake at White Oak Dam	Monthly	PCBs, gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements[a]
WCK 2.6; White Oak Creek downstream from ORNL	Bimonthly (Jan, Mar, May, Jul, Sep, Nov)	Gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements[a]
WCK 6.8; White Oak Creek upstream from ORNL	Quarterly (Feb, May, Aug, Nov)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements[a]
WBK 0.1; Walker Branch prior to entering CRK 53.4	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[a]
MCCBK 1.8; McCoy Branch prior to entering CRK 60.3	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[a]

Table 5.12 (continued)

Location (K indicates kilometer)	Frequency	Parameters
GCK 3.6; Grassy Creek upstream of SEG and IT Corp. at CRK 23	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[a]
ICK 0.7; Ish Creek prior to entering CRK 30.8	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[a]
RCK 2.0; Raccoon Creek sampling station prior to entering CRK 31	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements[a]
NWTK 0.1; Northwest Tributary prior to entering CRK 31 (ORNL)	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements[a]
1STCK 0.1; First Creek just upstream of NWT (ORNL)	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements[a]
FIFTHCK 0.1; Fifth Creek just upstream of White Oak Creek (ORNL)	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements[a]

[a]Dissolved oxygen, pH, temperature.

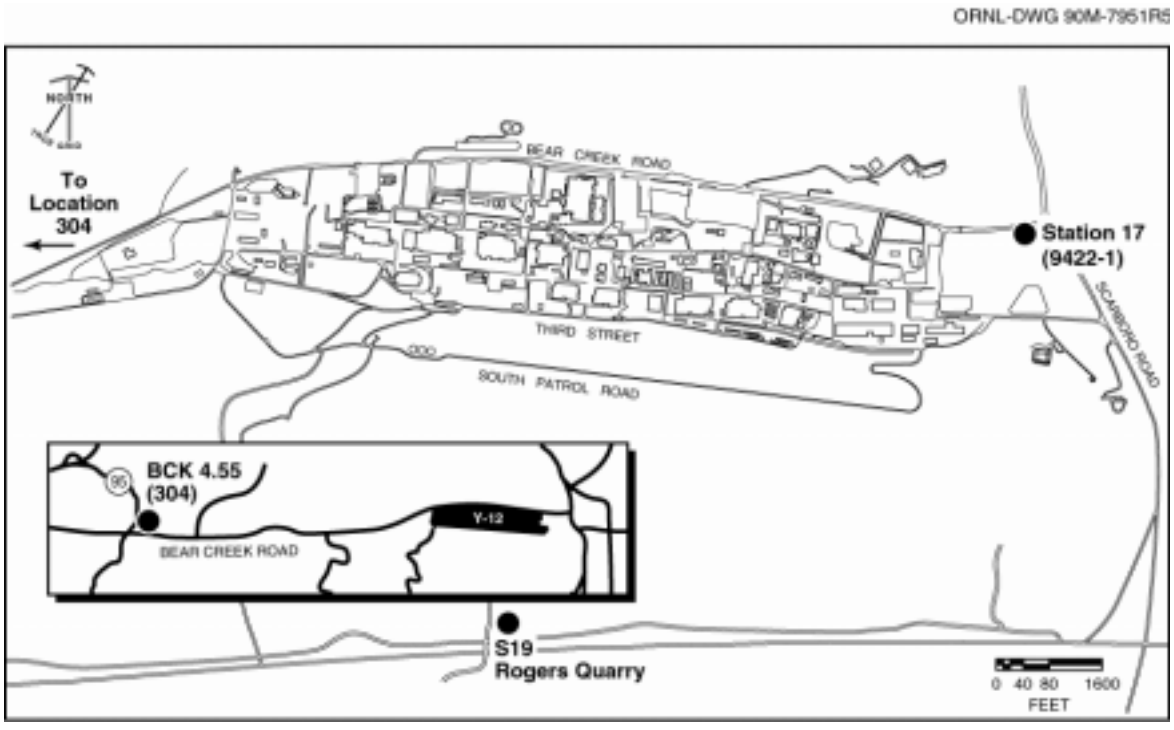

Fig. 5.15. Locations of Y-12 Plant surface water surveillance sampling stations.

In addition to these exit pathway locations, a network of real-time monitors is located at in-stream locations along UEFPC and at key points on the storm drain system that flows to the creek. The Surface Water Hydrological Information Support System (SWHISS) houses are available for real-time water quality measurements, such as pH, temperature, dissolved oxygen, conductivity, and chlorine. The locations are noted in Fig. 5.16. Not all stations are operated on a routine basis, but all are available as necessary and as available funding allows.

For nonradiological parameters that are sampled, and detected above the analytical method reporting detection limit, the data are compared with Tennessee water quality criteria. The most restrictive of either the freshwater fish and aquatic life "criterion maximum concentration" (CMC) or the "recreation concentration for organisms only" standard (10^{-5} risk factor for carcinogens) is used. This comparison serves as a record of water quality, and the comparison to state water quality criteria limits is for informational purposes only; as such, no attempt is made to achieve the lowest possible detection limit for all parameters.

More than 500 surface water surveillance samples were collected in 1997. Comparisons with Tennessee water quality criteria indicate that only silver, mercury and zinc, from samples collected at Station 17, were detected at values exceeding a criteria maximum. Results are shown in Table 5.13. Of all the parameters measured in the surface water as a BMP, mercury is the only demonstrated contaminant of concern (see "Reduction of Mercury in Plant Effluent: Phase II" in Sect. 4.2.2.2 for details on activities to reduce mercury discharges).

Additional surface-water sampling is conducted on Bear Creek in accordance with the Y-12 Plant Groundwater Protection Program (GWPP) to monitor trends throughout the Bear Creek Hydrogeologic Regime (see Chap. 7).

5.5.3 ORNL Surface Water Monitoring at Reference Locations

The net impact of ORNL activities on surface waters is evaluated by comparing data from samples collected at background locations with information from samples collected downstream of the facility. Monthly surface water samples are collected at two reference sampling locations to determine contamination levels before the influence of WOC, the primary discharge point into Watts Bar Lake from the ORNL plant site. One sampling location is Melton Hill Dam above ORNL's main discharge point into the Clinch River. The other sampling location is WOC headwaters above any ORNL discharge points to WOC (Fig. 4.15).

Analyses were performed to detect radioactivity, conventional, and inorganic pollutants in the water. Conventional pollutants are indicated by

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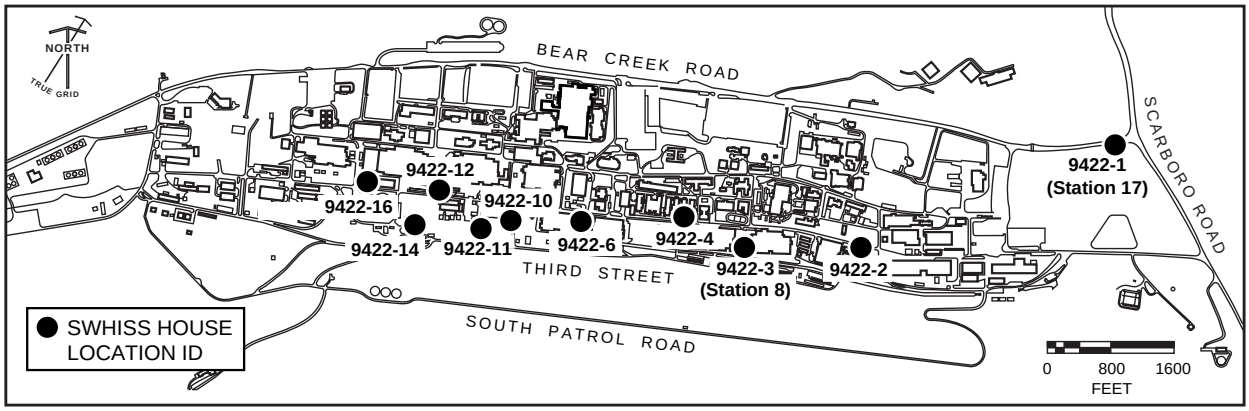

Fig. 5.16. Surface Water Hydrological Information Support System monitoring locations.

Table 5.13. Surface water surveillance measurements exceeding Tennessee water quality criteria at the Y-12 Plant, 1997

Parameter detected	Location	Number of samples	Concentration (mg/L)			Water quality criteria (mg/L)	Number of measurements exceeding criteria
			Detection limit	Max	Av		
Mercury	Station 17	408	0.0002	0.011	0.0007	0.00015	408
Silver	Station 17	158	0.006	0.01	<0.006	0.0041	1
Zinc	Station 17	158	0.01	0.15	0.04	0.117[a]	1

[a]The standard is a function of total hardness. This value corresponds to a total hardness value of 100 mg/L.

measurements of conductivity, temperature, turbidity, pH, TSS, and oil and grease. Inorganic parameters are indicated by analyses for metals and anions (Table 5.14).

In an effort to provide a basis for evaluation of analytical results and for assessment of surface water quality, Tennessee General Water Quality Criteria (TWQC) have been used as reference values. The TWQC for domestic water supply have been used at Melton Hill, whereas TWQC for fish and aquatic life have been used at WOC headwaters (see Appendix D, Table D.2 for TWQC for all parameters in water).

There is reasonably good agreement between parameters measured at WOC headwaters and those at Melton Hill Dam, the two reference locations. The average concentration is expressed as a percentage of the reference value when the parameter is a contaminant, the parameter is detected, and a reference value exists (Table 5.14). Eight metals met these criteria; the largest percentage of reference value was zinc at WOC headwaters at 11% of the reference value.

Radiological data are compared with DOE DCGs in Table 5.15. The average concentration for a radionuclide is expressed as a percentage of its DCG when a DCG exists and when the average concentration is significantly greater than zero. At the reference locations, only one average for 1997 met the criteria; the average concentration of ^{137}Cs at Melton Hill Dam was less than 1% of its DCG.

5.5.4 ETTP Surface Water Monitoring

Surface water surveillance is currently conducted at five locations at the ETTP (Fig. 5.17). Station K-1710 provides information on conditions upstream of ETTP. Station K-716 is located downstream from most ETTP operations and provides information on the cumulative effects of the ETTP 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 (K-1007-B and K-1700) or to the Clinch River (K-901-A).

Samples are analyzed monthly for radionuclides and selected metals. Quarterly samples are collected and analyzed for general water quality parameters and for organic compounds. In addition, samples from K-1700 are analyzed quarterly for PCBs. 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 TWQC, which are a subset of the WQSs.

In most instances, results of the analyses for nonradiological parameters are well below the applicable standards. Heavy metals were occasionally detected but always in very low concentrations. In addition, natural conditions cause periodic exceedences of WQSs for dissolved

Table 5.14. 1997 analyses of ORNL background surface waters[a]

Parameter	No. detect/ No. total	Concentration			Standard error[d]	Reference value[e]	Percentage of reference value[f]
		Max[b]	Min[b]	Av[c]			
Melton Hill Dam							
Anions (mg/L)							
Sulfate, as SO_4	11/11	19	16	17	0.33	*g*	*g*
Field measurements							
Conductivity (mS/cm)	11/11	0.25	0.17	0.21	0.0086	*g*	*g*
Dissolved oxygen (mg/L)	11/11	13	5.8	8.6	0.61	*g*	*g*
Temperature (°C)	11/11	21	8.6	16	1.3	*g*	*g*
Turbidity (NTU)	11/11	68	3.0	15	5.4	*g*	g
pH (std. units)	11/11	8.1	7.5	7.8	0.060	*g*	*g*
Metals[h] (mg/L)							
Antimony, total	6/10	0.00070	<0.00010	~0.00019	0.000059	0.006	3.1
Arsenic, total	2/10	0.0020	<0.0010	~0.0011	0.00010	0.05	2.2
Cadmium, total	0/10	<0.00010	<0.00010	~0.00010	0	0.005	*g*
Chromium, total	8/10	0.0031	<0.00050	~0.0013	0.00026	0.1	1.3
Copper, total	8/10	0.0024	<0.0010	~0.0016	0.00015	*g*	*g*
Iron, total	0/10	<0.25	<0.25	~0.25	0	*g*	*g*
Lead, total	8/10	0.0010	<0.00010	~0.00044	0.000095	0.005	8.7
Nickel, total	7/10	0.0023	<0.0010	~0.0014	0.00013	0.1	1.4
Selenium, total	0/10	<0.0020	<0.0020	~0.0020	0	0.05	*g*
Silver, total	3/10	0.0046	<0.00010	~0.00055	0.00045	*g*	*g*
Zinc, total	10/10	0.011	0.0039	0.0067	0.00066	*g*	*g*
Others (mg/L)							
Oil and grease	0/11	<5.7	<5.5	~5.6	0.019	*g*	*g*
Physical (mg/L)							
Total suspended solids	7/11	19	<1.0	~3.5	1.7	*g*	*g*
White Oak Creek headwaters							
Anions (mg/L)							
Sulfate, as SO_4	11/11	4.1	1.8	2.8	0.22	*g*	*g*
Field measurements							
Conductivity (mS/cm)	11/11	0.23	0.087	0.15	0.015	*g*	*g*
Dissolved oxygen (mg/L)	11/11	13	7.2	9.8	0.46	*g*	*g*
Temperature (°C)	11/11	17	8.2	13	0.85	*g*	*g*
Turbidity (NTU)	11/11	90	3.0	15	7.6	*g*	*g*
pH (std. units)	11/11	8.2	7.0	7.8	0.11	*g*	*g*

Table 5.14 (continued)

Parameter	No. detect/ No. total	Concentration			Standard error[d]	Reference value[e]	Percentage of reference value[f]
		Max[b]	Min[b]	Av[c]			
Metals[h] (mg/L)							
Antimony, total	2/10	0.00040	<0.00010	~0.00013	0.000030	*g*	*g*
Arsenic, total	1/10	0.0024	<0.0010	~0.0011	0.00014	*g*	*g*
Cadmium, total	0/10	<0.00010	<0.00010	~0.00010	0	0.0039	*g*
Chromium, total	8/10	0.0036	<0.00050	~0.0016	0.00029	0.016	10
Copper, total	2/10	0.0014	<0.0010	~0.0011	0.000053	0.0177	6.1
Iron, total	7/10	0.94	<0.25	~0.48	0.079	*g*	*g*
Lead, total	10/10	0.0024	0.00014	0.0011	0.00025	0.0817	1.4
Nickel, total	7/10	0.0018	<0.0010	~0.0013	0.00010	1.418	0.089
Selenium, total	0/10	<0.0020	<0.0020	~0.0020	0	0.02	*g*
Silver, total	0/10	<0.00010	<0.00010	~0.00010	0	0.0041	*g*
Zinc, total	10/10	0.029	0.0060	0.013	0.0023	0.117	11
Others (mg/L)							
Oil and grease	0/11	<5.7	<5.5	~5.6	0.023	*g*	*g*
Physical (mg/L)							
Total suspended solids	11/11	100	15	38	7.4	*g*	*g*

[a]NPDES permit became effective on February 3, 1997; therefore, this table includes data for February–December 1997 to reflect the new permit.

[b]Prefix "<" indicates the value of a parameter (excluding organics) was not quantifiable at the analytical detection limit.

[c]A tilde (~) indicates that estimated values and/or detection limits were used in the calculation.

[d]Standard error of the mean.

[e]Tennessee General Water Quality Criteria for Domestic Water Supply is used as a reference value for Melton Hill Dam; Tennessee General Water Quality Criteria for Fish and Aquatic Life is used as a reference value for White Oak Creek headwaters.

[f]Average concentration as a percentage of the reference value, calculated when a reference exists, the parameter is a contaminant, and the parameter is detected.

[g]Not applicable.

[h]Metals analyses began in March 1997.

oxygen. During 1997, Aroclor 1254 was detected at K-1700 on one occasion. This incident correlated with a very high suspended solids value, indicating that the Aroclor 1254 was adhering to sediment particles resuspended in the water column as a result of heavy rainfall and high streams flows.

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. No evidence that these conditions have a negative impact on the aquatic communities was discovered during 1997. For most of the 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 locations remained below the annual limit, as required by DOE Order 5400.5 (Fig. 5.18). The highest sum of the fractions, 1.7% of the allowable sum of the fractions of the DCGs, was reported for sampling location K-1700. These results are still well below the conservative limits

Table 5.15. 1997 radionuclide concentrations in background surface waters above ORNL

Radionuclide	No. detect/ No. total	Concentration (pCi/L)			Standard error[c]	DCG[d]	Percentage of DCG[e]
		Max[a]	Min[a]	Av[b]			
Melton Hill Dam							
^{60}Co	3/12	24*	–9.2	4.7	3.1	5,000	*f*
^{137}Cs	3/12	30*	–13	6.8*	3.7	3,000	0.23
Gross alpha	4/12	3.5*	–0.98	1.1*	0.40	*f*	*f*
Gross beta	4/12	8.5*	–1.8	2.1*	0.79	*f*	*f*
White Oak Creek headwaters							
^{60}Co	2/12	18*	–17	3.8	2.8	5,000	*f*
^{137}Cs	3/12	18*	–19	2.2	3.2	3,000	*f*
Gross alpha	4/12	2.8*	–2.1	0.72*	0.35	*f*	*f*
Gross beta	6/12	6.3*	–6.5	2.1*	1.0	*f*	*f*

[a]Individual radionuclide concentrations significantly greater than zero are identified by an asterisk (*).
[b]Average radionuclide concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Derived concentration guide for ingestion of water. From DOE Order 5400.5.
[e]Average concentration as a percentage of the derived concentration guide (DCG), calculated only when a DCG exists and the average concentration is significantly greater than zero.
[f]Not applicable.

established by the order. The 1997 radiological data do not indicate any significant radiological effects from ETTP operations on perimeter surface waters.

5.5.5 Off-Site Monitoring

The ORNL program for assessing impacts to the Clinch and Tennessee rivers uses empirical data from samples taken at the Kingston and Gallaher potable water treatment plants (Fig. 5.19). In 1997, composite samples of treated water from Gallaher and untreated water from Kingston were collected monthly and analyzed quarterly for specific radionuclides.

Federal and state drinking water standards (DWSs) (40 CFR Parts 141 and 143 and TWQC for domestic water supply) were used as reference values. If a DWS for a radionuclide has not been established, then 4% of the DOE DCG for that radionuclide is used as the reference value. The average radionuclide concentration is expressed as a percentage of the reference value when a reference exists and when the average is significantly greater than zero. In 1997, ^{238}Pu and total uranium were the only parameters at the Gallaher Water Treatment Plant that met these criteria, with the largest being ^{238}Pu at 2.8% of the reference value. Only one parameter at the Kingston Water Treatment Plant met these criteria; total uranium was 0.88% of the reference value.

5.6 SOIL

Soil sampling at the plots located at the ambient air stations was discontinued in 1997. After four years of analyses, no evidence exists of increased radionuclide levels that can be attributed to deposition.

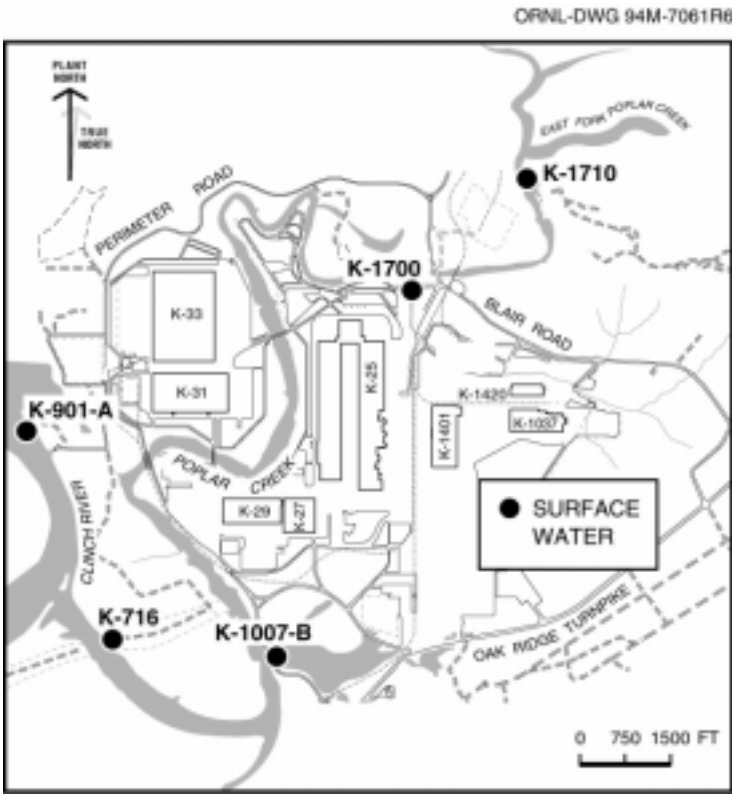

Fig. 5.17. Monitoring locations for surface water at the ETTP.

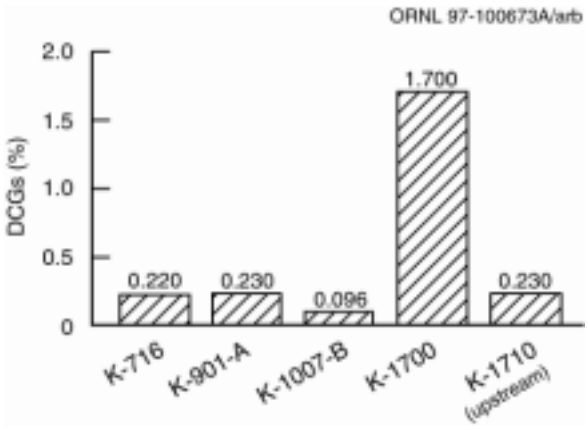

Fig. 5.18. Percentage of DCGs for ETTP surface water monitoring locations.

5.7 ORR SEDIMENT

Stream and lake sediments act as a record of some aspects of water quality by concentrating and storing certain contaminants. The program underwent reevaluation in 1996, which resulted in significant modification to the sampling locations and parameters of interest beginning with 1997. Sampling sites are the Clinch River downstream from all DOE inputs (CRK 16) and the Clinch River downstream from ORNL (CRK 32) and one background location, the Clinch River at the Solway Bridge upstream from all DOE inputs (CRK 70) (Fig. 5.20). The locations are sampled annually and, under the revised program, gamma scans were performed on the samples in 1997.

An additional sampling component was added to the program in 1997. Samples are collected on a semiannual basis in conjunction with a heavy rain event to characterize sediments that exit the ORR during a storm event. The sampling locations are Melton Branch upstream from ORNL (MEK 2.1), WOL at WOD (WCK 1.0), and WOC downstream from ORNL (WCK 2.6) (Fig. 5.20). These samples are filtered, and the residue (settleable solids) is analyzed for gross alpha emitters, gross beta emitters, and gamma emitters.

5.7.1 Results

Potassium-40 was the only radionuclide detected by the gamma scan at the upstream location (CRK 70). Downstream from ORNL at CRK 32, ^{60}Co, ^{137}Cs, ^{7}Be, and ^{40}K were all detected. At CRK 16, which is downstream from all DOE inputs, only ^{137}Cs and ^{40}K were detected by the gamma scan. Beryllium-7 and ^{40}K are naturally occurring radionuclides. None of the radionuclide concentrations at any of the three locations pose a problem for humans.

The heavy rain event sampling took place in March 1997. A second sample later in the year was analyzed using a different protocol because standard laboratory procedures were under development for this program. The second method produced results that did not reflect the purpose of the program. Cobalt-60 and ^{137}Cs were not de-

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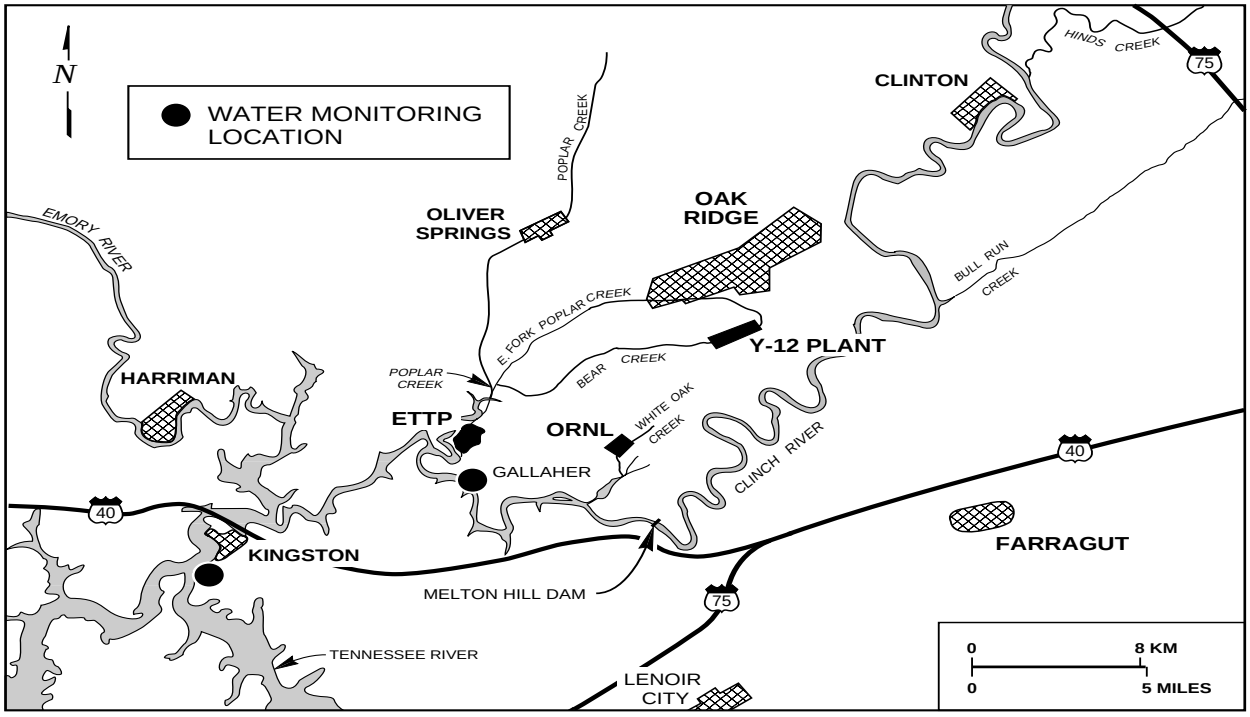

Fig. 5.19. ORNL off-site monitoring at the Gallaher and Kingston water treatment plants.

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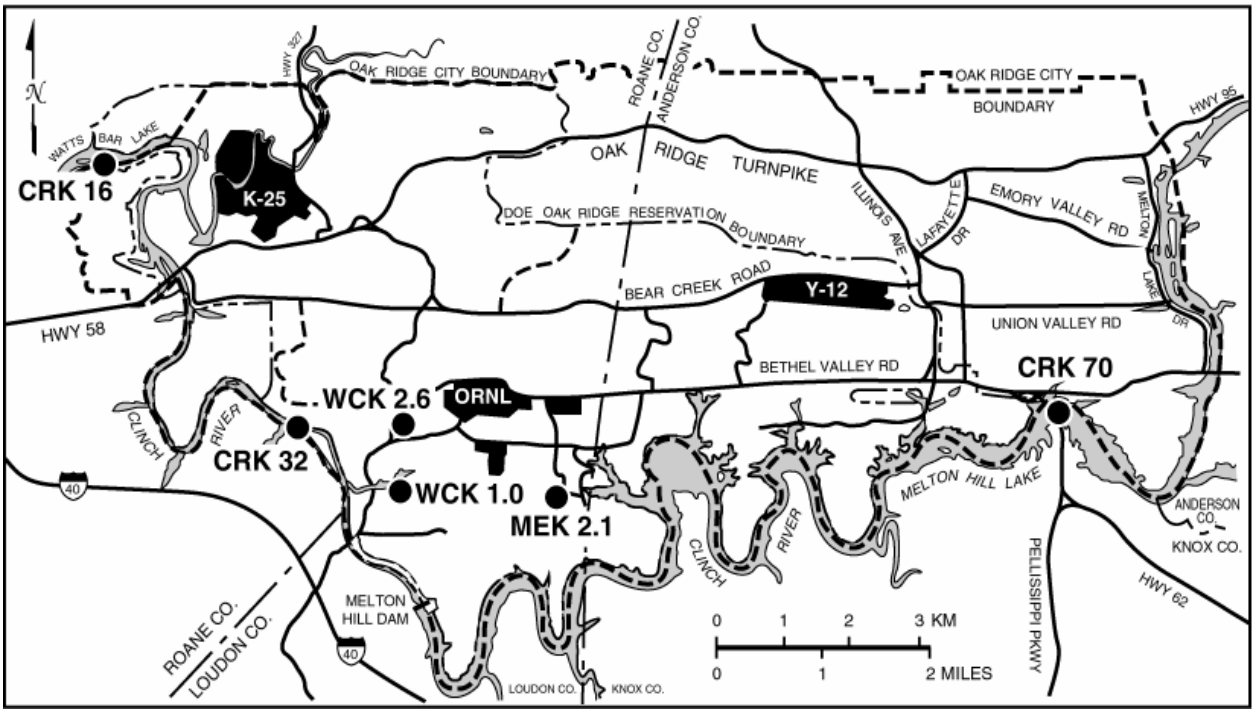

Fig. 5.20. ORR environmental monitoring plan sediment sampling locations.

tected in the settleable solids of the sample from the location upstream from ORNL; they were detected at the other two locations. Gross alpha and gross beta were detected at all three locations, with the upstream location having the least and WOL at WOD having the most. As more data are collected in future events, some conclusions may be drawn.

5.7.2 Y-12 Sediment Sampling

In 1997, revisions to the ORR EMP and the scope of ORR surveillance monitoring conducted by ORNL resulted in discontinuation of sediment sampling at the Y-12 Plant in EFPC and Bear Creek. However, historical data have shown that mercury, PCBs, and isotopes of uranium are present at detectable levels in the sediment. Therefore, as a best management practice, the Y-12 Plant maintains an annual sampling program to determine if these constituents are accumulating in the sediments of EFPC and Bear Creek as a result of Y-12 Plant discharges. Results of the 1997 monitoring activity are given in Table 5.16.

Table 5.16. 1997 results of Y-12 Plant sediment monitoring

	Station 17	BCK 9.4
^{226}Ra (pCi/g)	2.8	2.4
^{228}Th (pCi/g)	0.97	0.70
^{230}Th (pCi/g)	1.2	0.41
^{232}Th (pCi/g)	0.73	0.68
^{234}U (pCi/g)	2.6	3.6
^{235}U (pCi/g)	0.13	0.20
^{238}U (pCi/g)	2.9	6.3
Mercury µg/g	9.5	0.3
Total PCBs µg/kg	370J	350J

J—The J flag of the PCB data indicates an estimated value below the analytical method reporting limit.

5.8 FOOD

Collection and analysis of vegetation samples serves three purposes: to evaluate potential radiation doses received by people consuming food crops; to predict possible concentrations in meat, eggs, and milk from animals consuming grains; and to monitor trends in environmental contamination and possible long-term accumulation of radionuclides.

5.8.1 Hay

Hay is cut on the ORR and sold to area farmers for fodder. Six areas from which hay is cut have been identified as potential depositional areas for airborne materials from ORR sources (Fig. 5.21). Areas 1, 2, and 3 are within the predicted air plume for an ORNL source and could also be affected by the ETTP. Baled hay was collected from each of these three sites and composited for analysis. Areas 2, 4, 5, and 6 are within the predicted air plume for an ETTP, an ORNL, and a Y-12 Plant source. Baled hay was collected from each of these sites and composited for laboratory analysis. Area 6 best represents the combined plumes from all three sites; baled hay was collected from this site. Area 8, not shown on Fig. 5.21, represents a reference site near the Fort Loudoun ambient air monitoring station (Statio31n 52).

5.8.1.1 Results

Hay samples were collected during August 1997, and samples were analyzed for gross alpha and beta, and gamma emitters. Table 5.17 summarizes the results of the sampling effort. Composite samples from Areas 1, 2, and 3 and Areas 2, 4, and 5 had statistically significant concentrations of ^{137}Cs. Gross beta and ^{7}Be were statistically significant in the two composite samples (Areas 1, 2, and 3; and Areas 2, 4, and 5) and in the two individual locations, Area 6 and Area 8. Beryllium-7 is a naturally occurring isotope. There were no other significant radiological results in the 1997 hay samples.

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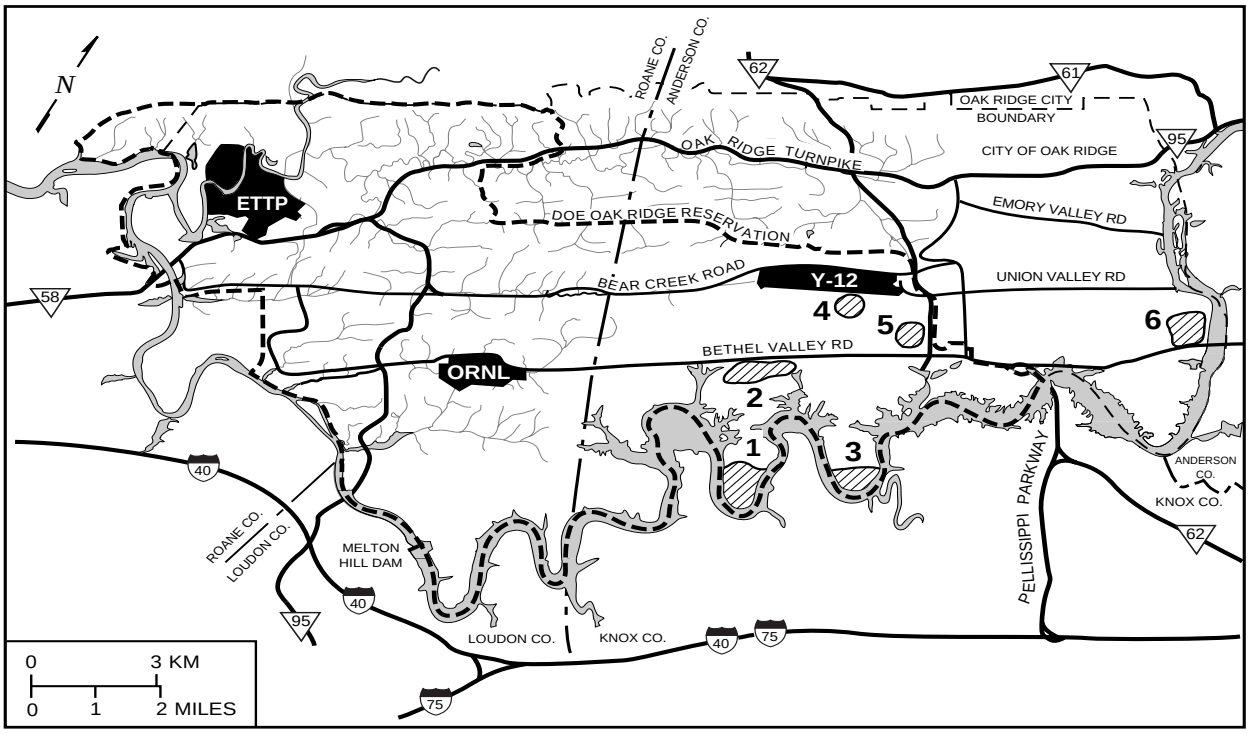

Fig. 5.21. Hay sampling locations on the ORR.

Table 5.17 Significant concentrations of radionuclides in hay from the ORR, 1997[a]

Analyte	Area			
	1,2,3	2,4,5	6	8
Gross beta	8500	4600	4400	5300
^{7}Be	5500	5500	3500	3600
^{137}Cs	34	19	*b*	*b*

[a]All radionuclide data are given in picocuries per kilogram (1 pCi = 3.7E–02 Bq).
[b]Not significant.

5.8.2 Vegetables

Tomatoes, lettuce, and turnips were purchased from five local farmers near the ORR. The locations were chosen based on availability and the likelihood of their being affected by routine releases from the Oak Ridge facilities.

5.8.2.1 Results

Samples were analyzed for gross alpha, gross beta, and gamma emitters. Table 5.18 summarizes the results of the sampling effort. Gross alpha was detected in one of the lettuce samples, and gross beta was detected in all of the samples. Cesium-137, ^{60}Co, ^{7}Be, and ^{40}K were detected by the gamma scan. Beryllium-7 and ^{40}K are naturally occurring radionuclides. Information regarding potential health impacts associated with chemical and radiological constituents detected in vegetables is discussed in Chap. 6.

5.8.3 Milk

Ingestion is one of the pathways of exposure to radioactivity for humans. Radionuclides can be transferred from the environment to people via food chains such as the grass-cow-milk pathway. Milk is a potentially significant source to humans of some radionuclides deposited from airborne emissions because of the relatively large surface

Table 5.18. Radiological constituents in tomatoes and lettuce at sites near the ORR, 1997[a]

Location	^{7}Be	^{60}Co	^{137}Cs	^{40}K	Gross alpha	Gross beta
			Lettuce			
East of the Y-12 Plant	540	*b*	4.3	3800	*b*	2000
East of the Y-12 Plant, Claxton	350	*b*	*b*	3800	*b*	1900
Northeast of the Y-12 Plant, Scarboro	320	*b*	*b*	3800	*b*	1900
South of ORNL	460	*b*	*b*	4300	*b*	2700
West of the ETTP	510	*b*	3.2	3800	43	2300
			Tomatoes			
East of the Y-12 Plant	*b*	*b*	*b*	1800	*b*	1600
East of the Y-12 Plant, Claxton	*b*	4.8	*b*	2000	*b*	1300
Northeast of the Y-12 Plant, Scarboro	*b*	*b*	*b*	2200	*b*	1500
South of ORNL	*b*	3.4	*b*	1900	*b*	1700
West of the ETTP	*b*	*b*	*b*	1900	*b*	1700
			Turnips			
East of the Y-12 Plant	*b*	*b*	2.4	2500	*b*	2200
East of the Y-12 Plant, Claxton	*b*	*b*	*b*	2400	*b*	2500
Northeast of the Y-12 Plant, Scarboro	*b*	*b*	*b*	1800	*b*	1900
South of ORNL	*b*	5.7	*b*	2000	*b*	1600
West of the ETTP	*b*	*b*	*b*	2800	*b*	3200

[a]All data are given in picocuries per kilogram (1 pCi = 3.7E–2 Bq).
[b]No significant result.

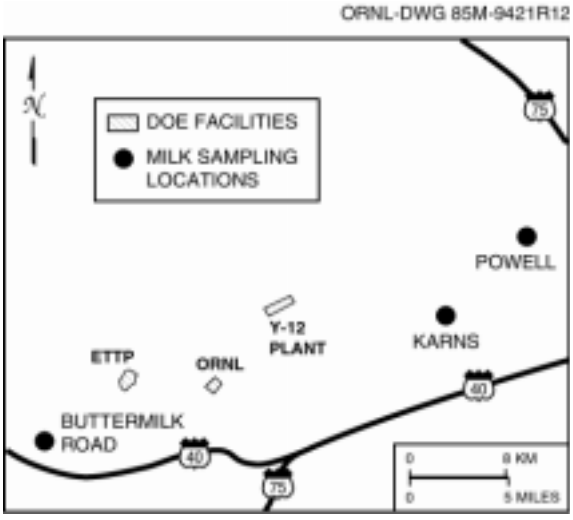

Fig. 5.22. Milk sampling locations in the vicinity of the ORR.

area that a cow can graze daily, the rapid transfer of milk from producer to consumer, and the importance of milk in the diet.

The 1997 milk sampling program consisted of grab samples collected every other month from three locations in the vicinity of the ORR (Fig. 5.22). Milk samples are analyzed at ORNL for radioactive iodine (^{131}I) by gamma spectrometry and for total radioactive strontium (^{89}Sr + ^{90}Sr) by chemical separation and low-background beta counting. Liquid scintillation is used to analyze for tritium (^{3}H).

5.8.3.1 Results

Radioactivity measurements are reported as the net activity (the difference between the gross activity and instrument background). A 95%

confidence level is used to determine statistical significance. Concentrations of radionuclides detected in milk are presented in Table 5.19. There were no detected concentrations of ^{3}H. Average values for detected radionuclides were converted to EDEs and are presented in Chap. 6 of this report. Results are consistent with data from previous years.

5.8.4 Honey

Before 1995, honey from privately owned hives in the vicinity of the ORR was analyzed for radionuclides to determine whether a potential exposure pathway existed. In 1995, beehives were established on the reservation at strategic locations at the Y-12 Plant, ORNL, and the ETTP. Honey samples from the hives were analyzed in 1995 and 1996. Because of major changes in the ORR surveillance program (see Sect. 5.1 for changes), collection and analysis of honey samples on the ORR was discontinued in 1997.

5.8.5 Fish

Members of the public potentially could be exposed to contaminants originating from DOE-ORO activities through consumption of fish caught in area waters. This exposure pathway is monitored under the EMP by collecting fish from three river locations annually and analyzing edible fish flesh. Because of the limited number and size of fish available for sampling on creek locations, different fish-processing and analytical procedures are used.

The program was revised, which resulted in fewer sampling locations beginning in 1997. The river locations are on the Clinch River (see Fig. 5.23):

Table 5.19. Concentrations of radionuclides detected in raw milk, 1997[a]

Analysis	No. detected/ No. total	Detected concentration pCi/L			Standard error of mean
		Max[b]	Min[b]	Av[b]	
Buttermilk Road					
^{131}I	1/6	84*	–41	15	18
^{40}K	2/2	32,000*	30,000*	31,000*	1,400
Total radioactive Sr	2/6	32*	0.11	14*	5.4
Karns					
^{40}K	2/2	35,000*	32,000*	34,000*	1,400
Total radioactive Sr	4/6	68*	0.65	31*	11
Powell					
^{40}K	2/2	35,000*	35,000*	35,000	0
Network summary					
^{131}I	1/17	84	–46	3.9	8.5
^{40}K	6/6	35,000	30,000	33,000*	900
Total radioactive Sr	6/17	68	0.11	20*	4.7

[a]1 pCi = 3.7E-02 Bq.

[b]Individual and average concentrations significantly greater than zero at the 95% confidence level are identified by an asterisk (*).

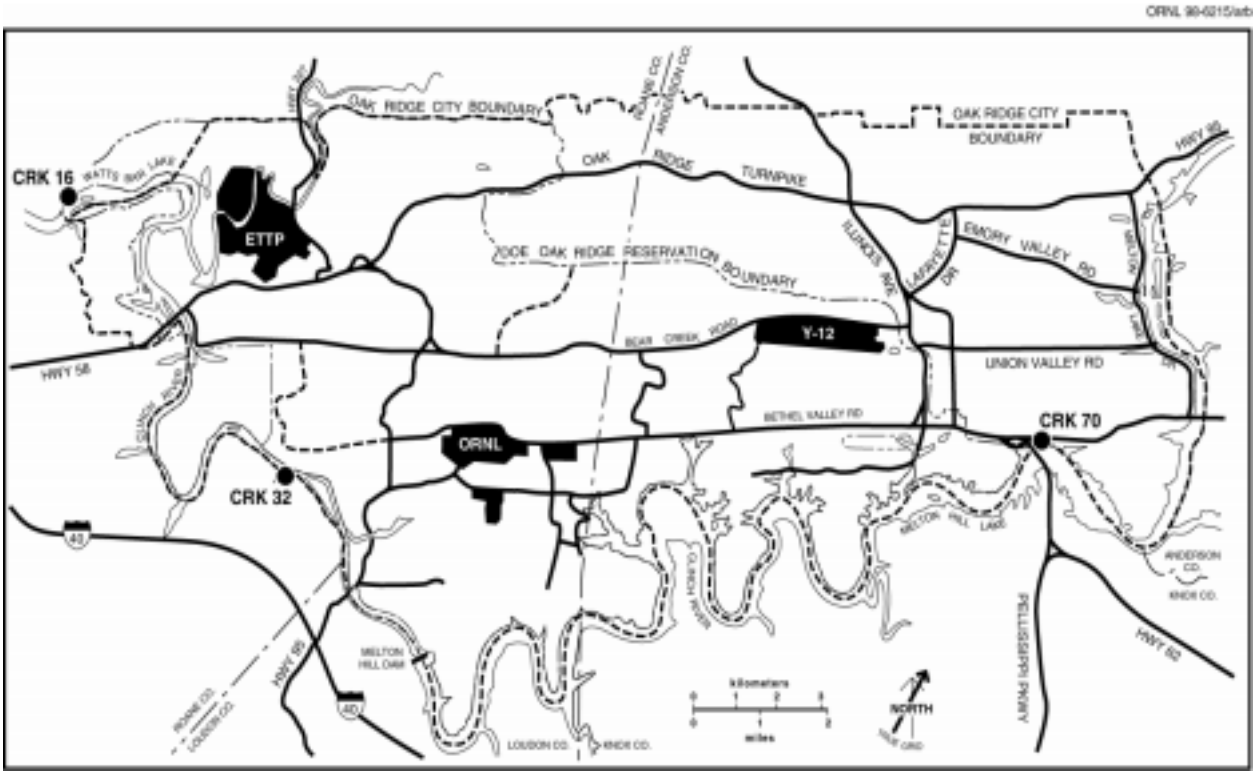

Fig. 5.23. Fish sampling locations for ORR environmental monitoring plan.

- Clinch River (Solway Bridge) upstream from all DOE inputs (CRK 70),
- Clinch River downstream from ORNL (CRK 32), and
- Clinch River downstream from all DOE inputs (CRK 16).

Sunfish (*Lepomis macrochirus*, *L. auritus*, and *Ambloplites rupestris*) are collected from each of the three river locations, filleted, and frozen. When enough fish have been collected (typically 150 to 200 per location), the samples are thawed and fillets from six of the largest are analyzed for selected metals, pesticides, and PCBs. The rest (separated into three composite samples) are ashed and analyzed for ^{60}Co, ^{137}Cs, and total radioactive strontium. To provide data from a second species, annual catfish sampling was initiated in 1993. Six to ten catfish are collected, and a composite sample is analyzed for selected metals, pesticides, and PCBs. A composite sample is also ashed and analyzed for ^{60}Co, ^{137}Cs, and total radioactive strontium.

5.8.5.1 Results

In 1997, most parameters analyzed for in sunfish and catfish were undetected or detected in fewer than all samples. For PCBs, reported values for sunfish and catfish were below the U.S. Food and Drug Administration (FDA) tolerance of 2 ppm; for mercury, all reported values were below the FDA action level of 1 ppm. This has been true for all years of the program. When PCBs have been detected, they have been primarily Aroclor-1254 and Aroclor-1260, many at estimated low levels. Information regarding potential health impacts associated with chemical and radiological constituents detected in the sunfish and catfish is discussed in Chap. 6.

5.8.6 White-Tailed Deer

The 13th annual deer hunts managed by DOE and the TWRA were held on the ORR during the final quarter of 1997. ORNL staff, TWRA, and student members of the Wildlife and Fishery

Society (University of Tennessee Chapter) performed most of the necessary operations at the checking station.

The 1997 hunts were held on three weekends. Shotgun/muzzle loader hunts were held on October 18–19 (900 permitted hunters), November 8–9 (900 permitted hunters), and December 13–14 (900 permitted hunters). During the November 8–9 hunt, the Tower Shielding/Park City Road was opened for an archery-only hunt with 350 permitted hunters. A few areas are also designated as "archery only" during the gun hunts and do not require special permitting. A two-deer limit (no more than one antlered) was established for the December 13–14 shotgun/muzzle loader hunt as well as the archery-only hunt held the weekend of November 8–9 at the Tower Shielding/Park City Road area.

From the total harvest of 438 animals, 269 (61.4%) were bucks and 169 (38.6%) were does. The heaviest buck had nine antler points and weighed 169 lb. The greatest number of antler points (14) was found on a buck weighing 121 lb. The heaviest doe weighed 113 lb.

5.8.6.1 Results

Of the 438 deer harvested, nine were confiscated because they exceeded established release limits (5 pCi/g for ^{137}Cs and/or 20 pCi/g for ^{90}Sr). The average concentration of ^{137}Cs (based on field data) in the deer released to the public was 0.07 pCi/g (0.003 Bq/g). The deer confiscated during the 1997 hunt represent 2% of the total deer harvested. Since the hunts began in 1985, 6787 deer have been harvested; a total of 158 (2.3%) were retained because of radiological contamination.

5.8.7 Resident Canada Geese

One objective of the ORR waterfowl program is to determine concentrations of gamma-emitting radionuclides accumulated by waterfowl associated with waste disposal areas. Radioactive elements found in waste material are the primary types of contaminants associated with the ORR.

During 1997, whole-body scans were conducted in 83 geese. The geese were collected from ORNL (39), the ETTP (28), and Melton Hill Dam (16). Of the 83 geese screened, only 1 goose was retained.

The sampling areas are selected because of high geese congregation. The geese are highly mobile animals that range freely to sites on and off the reservation. For that reason, the results in this report should be taken as an indication of the possible overall impact that the reservation has on the geese rather than as an evaluation of the collection sites.

5.8.7.1 Results

The average ^{137}Cs concentration in the nonconfiscated geese was 0.07 pCi/g (3E-03 Bq/g). The highest ^{137}Cs concentration, 15 pCi/g (0.6 Bq/g), was found in a goose collected at ORNL, and this goose was retained. The average weight of the Canada geese screened during the roundup was about 4 kg (8.6 lb). The maximum goose weight was about 5.2 kg (11.4 lb).

5.8.8 Turkey Monitoring

Two wild turkey hunts managed by DOE and TWRA were held on the reservation on April 12–13, 1997, and on April 19–20, 1997. Hunting was open for both shotguns and archery. A total of 90 birds were harvested, and only 1 was retained because of elevated beta counts in the leg bone. Of the 90 birds harvested, 11 were juveniles and 79 were adults. The average turkey weight was 18.8 lb. The largest tom for the 1997 hunts weighed 23.5 lb, had 1.0-in. spurs, and had a 9.5-in. beard. The longest beard was on a tom weighing 21.3 lb, and it was 11.5-in.. The average ^{137}Cs concentration in the nonconfiscated turkeys was 0.1 pCi/g (0.004 Bq/g). The maximum ^{137}Cs concentration in the nonconfiscated turkeys was 0.6 pCi/g (0.0 Bq/g).