DOE/ORO-2227/R5

ENVIRONMENTAL MONITORING PLAN FOR THE OAK RIDGE RESERVATION

UNITED STATES DEPARTMENT OF ENERGY OAK RIDGE OFFICE

October 2012

Controlled copies of the *Environmental Monitoring Plan for the Oak Ridge Reservation United States Department of Energy Oak Ridge Office*, DOE/OR-2227/R5, are available on the UT-Battelle external website at: http://www.ornl.gov/sci/env_rpt/orrem_plan.shtml.

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DOE/ORO-2227/R5

Environmental Monitoring Plan for the Oak Ridge Reservation

United States Department of Energy Oak Ridge Office

Prepared for the
US Department of Energy
Oak Ridge Office

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CONTENTS

FIGURES

Figure **Page**

TABLES

Table **Page**

ACRONYMS

ACTS	Assessments and Commitments Tracking System
AMAD	activity median aerodynamic diameter
ASER	*Oak Ridge Reservation Annual Site Environmental Report*
BERA	baseline and ecological risk assessment
CAP-88	Clean Air Assessment Package (software)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CRK	Clinch River kilometer
DOE	US Department of Energy
DOE EM	DOE Office of Environmental Management
DOE ORO	DOE Oak Ridge Office
ED	effective dose
EMP	environmental monitoring plan
EMWMF	Environmental Management Waste Management Facility
EPA	US Environmental Protection Agency
EPWSD	Environmental Protection and Waste Services Division
ESS	Environmental Surveillance System
ETTP	East Tennessee Technology Park
F&O/I&CTS	Facilities and Operations/Instrumentation and Control Technical Support group
FTM	functional training matrix
HA	hectares
HQs	hazard quotients
ICPT	Integrated Contractor Procurement Team
IDMS	Integrated Document Management System
IT	Information Technology Services Division
NNSA	National Nuclear Security Administration
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
QA	quality assurance
QC	quality control
Rad-NESHAP	National Emission Standards for Hazardous Air Pollutants for Radionuclides
SBMS	Standards Based Management System
SOP	standard operating procedure
TDEC	Tennessee Department of Environment and Conservation

UCOR	URS | CH2M Oak Ridge LLC
Y-12	Y-12 National Security Complex

UNITS OF MEASURE AND CONVERSION FACTORS

Units of measure and their abbreviations

acre	acre	milliliter	mL
becquerel	Bq	millimeter	mm
centimeter	cm	million	M
curie	Ci	millirad	mrad
day	day	millirem	mrem
degrees Celsius	°C	millisievert	mSv
degrees Fahrenheit	°F	minute	min
disintegrations per minute	dpm	nanocurie	nCi
foot	ft	nephelometric turbidity unit	NTU
gallon	gal	parts per billion	ppb
gallons per minute	gal/min	parts per million	ppm
gram	g	parts per trillion	ppt
hectare	ha	picocurie	pCi
hour	h	pound	lb
inch	in.	pounds per square inch	Psi
kilogram	kg	quart	qt
kilometer	km	rad	rad
kilowatt	kW	roentgen	R
liter	L	roentgen equivalent man	rem
megawatt	MW	second	s
meter	m	sievert	Sv
microcurie	μCi	standard unit (pH)	SU
microgram	μg	ton, short (2,000 lb)	ton
millicurie	mCi	yard	yd
milligram	mg	year	Year

Quantitative prefixes

tera	$\times 10^{12}$	Pico	$\times 10^{-12}$
giga	$\times 10^{9}$	Nano	$\times 10^{-9}$
mega	$\times 10^{6}$	Micro	$\times 10^{-6}$
kilo	$\times 10^{3}$	Milli	$\times 10^{-3}$
hecto	$\times 10^{2}$	Centi	$\times 10^{-2}$
deka	$\times 10^{1}$	Deci	$\times 10^{-1}$

Unit Conversions

Unit	Conversion	Equivalent	Unit	Conversion	Equivalent
		Length			
in.	× 2.54	cm	cm	× 0.394	in.
ft	× 0.305	m	m	× 3.28	ft
mile	× 1.61	km	km	× 0.621	mile
		Area			
acre	× 0.405	ha	ha	× 2.47	acre
ft^2	× 0.093	m^2	m^2	× 10.764	ft^2
$mile^2$	× 2.59	km^2	km^2	× 0.386	$mile^2$
		Volume			
ft^3	× 0.028	m^3	m^3	× 35.31	ft^3
qt (US liquid)	× 0.946	L	L	× 1.057	qt (US liquid)
gal (US liquid)	× 3.785	L	L	× 0.264	gal (US liquid)
		Concentration			
ppm	× 1	mg/L	mg/L	× 1	ppm
		Weight			
lb	× 0.454	kg	kg	× 2.205	lb
ton (short)	× 907.185	kg	kg	× 0.001	ton (short)
		Temperature			
°C	°F = (9/5) °C + 32	°F	°F	°C = (5/9) (°F – 32)	°C
		Activity			
Bq	$\times 2.7 \times 10^{-11}$	Ci	Ci	$\times 3.7 \times 10^{10}$	Bq
Bq	× 27	pCi	pCi	× 0.037	Bq
mSv	× 100	mrem	mrem	× 0.01	mSv
Sv	× 100	rem	rem	× 0.01	Sv
nCi	× 1,000	pCi	pCi	× 0.001	nCi
mCi/km^2	× 1	nCi/m^2	nCi/m^2	× 1	mCi/km^2
dpm/L	$\times 0.45 \times 10^{9}$	$\mu Ci/cm^3$	$\mu Ci/cm^3$	$\times 2.22 \times 10^{9}$	dpm/L
pCi/L	$\times 10^{-9}$	μCi/mL	μCi/mL	$\times 10^{9}$	pCi/L
pCi/m^3	$\times 10^{-12}$	$\mu Ci/cm^3$	$\mu Ci/cm^3$	$\times 10^{12}$	pCi/m^3

1. INTRODUCTION

1.1 PURPOSE

The purpose of Oak Ridge Reservation (ORR) environmental surveillance is to characterize radiological and nonradiological conditions of the off-site environs and estimate public doses related to these conditions, confirm estimations of public dose based on effluent monitoring data, and, where appropriate, provide supplemental data to support compliance monitoring for applicable environmental regulations. This environmental monitoring plan (EMP) is intended to document the rationale, frequency, parameters, and analytical methods for the ORR environmental surveillance program and provides information on ORR site characteristics, environmental pathways, dose assessment methods, and quality management. ORR-wide environmental monitoring activities include a variety of media including air, surface water, vegetation, biota, and wildlife. In addition to these activities, site-specific effluent, groundwater, and best management monitoring programs are conducted at the Oak Ridge National Laboratory (ORNL), the Y-12 National Security Complex (Y-12), and the East Tennessee Technology Park (ETTP). These site-specific programs are not included in this ORR EMP, but results from each of these activities are discussed in the *Oak Ridge Reservation Annual Site Environmental Report* (ASER) (DOE 2011a), which is available at http://www.ornl.gov/sci/env_rpt/. ASER is required by DOE O 231.1B (DOE 2011b), *Environment, Safety and Health Reporting*, and will continue to be issued to communicate the results of surveillance monitoring conducted under this EMP and effluent monitoring and best management practice monitoring conducted by each site's operating contractor. Guidance for environmental monitoring is included in DOE O 458.1 (DOE 2011c), *Radiation Protection of the Public and the Environment*; DOE/EH-0173T (DOE 1991), *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (the Regulatory Guide); and state and federal regulations that implement federal environmental laws.

1.2 OAK RIDGE RESERVATION BACKGROUND INFORMATION

ORR is owned by the federal government and contains three major operating sites: ETTP, ORNL, and Y-12. Facilities at these sites were constructed as part of the Manhattan Project. Their primary missions have evolved over the years and continue to adapt to meet the changing research, defense, and environmental restoration needs of the United States.

B&W Technical Services Y-12 L.L.C. is the US Department of Energy (DOE) prime contractor responsible for operating Y-12, a manufacturing facility that continues to play an integral role in the nation's nuclear weapons complex. The Y-12 site is undergoing significant modernization. Key considerations of the modernization strategy include incorporation of sustainable environmental stewardship in planning, design, and construction; maintaining compliance with regulatory requirements; and coordinating modernization activities with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements. In addition to National Nuclear Security Administration (NNSA) work scope at the Y-12 site, the DOE Office of Environmental Management (DOE EM) is conducting environmental restoration activities at the site and manages the site landfills.

UT-Battelle, LLC, is the DOE prime contractor responsible for operating ORNL, DOE's largest science and energy research laboratory. ORNL is an international leader in a range of scientific areas that support the DOE mission. The six major mission roles include neutron science, energy, high-performance computing, systems biology, materials science at the nanoscale, and national security. In addition to the DOE Office of Science work at ORNL, the DOE EM program is conducting environmental restoration and waste management activities at the site.

URS | CH2M Oak Ridge LLC (UCOR) is the DOE prime contractor responsible for operations at ETTP. The mission at ETTP is environmental cleanup and reindustrialization/reuse of the assets of the shutdown gaseous diffusion plant. The ETTP mission is accomplished through the DOE EM. UCOR conducts some waste management activities at the Environmental Management Waste Management Facility (EMWMF) and ORNL.

ORR is on the US Environmental Protection Agency (EPA) National Priorities List, and environmental restoration is being addressed under a Federal Facility Agreement between EPA and the State of Tennessee.

1.3 ENVIRONMENTAL MONITORING PLAN HISTORY

DOE/OR-1066, the *Environmental Monitoring Plan for the Oak Ridge Reservation,* (DOE 1992to provide a single point of reference for the effluent monitoring and environmental surveillance programs conducted by the DOE contractor at the major operating sites and at ORR areas outside specific facility boundaries. The ORR effluent monitoring and environmental surveillance programs have historically collected and analyzed data to assess the impacts of ORR activities on the environment and human health. Since 1992, DOE/OR-1066 was revised six times; the last revision was completed in 2003.

As a result of a decision by the DOE Oak Ridge Office (DOE ORO) to provide separate environmental monitoring plans for site and ORR-level activities, DOE/ORO-2227 was issued to replace DOE/OR-1066/R5 (DOE 2003), which has been archived.

The Tennessee Oversight Agreement (TDEC 2011) between the State of Tennessee and DOE commits DOE to maintaining the ORR-wide EMP and provides the state the opportunity to review ORR EMP modifications before implementation. Additional data are available through the projects related to DOE EM environmental restoration and/or waste management efforts such as the Water Resources Restoration Program, which evaluates remedial project effectiveness by comparing baseline information with post-remediation data and specified performance goals. This and other special studies carried out on ORR in support of remediation projects provide data supplemental to the routine, historical environmental effluent and surveillance monitoring conducted by the individual site programs.

2. SITE CHARACTERISTICS

The city of Oak Ridge lies within the Great Valley of Eastern Tennessee between the Cumberland and Great Smoky Mountains and is bordered by the Clinch River (Fig. 2.1). The Cumberland Mountains are 16 km to the northwest; the Great Smoky Mountains are 51 km to the southeast.

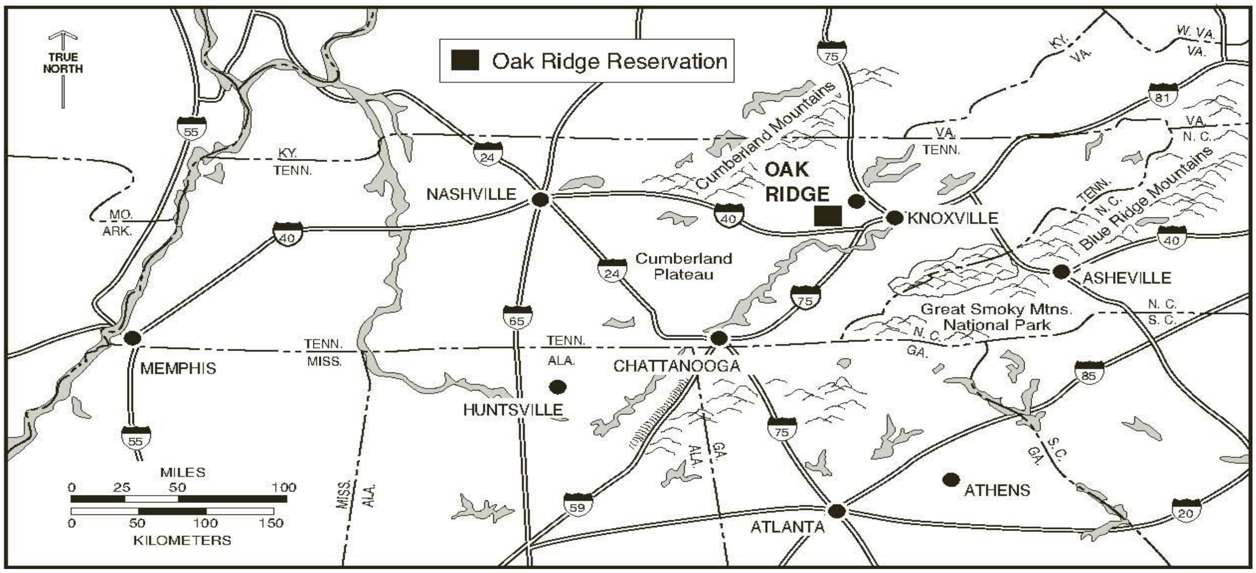

Fig. 2.1. Location of the city of Oak Ridge.

ORR encompasses about 33,515 acres (13,563 ha) of mostly contiguous land owned by the federal government and under the management of DOE (Fig. 2.2). Most of it lies within the corporate limits of the city of Oak Ridge; some of the area west of ETTP lies outside the city limits. About 11,533 acres (4,667 ha) of ORR is situated in Anderson County, and about 22,008 acres (8,906 ha) is in Roane County. The population of the 10-county region surrounding ORR is about 946,830 with less than 2% of the labor force employed on ORR. Other municipalities within about 30 km (18.6 miles) of the reservation include Oliver Springs, Clinton, Lake City, Lenoir City, Farragut, Kingston, and Harriman (Fig. 2.3).

Knoxville, the major metropolitan area nearest Oak Ridge, is located about 40 km to the east and has a population of about 185,100. Except for the city of Oak Ridge, the land within 8 km of ORR is semirural and is used primarily for residences, small farms, and cattle pasture. Fishing, hunting, boating, water skiing, and swimming are popular recreational activities in the area.

The topography, geology, hydrology, vegetation, and wildlife of ORR provide a complex and intricate array of resources. Detailed information regarding the natural resources and physical characteristics of ORR are available at http://www.esd.ornl.gov/facilities/nerp/ORNL-TM2006-110.pdf (Parr and Hughes 2006).

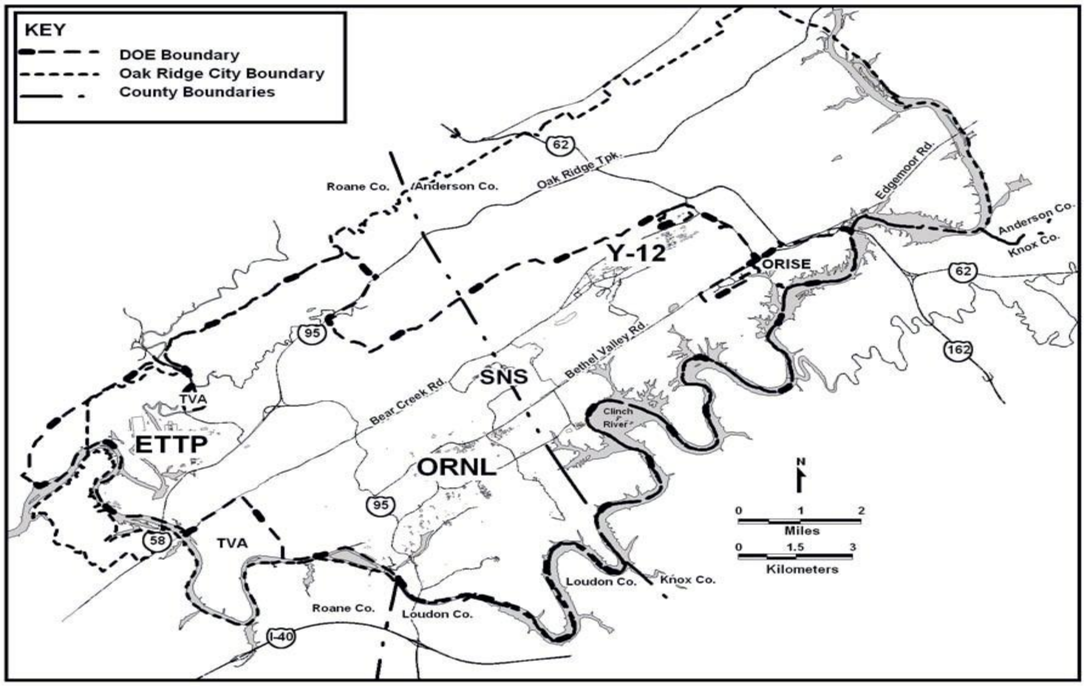

Fig. 2.2. Oak Ridge Reservation.

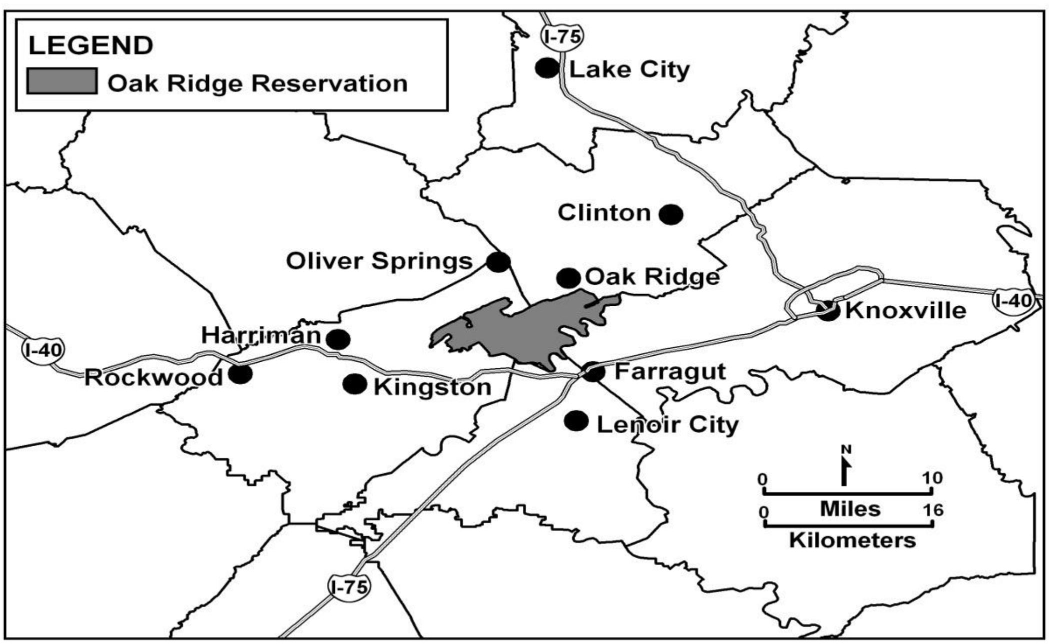

Fig. 2.3. Locations of towns nearest the Oak Ridge Reservation.

3. ENVIRONMENTAL PATHWAYS AND DOSE CALCULATIONS

3.1 INTRODUCTION

Operations at the three ORR facilities may emit airborne and waterborne radionuclides and chemicals. After release, these substances migrate throughout the environment by applicable transport mechanisms, and eventually some may reach and affect humans. This section describes the methods used to characterize dispersion of released radionuclides and to estimate human exposures to and intakes of the dispersed substances. Human exposures to radionuclides are quantified in terms of total effective dose (ED) to maximally exposed off-site members of the public and the entire population residing within 80 km of ORR and each facility on ORR. For chemical releases into the environment, regulatory standards and facility specific permits typically specify release concentration criteria and limits and do not require dose or risk estimates. Therefore, only exposures from drinking water and consuming fish, characterized by hazard quotients (HQs) for noncarcinogenic chemicals and risk estimates for carcinogenic chemicals, are evaluated.

3.2 CONFORMANCE WITH STANDARDS FOR PUBLIC DOSE CALCULATIONS

Dose calculations are performed to demonstrate compliance with EPA's *National Emission Standards for Hazardous Air Pollutants: Standards for Radionuclides* (40 CFR 61, Subpart H) (Rad-NESHAP) and DOE O 458.1. Models selected to assess environmental transport of and human exposures to substances released from ORR are appropriate for the physical and environmental situation encountered and for the data available to characterize the situation. Emission monitoring and compliance procedures for DOE facilities [40 CFR 61.93(a)] require the use of the Clean Air Assessment Package (CAP-88) (Version 3) model, or other approved procedures, to calculate doses to members of the public. CAP-88 is used to estimate doses from ORR radionuclide airborne emissions. CAP-88 PC uses a modified Gaussian plume equation to estimate the average dispersion of radionuclides released from emitting sources. This model includes some limiting criteria and assumptions. For instance, flat terrain is assumed, and it is recommended that the model be used for receptors greater than 100 m from the source. The dose estimates are applicable only to low level chronic exposures because the health effects and dosimetric data are based on low level chronic intakes (EPA 2007). Some radionuclides are not included in the database; in these cases, EPA Region 4 has approved the use of surrogate radionuclides.

The Liquid Annual Dose to All Persons computer code, Excel version (LADTAP XL; Hamby 1991), with modifications applicable to ORR, is used to calculate individual and population doses for waterborne exposure pathways. When radionuclide concentrations are measured directly in specific water bodies, the measured values are used to calculate concentrations in fish and shoreline concentrations. For downstream and other water bodies for which direct measurements are not available, concentrations are calculated using ORR radionuclide discharge and flow rate data. Discharge data may be in the form of (1) total activities discharged per year (Ci/year) or (2) activities per unit volume of water discharged (Ci/L) plus the total volume of water discharged per year (L/year).

3.3 MAJOR CONSIDERATIONS

The EPA Rad-NESHAP standard limits the annual ED to a member of the public from radionuclides released in the air to 10 mrem (0.1 mSv). DOE O 458.1 states that DOE radiological activities will not cause a total ED exceeding 100 mrem (1 mSv) in a year, an equivalent dose to the lens of the eye exceeding 1,500 mrem (15 mSv) in a year, or an equivalent dose to the skin or extremities exceeding 5,000 mrem (50 mSv) in a year from all sources of ionizing radiation and exposure pathways that could contribute significantly to the total dose. Members of the public have the potential to receive radiation doses from internal and external exposures due to materials released to the atmosphere, ground and surface waters, soils and sediment, and cleared property. In addition, some members of the public may receive external radiation doses through direct external irradiation and by radiation emanating from buildings and other objects (e.g., drum storage and burial areas) located within facility and ORR boundaries.

Table 3.1 lists environmental release and transport mechanisms that apply to emissions from ORR.

Table 3.1. Environmental Transport Mechanisms Applicable to Releases from the Oak Ridge Reservation

Releases to air	Remain suspended in air Deposit on ground Deposit on vegetation Deposit on water surfaces
Releases to surface water	Remain dissolved or suspended in water Deposit in sediments Infiltrate to groundwater
Releases to groundwater	Remain dissolved or suspended in water Flow into surface water
Radionuclides in objects	Remain in fixed sources
Releases to ground surfaces	Remain on ground Dissolve or suspend in surface water Infiltrate to groundwater Become suspended in air

Section 3.4 discusses the environmental transport, food chain, and dosimetric models used to evaluate human exposures due to ORR operations. Input data to the models will be either site specific (e.g., collected under the environmental monitoring and surveillance activities described in this EMP) or generic (default values). In the absence of nuclide-specific data only bounding dose calculations will be made.

Models and computer codes for evaluating public exposures to released radionuclides will be selected based on the regulatory requirements, the applicability of the model to the situation being evaluated, the degree to which the model has been documented and verified, and the availability of the data needed to implement the model. Unless otherwise required by regulatory or legal mandates, the simplest model needed to characterize a situation will be used.

3.4 TRANSPORT MODELS

This section describes the methods used to characterize environmental concentrations of materials released from ORR. In some cases transport models are used to calculate concentrations; in other cases measured concentrations are available. When both predicted and measured concentrations are available, measured concentrations are compared to modeling predictions.

3.4.1 Atmospheric Transport

Contaminants released into the atmosphere may remain suspended in air and may deposit on soil, vegetation, and water surfaces (Table 3.1). Atmospheric transport models are used to calculate annual average ground-level airborne concentrations of contaminants and associated rates of deposition on the ground and vegetation.

Calculations of airborne concentrations and deposition rates of radionuclides released to the atmosphere are estimated using CAP-88 PC, which is specified by EPA for demonstrating compliance with the Rad-NESHAP standard (EPA 2007). The CAP-88 computer codes are used to calculate annual average ground-level air concentrations and deposition rates at selected environmental locations. The locations are selected to (1) allow identification of the maximally exposed individual for each source, each facility, and the entire ORR and (2) characterize exposures of the entire population within 80 km of ORR**.**

When possible, site-specific parameter values will be used to quantify radionuclide releases [e.g., release rates, particle size in terms of activity median aerodynamic diameter (AMAD), and chemical composition], meteorological variables (e.g., wind speed and direction, atmospheric stability class, air temperature, rainfall rate, and mixing layer height), and source parameters (e.g., release height, stack diameter, exit gas velocity and temperature, and location with respect to exposed persons). These parameters are obtained from data collected under the environmental monitoring, sampling, and surveillance programs conducted on ORR. An AMAD of 1.0 μm is currently the only particle size available in CAP-88 PC. If solubility data are not provided, the default solubility class via inhalation is used unless otherwise requested.

Doses calculated from ambient air monitoring data are compared to doses calculated by CAP-88 PC (EPA 2007) at air monitor locations to verify that the atmospheric dispersion codes are not significantly underestimating airborne concentrations of radionuclides around ORR.

3.4.2 Surface Water Transport

Contaminants released to surface water may remain dissolved or suspended in the water, be deposited in sediments, be deposited on the ground or on vegetation by irrigation, or infiltrate to groundwater. Because opportunities for direct human exposure to sediments are limited and irrigation is not widely practiced along the Clinch River system, sedimentation and irrigation pathways are considered less significant in modeling human exposures than other more probable pathways such as air inhalation or immersion.

Drinking water and creel survey data associated with the Clinch-Tennessee River system are collected each year; these data are used to quantify drinking water populations and fish harvests. Data on the population served from water treatment plants located on the Clinch River and downstream of ORR are obtained annually from the Tennessee Department of Environment and Conservation (TDEC) Division of Water Supply (Regions III and IV). The creel data are obtained from the Tennessee Reservoir Creel Report prepared annually by the Tennessee Wildlife Resources Agency. The creel data are obtained annually from the Tennessee Wildlife Resources Agency. The creel data provide information which is used to estimate the number of persons consuming fish from these water bodies.

Quantities of radionuclides released to surface waters are determined by sampling data collected at points of discharge. Concentrations of radionuclides in surface waters accessible to the public are also quantified by sampling results. A simple dilution model is used to calculate radiation doses at sampling and downstream locations.

3.4.3 Environmental Pathway Models

This section describes the methods that will be used to characterize mechanisms for human uptake and exposure. Both modeling results and sampling data will be used, as available, to estimate contaminant concentrations in media and foods to which humans may be exposed. National Council on Radiation Protection and Measurements (NCRP 1996) and/or Regulatory Guide 1.109 models (NRC 1977) will be used unless better site-specific models and data are available.

3.4.4 Contaminants in Air

Potential direct pathways of human exposure to airborne contaminants include inhalation (breathing) and immersion. Indirect pathways, which are discussed in the following sections, involve deposition of contaminants on soil, crops, and water and uptake by terrestrial animals.

The CAP-88 computer code is used to calculate total EDs from inhalation of and immersion in air containing radionuclides. CAP-88 uses air concentrations at each selected location (Sect. 3.4.1) and NCRP 123 pathway models (NCRP 1996) to calculate quantities of radionuclides inhaled by a person remaining at a selected location for the entire year.

The inhaled quantities and air concentrations are combined with air inhalation and immersion dose coefficients to calculate an ED to an individual at each selected location. Dose coefficients are chosen based on particle size and solubility class. In the absence of actual data, a 1.0 µm particle size and the default solubility class via inhalation are assumed. CAP-88 also calculates the collective ED from inhalation and immersion to the population residing within 80 km of ORR.

3.4.5 Contaminants in Surface Water

Potential direct pathways of human exposure to contaminants in surface waters include ingestion (drinking water), eating fish, immersion (swimming, wading, showering), direct irradiation (boating, skiing, shoreline use), and inhalation (breathing water vapor while showering). Indirect pathways involve deposition on soil and crops by irrigation, deposition in sediments, uptake by fish, and ingestion by terrestrial animals.

The direct pathways for human exposure to contaminants from surface waters on or near ORR which are evaluated for dose estimates include drinking water, swimming, boating, and shoreline use. *Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR PART 50, Appendix I, Regulatory Guide 1.109* (NRC 1977) models are used to estimate radiation doses due to immersion in and direct irradiation from surface water. Both measured and calculated radionuclide concentrations are used in the calculations, which are performed using the LADTAP XL computer code (Hamby 1991) or its equivalent.

For radionuclides, EDs are calculated for drinking water at nearby drinking water plants. Data from water samples collected before entry into a drinking water plant are used; water plant outputs are not sampled. A population dose estimate is made for the entire population residing within 80 km of ORR.

For chemicals, HQs for noncarcinogenic chemicals and risk estimates for carcinogenic chemicals are calculated. Both chemical and radiation dose estimates from drinking water will be performed using measured concentrations in drinking water when such concentrations are available.

3.4.6 Contaminants in Soil

Contaminants may reach soil by deposition of airborne materials, deposition of materials contained in irrigation water, and direct dumping. Potential direct pathways of human exposure to contaminants in soil include inhalation of resuspended soil, ingestion of soil, and direct exposure to (being near or in contact with) the soil. Indirect pathways involve uptake of contaminants from soil by crops.

The resuspension of soil and soil ingestion pathways are not evaluated because their potential consequences are considered insignificant relative to those from inhalation of newly emitted contaminants and ingestion of foodstuffs. The CAP-88 computer code is used to calculate EDs due to direct irradiation by radionuclides on soil. CAP-88 calculates concentrations of radionuclides at each selected location as if deposition has occurred for 100 years. A person is assumed to remain unprotected at a location for the entire year. Ground concentrations and exposure times are combined with the dose coefficients for exposure to a contaminated ground surface to calculate EDs to an individual at each selected location. CAP-88 is used also to calculate the collective ED to the population residing within 80 km of ORR from exposure to contaminated ground surfaces.

3.4.7 Contaminants in or on Vegetation

Contaminants may reach vegetation (food and feed crops) by deposition of airborne materials, uptake from soil, and deposition of materials contained in irrigation water. The significant potential direct pathway for human exposure to contaminants in food crops is ingestion. Indirect pathways involve ingestion of feed crops by terrestrial animals.

The CAP-88 computer code uses NCRP 123 models and parameters to estimate concentrations of radionuclides in vegetables at selected locations due to deposition from the air and uptake from soil. Other NCRP 123 models and parameters (e.g., EPA 2009) are used to estimate human intakes of the vegetables and, thus, of the radionuclides. The code treats radionuclide deposition as if it had occurred for 100 years. The radionuclide intakes are combined with dose coefficients for ingestion to calculate total EDs to an individual residing at each location and the entire population residing within 80 km of ORR.

The ORR environmental surveillance program includes sampling of radionuclides in selected food crops. These sampling data and the intake models described above will be used to provide additional estimates of doses from ingestion of locally grown foods.

3.4.8 Contaminants in Terrestrial Animals and Fish

Contaminants may accumulate in terrestrial animals from eating contaminated feed, drinking contaminated water (not modeled), and breathing contaminated air (not modeled). Contaminants may accumulate in fish when they eat contaminated foods. Potential direct pathways for human exposure to contaminants in terrestrial animals and fish are eating meat and fish and drinking milk.

The CAP-88 computer code uses NCRP 123 models and parameters to estimate concentrations of radionuclides in beef and milk due to consumption of feed contaminated with radionuclides released to the atmosphere. Other NCRP models and parameters (EPA 2009) are used to estimate human intake values of milk and beef and, thus, of the radionuclides. The radionuclide intake values are combined with the dose coefficients for ingestion to calculate EDs to an individual residing at each location and to the entire population residing within 80 km of ORR.

A second set of estimates of potential doses is based on measured contaminant concentrations in food products and aquatic or terrestrial organisms. Maximum individual doses are calculated for ingestion of milk containing measured quantities of radionuclides and of fish containing measured quantities of radionuclides. Potential doses from ingesting deer, turkey, and selected water fowl (e.g., geese) harvested legally from the reservation are also calculated.

3.5 RADIONUCLIDES IN OBJECTS

Sources of potential exposure to the public from radiation emanating from radionuclides contained in structures and other objects will be evaluated. Based on measured exposure rates, theoretical EDs are calculated to hypothetical, maximally exposed individuals. Calculated doses will be modified to reflect any changes in the measured dose rates. When sources of direct radiation are identified, appropriate exposure scenarios will be devised and doses estimated.

3.6 INTERNAL DOSIMETRY MODELS

The dose calculation results are reported in terms of total ED, the sum of EDs received during the year from external exposures, and the 50-year committed EDs from intake of radionuclides during the year. The dose coefficients are obtained from the following sources and any revisions thereto. For calculations using CAP-88 PC (Version 3), the dose coefficients supplied with the package are used. Factors to be used in all other calculations include ED coefficients for the reference person given in DOE STD-1196-2011, *DOE Derived Concentration Technical Standard* (DOE 2011d); EPA 402-R-99-001, Federal Guidance Report No. 13, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides* (EPA 1999); and EPA 402-R-93-081, *External Exposure to Radionuclides in Air, Water, and Soil* (EPA 1993). Although not used in specific dose calculations, the derived concentration standards given in DOE STD-1196-2011 (DOE 2011d) may be used to infer the acceptability or magnitude of doses associated with measured concentrations of radionuclides in environmental media.

3.7 RADIATION DOSE TO NATIVE AQUATIC AND TERRESTRIAL ORGANISMS

DOE O 458.1 (DOE 2011c) states that procedures and practices should be established and implemented to ensure that biota are protected and radiological activities that have the potential to impact the environment must be conducted in a manner that protects populations of aquatic animals, terrestrial plants, and terrestrial animals in local ecosystems from adverse effects due to radiation and radioactive material released from DOE operations. DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002) establishes the dose limit of 0.1 rad/day for terrestrial animals and 1 rad/day for aquatic organisms and terrestrial plants.

To demonstrate compliance with these limits, the method described in DOE-STD-1153-2002 is used to estimate absorbed dose rates to aquatic organisms and terrestrial organisms. The absorbed doses are generally calculated using the RESRAD-BIOTA computer code (DOE 2004), but other methods may also be used. The RESRAD-BIOTA code is also available as a screening tool to estimate whether doses to terrestrial organisms exceed the recommended absorbed dose rate of 0.1 rad/day.

4. OAK RIDGE RESERVATION ENVIRONMENTAL SURVEILLANCE

In addition to environmental monitoring conducted at the three major DOE ORR installations, reservationwide surveillance monitoring is performed to directly measure radiological and nonradiological parameters in environmental media adjacent to the facilities. Data from the reservation surveillance programs are analyzed to assess the environmental impact of DOE operations on the entire reservation and the surrounding area.

4.1 AMBIENT AIR

4.1.1 Purpose and Scope

Ambient air monitoring is performed to directly measure radiological parameters in the ambient air adjacent to the facilities and supplements data from exhaust stack monitoring conducted at the DOE and NNSA Oak Ridge facilities. Ambient air monitoring also provides a means to verify that fugitive and diffuse sources are insignificant, serves as a check on dose modeling calculations, and would allow determination of contaminant levels at monitoring locations in the event of an emergency.

4.1.2 Sampling Locations

The ORR ambient air monitoring network includes eight stations sited on or near the reservation and one reference station in an area not affected by Oak Ridge operations (Fig. 4.1). Atmospheric dispersion modeling was used to select appropriate sampling locations. Because of changes in operations, land ownership, and accessibility of areas that once were not available to the public, the ambient air locations and parameters are to be reviewed as remediation projects are completed.

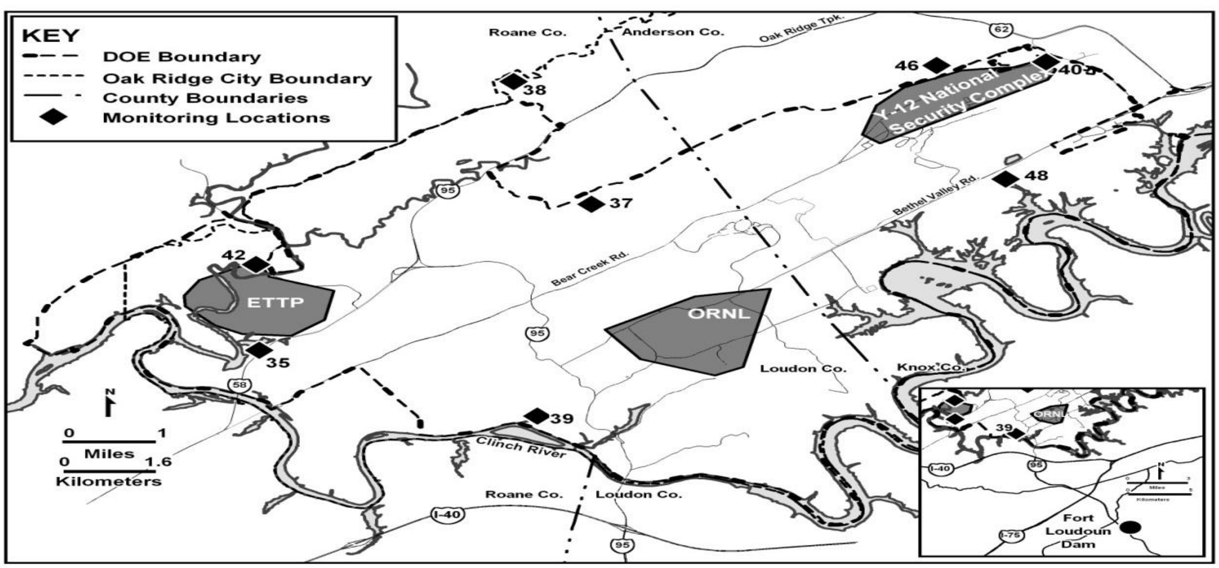

Fig. 4.1. Locations of Oak Ridge Reservation ambient air monitoring stations.

4.1.3 Frequency

Continuous sampling is performed with weekly to biweekly collection of sampling media. Quarterly composites are submitted for laboratory analyses and analyzed as described in Table 4.1.

Table 4.1. Ambient Air Parameters and Methods

Parameter	Media	Method	MDA[a]
Gross alpha	Glass-fiber filter	EPA 900.0	4.7 pCi
Gross beta	Glass-fiber filter	EPA 900.0	7.5 pCi
Gamma scan[b]	Glass-fiber filter	EPA 901.1	Lab specific
Alpha spec[c]	Glass-fiber filter	Lab Specific	Lab specific
Tritium	Silica gel	EPA 906.0	100 pCi

[a] Minimum detectable activity
[b] Report ^{40}K and all detectable man-made isotopes
[c] Report ^{234}U, ^{235}U, and ^{238}U

4.1.4 Parameters and Methods

The sampling system consists of two separate instruments, one for particulates and one for tritiated water vapor. Particulates are captured on glass-fiber filters in a high volume air sampler. Tritiated water vapor is captured using a sampler that 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 (Table 4.1).

4.2 EXTERNAL GAMMA RADIATION

4.2.1 Purpose and Scope

Members of the public could hypothetically be exposed directly to gamma radiation from radionuclides released into the environment; previously released radionuclides deposited on soil and vegetation or in sediments; radiation-generating facilities, especially high-energy accelerators; and the storage of radioactive materials.

4.2.2 Sampling Locations

Direct radiation levels will be monitored continuously at five ORR ambient air stations (39, 40, 42, 46, 48) and the Fort Loudoun reference location (Fig. 4.2).

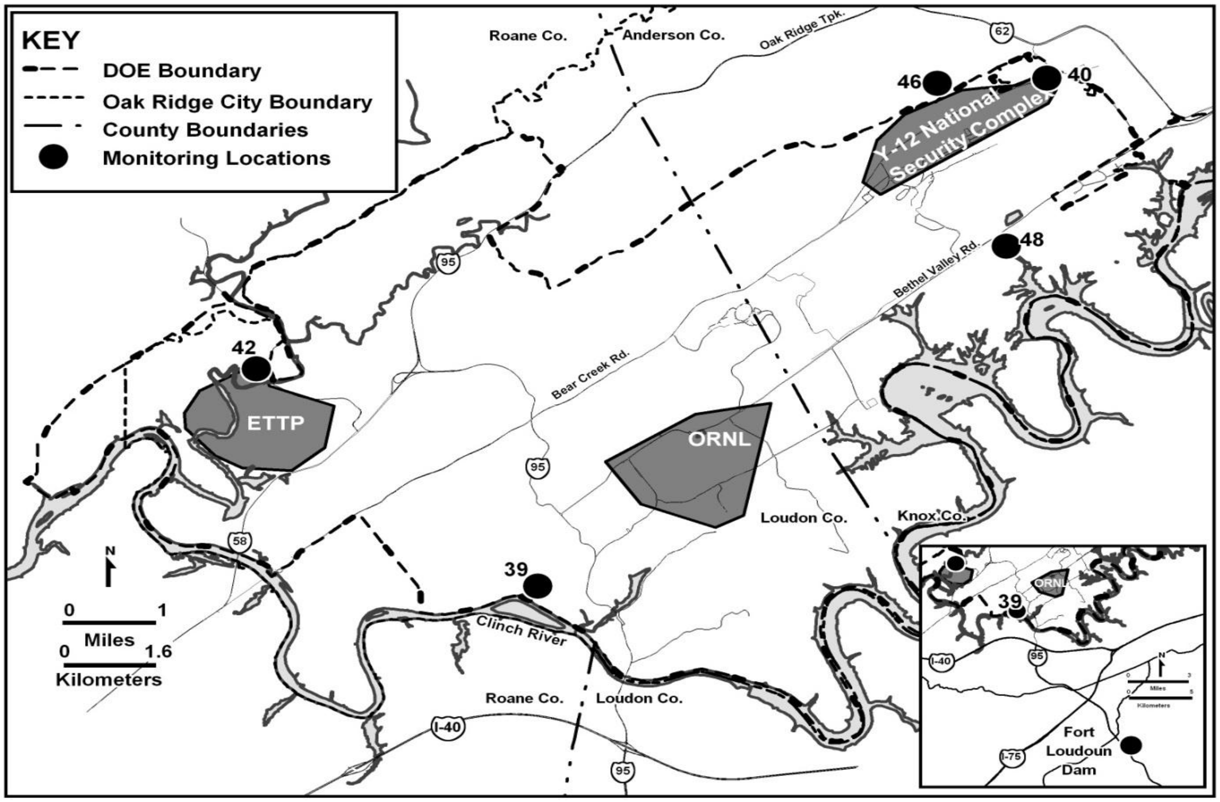

Fig. 4.2. External gamma radiation monitoring locations on the Oak Ridge Reservation.

4.3 SURFACE WATER

4.3.1 Purpose and Scope

The ORR surface water surveillance monitoring program includes quarterly monitoring at five locations on the Clinch River. This program is conducted in addition to surface water monitoring required for National Pollutant Discharge Elimination System and DOE order compliance and other facility or site-specific monitoring activities.

4.3.2 Sampling Locations

The five surface water sampling locations are as follows (Fig. 4.3).

- Clinch River above DOE inputs at Oak Ridge water supply intake [Clinch River kilometer (CRK) 66]
- Clinch River at Knox County water supply intake (CRK 58)
- Clinch River downstream from ORNL at Jones Island (CRK 32)
- Clinch River at ETTP water supply intake (CRK 23)
- Clinch River downstream of DOE inputs at Brashear Island (CRK 16)

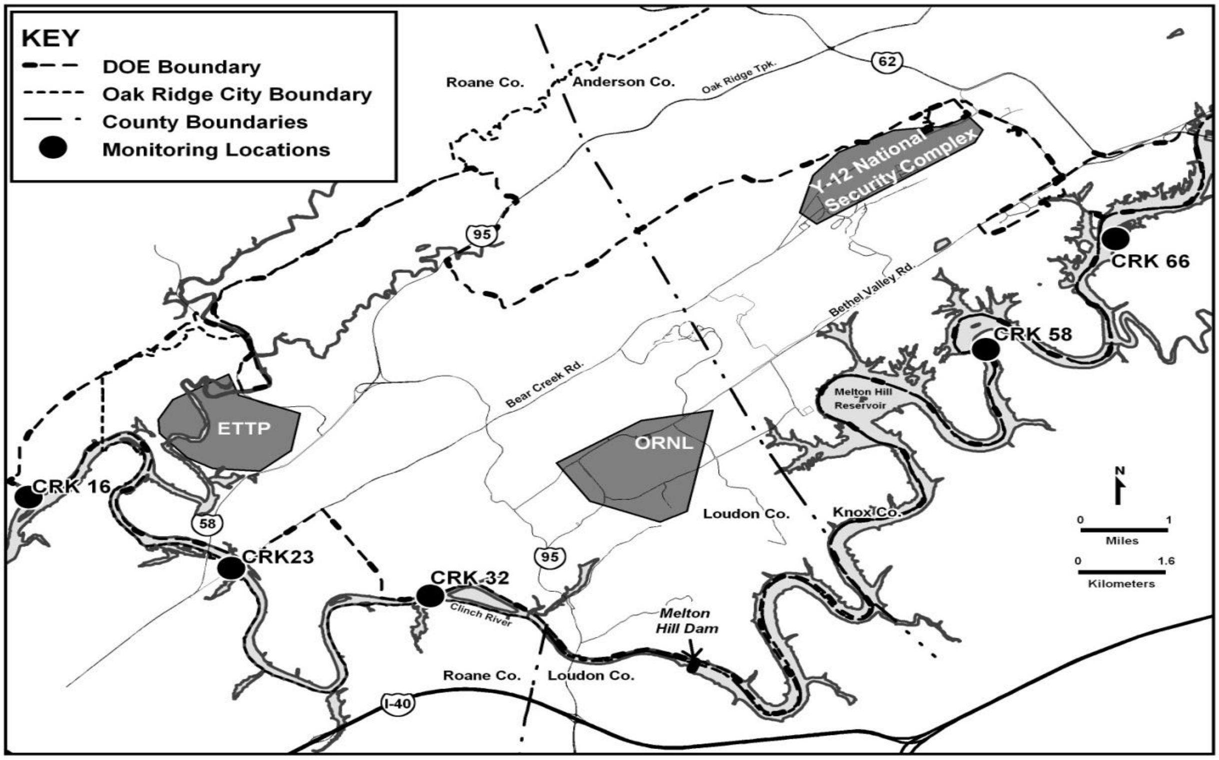

Fig. 4.3. Surface water sampling locations.

4.3.3 Parameters and Methods

Table 4.2 indicates the parameters included in the surface water program, monitoring locations, and srequired analytical methods.

Table 4.2. Surface Water Parameters and Methods

Location	Parameter	Suggested Method
CRK[a] 16, 23, 66	Mercury	EPA 7471
All	Gross alpha[b]	EPA 900.0
All	Gross beta[c]	EPA 900.0
All	Gamma scan	EPA 901.1
CRK 32, 66	Total strontium	EPA 905.0
All	Tritium	EPA 906.0
All	Field measurements[d]	NA

4.3.3.1 [a] CRK = Clinch River kilometer.

[b] Specific isotopic analyses are performed when gross alpha measurements exceed 15 pCi/L (national primary drinking water standard).
[c] Specific isotopic analyses are performed when gross beta measurements exceed 50 pCi/L and are not accounted for by total radioactive strontium activity.
[d] Temperature, dissolved oxygen, and pH.

4.4 VEGETATION

4.4.1 Vegetables

4.4.1.1 Purpose and Scope

Food crops are sampled annually from garden locations which have the potential to be affected by airborne releases from ORR to evaluate possible radiation doses received by consumers as a result of DOE activities in the area. Samples are also obtained from a reference location in an area not impacted by ORR activities for comparison. Crops that represent broad-leaf systems (lettuce or turnip greens), root-plant-vegetable systems (tomato), and root system vegetables (turnips) are obtained from each location.

4.4.1.2 General Locations

The following general locations are included if available.

- Reference location
- East of ORR (Claxton Area)
- North of ORR and northeast of ETTP
- Southwest of ORNL (Jones Island area)
- Southeast of ORNL (Gallaher Bend area)
- North of Y-12 (Scarboro community)

4.4.1.3 Parameters, Methods, and Detection Levels

All samples are analyzed for gross alpha, gross beta, gamma emitting radionuclides, and specific radionuclides that contribute ≥0.1 mrem to the ORR ED (Table 4.3).

Table 4.3. Vegetable Parameters, Methods, and Detection Levels

Parameter	Method	Detection Level
Gross alpha	EPA 900.0	0.7 pCi/kg
Gross beta	EPA 900.0	20 pCi/kg
Gamma spec	EPA 901.1	^{7}Be - 2.1E4 pCi/kg ^{40}K - 0.002 pCi/kg
^{234}U	Lab specific	10 pCi/kg
^{235}U	Lab specific	10 pCi/kg
^{238}U	Lab specific	10 pCi/kg

4.4.2 Milk

An availability assessment of potential dairy operations in the areas surrounding ORR will be performed annually, and milk samples will be collected bimonthly if dairy operations are identified in areas potentially impacted by ORR activities. The parameters, methods, and detection levels applicable to milk samples, when available, are presented in Table 4.4.

Table 4.4. Milk Parameters, Methods, and Detection Levels

Parameter	Method	Detection Level
Tritium	EPA 906.0	710 pCi/l
Total rad strontium	EPA 905.0	2.1 pCi/l
Gamma scan[a]	EPA 901.1	^{7}Be - 75 pCi/L ^{40}K - 100 pCi/L

[a] Report ^{40}K, ^{7}Be, and all detectable man-made isotopes.

4.5 WILDLIFE MONITORING

The ORR Surveillance Program will continue to conduct annual screenings of Canada geese and to analyze data collected by wildlife management staff from radiological screenings and samples of deer and turkey harvested during hunts on ORR as available.

4.5.1 Deer Hunts

Deer hunts are held annually on ORR. Deer are screened for radioactivity before release to hunters. These screening data and any data available from laboratory analyses will be used to estimate doses to consumers of deer harvested on ORR.

4.5.2 Turkey Hunts

Turkey hunts are also held annually on ORR. Turkeys are screened for radioactivity before release to hunters. These screening data and any data available from laboratory analyses will be used to estimate doses to consumers of turkey harvested on ORR.

4.5.3 Goose Roundup

An annual goose roundup is conducted on the reservation in the June–July timeframe as part of the ORR Surveillance Program. Canada geese undergo live screenings for gamma emitting radionuclides to confirm that radionuclide levels remain negligible. No geese will be sacrificed for laboratory analyses based on historical results, which demonstrate multiyear correlations between field radiological screening results and laboratory analyses.

4.5.4 Fish

4.5.4.1 Purpose and Scope

Members of the public could be exposed to contaminants originating from DOE ORR activities through consumption of fish caught in area waters. To monitor this human exposure pathway, sunfish and catfish are collected annually from three locations on the Clinch River, and edible fish flesh is analyzed for selected parameters (Fig. 4.4).

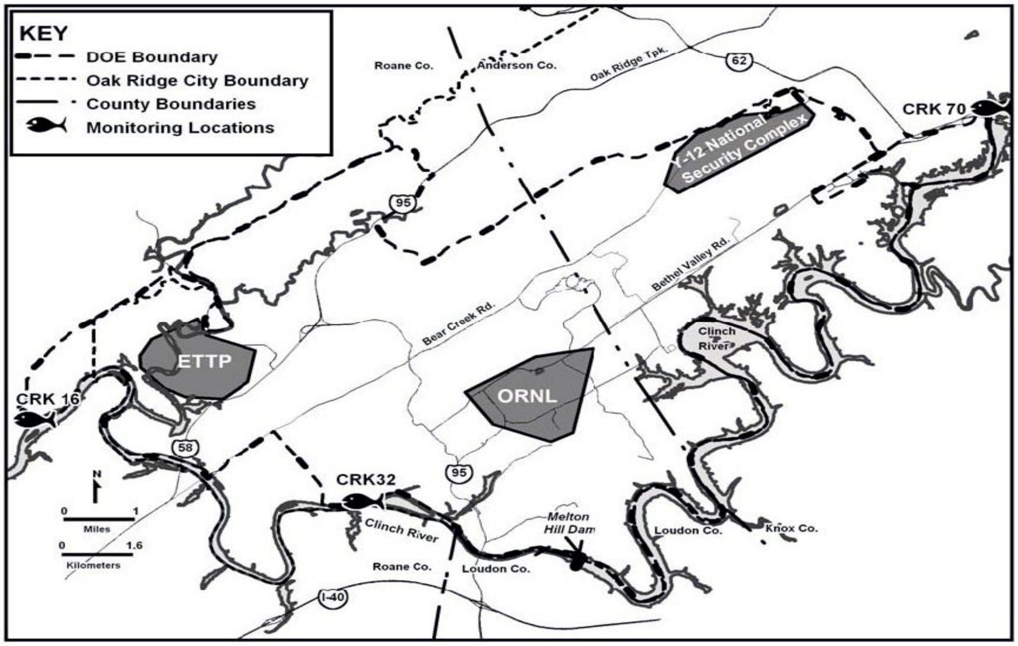

Fig. 4.4. Fish sampling locations for the Oak Ridge Reservation.

4.5.4.2 Locations

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

4.5.4.3 Parameters, Methods, and Detection Levels

Table 4.5 indicates the parameters that are included in the fish sampling program, required analytical methods, and analytical detection levels.

Table 4.5. Fish Parameters, Methods, and Detection Levels

Parameter	Method	Detection Level
Tritium	EPA 906.0	1.2E4 pCi/kg
Total radiostrontium	EPA 905.0	31 pCi/kg
Gross alpha	EPA 900.0	1.1 pCi/kg
Gross beta	EPA 900.0	31 pCi/kg
Gamma spec	EPA 901.1	
Mercury	EPA 7471	0.04 mg/kg
Metals	EPA 6010/6020	
PCBs	EPA 8082	

4.6 ADDITIONAL MONITORING

DOE O 458.1 (DOE 2011c) states that procedures and practices should be established and implemented to ensure that biota are protected and radiological activities that have the potential to impact the environment are conducted in a manner that is protective of populations of aquatic animals, terrestrial plants, and terrestrial animals in local ecosystems. DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, (DOE 2002) establishes the dose limit of 0.1 rad/day for terrestrial animals and 1 rad/day for aquatic organisms and terrestrial plants.

As a result of CERCLA and programs initiated to remediate the effects of hazardous waste disposal on ORR, baseline and ecological risk assessments (BERAs) were conducted between 1997 and 2000 for all major disposal sites at the three DOE facilities on ORR. These sites included Bethel Valley and Melton Valley at ORNL, Bear Creek Valley and upper East Fork Poplar Creek at Y-12, and ETTP. In some cases, additional BERAs were conducted for specific waste sites (e.g., selected disposal ponds and burial grounds at ETTP in 1995, sitewide residual contamination in soils and Mitchell Branch at ETTP in 2006, Melton Valley Watershed in 2004). The results of these BERAs served as the basis for identifying additional sampling needs.

4.6.1 Sampling Strategy

A two prong sampling strategy was developed: (1) initial sampling to estimate doses based on the radionuclide concentrations in soil followed by (2) site-specific sampling of biota if the benchmark of 0.1 rad/day for terrestrial biota is exceeded. In the initial sampling phase, doses were estimated for soil invertebrates and small mammals such as shrews and mice (*Peromyscus leucopus*). In cases where results indicated terrestrial biota could be at risk from exposure to radionuclides, site-specific sampling of mice was conducted. Doses to wide-ranging terrestrial wildlife species are unlikely to exceed the terrestrial biota dose limit and will not be sampled.

4.6.2 Sampling Locations

Soil sampling initiated in 2007 focused on unremediated areas such as floodplains and some upland areas. Floodplains are often downstream of contaminant source areas and are dynamic systems where soils are eroding in some areas and being deposited in others. Based on the soil sampling results, biota sampling was conducted in 2009 at the confluence of Melton Branch and White Oak Creek and in the floodplain upstream of White Oak Lake. The absorbed dose rates to mice and hispid cotton rats (*Sigmodon hispidus*) sampled in these areas was less than 0.1 rad/day. Soils from some of the biosolid applications areas where nitrates have been detected at elevated levels will be included in future sampling efforts. Other soil and tissue sampling will be dependent on activities in Melton Valley that could significantly impact the doses to terrestrial biota.

Soil sampling was conducted in the following areas.

White Oak Creek floodplain and upland location. The sampling locations were located at the confluence of Melton Branch and White Oak Creek, White Oak Creek floodplain upstream of White Oak Lake, and off Burial Ground Road and Seepage Pit Loop.

Bear Creek Valley floodplain. The sampling locations were on Bear Creek floodplain below the Bone Yard and near EMWMF.

Mitchell Branch floodplain. The sampling locations were Mitchell Branch floodplain near the Central Neutralization Facility and the Laydown Yard and where Mitchell Branch enters Poplar Creek.

Background locations. Reference samples were obtained from Gum Hollow, which represents Conasauaga soils, and from a location near Bearden Creek, which represents Chickamauga soils.

At all soil sampling locations, with the exception of areas in the White Oak Creek floodplain, samples passed either the initial-level screening, (using default parameters and maximum soil concentrations) or second-level screening (using default parameters and average soil concentrations).

Based on the biota doses estimated using soil sampling results, site-specific sampling of biota on the White Oak floodplain and a background location was conducted in 2009. Deer mice (*Peromyscus maniculatus*) were selected as the representative species.

4.6.3 Parameters

Soil analyses focused on radionuclides that had been found in previous sampling conducted in the same areas (Table 4.6).

Table 4.6. Soil Sampling for Initial Terrestrial Biota Dose Screening

Location	Parameters
White Oak Creek floodplain	^{241P}Am, ^{244}Cm, ^{60}Co, ^{137}Cs, ^{40P}K, $^{239/240P}$Pu, ^{90}Sr, ^{234}U, and ^{238}U.
Bear Creek Valley floodplain	^{234}U,^{238}U, ^{241}Am, and ^{238}Pu..
Mitchell Branch floodplain	$^{239/240P}$Pu, ^{234}U, and ^{238}U.
Background locations	^{241P}Am, $^{243/244}$Cm, ^{60}Co, ^{137}Cs, ^{40P}K, ^{238P}Pu, $^{239/240P}$Pu, ^{90}Sr, ^{234}U, and ^{238}U.

Biota analyses also included radionuclides found in previous soil sampling but focused on radionuclides that primarily contributed to the terrestrial biota dose. The radionuclide that contributed the most to terrestrial biota dose was ^{137}Cs. Other analytical parameters included ^{90}Sr, ^{40}K, ^{234}U, ^{235}U, and ^{238}U. Deer mice were sampled on the White Oak Creek floodplain due to habitat and feeding behavior.

4.6.4 Frequency

Based on the 2007 soil sampling results, biota sampling was conducted in 2009 at the confluence of Melton Branch and White Oak Creek and in the floodplain upstream of White Oak Lake. White footed mice, deer mice, and hispid cotton rats were selected for sampling because they live and forage in these areas, are food for other mammals, and have relatively small home ranges. The biota sampling areas were in locations and areas similar to the soil sampling areas. Based on the measured radionuclide concentrations in soil and tissue, the absorbed dose rates to sampled mice and hispid cotton rats in these areas was less than 0.1 rad/day. Frequency of future soil and tissue sampling will be dependent on future activities in Melton Valley that could significantly impact the doses to terrestrial biota.

5. QUALITY ASSURANCE PROGRAM

5.1 INTRODUCTION

The application of quality assurance (QA)/quality control (QC) programs for environmental monitoring activities on ORR is essential for generating data of known and defensible quality. Each aspect of an environmental monitoring program from sample collection to data management and record keeping must address and meet applicable quality standards.

The activities associated with administration, sampling, data management, and reporting for ORR environmental surveillance programs are performed by the UT-Battelle Environmental Protection and Waste Services Division (EPWSD). Project scope is established by a task team composed of members representing DOE and each of the three major ORR facilities. UT-Battelle uses the Standards Based Management System (SBMS) to provide a systematic approach to integrating QA, environmental, and safety considerations into every aspect of ORR environmental monitoring. SBMS is a web-based system that provides a single point of access to all the requirements necessary for staff to safely and effectively perform their work. SBMS translates laws, orders, directives, policies, and best management practices into laboratorywide subject areas and procedures.

5.2 WORK/PROJECT PLANNING AND CONTROL

UT-Battelle's Work/Project Planning and Control Management System establishes the processes and requirements for executing work activities at ORNL. All environmental sampling tasks are performed following the four steps required in the work control subject areas.

- Define Scope of Work
- Work Planning: Analyzing Hazards and Defining Controls
- Work Execution
- Provide Feedback

In addition, EPWSD has approved project specific standard operating procedures (SOPs) for all activities which are controlled and maintained through the ORNL Integrated Document Management System (IDMS). Requirements for the development and control of EPWSD documents, including SOPs, are established in *Standard Operating Procedure for Document Control*, EPWSD AP-200.

Environmental sampling SOPs developed for ORR environmental surveillance programs provide detailed instructions on maintaining chain of custody; sample identification; sample collection and handling; sample preservation; equipment decontamination; and collection of QC samples such as field and trip blanks, duplicates, and equipment rinses.

5.3 PERSONNEL TRAINING AND QUALIFICATIONS

The UT-Battelle Training and Qualification Management System provides employees and nonemployee staff of UT-Battelle, LLC, with the knowledge and skills necessary to perform their jobs safely, effectively, and efficiently with minimal supervision. This capability is accomplished by establishing site-level procedures and guidance for training program implementation with an infrastructure of supporting systems, services, and processes.

A functional training matrix (FTM) has been defined for all EPWSD job functions and is maintained on the EPWSD internal training requirements web page. FTMs were derived using several resources, including verification analysis (i.e., similar job positions on the Internal Training Requirements Matrix), document analysis (i.e., SBMS procedures, internal division and specific group standard operating procedures), and functional job analysis (i.e., interviews with EPWSD staff and management). Training status is routinely monitored by the Division Training Officer, and notices of training needs or deficiencies are automatically sent to individual employees. Assessments of EPWSD staff training activities and qualifications are included in the EPWSD Assessment Program.

The training program is supplemented by the EPWSD Required Reading Program. This program ensures that staff have reviewed new/revised documents (procedures, lessons learned, etc.) applicable to their jobs.

5.4 EQUIPMENT AND INSTRUMENTATION

5.4.1 Calibration

The UT-Battelle Quality Management System includes subject area directives that establish the standard that all ORNL staff shall use equipment of known accuracy based on appropriate calibration requirements that are traceable to an authority standard. The UT-Battelle Facilities and Operations Instrumentation and Control Technical Support group (F&O/I&CTS) tracks all equipment used in ORR environmental monitoring programs through a maintenance recall program to ensure equipment is functioning properly and within defined tolerance ranges. Upon receipt, each instrument is clearly identified and entered into the recall system. The determination of calibration schedules and frequencies is based on a graded approach at the activity planning level. EPWSD environmental monitoring programs follow rigorous calibration schedules to eliminate gross drift and the need for data adjustments. Instrument tolerances, functions, ranges, and calibration frequencies are established based on manufacturer specifications, program requirements, actual operating environment and conditions, and budget considerations. At a minimum, equipment manufacturer recommendations are followed. F&O/I&CTS project plans and work control evaluations incorporate all calibration requirements.

5.4.2 Standardization

EPWSD sampling procedures, maintained on IDMS, include requirements and instructions for the proper standardization and use of monitoring equipment. These requirements include the use of traceable standards and measurements, performance of routine, before-use equipment standardizations, and actions to follow when standardization steps do not produce required values. Sampling SOPs also include instructions for designating nonconforming instruments as “out-of-service” and initiating requests for F&O/I&CTS maintenance.

5.4.3 Visual Inspection, Housekeeping, and Grounds Maintenance

EPWSD environmental sampling personnel conduct routine visual inspections of all sampling instrumentation and sampling locations. These inspections identify and address any safety, grounds keeping, general maintenance, and housekeeping issues or needs.

5.5 ASSESSMENT

Independent audits, surveillance, and internal management assessments are performed to verify that requirements have been accurately specified and that activities performed conform to expectations and requirements. The EPWSD assessment schedule is developed in the UT-Battelle Assessments and Commitments Tracking System (ACTS) and includes information on both external and internal assessments. External assessments are scheduled based on requests from auditing agencies. EPWSD also conducts internal management assessments of ORR environmental monitoring procedural compliance, safety performance, and work planning and control. This includes surveillances by both direct line management and by organizations independent of the group performing work. As part of the required management observation activities, DOE ORNL site office representatives participate in several surveillance assessments annually. Surveillance results, recommendations, and completion of corrective actions, if required, are also documented and tracked in ACTS.

EPWSD uses a Problem Event Reporting System that enables staff to document and disseminate information on any unplanned or unexpected event. This includes events that do not meet any reporting thresholds and enables early detection and correction of any low-level problems or trends. This system also captures positive events and observations and provides a means for sharing information on improvement opportunities.

The TDEC DOE Oversight Division routinely oversees sample collection activities for the reservation monitoring programs and reviews data to confirm that no unusual or unexpected events or outcomes have occurred.

5.6 ANALYTICAL QUALITY ASSURANCE

The contract laboratories that perform analyses of environmental samples from ORR environmental monitoring programs are required to have documented QA/QC programs, trained and qualified staff, appropriately maintained equipment and facilities, and applicable certifications.

A competitive award system is used by UT Battelle to select laboratories that are contracted under Basic Ordering Agreements to perform analytical work to characterize ORR environmental samples. EPWSD’s *Guidance for Analytical Services Support* (EPWSD-OQS-TP-252), maintained on the UT-Battelle IDMS, sets forth the processes that EPWSD follows to procure laboratory support. Commercial laboratories are required to comply with the quality requirements set forth in the Integrated Contractor Procurement Team (ICPT) Basic Ordering Agreement Terms and Conditions. Oversight of subcontracted commercial laboratories is performed by the DOE Consolidated Audit Program. This program, administered by DOE and subcontractors from across the DOE complex, establishes required internal and external laboratory control and performance evaluation programs and conducts on-site laboratory reviews that monitor the performance of all subcontracted laboratories and verifies all quality requirements are met. The ICPT process achieves efficiencies across the DOE complex by providing leveraged procurement and the use of the consolidated audit program to eliminate the need for individual purchasers to conduct quality audits.

A statement of work for each project specifies any additional QA/QC requirements and includes detailed information on data deliverables, turnaround times, and required methods and detection limits. Blank and duplicate samples are routinely submitted along with ORR environmental samples to provide an additional check on analytical laboratory performance.

5.7 DATA MANAGEMENT AND REPORTING

ORR environmental surveillance and monitoring data management is accomplished using the Environmental Surveillance System (ESS), a web interface data management tool which was developed by UT-Battelle's Information Technology Services Division (IT). IT performs routine system maintenance and completes modifications and upgrades through work authorizations with EPWSD. In managing ESS, IT adheres to the SBMS Information Technology Management System subject area, *Software Quality Assurance*, which defines the minimum requirements to be met with the development and acquisition of software at ORNL. This subject area requires that all software incorporates a level of formal QA that is commensurate with the potential impact of the software on the environment, safety, health, security, legal requirements, costs, or mission of the laboratory. The *Software Quality Assurance Plan for the Environmental Sampling System* (EPWSD-EPS-PL-SQA-ESS) describes how quality is ensured within ESS (additional system documentation is available at https://home.ornl.gov/~sps/prod/).

Field measurements and sample information are entered into ESS, and an independent verification is performed on all records to ensure accurate data entry. Sample results and associated information are loaded into ESS from electronic files provided by analytical laboratories. An automated compliance screening is performed on each file during loading to ensure all required analyses were performed, appropriate analytical methods were used, holding times were met, and specified detection levels were achieved.

Following the compliance screening, a series of checks is performed to determine whether results are consistent with expected outcomes and historical data. QC sample results (i.e., blanks and duplicates) are reviewed to check for potential sample contamination and to confirm repeatability of analytical methods within required limits. More in-depth investigations are conducted to explain results that are questionable. This involves examination of field- and laboratory-generated records and log sheets, communication with analytical laboratory and/or sampling personnel, and determining any other factors that may account for the unexpected result (e.g., atypical weather or site activity that may have affected the sampling).

ORR environmental surveillance data are summarized and reported annually in ASER and are provided to the Oak Ridge Environmental Information System.

5.8 RECORDS MANAGEMENT

The UT-Battelle Records Management System provides the requirements for managing all ORNL records. Requirements include creating and identifying record material; scheduling, protecting, and storing records in both office areas and the ORNL Inactive Records Center; and destroying records.

5.9 DOSE CALCULATION QUALITY ASSURANCE

Each calculation is documented, along with all support information, and documentation is maintained in accordance with SBMS Records Management subject areas. A description of models used, implementing computer codes, values and sources of input data, and underlying assumptions are also maintained. This information may consist of references to published descriptions or to actual mathematical formulas developed for special calculations.

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