# 7. ORR Environmental Monitoring Programs

***Setting***

Environmental monitoring is a major activity on the ORR. Environmental monitoring encompasses two activities, effluent monitoring and environmental surveillance. Effluent monitoring consists of the collection and analysis of effluent samples at their emission point to determine and quantify contaminants released. Environmental surveillance consists of the collection and analysis of samples of air, water, vegetation, biota, and other media from the ORR and its surroundings. Data from environmental monitoring activities are used to assess exposures to members of the public and to assess effects on the local population and the environment.

***Update***

In July 2001, a different laboratory began performing the analyses for most of the surveillance sampling programs discussed in this chapter. Variability in results between analytical laboratories is normal and expected because of differences in personnel, instrumentation, background radiation levels, and individual laboratory operating procedures. The discussions on the surveillance programs include explanations of variations in results that are due to the change in analytical laboratories.

In 2001, the mean value for external gamma radiation measured at five ambient-air monitoring stations on the ORR was $4.1 \times 10^{-3}$ mrem/h, compared to a mean value of $3.9 \times 10^{-3}$ mrem/h observed at the reference location for the same time period. This indicates that the effects of Oak Ridge operations on external gamma levels, if any, are very minor. Similarly, a comparison of sampling data from the ORR perimeter air monitoring stations with data from the reference station in 2001 shows that for all radionuclides of interest there are no statistically significant differences in the average concentrations measured at the ORR and the averages measured at the reference location.

Samples are collected and analyzed from 21 surface water locations around the ORR. Radionuclides were detected at all locations in 2001, with the highest levels at 3 locations downstream from ORNL (Melton Branch, White Oak Creek, and White Oak Creek at White Oak Dam). Analyses of locally grown hay, produce, milk, and fish from the Clinch River provided data for assessing potential health impacts.

## 7.1 METEOROLOGICAL MONITORING

Nine 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, which would be used in the event of accidental releases from a facility. Data from the towers are also used to support various research and engineering projects.

### 7.1.1 Description

The nine meteorological towers, depicted in Fig. 7.1, consist of one 330-ft (100-m) tower (MT5) and one 200-ft (60-m) tower (MT6) at the Y-12 Complex, 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 (30-m) tower (MT7) at the ETTP. Additionally, ETTP has two satellite towers, 208A and 208B, both 30 ft (10-m) high.

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. All of the towers collect data at the 32.8-ft (10-m) level. Additionally, selected towers collect data at 100-ft (30-m), 200-ft (60 m), and 330-ft (100-m) levels. At each measurement level, 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 measured at each tower. Barometric

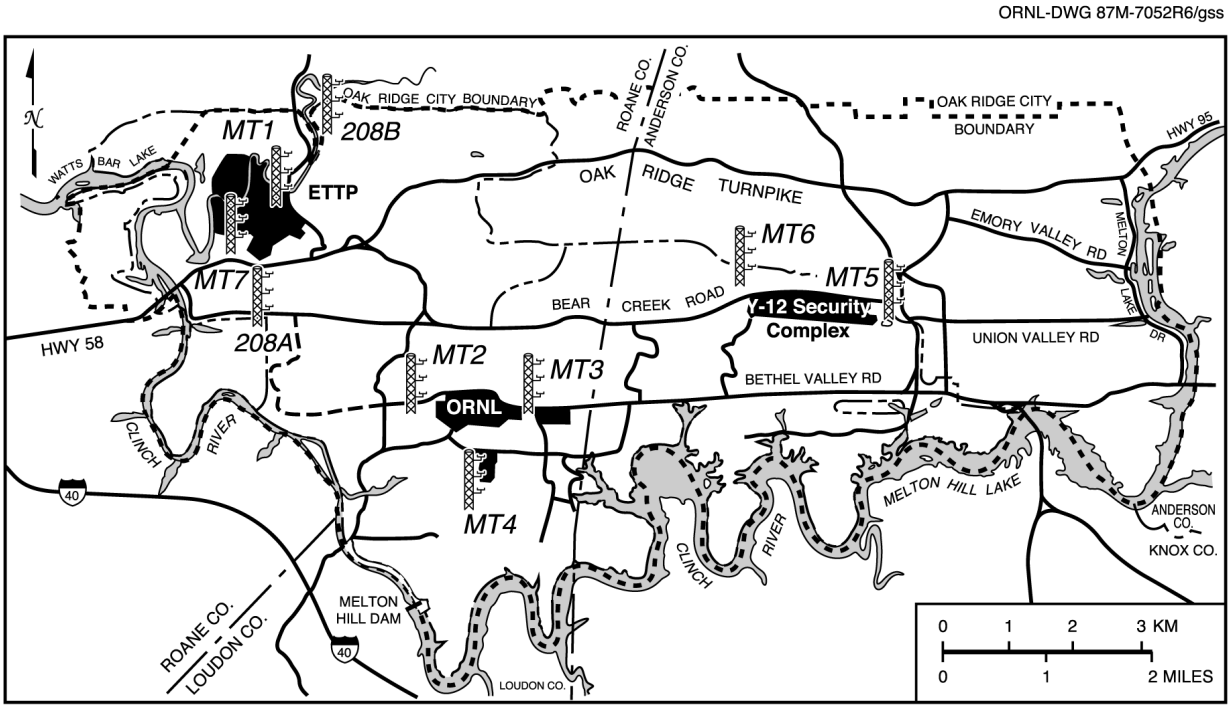


**Fig. 7.1. The ORR meteorological monitoring network.**

pressure is measured at one or more towers at each facility (MT1, MT2, MT5, and MT7). Precipitation is measured at MT5 and MT6 at the Y-12 Complex, at MT1 and MT7 at the ETTP, and at MT2 at ORNL; solar radiation is measured at MT2 at ORNL, MT1 and MT7 at the ETTP, and MT5 and MT6 at the Y-12 Complex.

Data from the towers at each site are collected by a dedicated control computer. The towers are polled, and the data are archived on disk. One-minute, fifteen-minute, and hourly values are automatically stored at two locations (ETTP for Y12 and ETTP, ORNL for ORNL). Long-term archives are kept of 1-min data at ORNL and ETTP (MT1 tower only) and for all sites for 15 min and hourly data. The meteorological monitoring data from ORNL are summarized monthly as wind roses and data tables. Quarterly calibrations of the instruments are conducted for each site on the ORR by an outside contractor.

Fifteen-min and hourly data are used directly at each site 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. Additionally, records of data problems/errors are routinely kept for all nine tower sites.

## 7.1.2 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 bottomland 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 as the height at which measurements are made increases. This characteristic is typical 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. Such 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 systems 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 12 tower levels was approximately 98.6% in 2001. The maximum data recovery rate was 99.7% at ORNL MT3 and ETTP MT7. The minimum data recovery rate was approximately 95.2% at ETTP 208B.

## 7.2 EXTERNAL GAMMA RADIATION MONITORING

External gamma radiation monitoring is conducted to determine whether radioactive effluents from the ORR are increasing external radiation levels significantly above normal background levels. The data also provide a means for comparing results from year to year and establishing trends.

### 7.2.1 Data Collection and Analysis

External gamma measurements (exposure rates) are recorded weekly at six ambient air stations from resident external gross gamma monitors (Fig. 7.2). 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 exposure.

### 7.2.2 Results

Table 7.1 summarizes the data collected at each station during the year. The mean observed exposure rate for the reservation network for the year was $4.1 \times 10^{-3}$ mrem/h, which is not statistically different from the average of $3.9 \times 10^{-3}$ mrem/h measured at the reference location. A person exposed to the mean exposure rate

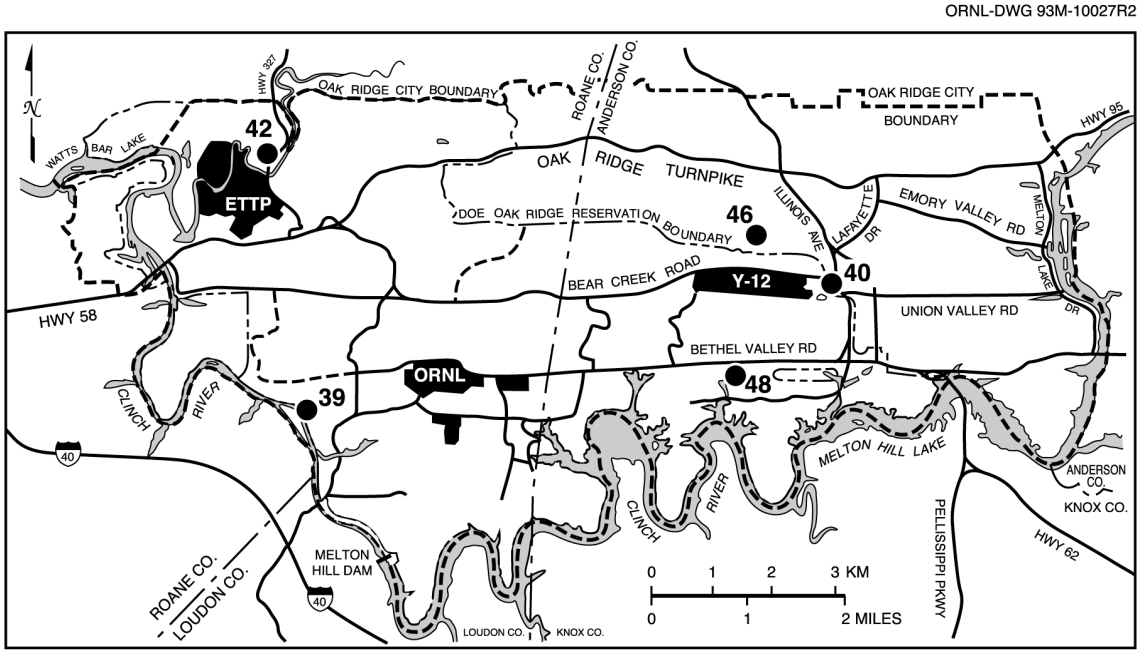


**Fig. 7.2. External gamma radiation monitoring locations on the ORR.** Location 52, at Fort Loudoun Dam, approximately 15 miles southwest of ORNL, is not shown on this map.

**Table 7.1. External gamma averages for the Oak Ridge Reservation, 2001**

| Monitoring location | Number of data values collected | Measurement (μR/h)[a] | | | Standard error of mean |
|---|---|---|---|---|---|
| | | Min | Max | Mean | |
| 39 | 52 | 6.0 | 6.8 | 6.4 | 0.00003 |
| 40 | 51 | 5.2 | 6.0 | 5.6 | 0.00002 |
| 42 | 52 | 3.6 | 5.5 | 4.6 | 0.00005 |
| 46 | 52 | 4.7 | 6.6 | 6.1 | 0.00003 |
| 48 | 52 | 4.3 | 6.2 | 4.6 | 0.00004 |
| 52 | 50 | 4.5 | 5.9 | 5.2 | 0.00006 |

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

for 1 year could have received an effective dose equivalent of about 36 mrem.

## 7.3 AMBIENT AIR MONITORING

In addition to exhaust stack monitoring conducted at the DOE Oak Ridge installations, ambient air monitoring is performed to measure radiological parameters directly in the ambient air adjacent to the facilities. Ambient air monitoring provides direct measurement of airborne radionuclide concentrations in the environment surrounding the facilities, allows determining the levels of contaminants at the monitoring locations during an emergency, verifies that 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. Other air monitoring programs are discussed in the site-specific chapters, Chap. 4 (ETTP), Chap 5 (ORNL), and Chap. 6 (the Y-12 Complex).

### 7.3.1 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 network includes stations 35, 37, 38, 39, 40, 42, 46, and 48 (Fig. 7.3). Reference samples are collected from Station 52 (Fort Loudoun Dam). Sampling was conducted at each ORR station during 2001 to quantify levels of alpha-, beta-, and gamma-emitting radionuclides and $^{3}H$.

Atmospheric dispersion modeling was used to select appropriate sampler locations. The locations selected are those likely to be affected most by releases from the Oak Ridge facilities. Therefore, in the event of a release, no residence or business in the vicinity of the ORR should receive a radiation dose greater than doses calculated at the sampled locations. To provide an estimate of background radionuclide concentrations, an additional station is located at Fort Loudoun Dam, a site not affected by releases from the ORR.

The sampling system consists of two separate instruments. Particulates are captured on glass-fiber filters in a high-volume air sampler. 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 $^{3}H$ analysis.

The ORR ambient air network (Fig. 7.3) provides appropriate monitoring for all facilities within the reservation and thus 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 Complex operation. Station 40 monitors the east end of the Y-12 Complex, and Station 37 monitors the overlap of Y-12 Complex, ORNL, and ETTP emissions.

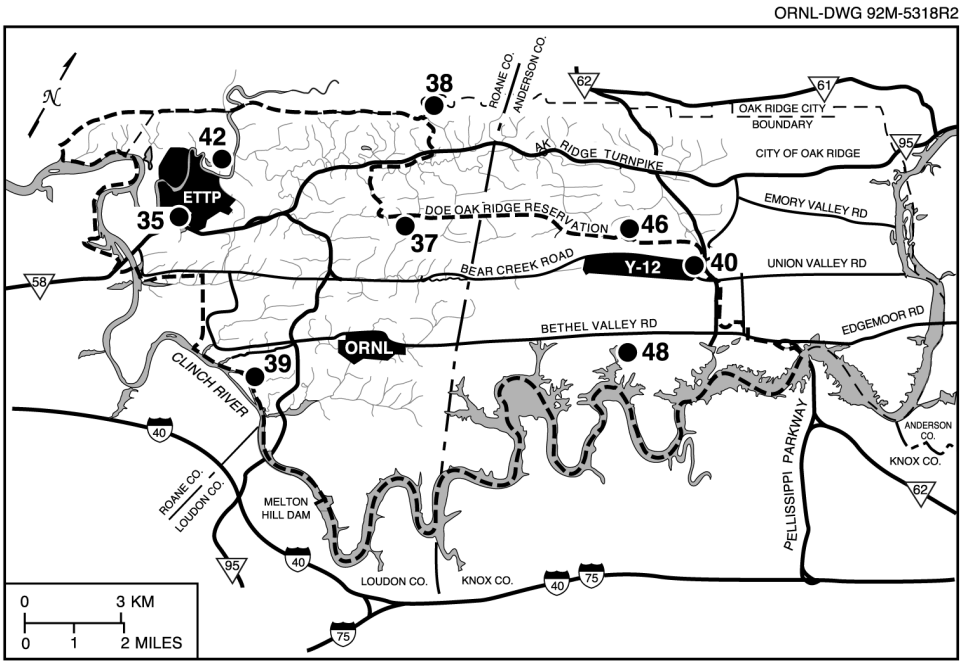


**Fig. 7.3. Locations of ORR perimeter air monitoring stations.** Location 52, at Fort Loudoun Dam, approximately 15 miles southwest of ORNL, is not shown.

## 7.3.2 Results

Data from the ORR ambient air 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. In the middle of 2001 a new laboratory was engaged to analyze radionuclide samples which resulted in a different approach to reporting gamma-emitting radionuclides. Comparisons of ORR ambient air station sampling data and data collected from reference Station 52 show that there were no statistically significant differences in any of the radionuclides of interest (Table 7.2). Each measured radionuclide concentration is also compared to the DOE Derived Concentration Guides (DCG), which serve as reference values for conducting environmental protection programs at DOE sites. All radionuclide concentrations measured at the ORR ambient air stations were less than 1% of applicable DCGs.

Table 7.3 represents the average concentration of three isotopes of uranium at each station for sampling years 1999, 2000, and 2001. There are no statistically significant differences between any of the concentrations for the three uranium isotopes when comparing the perimeter network averages with the concentrations measured at the reference station (Station 52). After July 2001, when the change in analytical service providers occurred, some differences were observed in individual values for the three uranium isotopes. The current laboratory has achieved a lower minimum detectable activity, which has resulted in more activity being detected. Differences in results between analytical laboratories is normal and expected.

# 7.4 SURFACE WATER MONITORING

## 7.4.1 ORR Surface Water Monitoring

Surface water samples are collected and analyzed from 21 locations around the ORR to assess the impact of past and current DOE operations on the quality of local surface water. This program is conducted in addition to the surface water monitoring required by National Pollutant Discharge Elimination System permits

**Table 7.2. Radionuclide concentrations at Oak Ridge Reservation perimeter air monitoring stations, 2001[a,b]**

| Isotope | Air monitoring station | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 35 | 37 | 38 | 39 | 40 | 42 | 46 | 48 | 52[c] |
| $^{241}$Am | 4.96E–13 | 7.78E–13 | 2.14E–13 | 6.02E–13 | –3.12E–13 | 5.89E–13 | 7.82E–13 | 5.73E–13 | 6.61E–13 |
| $^{7}$Be | 5.88E–08[d] | 5.59E–08[d] | 5.45E–08[d] | 4.79E–08[d] | 5.47E–08[d] | 5.25E–08[d] | 6.40E–08[d] | 5.96E–08[d] | 6.28E–08[d] |
| $^{244}$Cm | 5.96E–13 | 5.99E–13 | 8.43E–13 | 8.83E–13 | 2.34E–14 | 7.74E–15 | 7.90E–14 | 2.98E–13 | 1.97E–13 |
| $^{60}$Co | 5.20E–11 | 2.14E–11 | 1.72E–11 | 2.42E–11 | –3.04E–11 | –3.64E–13 | –4.34E–11 | 4.20E–11 | 3.17E–11 |
| $^{137}$Cs | 1.07E–10[d] | –5.13E–12 | 8.81E–12 | 5.31E–11 | 1.51E–11 | –8.95E–12 | 2.29E–11[d] | 6.46E–11 | 4.32E–11 |
| $^{3}$H | 1.42E–06 | –3.61E–07 | 5.05E–07 | 1.21E–06 | –5.86E–07 | 4.21E–06 | 1.11E–06 | 8.24E–07 | –2.85E–07 |
| $^{40}$K | 2.89E–09[d] | 3.11E–09[d] | 2.82E–09[d] | 3.00E–09[d] | 3.03E–09[d] | 2.79E–09[d] | 3.03E–09[d] | 4.33E–09[d] | 3.34E–09[d] |
| $^{238}$Pu | 7.74E–15[d] | 1.01E–13 | 2.22E–13 | –1.04E–13 | 2.65E–13 | –1.47E–13 | 2.13E–13 | 9.93E–14 | –2.36E–13 |
| $^{239}$Pu | 7.74E–13 | 1.48E–13 | 1.61E–13 | 1.60E–13 | 2.58E–13 | 1.55E–13 | 1.66E–13 | 1.83E–13 | 2.75E–13 |
| $^{228}$Th | 1.16E–12 | 8.56E–13 | 1.23E–12 | 7.62E–13 | 9.37E–13 | 5.81E–13 | 1.26E–12 | 1.30E–12 | 1.65E–12 |
| $^{230}$Th | 7.74E–13 | 4.05E–13 | 7.35E–13 | 6.50E–13 | 1.48E–12 | 9.29E–13 | 7.90E–13 | 8.40E–13 | 7.24E–13 |
| $^{232}$Th | 7.67E–13 | 4.98E–13 | 8.43E–13 | 5.38E–13 | 8.59E–13 | 1.16E–12 | 1.03E–12 | 1.07E–12 | 1.10E–12 |
| $^{89/90}$Sr | 7.86E–12 | 1.03E–12[d] | 5.98E–13 | 3.16E–12 | 6.32E–13 | 1.62E–12 | 9.04E–13 | 7.87E–13 | 7.57E–13 |
| $^{234}$U | 2.07E–11[d] | 1.22E–11[d] | 1.69E–11[d] | 8.12E–12[d] | 4.98E–11[d] | 2.37E–11[d] | 2.74E–11[d] | 1.13E–11[d] | 8.17E–12[d] |
| $^{235}$U | 7.60E–13[d] | 9.96E–13 | 7.92E–13[d] | 1.51E–12 | 2.08E–12[d] | 1.13E–12 | 1.23E–12[d] | 5.31E–13[d] | 5.71E–13[d] |
| $^{238}$U | 3.00E–11 | 1.36E–11[d] | 2.69E–11[d] | 7.65E–12[d] | 1.65E–11 | 3.48E–11[d] | 1.85E–11[d] | 1.09E–11[d] | 6.97E–12[d] |

[a]All values are mean concentrations.
[b]Units are picocuries per milliliter.
[c]Reference location.
[d]Statistically significant average at 95% confidence level.

for individual DOE ORR facilities; sampling location, frequency, and analytical parameters vary between the two programs. Sampling locations include streams downstream of ORR waste sources, reference points on streams and reservoirs upstream of waste sources, and public water intakes (see Fig. 7.4 and Table 7.4).

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 are also checked for volatile organic compounds and/or polychlorinated biphenyls (PCBs). Samples at three Clinch River sites are analyzed for metals: Clinch River kilometer (CRK) 16, 23, and 70. Table 7.4 lists the specific locations and their sampling frequencies and parameters.

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

## 7.4.2 Results

Radionuclides were detected above minimum detectable activity at all surface water locations in 2001. The highest levels of gross beta, total radioactive strontium, and $^{3}$H continue to be at Melton Branch kilometer (MEK) 0.2, White Oak Creek at White Oak Dam [White Oak kilometer (WCK) 1.0], and WCK 2.6 (see Table C.3 in Appendix C). These data are consistent with historical data and with the processes or legacy activities nearby or upstream from these locations.

Remediation efforts by Bechtel Jacobs Company LLC (BJC) have resulted in decreases in levels of gross alpha, gross beta, and total radioactive strontium at the First Creek location. The levels are seasonal; for example, they are

**Table 7.3. Uranium concentrations in ambient air on the Oak Ridge Reservation**

| Isotope | Concentration ($10^{-15}$ µCi/mL) | | | |
|---|---|---|---|---|
| | 1998 | 1999 | 2000 | 2001 |
| | | *Station 35* | | |
| $^{234}U$ | 1.1E–02 | 2.0E–02 | 9.8E–03 | 2.07E–02 |
| $^{235}U$ | 4.5E–04 | 1.5E–03 | 6.8E–04 | 7.60E–04 |
| $^{238}U$ | 1.4E–02 | 2.3E–02 | 1.1E–02 | 3.00E–02 |
| | | *Station 37* | | |
| $^{234}U$ | 1.0E–02 | 2.7E–02 | 8.5E–03 | 1.22E–02 |
| $^{235}U$ | 5.9E–04 | 6.9E–04 | 4.4E–04 | 9.96E–04 |
| $^{238}U$ | 1.5E–02 | 2.1E–02 | 1.1E–02 | 1.36E–02 |
| | | *Station 38* | | |
| $^{234}U$ | 8.5E–03 | 1.5E–02 | 7.9E–03 | 1.69E–02 |
| $^{235}U$ | 8.5E–04 | 1.1E–03 | 1.1E–03 | 7.92E–04 |
| $^{238}U$ | 1.2E–02 | 1.9E–07 | 9.5E–03 | 2.69E–02 |
| | | *Station 39* | | |
| $^{234}U$ | 5.5E–03 | 8.9E–03 | 7.6E–03 | 8.12E–03 |
| $^{235}U$ | 6.0E–04 | 7.7E–04 | 5.7E–04 | 1.51E–03 |
| $^{238}U$ | 8.6E–03 | 9.7E–03 | 8.5E–03 | 7.65E–03 |
| | | *Station 40* | | |
| $^{234}U$ | 1.8E–02 | 3.5E–02 | 2.8E–02 | 4.98E–02 |
| $^{235}U$ | 1.0E–03 | 1.0E–03 | 1.8E–03 | 2.08E–03 |
| $^{238}U$ | 1.3E–02 | 2.0E–02 | 1.2E–02 | 1.65E–02 |
| | | *Station 42* | | |
| $^{234}U$ | 1.0E–02 | 2.2E–02 | 1.6E–02 | 2.37E–02 |
| $^{235}U$ | 7.1E–04 | 9.3E–04 | 1.3E–03 | 1.13E–03 |
| $^{238}U$ | 1.7E–02 | 2.5E–02 | 1.3E–02 | 3.48E–02 |
| | | *Station 46* | | |
| $^{234}U$ | 1.5E–02 | 2.8E–02 | 2.4E–02 | 2.74E–02 |
| $^{235}U$ | 8.8E–04 | 2.9E–03 | 1.9E–03 | 1.23E–03 |
| $^{238}U$ | 1.5E–02 | 2.4E–02 | 1.4E–02 | 1.85E–02 |
| | | *Station 48* | | |
| $^{234}U$ | 7.0E–03 | 2.1E–02 | 1.2E–02 | 1.13E–02 |
| $^{235}U$ | 4.6E–04 | 7.1E–04 | 7.9E–04 | 5.31E–04 |
| $^{238}U$ | 7.1E–03 | 1.9E–02 | 1.2E–02 | 1.09E–02 |
| | | *Station 52* | | |
| $^{234}U$ | 5.0E–03 | 9.9E–02 | 6.2E–03 | 8.17E–03 |
| $^{235}U$ | 7.5E–04 | 2.0E–03 | 7.8E–04 | 5.71E–04 |
| $^{238}U$ | 4.6E–03 | 3.4E–02 | 9.2E–03 | 6.97E–03 |

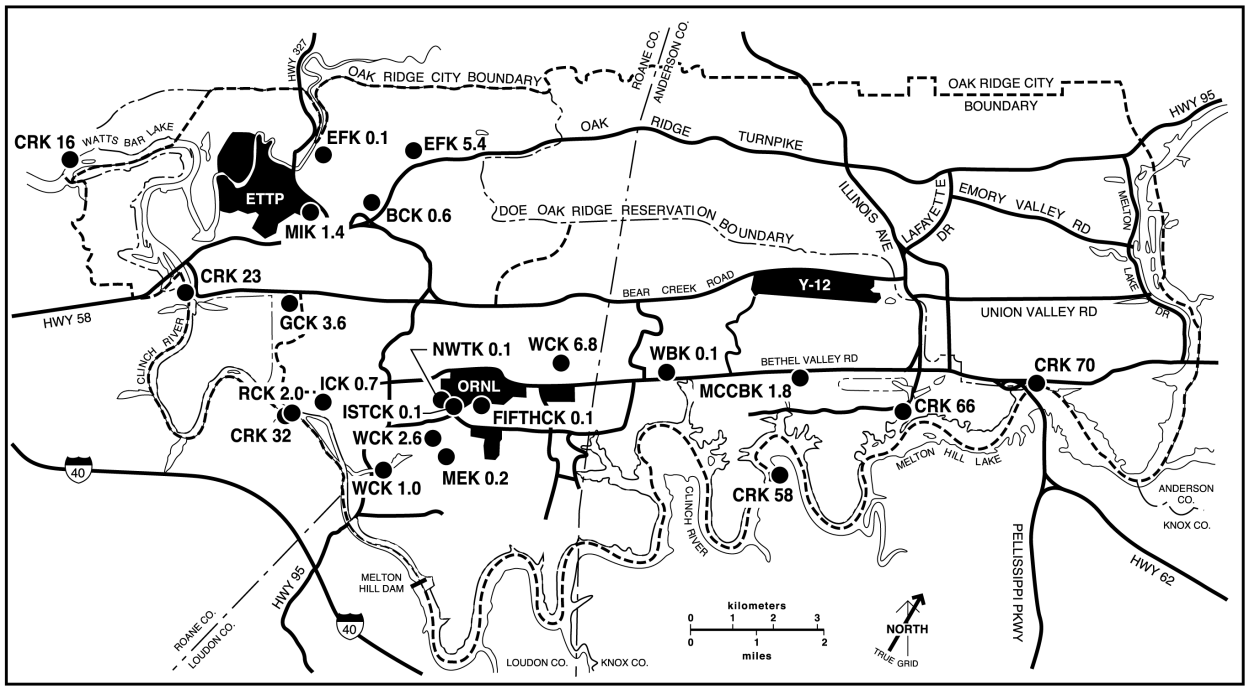


**Fig. 7.4. Locations of ORR surface water surveillance sampling stations.**

lower in the spring (wet season) because of dilution. Uranium isotopes, including $^{233}U$, $^{234}U$, $^{235}U$, and $^{238}U$, were determined to be the primary alpha emitters. These phenomena are related to radiologically contaminated groundwater whose source is leakage to backfill and soil from Tank W-1A, an underground radioactive waste storage tank located in the North Tank Farm within the main ORNL facilities complex. Work conducted in 1998 indicates that there is infiltration of storm drains that discharge into Outfall 341, which discharges into First Creek. BJC began pumping a well south of the North Tank Farm in 2000 to remediate the groundwater; one of the consequences of this effort is the decline in radionuclides detected in surface water at First Creek (DOE 2001). In 2001 the radionuclide levels showed an increase (from 2000) because pumping to treat the contaminated groundwater continues but at a slower rate.

A few locations were monitored for volatile organic compounds. WCK 1.0 had chloroform detected in the August sample and 1,1,1-trichlorethane detected in the September sample; both of these were low, estimated levels. Samples for polychlorinated biphenyls are collected monthly at WCK 1.0. Aroclor-1254 was detected at a low, estimated level in the May sample.

Two locations, one on Northwest Tributary (NWTK 0.1) and one on Raccoon Creek (RCK 2.0), also had elevated levels of gross beta and total radioactive strontium. Results at both locations have a seasonal pattern. Concentrations at Northwest Tributary are higher in the spring, whereas concentrations at Raccoon Creek are higher in the fall. Both of these locations are impacted by contaminated groundwater from Solid Waste Storage Area 3.

## 7.5 ORR SEDIMENT

Stream and lake sediments act as a record of some aspects of water quality by concentrating and storing certain contaminants. Sampling sites for sediment are the Clinch River downstream from all DOE inputs (CRK 16), the Clinch River downstream from ORNL (CRK 32), and the Clinch River at the Solway Bridge, upstream from all DOE inputs (CRK 70) (Fig. 7.5). The locations are sampled annually, and gamma scans are performed on the samples.

In addition, two samples per year containing settleable solids are collected in conjunction with a heavy rain event to characterize sediments that exit ORNL during a storm event. The sampling locations are Melton Branch upstream from

**Table 7.4. Oak Ridge Reservation surface water sampling locations, frequencies, and parameters, 2001**

| Location[a] | Description | Frequency | Parameters |
|---|---|---|---|
| BCK 0.6 | Bear Creek downstream from Y-12 Complex inputs | Semiannually (Apr, Oct) | Gross alpha, gross beta, gamma scan, field measurements[b] |
| CRK 16 | Clinch River downstream from all DOE inputs | Monthly | Volatiles, metals, gross alpha, gross beta, gamma scan, field measurements[b] |
| CRK 23 | Water supply intake for the ETTP | Monthly | Gross alpha, gross beta, total radioactive strontium, gamma scan, $^{3}H$, field measurements[b] |
| CRK 32 | Clinch River downstream from ORNL | Monthly | Gross alpha, gross beta, gamma scan, total radioactive strontium, $^{3}H$, field measurements[b] |
| CRK 58 | Water supply intake for Knox County | Monthly | Gross alpha, gross beta, gamma scan, field measurements[b] |
| CRK 66 | Melton Hill Reservoir above city of Oak Ridge water intake | Monthly | Gross alpha, gross beta, gamma scan, field measurements[b] |
| CRK 70 | Solway Bridge | Monthly | Volatiles, metals, gross alpha, gross beta, total radioactive strontium, gamma scan, $^{3}H$, field measurements[b] |
| EFK 0.1 | East Fork Poplar Creek prior to entering Poplar Creek | Semiannually (Apr, Oct) | Gross alpha, gross beta, gamma scan, field measurements[b] |
| EFK 5.4 | East Fork Poplar Creek downstream from floodplain | Semiannually (Apr, Oct) | Gross alpha, gross beta, gamma scan, field measurements[b] |
| MEK 0.2 | Melton Branch downstream from ORNL | Bimonthly (Jan, Mar, May, Jul, Sep, Nov) | Gross alpha, gross beta, gamma scan, total radioactive strontium, $^{3}H$, field measurements[b] |
| WCK 1.0 | White Oak Lake at White Oak Dam | Monthly | Volatiles, metals, PCBs, gross alpha, gross beta, gamma scan, total radioactive strontium, $^{3}H$, field measurements[b] |
| WCK 2.6 | White Oak Creek downstream from ORNL | Bimonthly (Jan, Mar, May, Jul, Sep, Nov) | Gross alpha, gross beta, gamma scan, total radioactive strontium, $^{3}H$, field measurements[b] |
| WCK 6.8 | White Oak Creek upstream from ORNL | Quarterly (Feb, May, Aug, Nov) | Gross alpha, gross beta, total radioactive strontium, gamma scan, $^{3}H$, field measurements[b] |
| WBK 0.1 | Walker Branch prior to entering CRK 53.4 | Semiannually (Apr, Oct) | Gross alpha, gross beta, gamma scan, field measurements[b] |
| GCK 3.6 | Grassy Creek upstream of SEG and IT Corp. at CRK 23 | Semiannually (Apr, Oct) | Lead, gross alpha, gross beta, gamma scan, field measurements[b] |
| ICK 0.7 | Ish Creek prior to entering CRK 30.8 | Semiannually (Apr, Oct) | Gross alpha, gross beta, gamma scan, field measurements[b] |
| MCCBK 1.8 | McCoy Branch prior to entering CRK 60.3 | Semiannually (Apr, Oct) | Gross alpha, gross beta, gamma scan, field measurements[b] |

**Table 7.4 (continued)**

| Location[a] | Description | Frequency | Parameters |
|---|---|---|---|
| RCK 2.0 | Raccoon Creek sampling station prior to entering CRK 31 | Semiannually (Apr, Oct) | Gross alpha, gross beta, total radioactive strontium, gamma scan, $^{3}H$, field measurements[b] |
| NWTK 0.1 | Northwest Tributary prior to the confluence with First Creek | Semiannually (Apr, Oct) | Gross alpha, gross beta, total radioactive strontium, gamma scan, $^{3}H$, field measurements[b] |
| FCK 0.1 | First Creek prior to the confluence with Northwest Tributary | Semiannually (Apr, Oct) | Gross alpha, gross beta, total radioactive strontium, gamma scan, $^{3}H$, field measurements[b] |
| FFK 0.1 | Fifth Creek just upstream of White Oak Creek (ORNL) | Semiannually (Apr, Oct) | Gross alpha, gross beta, total radioactive strontium, gamma scan, $^{3}H$, field measurements[b] |

[a]Locations identify bodies of water and locations on them (e.g., BCK 0.6 = 0.6 km along Bear Creek).
[b]Field measurements consist of dissolved oxygen, pH, and temperature.

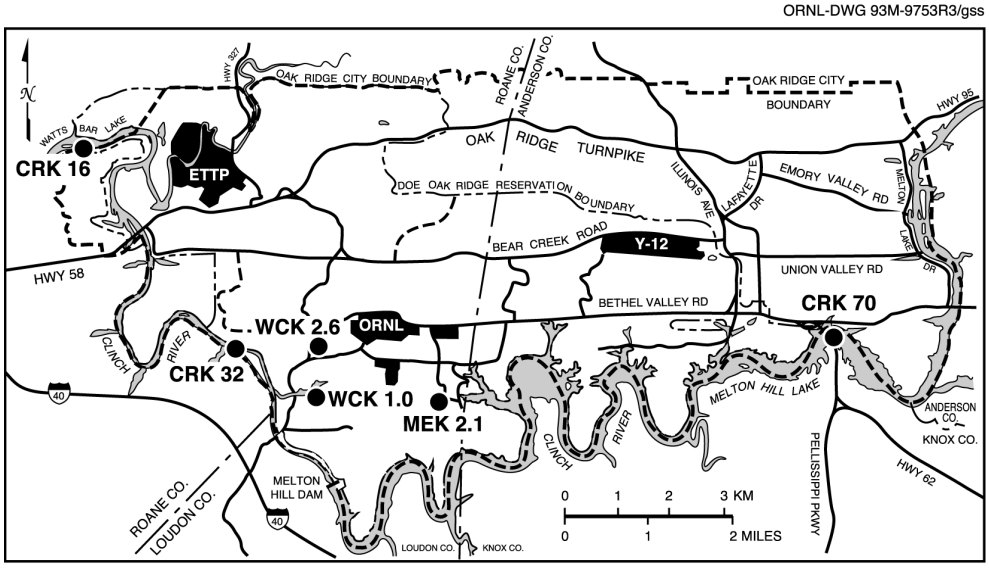


**Fig. 7.5. ORR environmental monitoring plan sediment sampling locations.**

ORNL (MEK 2.1), White Oak Lake at White Oak Dam (WCK 1.0), and White Oak Creek downstream from ORNL (WCK 2.6) (Fig. 7.5). These samples are filtered, and the residue (settleable solids) is analyzed for gross alpha, gross beta, and gamma emitters.

## 7.5.1 Results

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

Heavy-rain-event sampling took place in January and February 2001. At the upstream location (MEK 2.1), $^{137}Cs$ was detected from the January rain event; no other radionuclides were detected at this location during either event. Gross beta and $^{137}Cs$ were detected at the location downstream from ORNL (WCK 2.6) and at White Oak Dam during both rain events. The highest concentration of both radionuclides were found at White Oak Dam during the January event and at

WCK 2.6 during the February event. Gross alpha was detected at White Oak Dam in the January event and at WCK 2.6 during the February event. Sample size has a strong impact on results and associated counting statistics and may account for the variability between the January and February results at each location. The quantity of residue from the February sample was larger than that from the January sample at all three locations.

## 7.6 FOOD

Collection and analysis of vegetation samples serves three purposes: to evaluate potential radiation doses received by people consuming foodcrops; to predict possible concentrations in meat, eggs, and milk from animals consuming hay; and to monitor trends in environmental contamination and possible long-term accumulation of radionuclides. In the middle of 2001, a new laboratory was engaged to analyze radionuclide samples. This resulted in a different approach to reporting gamma-emitting radionuclides.

### 7.6.1 Hay

Hay from five areas on the ORR and one area immediately adjacent to the reservation is sampled annually. In previous years, hay from these six areas (Fig. 7.6) has been sold for silage, and each has the potential for deposition of airborne materials from ORR sources. Areas 1, 2, and 3 are within the predicted air plume for an ORNL source and could be affected by ETTP sources. Areas 4, 5, and 6 are within the predicted air plumes for ETTP, ORNL, and Y-12 sources. Individual samples are collected from all six sites, and a composite from Areas 1, 2, and 3 and a composite from Areas 4, 5, and 6 are submitted for laboratory analyses. In addition, a sample from Area 6 is submitted separately because this location best represents the combined plumes from all three sites. A reference sample is collected from a site near Fort Loudoun Dam (Area 8, not shown on Fig. 7.6), which is outside the influence of ORR sources.

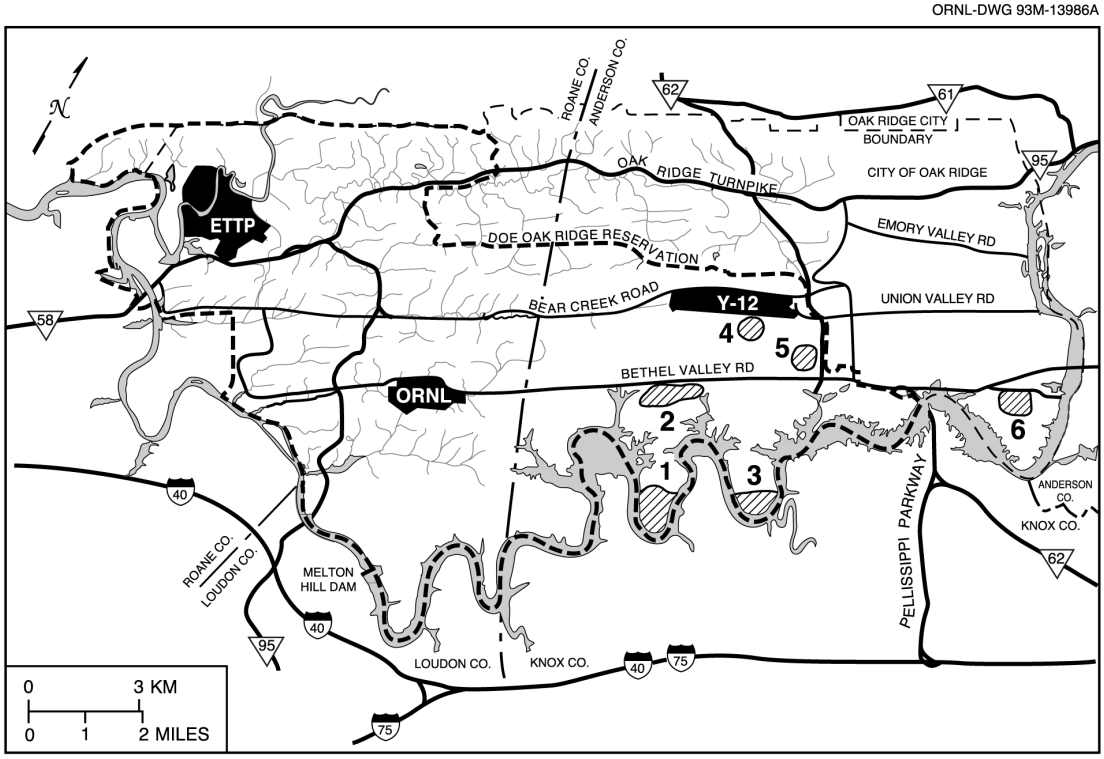


**Fig. 7.6. Hay sampling locations on the ORR, indicated by numbered areas.** Area 8 is a reference location at Fort Loudoun Dam and is not shown on this map.

#### 7.6.1.1 Results

Hay samples were collected during August 2001, and samples were analyzed for gross alpha, beta, and gamma emitters. None of the locations had gamma emitting radionuclides that were detected above minimum detectable activity, with the exception of naturally occurring radionuclides $^{7}$Be and $^{40}$K.

### 7.6.2 Vegetables

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

#### 7.6.2.1 Results

Samples were analyzed for gross alpha, gross beta, and gamma emitters. None of the vegetables had gamma-emitting radionuclides that were statistically significant, with the exception of naturally occurring radionuclides $^{7}$Be and $^{40}$K.

### 7.6.3 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 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 2001 milk-sampling program consisted of grab samples collected every other month from three locations (Fig. 7.7). One is a commercial dairy in Powell that processes milk from various locations in east Tennessee; the second dairy is in Claxton, and the third is in Maryville (a reference location). Milk samples are analyzed 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 $^{3}$H.

#### 7.6.3.1 Results

Concentrations of radionuclides detected above minimum detectable activity in milk are presented in Table 7.5. Tritium was detected in one of the five samples collected at the Powell location (tritium was inadvertently omitted in the July event, resulting in only five measurements for the year) but was not found in any of the samples from the other two locations (see Table 7.5). No radionuclides were detected in any of the samples collected from the reference location in Maryville.

## 7.7 FISH

Members of the public could potentially be exposed to contaminants originating from DOE-Oak Ridge Operations activities through consumption of fish caught in area waters. This exposure pathway is monitored by collecting fish from three locations on the Clinch River annually and analyzing edible fish flesh. The locations are (see Fig. 7.8)

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

Sunfish (*Lepomis macrochirus*, *L. auritus*, and *Ambloplites rupestris*) are collected from each of the three locations, filleted, and frozen. In 2001, two composite samples were analyzed for selected metals, pesticides, PCBs, and $^{3}$H, and two samples were analyzed for gross alpha, gross beta,

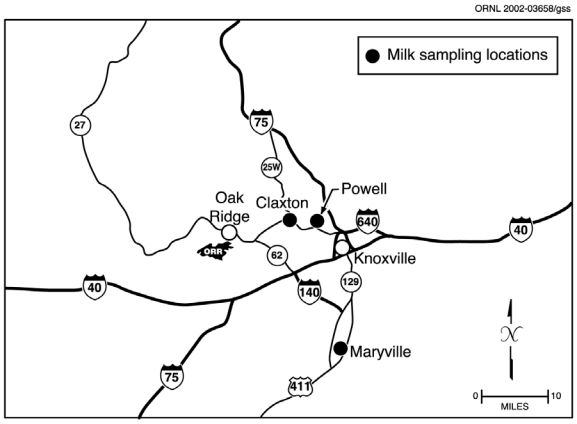


**Fig. 7.7. Milk sampling locations in the vicinity of the ORR.**

**Table 7.5. Concentration of radionuclides detected in raw milk, 2001[a]**

| Analysis | No. detected/ no. total | Detected concentration (pCi/L)[b,c] | | | Standard error of mean |
|---|---|---|---|---|---|
| | | Max | Min | Avg | |
| | | *Claxton* | | | |
| Total rad Sr | 1/6 | 1.6* | 0.15 | 0.79* | 0.23 |
| | | *Powell* | | | |
| $^{3}H$ | 1/5 | 370* | –370 | –30 | 140 |
| Total rad Sr | 1/6 | 2.2* | 0.35 | 1.1* | 0.30 |
| | | *Network Summary* | | | |
| $^{3}H$ | 1/15 | 370 | –740 | –110 | 81 |
| Total rad Sr | 2/18 | 2.2 | 0.080 | 0.85 | 0.15 |

[a]No radionuclides were detected in any of the samples collected from the reference location in Maryville.

[b]1 pCi = $3.7 \times 10^{-2}$ Bq. Detected radionuclides are those detected above minimum detectable activity.

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

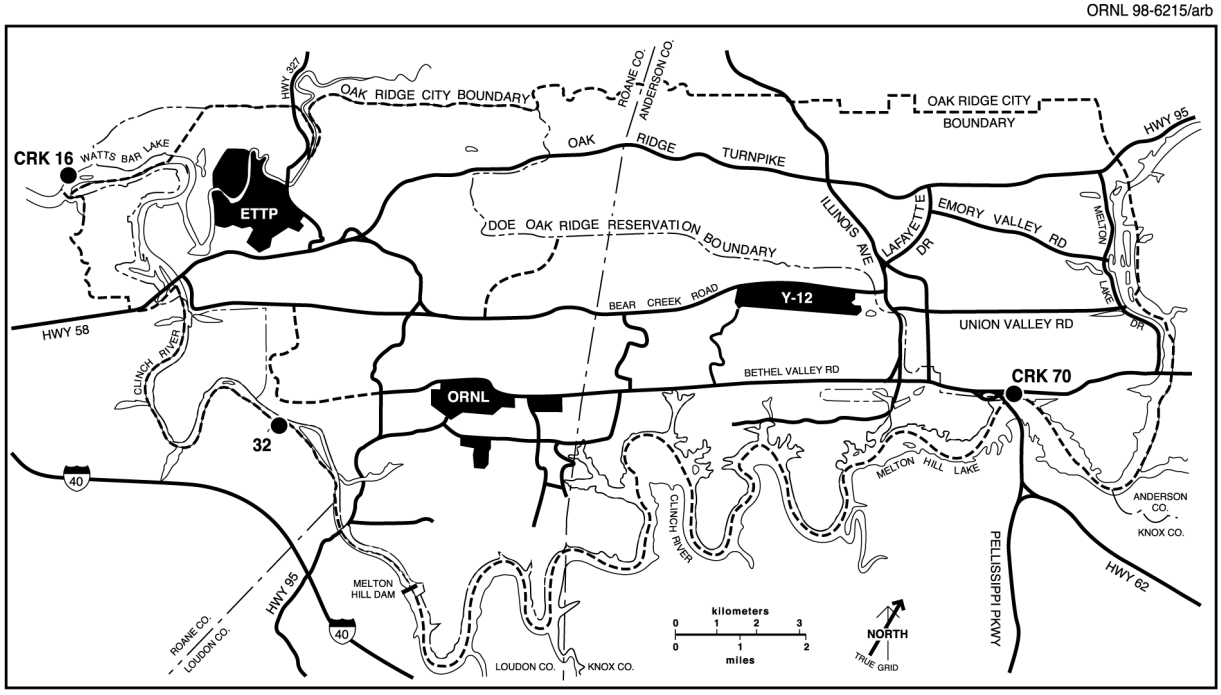


**Fig. 7.8. Fish sampling locations for the ORR.**

and gamma-emitting radionuclides and for total radioactive strontium.

Annual catfish sampling was initiated in 1993. In 2001, catfish were collected at each location and were composited; one sample was analyzed for selected metals, pesticides, PCBs, and $^{3}H$. Two samples from each location were analyzed for gross alpha, gross beta, and gamma-emitting radionuclides and for total radioactive strontium.

### 7.7.1 Results

In 2001, most nonradiological parameters analyzed in sunfish and catfish were undetected or were detected in only a few samples. The Tennessee Department of Environment and Conservation (TDEC) adopted the U.S. Environmental Protection Agency method for establishing fish consumption advisories for carcinogenic contaminants found in fish collected in waters designated for recreation and domestic water supply. There is a "do not consume" fish advisory (applicable to typical fishermen consumers) for catfish in Melton Hill Reservoir (in its entirety) because of PCB contamination and a precautionary fish advisory (applicable to atypical consumers, those persons who, because of physiological factors or previous exposures, are more sensitive to specific pollutants; this may include pregnant or nursing women, children, and subsistence fishermen) for catfish in the Clinch River arm of Watts Bar Reservoir because of PCB contamination (TDEC 1993).

Aroclor-1260 was detected in the sunfish samples at all three locations; Beta-BHC, a pesticide, was detected in one of the two sunfish composite samples collected at CRK 32. Aroclor-1260 was detected in the catfish composite samples collected at all three locations. Only two pesticides were detected in the catfish composite sample collected at CRK 32, downstream from ORNL. A number of pesticides were detected in the catfish composite samples collected at CRK 70 (upstream from all DOE ORR inputs) and at CRK 16, downstream from all DOE inputs. Information regarding potential health impacts associated with chemical and radiological constituents detected in the sunfish and catfish are discussed in Chap. 8.

## 7.8 WHITE-TAILED DEER

Due to security concerns, no deer hunts were held on the ORR during 2001.

## 7.9 FOWL

Thirty-two species of birds were observed on the ORR in 2001, the lowest number of species observed in at least seven years. Reductions this year are related to fewer species being observed from the families *Anatidae* (ducks, geese, and swans) and *Scolopacidae* (sandpipers). On a per-survey basis, the number of observations (n = 353 per survey) made in 2001 is comparable to that of recent years (319–397 per survey).

The number of Canada geese on the ORR appears to have rebounded slightly in 2001. An apparent decade-long decline in the local Canada goose population may have finally ended. The number of geese observed per survey in 2001 was 209, compared with 156 per survey in 2000. The increased number of observations is partly because no geese were relocated off site in 2000 or 2001, unlike the five-year period from 1995 to 1999. Non-goose waterfowl observations averaged 144 per survey in 2001, down from 207 per survey in 2000, but up from the 86 non-goose waterfowl observations per survey in 1995.

### 7.9.1 Waterfowl Surveys—Canada Geese

The consumption of Canada geese is a potential pathway for exposure of members of the public to radionuclides released from Oak Ridge operations because open hunts for Canada geese are held in counties adjacent to the ORR each year. To determine concentrations of gamma-emitting radionuclides accumulated by waterfowl that feed and live on the ORR, Canada geese are rounded up each summer and are subjected to noninvasive gross radiological surveys. The 2001 ORR roundup was conducted on June 26 and 27.

From the roundup, 113 geese were subjected to live whole-body gamma scans. These geese were collected from ETTP (39), ORNL (49), Union Valley (15), and Solway Park (10). None of the 113 geese exceeded the administrative release limits.

#### 7.9.1.1 Results

The average $^{137}Cs$ concentration in the released geese was 0.2 pCi/g (0.007 Bq/g). The maximum $^{137}Cs$ concentration in the released geese was 0.88 pCi/g (0.033 Bq/g). No geese were retained in 2001. The average weight of the geese screened during the roundup was about 3.66 kg (8.1 lb). The maximum goose weight was about 5.2 kg (11.5 lb).

### 7.9.2 Turkey Monitoring

Two wild turkey hunts managed by DOE and the Tennessee Wildlife Resources Agency were held on the reservation April 7–8, 2001, and April 28–29, 2001. Hunting was open for both shotguns and archery.

#### 7.9.2.1 Results

A total of 54 birds was harvested, and only one exceeded the administrative release limits established for radiological contamination. The average $^{137}Cs$ concentration in the released turkeys was 0.11 pCi/g (0.004 Bq/g), and the maximum $^{137}Cs$ concentration in the released birds was 0.4 pCi/g (0.015 Bq/g).

Of the birds harvested, 14 were juveniles and 40 were adults. The average turkey weight was about 7.98 kg (17.6 lb). The largest tom weighed 11.2 kg (24.6 lb), had 1.0-in. spurs and a 11.2-in. beard. The longest beard (11.9 in.) was measured on a tom weighing 10.4 kg (22.9 lb).

It is assumed that about 50% of the field weight is edible meat; therefore, the average turkey would yield about 4 kg (8.8 lb) of meat. Based on the average weight, the total harvest of edible meat (53 released birds) is estimated to be about 211.5 kg (466.4 lb).