TENNESSEE DEPARTMENT
OF
ENVIRONMENT AND CONSERVATION

DIVISION OF REMEDIATION
OAK RIDGE OFFICE

ENVIRONMENTAL MONITORING PLAN

For Work to be Performed:

July 1, 2025, through June 30, 2026

June 30, 2025

Tennessee Department of
Environment and Conservation,
Authorization No. 327023

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ACRONYMS

A	Am-241	americium-241 (transuranic isotope)
	ANOVA	Analysis of variance in statistics
	ARARs	applicable or relevant and appropriate requirements
	As	arsenic (metal)
	ASER	Annual Site Environmental Report (ASER), Calendar Year, DOE
	ASWSP	Ambient Surface Water Sampling Project
	AWQC	Ambient Water Quality Criteria
B	Ba	barium (metal)
	Background site -	reference site: background site located outside of a 5-mile radius of potential impact from the Oak Ridge Reservation
	BCAP	Bear Creek Assessment Project
	BCK	Bear Creek Station or Bear Creek Kilometer
	BC/BCK/BCV	Bear Creek/Bear Creek kilometer or station/Bear Creek Valley
	BCBGs	Bear Creek Burial Grounds
	Be-7	beryllium-7 (metal)
	Benthic Life -	Organisms that live on or in the streambed (aquatic insects, amphibians, spiders, worms, etc.)
	Bi-214	bismuth-214
	Biocides - -	Any product or substance used in a cooling tower which is intended to destroy, control or prevent the effects of algae, bacteria, sulfate-reducing bacteria, protozoa, and fungi.
	BMP	Best Management Practices
	Bo	boron (metal)
C	CAA	Clean Air Act
	CBSQGs	Consensus Based Sediment Quality Guidelines
	CC/CCK	Clear Creek/Clear Creek kilometer (background stream)
	Cd	cadmium (metal)
	CERCLA - -	*The Comprehensive Environmental Response, Compensation, and Liability Act* (commonly known as Superfund) enacted by Congress on December 11, 1980.
	Cm	curium
	Co-60	cobalt-60
	COC	Chain of Custody
	COCs	Contaminants of Concern
	COND	conductivity

	Cr_6	Hexavalent Chromium (metal)
	CR/CRK	Clinch River/Clinch River kilometer
	Cs-137	cesium-137 (metal)
	CSU	Combined Standard Uncertainty
	Cu	copper (metal)
D	D&D	Decontamination and Decommissioning
	DO	Dissolved oxygen
	DOE	U.S. Department of Energy
	DOE EM	U.S. Department of Energy Environmental Management
	DoR	Division of Remediation
	DOR-OR	Division of Remediation – Oak Ridge
	DWR	Division of Water Resources
E	EFPC/EFK	East Fork Poplar Creek/East Fork Poplar Creek Kilometer
	EFPCAP -	East Fork Poplar Creek Holistic Watershed Assessment Program/ East Fork Poplar Creek Assessment Project
	EFPC-PC	East Fork Poplar Creek - Poplar Creek Confluence
	EMDF	Environmental Management Disposal Facility
	EMP	Environmental Monitoring Plan
	EMR	Environmental Monitoring Report
	EMWMF	Environmental Management Waste Management Facility
	EPA	U.S. Environmental Protection Agency
	EPT -	*Ephemeroptera* (mayflies*), Plecoptera (*stoneflies*), and Trichoptera (*caddisflies*)*
	%EPT – Cheum	Percent EPT - *Cheumatopsyche* (tolerant Trichoptera)
	ESOA	Environmental Surveillance Oversight Agreement
	ETTP	East Tennessee Technology Park (formerly K-25)
F	FFA	Federal Facility Agreement
G	GPS	Global Positioning System
H	H_2SO_4	sulfuric acid
	H-3	tritium
	HAs	Health Advisory Values
	HCl	hydrochloric acid
	HFIR	High Flux Isotope Reactor
	Hg	mercury (metal)

	HQ	Hazard Quotient (noncarcinogenic risk equations)
	HNO_3	nitric acid
	HRE	Homogeneous Reactor Experiment
I	I-129	iodine-129
	IACUC	Institutional Animal Care and Use Committee
	IC25 -	Inhibition Concentration 25% reduction in survival, growth and reproduction of test organism
	ISM	Incremental Sampling Methodology
	ITRC	Interstate Technology Regulatory Council
J	J values	Result less than MQL but greater than or equal to MDL
K	K-25	Former site of Gaseous Diffusion Plant closed in 1987, now ETTP
	K-40	potassium-40
L	LSC	Liquid Scintillation Counting
M	MB/MBK	Mill Branch/Mill Branch kilometer (background stream)
	MCL	Maximum Contaminant Limit
	MDC	Minimum Detectable Concentration
	MDL	Minimum Detection Limit
	MeHg	methylmercury
	MIB	Mean Index Biomass
	MIK	Mitchell Branch/Mitchell Branch kilometer
	MQL	Minimum Quantification Limit
	MQL	Method Quantification Limit
	MSRE	Molten Salt Reactor Experiment
	MV	Melton Valley
	MV-OS	Melton Valley Offsite Subarea
N	NaI	sodium iodide (used in gamma scintillator probe)
	NAREL	National Air and Radiation Environmental Laboratory (EPA)
	NBG	North Boundary Greenway
	NCBI	North Carolina Biotic Index
	NCP	National Contingency Plan
	NEON	National Ecological Observatory Network
	NESHAPS	National Emissions Standards for Hazardous Air Pollutants

	Ni	nickel (metal)
	NNSA	National Nuclear Safety Administration
	NOAA	National Oceanic and Atmospheric Administration
	Np-237	neptunium-237 (transuranic isotope)
	NPDES	National Pollution Elimination System permit
	NPL	National Priority List
	NRC	Nuclear Regulatory Commission
	NT-5	Bear Creek Northwest Tributary 5
	NTU	nephelometric turbidity units
	NUREG	NRC Regulation
O	OF-200 MTF	Outfall 200 Mercury Treatment Facility at Y-12
	ORAU	Oak Ridge Associated Universities
	OREIS	Oak Ridge Environmental Information System
	ORNL	Oak Ridge National Laboratory, also known as X-10
	ORP	Oxygen Reduction Potential
	ORR	Oak Ridge Reservation
	OS	Offsite Subarea
	OSL	Optically Stimulated Luminescence Dosimeter
	%OC	Percent *Oligochaeta* and *Chironomidae*
P	Pb	lead, Pb-212/214
	PC-CR	Poplar Creek – Clinch River Confluence
	PC/PCK/PCM	Poplar Creek/Poplar Creek kilometer/Poplar Creek mile
	PCBs	Polychlorinated Biphenyls
	PCCR	Phased Construction Completion Report
	PEC	Probable Effects Concentration
	POP	Persistent Organic Pollutants
	PPE	Personal Protective Equipment
	PRGs	Preliminary Remediation Goals
	Pu	plutonium-238/239/240 (transuranic isotope)
	PWTC	Process Waste Treatment Complex
Q	QA/QC	Quality Assurance/Quality Control
	QAPP	Quality Assurance Project Plan
R	RA	Remedial Activities/ Radiological Area
	Ra	radium

	RCPs	Radiation Control Personnel
	RCS	Roving Creel Survey
	RER	Remediation Effectiveness Report
	ROD	Record of Decision
	RSLs	Regional Screening Levels
S	SAP	Sampling and Analysis Plan
	SMCLs	Secondary Maximum Contaminant Levels same as NSDWRs
	SNS	Spallation Neutron Source
	SOP	Standard Operating Procedure
	Sr-90	strontium-90
	SRS	Sediment Retention Structure
	SSL	Soil Screening Level
	Station -	A specific location where environmental sampling or monitoring takes place.
	SU	standard units
	SW	Surface Water
	StW	Storm Water
	SWPPP	Storm Water Pollution Prevention Plan
	SWSA	Solid Waste Storage Area
T	T&E species -	State- or Federally listed threatened and endangered species as protected under the Endangered Species Act of 1973.
	Tc-99	technetium-99
	TDEC	Tennessee Department of Environment and Conservation
	TDEC-DoR	TDEC - Division of Remediation
	TECs	Threshold Effects Concentrations
	Th	thorium-228/230/232
	THg	total mercury
	Tl-208	thallium-208
	TMI	Tennessee Macroinvertebrate Index
	TNUTOL	Total Nutrient Tolerant
	TN AWQC	State of Tennessee Ambient Water Quality Criteria
	TOReis	TDEC DoR-OR internet database
	TWQC	Tennessee Water Quality Criteria
	TWRA	Tennessee Wildlife Resources Agency

U	U	Result is less than Method Detection Limit (MDL)
	U-234/235/238	uranium-234/235/238
	UEFPC/UEFK	Upper East Fork Poplar Creek/Upper East Fork Creek Kilometer
	USDI	U.S. Department of the Interior
	USFWS	US. Fish and Wildlife Service
V	VOCs	volatile organic compounds
W	WC/WCK	White Oak Creek/White Oak Creek/White Oak Creek kilometer
	WET	Whole Effluent Toxicity
	WOCAP	White Oak Creek Assessment Project
	WOE/WOCE	White Oak Creek Embayment
	WOCE-CR	White Oak Creek Embayment - the Clinch River Confluence
	WOCW	White Oak Creek Watershed
	WOL	White Oak Lake
	WOL-CR	White Oak Lake-Clinch River
	WQPP	Water Quality Protection Plan
X	X-10	Historical name, renamed Oak Ridge National Lab (ORNL)
Y	Y-12	Y-12 National Security Complex (Building 9213, 9219, 9723-28)

UNITS OF MEASURE AND THEIR ABBREVIATIONS

°C	degrees Celsius/Centigrade
µS/cm	micro-Siemens per centimeter
mV	millivolts
DO	amount of gaseous (O_2) dissolved in water
pH	scale of acidity from 0 to 14
µg/L	micrograms per liter (parts per billion)
mg/L	milligrams per liter (parts per million)
ng/g	nanograms per gram (parts per billion)
µg/g	micrograms per gram (parts per million)
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
millirem	A millirem is one thousandth of a rem
rem	A rem is the unit of effective absorbed dose of ionizing radiation in human tissue, equivalent to one roentgen of X-rays
mrem	Abbreviation for millirem which is a unit of absorbed radiation dose

EXECUTIVE SUMMARY

The Tennessee Department of Environment and Conservation, Division of Remediation, Oak Ridge Office (TDEC DoR-OR), provides the annual *Environmental Monitoring Plan* (EMP), for fiscal year 2026 (FY26) with a period of performance from July 1, 2025, through June 30, 2026. This EMP supports projects under two programs within the DoR-OR office; the *Federal Facility Agreement (FFA),* and the *Environmental Surveillance and Oversight Agreement* (ESOA) programs.

This document defines the oversight and verification work scopes (including independent monitoring and assessment of the U.S. Department of Energy's (DOE's) environmental monitoring and remediation actions across the Oak Ridge Reservation) that TDEC has determined to be necessary to ensure protectiveness of human health and the environment for this period (FY26).

DoR-OR performs independent monitoring and verification sampling as well as conducting oversight of current DOE activities across the Oak Ridge Reservation (ORR) to confirm existing DOE project results and assure the residents of Tennessee that DOE's activities are being performed in a manner that is protective of their health, safety, and environment. DoR-OR utilizes the data and information derived from these work scopes to support environmental restoration decisions, evaluate performance of existing remedies, and to investigate the extent and movement of legacy contamination. This monitoring program is designed to document current conditions for ORR related environmental media (i.e., air, surface water, soil, sediment, groundwater, drinking water, food crops, fish and wildlife and biological systems), by collecting data to evaluate or supplement DOE's environmental monitoring datasets. This State program is intended to monitor for potential emissions of any materials (i.e., hazardous, toxic, chemical, or radiological) from the ORR to its surrounding environment. Monitoring results from these activities will support TDEC's data needs for effective and efficient protectiveness decisions and agreements regarding the ORR.

While the inclusion of projects in this EMP does not associate projects with a specific funding source at this time, TDEC has determined all projects defined in this EMP are consistent with the National Contingency Plan (NCP) and are intentionally designed to be in compliance with the administrative and operational requirements of the ESOA and/or in support of the FFA.

Summaries of the FY26 independent monitoring projects, follow:

I. AIR MONITORING:

FUGITIVE RADIOLOGICAL AIR EMISSIONS

The project team will independently sample air at a planned 14 ORR locations, including at

EMWMF, Y-12, ORNL, with in Oak Ridge City and a background location in Lenoir City. The locations are selected to support assessments tied with planned DOE remedial activities, demolition activities, waste disposal operations and general current operations. The resulting data will be compared with DOE air monitoring data. Air samples will be screened for radiological emissions, and will include isotopic uranium, gross alpha and beta, and gamma, where appropriate. DoR-OR conducts this project in conjunction with DOE's ambient air sampling program. The project data will be used to correlate or supplement data collected by the DOE at the ORR perimeter ambient air monitoring stations. These efforts will help to provide independent verification of protectiveness to the public and the environment. All data will be evaluated for compliance with Federal Regulatory Standards.

RadNet Precipitation

RadNet is a national program funded by the U.S. Environmental Protection Agency (EPA). EPA performs radiochemical analysis of precipitation samples taken from monitoring stations at three Oak Ridge locations that are co-located with the RadNet Air stations. Two (2) stations are located at ORNL: one in Melton Valley and one in Bethel Valley. The third site is located on the east end of Y-12. RadNet precipitation monitoring around both ORNL and Y-12 is valuable as Decontamination and Decommissioning (D&D) activities have begun to focus on these two campuses. Samples will be collected by TDEC DoR-OR, and independent analysis will be performed at the EPA NAREL.

II. Biological Monitoring:

Benthic Community Health

This project is a continuation of the ongoing macroinvertebrate study to assess stream function. Macroinvertebrates will be collected from 15 locations in streams affected by historical federal facility activity and 3 corresponding reference locations. This project will analyze aspects of biodiversity and biota tolerance functions of overall stream health. Unlike direct water toxicity analysis, this project observes the effects of chronic exposure to contaminants over a longer period of time on the biota. This project will consist of benthic macroinvertebrate monitoring to ascertain the current stream health of primary ORR exit pathway streams. Two riffles will be sampled on each reach. Animals collected from both riffles will be combined, randomly sub-sampled, and identified to species level when possible. The overall biodiversity of a sample plus the assemblage of sensitive indicator taxa will help to quantify stream health. These stream statistics will be compared to previous sampling years and to corresponding DOE monitoring data. For FY26, this project will submit a subset of collected benthic macroinvertebrates from White Oak Creek (WOC) tributary sites for radiological analysis in support of the WOC Assessment Project (WOCAP).

ORR Roving Creel Survey

This project measures angling effort at four key locations where impaired Oak Ridge Reservation (ORR) watersheds drain into publicly accessible waters. By boat, TDEC personnel will conduct angler interviews at the confluences of East Fork Poplar Creek and Poplar Creek, Poplar Creek and the Clinch River, Grassy Creek and the Clinch River, and White Oak Lake and the Clinch River. This project estimates total angling effort in these locations and evaluates qualitative angling habits.

For FY26, this project includes fish tissue collection of five fish at the Grassy Creek-Clinch River confluence for lab analysis. Game fish species (White bass, Black crappie, etc.) targeted by anglers for consumption at the GC-CR confluence will be analyzed for low-level mercury, methylmercury, Cs-137, Sr-90, and PCBs. Data from this project helps to support discussions on associated public risk management during ongoing ORR remediation efforts.

Contaminant Uptake in Biota

Mercury and other legacy contaminants have the potential to bioaccumulate in biota impacted by contaminated ORR water resources (e.g., streams, stormwater, groundwater). For FY26, this project will focus on the White Oak Creek (WOC) watershed and the East Fork Poplar Creek (EFPC) watershed. Biota samples from WOC, WOL (lake), and WOE (embayment) will be analyzed for radio contaminants, heavy metals and PCBs. Bird eggs will additionally be analyzed for dioxin/furans. At EFPC, snake tissue/blood samples will be analyzed for Hg and MeHg concentrations. Additionally, songbird eggs will be collected from established bird boxes and analyzed for *total mercury* (THg). The collection of songbird eggs, flying insects, and snake tissue or blood during this project will help discern if bioaccumulation of those contaminants of concern is occurring in the biota at these watersheds. These assessments are expected to guide discussions on site specific conceptual site model details and ecological risk of the assessment areas in future work, by evaluating potential bioaccumulation of radionuclide contaminants and heavy metals through the trophic levels of biota species living in these areas.

Terrestrial Invertebrate Community Health (Ground Beetles)

Mercury is found at elevated levels throughout the ORR and continues to be a contaminant of concern (COC) especially in East Fork Poplar Creek (EFPC). EFPC is an ORR exit pathway stream, whose headwaters originate within the Y-12 campus and are fed by surface water, stormwater runoff and groundwater that has been in contact with mercury-contaminated structures.

This project plans to focus on assessing ecological health and the environmental protectiveness of the food chain in this impacted area, by assessing terrestrial invertebrate communities including the ground beetle. Ground beetles, or carabids, will be passively collected, along with other terrestrial invertebrates, via pitfall traps. Data results will assist in understanding

bioaccumulation and contaminant migration in this food web and provide data to support ongoing discussions and evaluations of ecological protectiveness.

Radiological Uptake in Food Crops

This proposed project will assess possible radiological impacts of DOE ORR activities on food crops grown by local farmers and gardeners. While this project mirrors a similar DOE project, DoR-OR sampling will be conducted independently to verify and correlate DOE sample results. This food crops project will collect vegetables, hay, and animal products (eggs) from within a five-mile radius of the ORR boundary. For each type of sample, a corresponding background location outside the study area will be analyzed to establish background (i.e., reference) levels.

III. Groundwater Monitoring:

Offsite Groundwater Monitoring Project

The delineation of the nature and extent of groundwater contamination is incomplete in many areas of the ORR (DOE, 2022b). Several contaminant plumes across the ORR are not well defined and require ongoing investigation by DOE to delineate their vertical and horizontal extent. The geologically complex bedrock found at the ORR, including highly faulted/fractured areas and massive carbonates that exhibit karst terrains with large sinkholes, requires further DOE investigation to adequately evaluate contaminant transport flow pathways. Until that work is complete, DoR-OR will continue to support this *Offsite Groundwater Monitoring Project.* The locations of offsite sampling efforts for Fiscal Year 2026 (FY26) include selected private water wells and springs located downgradient, to the southwest and along strike, of the four main offsite subareas. These subareas include the ETTP, Bear Creek, Bethel Valley, and Melton Valley Offsite Subareas. The State conducts monitoring of selected residential drinking water wells, located offsite of the ORR, to independently assess that there remains no change in expected conditions, and assess that no identified threat to human health based on current downgradient water sampling results is identified.

IV. Landfill Monitoring:

EMDF: Surface Water Monitoring

DoR-OR staff will measure water quality parameters in EMDF discharges at five locations: SF-3, SF-6, BCK 7.6, BCK 8.63 and Spring D10W., and will collect water samples from five surface water locations to supplement DOE's baseline determinations for the EMDF site. The measured water quality parameters include temperature, pH, specific conductivity, dissolved oxygen, oxidation reduction potential and turbidity. TDEC DoR-OR personnel will monitor these locations at least semi-annually with the use of a YSI-Professional Plus water quality instrument or equivalent. Monitoring will also be completed with continuous water monitoring equipment that will be left instream at two locations on Bear Creek: BCK 7.6 and BCK 8.63. Sampling at the

stream locations, Flumes, and spring will be conducted twice a year to coincide with wet and dry seasons. Observations of site conditions and surface water parameter measurements (including turbidity) will be made semi-annually or more often as conditions warrant. Sampling will include evaluation of the analytical parameters listed in the *TN Ambient Water Quality Criteria* (AWQCs).

EMWMF Surface Water Monitoring

Contaminated materials from the *Comprehensive Environmental Response, Compensation, and Liability Act* of 1980 (CERCLA) remediation activities on the ORR are approved for disposal in the Environmental Management Waste Management Facility (EMWMF), if waste meets acceptance criteria. DoR-OR independently monitors the water resources at the EMWMF, along with evaluating DOE's sampling activities. State monitoring for FY26 includes, EMWMF discharge water quality monitoring, in-situ continuous monitoring and surface water sampling. These efforts will provide independent assurance to the public that DOE operations at the EMWMF are, and remain, protective of public health and the environment, and that DOE continues to adhere to remedial action objectives within facility surface water discharge limits.

V. Radiological Monitoring:

Haul Road Surveys

DoR-OR will periodically survey the Haul Road and all associated landfill access roads. Surveys of these ORR routes were previously initiated following an unintended release of materials on to a publicly accessible roadway. Annual monitoring has continued since that event and provides independent verification of the roads DOE Environmental Management has used for CERCLA waste hauling. For this period of performance, TDEC independent assessments will correspond with DOE's active waste hauling operations.

Ambient Gamma Radiation monitoring

The Ambient Gamma Radiation Monitoring Project is an ongoing TDEC project that measures concentrations of ambient gamma radiation in real time, at locations across the ORR. Specifically, the areas to be assessed during this period of performance include: the EMWMF, ORNL Building 3026 at the Hot Cells Facility, Building 3038 to monitor demolition of high-risk facilities associated with Isotope Row, the Molten Salt Reactor Experiment (MSRE), the Spallation Neutron Source (SNS), Building 3042 near the Oak Ridge Research Reactor, and the background location in Lenoir City. The detectors are programmable and will be recording at a 5-minute interval, with an automatic shift to 1-minute intervals above a set threshold of radiological activity based on site-specific parameters. Data will be downloaded at least once per month following established DoR-OR protocols. These monitors will allow for the assessment of conditions at locations where gamma emissions have been known to fluctuate

substantially over relatively short periods of time. DoR-OR's monitoring at these locations is ongoing, and data provides independent verification of DOE's sampling and risk assessment procedures.

Surplus Sales Verification

At the request of either Y-12 or ORNL's Excess Properties Sales Group, DoR-OR provides staff to screen selected auction items prior to public auction. These radiological surveys are independent verifications that are used to help verify that potentially contaminated items are not released to the public through the surplus sales program.

VI. Surface Water Monitoring:

Ambient Surface Water Parameters

DoR-OR conducts monthly sampling to obtain primary water quality parameters (e.g., conductivity, pH, temperature, and dissolved oxygen) from three ORR exit pathway streams. These three streams leave (exit) the reservation and then have the potential to be accessed by the public. Currently, DOE's parameter measurements are conducted in conjunction with their analytical sample collection and focuses primarily on the main branch of the Clinch River (CR). The exit pathway streams that DoR-OR monitors under this project include East Fork Poplar Creek (EFPC), Bear Creek (BC), and Mitchell Branch (MIK), with Mill Branch (MB) serving as an offsite reference (or background) stream location. For FY26, locations BCK 9.2 and BCK 7.6 data will be retained from the previous year, to assess water quality in BC that may be affected by ongoing construction work at EMDF. Stream reach EFK 24.4 parameter data will also be retained to assess potential UEFPC inputs from construction and demolition. Part of an ongoing monitoring program, started in 2005, this supplemental TDEC dataset allows for the State to better verify and assess the protectiveness of the surface waters leaving the ORR and passing into publicly accessible spaces.

Ambient Surface Water Sampling

The DoR-OR *Ambient Surface Water Sampling Project* has been implemented each year since 1993. Sampling locations may change from year to year, where necessary, to provide directed evaluation of DOE activities in alignment with current activities. During FY25, surface water monitoring focused on ambient water quality in the ORR exit-pathway streams. During FY26, this project will shift towards a more rigorous analysis of the Clinch River (CR). Sampling will be conducted near four DOE monitoring locations along the CR (CRK 66, CRK 58, CRK 32, and CRK 16.1). These locations are adjacent to the ORR and were selected by DOE due to their proximity to public water intakes or their location relative to pertinent ORR inputs. TDEC's FY26 monitoring will consist of collecting samples in one transect per CR reach. Each transect will be equally divided into thirds (i.e., left bank, mid-stream, right bank). Analytical samples and field

measurements will be taken at the top, middle, and bottom of the water column to support assessment of impacts throughout the water column. Analytes will include those constituents listed in *TN Rule 0400-40-03* for both recreation and fish and aquatic life (TDEC, 2019a).

CERCLA Stormwater

ORR stormwater runoff from construction activities and D&D of older facilities has the potential to transport various contaminants, including sediments, nutrients, organic and inorganic chemicals, metals, and bacteria, into waterways. During this period of performance, this project will focus on overseeing and conducting stormwater assessment activities for ORNL and Y-12 D&D facilities during pre-demolition, demolition, and post-demolition activities. Additionally, EMDF turbidity survey will be conducted in Bear Creek after each qualified rain events. TDEC will co-sample with DOE where possible and will compare DoR-OR stormwater monitoring data to available commensurate DOE data.

White Oak Creek Radionuclides

The purpose of the *White Oak Creek Radionuclides Monitoring Project* (WOCAP) is to evaluate the impacts of DOE ORR contamination to White Oak Creek and the Clinch River at the White Oak Creek confluence. White Oak Creek's (WOC) ambient surface water will be monitored quarterly for strontium-90 (Sr-90) and other radiological COCs at selected monitoring locations. This project has been separated from the primary *Ambient Surface Water Sampling Project* to allow for a more in-depth quantification of elevated Sr-90 concentrations have been identified throughout the watershed (from WCK 3.9, downstream to the confluence at CRK 33.5) at levels above the EPA derived drinking water limit of 8 pCi/L. While DOE has had ongoing projects seeking to define the sources of the strontium releases to WOC, those sources have not been fully vetted or contained yet. This TDEC sampling is intended to allow the State to continue to complete independent assessments of the impacts to this creek which ultimately discharges into the publicly accessible portions of the CR, including into the fishing areas at the confluence (as addressed in the *Roving Creel Survey* project described above). As DOE continues to evaluate sources and historic releases onsite, these independent assessments will provide supplemental information to support ongoing TDEC DoR-OR evaluations of impacts in these public areas.

VII. Sediment Monitoring:

Suspended Sediment (East Fork Poplar Creek – EFPC)

In FY26, the *Suspended Sediment Project* will continue to monitor sediment suspended in the water column at selected stream reaches for bound contaminants being transported in the impacted ORR waterways. Surface waters around the ORR have been adversely affected by past and present DOE activities, and while sediment is an integral component of stream ecosystems, it often serves as a sink for many contaminants. Sediment traps have been installed in

impacted stream reaches and will be used by this project team to collect these dispersed sediment particles. The information gathered from the chemical analyses of these sediments will reveal which contaminants are being actively transported downstream (and potentially offsite) in the water column within the suspended sediment load.

VIII. Watershed Assessments (Holistic) Monitoring:

TDEC DoR-OR will continue to complete comprehensive watershed assessments around the ORR to provide the residents of the State of Tennessee with a comprehensive evaluation of each ORR watershed. These assessments will help residents to visualize the interconnectedness of all the environmental media over an entire watershed collectively at a given point in time. The holistic understanding of all contaminants and their multiple inputs into one watershed will allow for an enhanced understanding of the health of the system. These data will also help support TDEC discussions regarding protectiveness to the public and prioritization of remediation project goals. Prior TDEC holistic watershed assessments included evaluations of Bear Creek Valley (BCAP) and East Fork Poplar Creek (EFPCAP). This fiscal year, the WOC Assessment (WOCAP) will continue.

White Oak Creek (WOCAP) Phase 2B:

As mentioned above, White Oak Creek (WOC) is one of the three main ORR exit-pathway streams. The primary COCs in this watershed include strontium (Sr-89/90) and other radiological nuclides. The *White Oak Creek Assessment Project* (WOCAP) is intended to establish a current benchmark of environmental conditions in this watershed. DOE's *White Oak Creek Remedial Investigation Report: Melton Valley Area* summarizes an assessment of the Melton Valley segment of the WOC watershed (DOE, 1996). Although comprehensive, this assessment is outdated. During FY26, DOR-OR will continue monitoring WOC and complete all remaining sampling from FY25 Phase 2a, including surface water, benthic macroinvertebrate community health, benthic macroinvertebrate chemical analysis, terrestrial biota (songbird eggs and flying insects), and gamma walk-over surveys as a preliminary soils analysis, as necessary.

1.0 INTRODUCTION

1.1 PURPOSE OF THE ENVIRONMENTAL MONITORING PLAN (EMP)

The Tennessee Department of Environment and Conservation, Division of Remediation, Oak Ridge Office (TDEC DoR-OR), provides the annual *Environmental Monitoring Plan* (EMP) for fiscal year 2026 (FY26) with a period of performance from July 1, 2025, through June 30, 2026. TDEC DoR-OR publishes its plan for DOE oversight so that this EMP is accessible to the public.

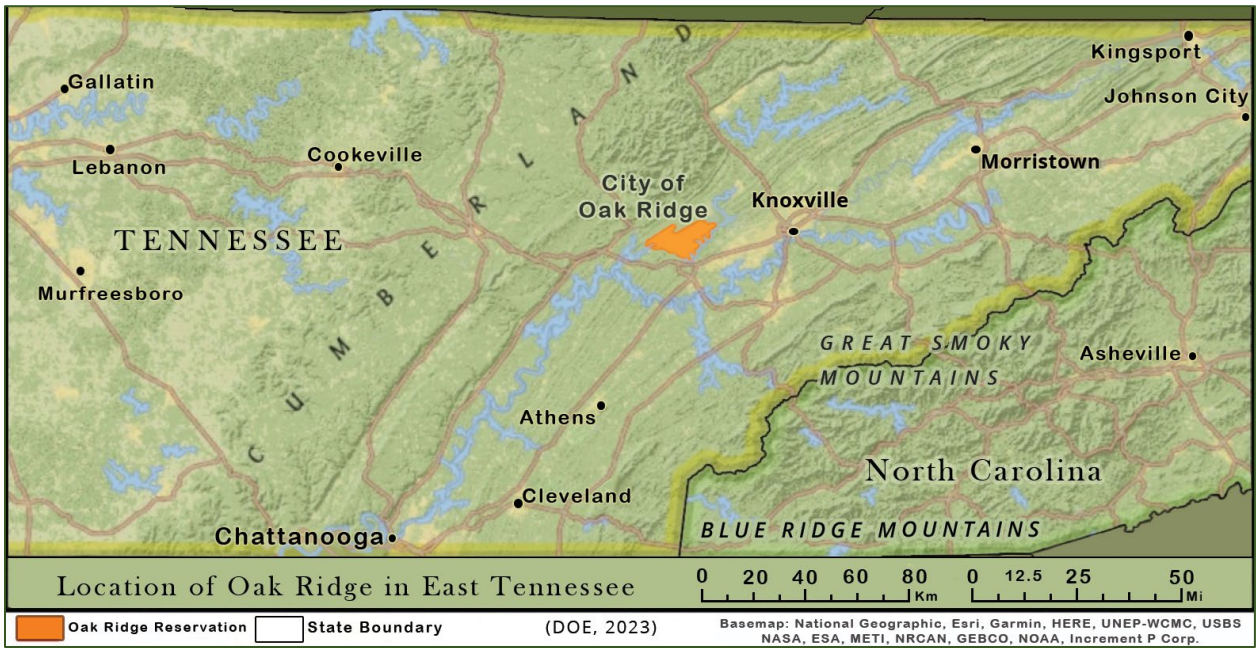

Figure 1.1.1: Location of Oak Ridge in East Tennessee

This DOR-OR EMP is specifically provided to clearly address and define the oversight and verification work scopes (including the independent monitoring and assessment of DOE's environmental monitoring and remediation actions across the Oak Ridge Reservation) that TDEC has determined to be necessary to ensure protectiveness of human health and the environment for the period of FY26 for the State of Tennessee. All projects defined in this EMP are found to be consistent with the NCP and are intentionally designed to comply with the administrative and operational requirements of the *Environmental Surveillance and Oversight Agreement* (ESOA) and, additionally, in support of the *Federal Facility Agreement (FFA*).

DoR-OR monitoring of current and upcoming DOE ORR activities is outlined in the ESOA, while the oversight / monitoring of DOE's legacy contamination management is addressed under the FFA. DoR-OR works collaboratively co-sampling and conducting oversight of field actions with the Office of Science, National Nuclear Safety Administration (NNSA), and DOE Environmental Management (DOE EM) and their contractors. The State also conducts independent environmental monitoring to ensure protection of human health and the environment and

support independent protectiveness assessments if necessary. All DoR-OR collected data is available to the public, including to DOE or EPA for triparty consideration. Independent sampling is conducted by TDEC to support comparison and correlation of results with DOE's monitoring programs. DoR-OR's monitoring program is intentionally designed and reviewed annually to (1) support active and ongoing environmental restoration decisions, to (2) help evaluate the performance of existing remedies, and to (3) make effective decisions going forward, including assessments and decisions surrounding the extent and movement of legacy contamination.

With the critical goal to provide verification of DOE's data and to support collection of information needed by the State to support efficient and effective decisions, these monitoring and oversight programs have been key. With a primary focus on ensuring protectiveness of human health and the environment, all TDEC DOR-OR environmental monitoring is performed to meet TDEC's mission statement. All work outlined in this monitoring plan will be performed in accordance with the *TDEC DoR-OR Technical Standard Operating Procedures* (SOPs).

Under Federal Guidelines, and to fulfill TDEC mission goals, stakeholder interests take a priority in project planning (Table 1.1.1). The key Stakeholders for this EMP include:

Table 1.1.1: Stakeholders

Stakeholders	
Citizens of Tennessee (Tennesseans)	External
Tennessee Department of Environment and Conservation (TDEC)	External and Internal
Local Governments	External
DOE and Contractors	External

1.2 OBJECTIVE

The overarching objective of TDEC DoR-OR's Environmental Monitoring Program is to provide State led independent monitoring and verification sampling, as well as supporting independent State oversight of current DOE activities across the Oak Ridge Reservation (ORR). Comparable independent DoR-OR monitoring results will be used to confirm yearly DOE data, such as that published in the ASER, to augment existing DOE project results as well as to support environmental restoration decisions; to assess and evaluate performance of existing remedies, and to investigate the extent and movement of legacy contamination (including in selected areas to evaluate the efficacy of DOE best management practices (BMPs)), to assure protectiveness of human health and the environment for the citizens of the State of Tennessee. This State led program is intended to provide independent assessment, for potential emissions of any materials (i.e., hazardous, toxic, chemical, or radiological) that may come from the ORR which could impact the surrounding populations or the environment. The environmental media and COCs to be sampled during FY26 are listed below in Table 1.2.1.

Tables 1.2.1: Types of Environmental Monitoring

Project Areas	Medium/Media	COCs *(Possible Assessments)*
Air	Particulates on Air Filters Particulates in Precipitation	**Radiological Materials:** Gamma spectrometry Uranium-234/235/238 Strontium (Sr-89/90) Technetium (Tc-99) Transuranic isotopes, Others **Chemical Pollutants:** PCBs and Pesticides VOCs and SVOCs Nitrates/Nitrates Nutrients **Mixed Waste** **Mercury** **Metals:** Chromium Arsenic Cadmium Uranium
Biota	Benthic Macroinvertebrate Taxa Fish Tissue Sampling Fathead Minnow and Water Flea - Biotoxicity Fish Consumption (Creel Surveys) Food Products (Vegetables/Eggs/Hay) Terrestrial Invertebrates (Ground Beetles) Bird eggs, flying insects, by-catch, snakeskin / blood	
Groundwater	Wells and Springs	
Landfill	Surface water Stormwater Groundwater Soil Sediment	
Radiological	Haul Road – dropped waste Gamma (Air Samplers) Surplus Equipment Sales	
Surface Water	Surface Water Parameters Stream Water Sampling Stormwater Sampling	
Soil	Landfill Samples Floodplain Samples	
Sediment	Suspended Sediment Sediment (landfill runoff)	
Watershed (*Holistic)*	All Samples from Projects in Watershed	

1.3 THE OAK RIDGE RESERVATION (ORR)

The ORR is comprised of three major campuses:

- **ORNL**: Oak Ridge National Lab (Formerly X-10)
- **Y-12**: Y-12 National Security Complex
- **ETTP**: East Tennessee Technology Park (Formerly K-25)

ORNL currently conducts leading-edge research in advanced materials, alternative fuels, climate change, and supercomputing. Previous projects and processes that have been the source of accidental releases of contaminants into the environment may include, fuel reprocessing,

isotopes production, waste management, radioisotope applications, reactor developments and multi-program laboratory operations

Y-12 continues to be vital to maintaining the safety, security, and effectiveness of the U.S. nuclear weapons stockpile and reducing the global threat posed by nuclear proliferation and terrorism. As with ORNL, Y-12 operational processes have also resulted in the accidental release of radionuclides and hazardous chemicals into the environment. Additionally, as D&D remedial activities move forward, legacy contaminants may be disturbed and migrate into the surrounding environment.

ETTP, in contrast, has undergone a transition from a gaseous diffusion facility (K-25) into an industrial technology park. Remediation activities continue and have reduced the amounts of legacy contaminants at this site. DOE recently released portions of this area back to the local government, and now private companies operate local businesses in this region of the ORR. CERCLA legacy contaminants remain on site in groundwater, burial grounds, sediments, and surface water with remedial decisions for those media to be addressed in current and future documents.

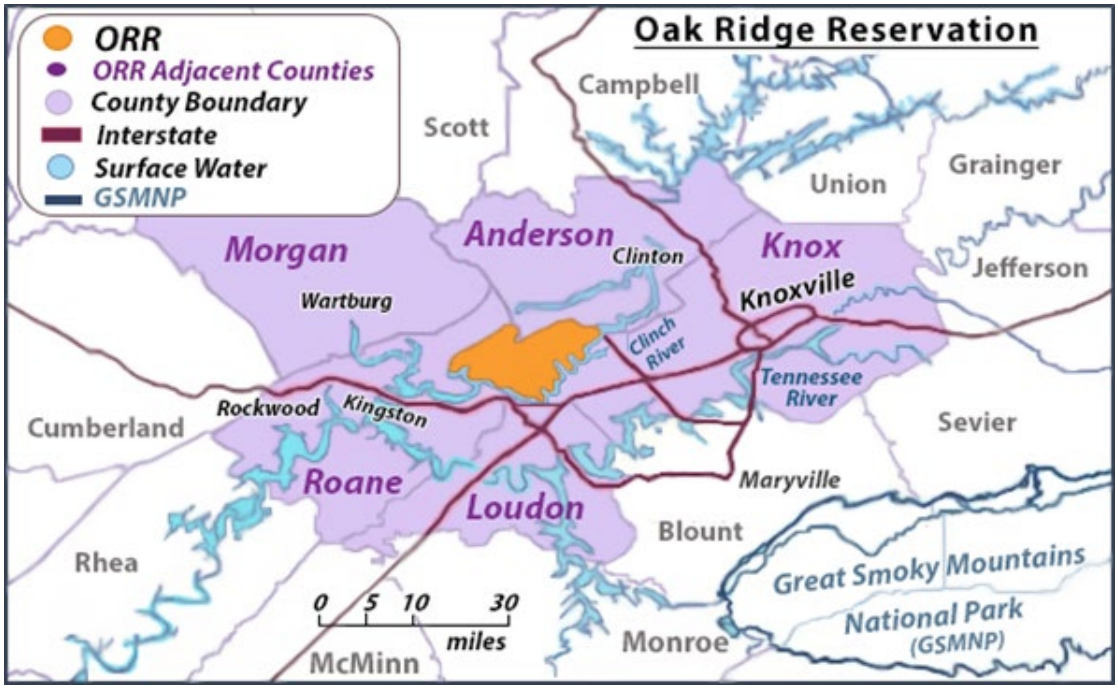

Figure 1.3.1: Location of the ORR in Relation to Surrounding Counties

1.3.1 Geography of the ORR Area

Located in the valley of East Tennessee, between the Cumberland Mountains and the Great Smoky Mountains, the ORR is partially bordered to the southeast and southwest by the Clinch

River. The ORR is in the southwest corner of Anderson County and the northeast region of Roane County. The ORR is contained within the corporate boundaries of the City of Oak Ridge. Counties adjacent to the reservation include Knox, Loudon, and Morgan Counties. Knox County resides east of Anderson County and is just across the Clinch River from the ORR. Portions of Meigs and Rhea counties reside immediately downstream from the ORR on the Tennessee River. The nearest cities to the ORR include Oak Ridge, Oliver Springs, Clinton, Kingston, Harriman, Farragut, and Lenoir City. The nearest metropolitan area, Knoxville, lies approximately 20 miles to the east.

The ORR encompasses approximately 32,500 acres of mostly contiguous land of alternating ridges and valleys in a southwest-to-northeast orientation. This section of the Valley and Ridge Province is a zone of complex geologic deposits dominated by a series of thrust faults. Sandstone, limestone, and dolomite form the underlying structure of the ridges, which themselves are relatively resistant to erosion. Weaker shales and more soluble carbonate rocks form a less stable basin for the valleys. Also, valley wind currents can differ substantially in speed and direction from the winds at higher elevations along the ridges.

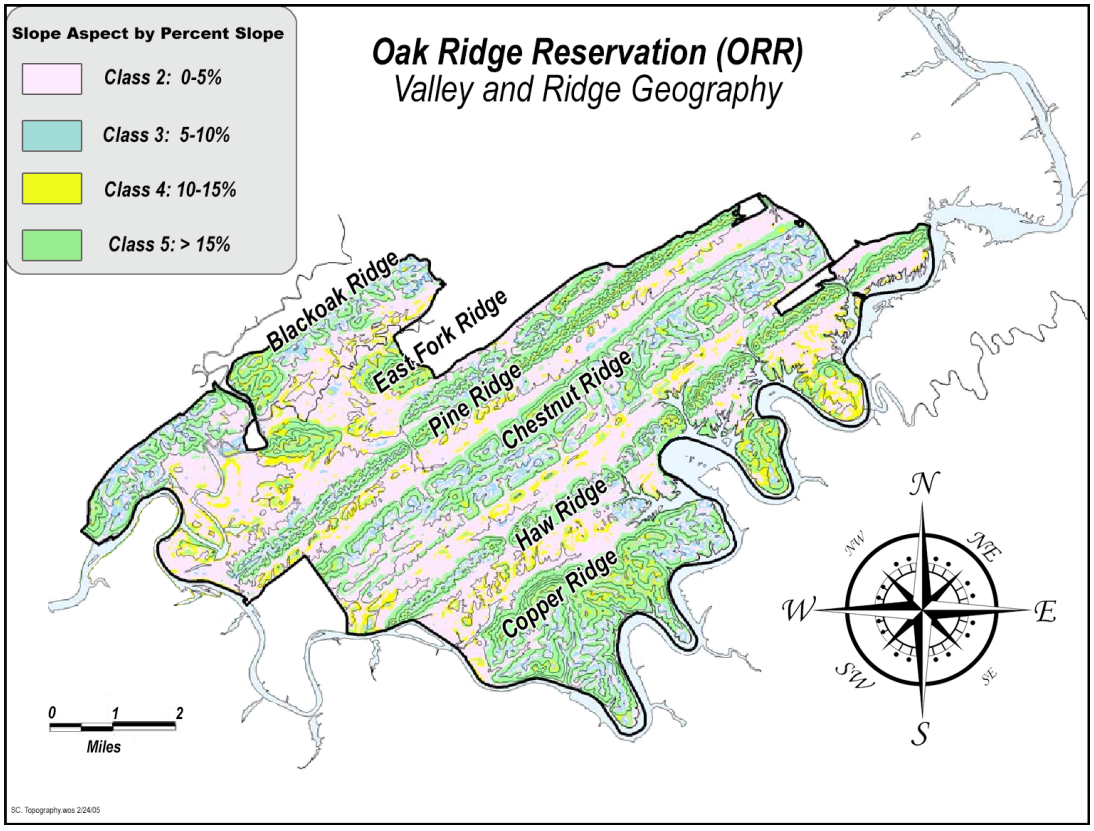

Figure 1.3.1.1: ORR Ridges (Southwest-to-Northeast Orientation)

1.3.2 CLIMATE OF THE ORR AREA

The climate of the ORR region is classified as humid and subtropical. Local climate is

characterized by a wide range of seasonal temperature changes between the summer and winter months. DOE reported that the total annual rainfall for 2023 was 47.2 in (1200 mm) as measured at an ORNL meteorological tower (MT-2). Rainfall was 15% below the 30-year average (DOE, 2023).

The geography of this region of *The Great Valley of East Tennessee* is shaped by the Ridge-and-Valley physiography, the Cumberland Plateau, and two mountain chains. These major landscape features also affect the wind flow regimes of Eastern Tennessee. Topography and climate are major factors in determining the potential for migration of contaminated media away from the ORR and into the surrounding areas.

1.3.3 Population of the ORR Area

More than one million Tennesseans reside in the counties immediately surrounding the ORR. Knoxville, in Knox County, is the only major metropolitan area near Oak Ridge. Excluding Knoxville, land use is semi-rural and made up of residences, small farms, and pastures. Popular recreation includes fishing, hunting, boating, water skiing, and swimming.

1.4 Tennessee's Commitment to Tennesseans

In accordance with objectives of the ESOA Agreement, the FFA Agreement, and in line with TDEC's mission statement, DoR-OR will conduct oversight of DOE ORR activities. Our purpose is to reassure all Tennesseans that activities on and around the ORR are being managed or performed in a manner protective of human health and the environment.

2.0 AIR MONITORING

2.1 FUGITIVE RADIOLOGICAL AIR EMISSIONS MONITORING

2.1.1 BACKGROUND

Historically, leaks and spills of radionuclide-contaminated materials were not uncommon on the ORR. Radioactive materials were released from operations as gaseous, liquid, and solid effluents with little to no treatment (ORAU, 2003). D&D and related remediation activities across the ORR have the potential to generate fugitive airborne contamination that could pose a risk if blown offsite or may also pose a risk to workers on the ORR.

For many years DoR-OR used three projects to aid in the monitoring of the air on the ORR for radiological contaminants. The three projects include Fugitive Radiological Air Emissions Monitoring, RadNet Air, and RadNet Precipitation. The Fugitive Radiological Air project has been the longest running, with the RadNet Air project a close second, with both beginning operations in the 1990s. The RadNet precipitation project began in the 2000s and monitors radionuclides in air brought to the ground with precipitation. Both RadNet projects are a part of the larger RadNet program of EPA, creating a broad radiation monitoring network across the United States. In FY24, the RadNet Air project was phased out (with the last samples collected in June 2024) and the Fugitive Air project was increased to include samplers at the prior RadNet locations as well as at additional ORR locations.

2.1.2 RELATED DOE PROJECTS

DOE conducts high-volume air sampling around the perimeter of the ORR, collecting samples weekly and compositing samples for analysis quarterly. The results from this air sampling are used to calculate the human dose exposure for vulnerable populations offsite. TDEC DoR-OR's *Fugitive Radiological Air Emissions Monitoring* sampling data will be compared to regulatory standards as well as to DOE ASER results (DOE, 2023).

2.1.3 PROBLEM STATEMENTS

Fugitive (non-point source) dispersal of contaminants can accidentally occur on the ORR. Legacy contaminants could potentially become exposed during remediation activities or due to a severe weather event. New releases could also occur due to current research and manufacturing projects.

Both Y-12 & ORNL have multiple buildings undergoing or slated to undergo D&D and removal. Y-12 contains multiple deteriorated buildings with uranium contamination which are undergoing or are proposed for future D&D. At ORNL, there are structures contaminated with

various fission and activation products in addition to uranium and plutonium isotopes. Some structures at ORNL were identified as the highest risk buildings on the ORR (ORAU, 2003). These buildings are physically deteriorating and can contain loose radiological contamination. The risk is exacerbated by the proximity of these structures to pedestrian and vehicular traffic, to privately funded businesses, and to other active ORNL buildings.

2.1.4 GOALS

To evaluate protectiveness of human health and the environment, DoR-OR will conduct independent air sampling and compare these results to published DOE air sampling data to confirm that both projects are not detecting elevated airborne emissions of radiological contaminants above regulatory limits. This independent monitoring is used to check that our data also does not show that DOE is over the levels from the Federal Regulatory Standards requiring that no member of the public receives an effective dose greater than 10 mrem per year (40 CFR 61.92, 2025a).

2.1.5 SCOPE

DoR-OR will conduct the *Fugitive Radiological Air Emissions Monitoring* project through continuous air monitoring at Y-12, EMWMF, ORNL, within the City of Oak Ridge, and a comparable background location.

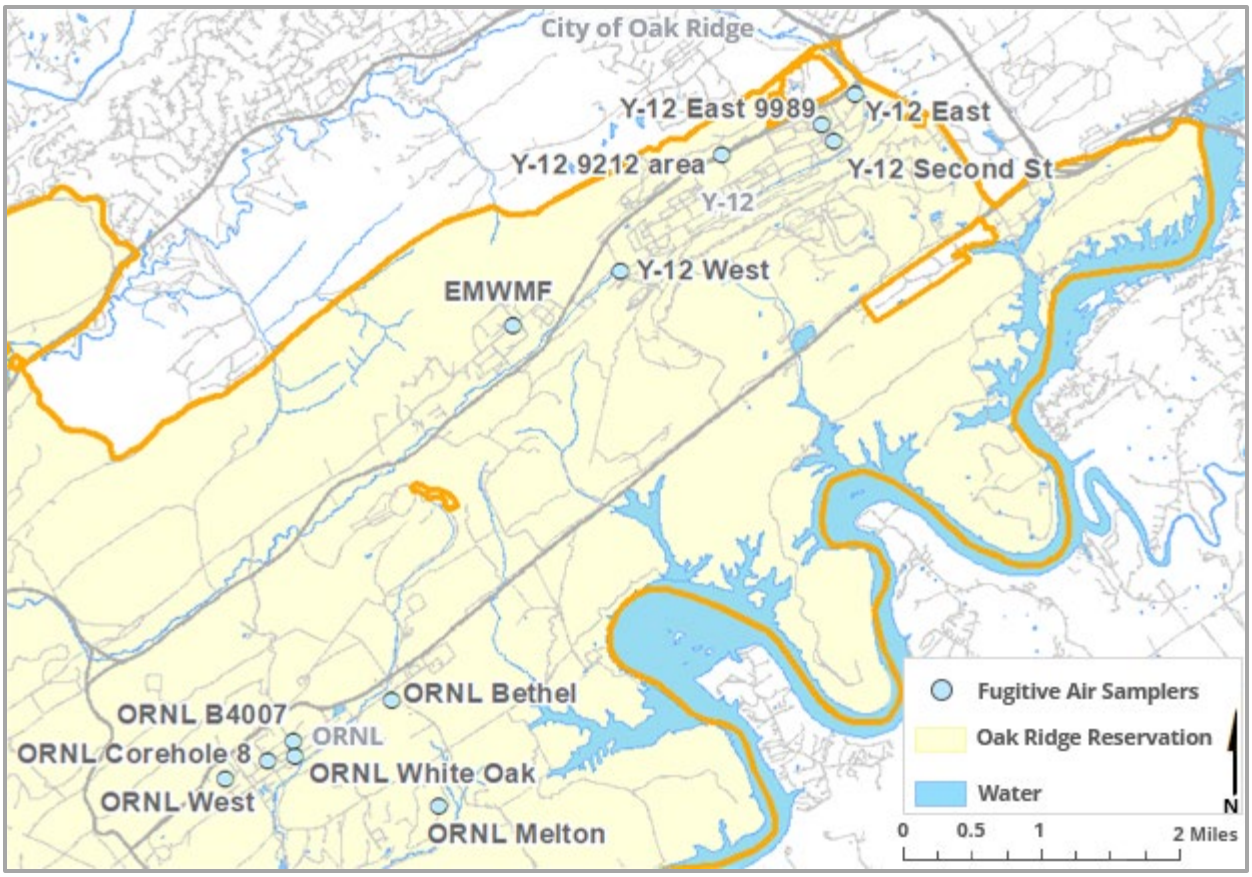

Figure 2.1.5.1: FY26 DoR-OR's ORR Fugitive Air Sampling Locations

For FY26, a total of fourteen air samplers will be located as follows: six in Bear Creek Valley (one at EMWMF, five at Y-12), six at ORNL, one in the City of Oak Ridge, and one sampler as a background site in Lenoir City. The ORR sampling locations shown in Figure 2.1.5.1. This background sampler is co-located with the DOE background monitoring station in Lenoir City.

2.1.6 Methods, Materials, Metrics

As shown in Figure 2.1.5.1, the *Fugitive Radiological Air Emissions Monitoring* project will use 14 high-volume air samplers to conduct continuous air monitoring on or near the ORR and at a nearby background location. Samplers will be placed at ORR locations where the potential for release of fugitive airborne emissions is the greatest. For example, areas of interest include locations where contaminated soils are being excavated, sites with contaminated structures undergoing demolition, or at waste disposal sites. These types of site activities warrant consideration for air monitoring placement.

Samples will be collected according to the SOP *T-200 Operation and Use of a High-Volume Air Monitor* (TDEC, 2024). Each of the high-volume air samplers use an 8 x 10-inch glass-fiber filter to collect particulates from the air. Air is drawn through the unit at a rate of approximately 35

ft^3 per minute. To ensure accuracy, airflow through each air sampler will be calibrated quarterly.

Samples will be collected from each air sampler weekly, with samples being composited every four weeks and analyzed by an environmental analytical laboratory contracted by DoR-OR. The lab analyses requested will be based upon sampler location and the known contaminants at that campus or site. One set of radiological analyses will include isotopic uranium, gross alpha and gross beta, and gamma activity for samples from nine stations: ORNL (six stations), EMWMF, Oak Ridge, and Lenoir City (background). The other set of analyses will include isotopic uranium, gross alpha, and gross beta analysis requested for the five stations located at Y-12.

Facilities slated for D&D were reviewed by the project team to ensure the placement of the fugitive air monitoring stations was set to be compatible with current and planned DOE activities at ORNL and Y-12.

ORNL D&D:

- Graphite Reactor Support Facilities (Buildings 3002, 3003, 3018): with demolition starting early 2025.

- Pre-demolition (takes place inside buildings) for: Building 3544 (currently in pre-demo), Building 3042 (pre-demo in DOE FY26), and Building 3038 (pre-demo expected to be complete in DOE FY26 with demo expected to begin FY28).

Y-12 D&D:

- 9201-2 (Alpha-2) with active D&D in 2025 and 2026.

- Beta-1 pre-demo and Beta-4 early pre-demo.

- 9720-17 (Ancillary Facility- CNS) with D&D in 2025.

Bear Creek Valley (EMWMF, EMDF):

- EMWMF continues to accept rad waste from the ORR sites undergoing D&D.

- Bear Creek Valley construction continues to prepare the new mixed waste rad landfill site (EMDF).

To assess contaminant concentrations measured at each location, results will be compared with the background data and to the standards provided in the National Emission Standards for Hazardous Air Pollutants (40 CFR 61H, 2024a). These standards associate radiological emissions to quantities that would not cause a member of the public to receive an effective dose

equivalent greater than 10 millirem (mrem) in a year. Associated findings will be reported to DOE, its contractors, and the public in the annual TDEC DoR-OR EMR (TDEC, 2025).

2.1.7 REFERENCES

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40 CFR 61, Subpart H. 2025b. *Title 40 of the Code of Federal Regulations, Chapter 1, Subchapter C, Part 61 National Emission Standards for Hazardous Air Pollutants (NESHAPS)*, *Appendix E, Table 2 Concentration Levels for Environmental Compliance*. National Archives. Washington, DC. https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-61/appendix-Appendix%20E%20to%20Part%2061

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2.2 ORR RadNet Precipitation Monitoring

2.2.1 Background

The nationwide EPA RadNet Precipitation Monitoring Program measures radioactive contaminants that are removed from the atmosphere and transported to the Earth's surface by precipitation. The *ORR RadNet Precipitation Monitoring* project provides radiochemical analysis on precipitation samples taken from monitoring stations at three locations on the ORR. Samples are collected by TDEC DoR-OR personnel, and gamma analysis is performed on monthly composite samples by the EPA lab, NAREL.

Gamma analysis is used as a screening tool because few isotopes of interest are pure beta or pure gamma emitters. Therefore, if a radiological release occurs on the ORR, some gamma radiation would likely be emitted either directly or indirectly from daughter products.

Additional analysis may be conducted at EPA's discretion if a radiological release is known to have occurred anywhere in the world or is indicated by monthly gamma analysis results.

While there are no regulatory standards that apply directly to contaminants in precipitation, this project will provide analyses that could potentially indicate the presence of radioactive materials on the ORR.

2.2.2 Related DOE Projects

This precipitation monitoring project does not directly correlate to any of DOE's air sampling programs per DOE's EMP for 2023 (DOE, 2022). This project seeks to fill a gap in DOE monitoring data by sampling a different medium that might capture radiological contaminants that are not collected by other methods.

2.2.3 Problem Statements

The ORNL and Y-12 sites on the ORR could potentially release legacy radioactive contaminants into the air. Potential releases could be from current operations, the deterioration of contaminated buildings, D&D remedial efforts, and/or from construction of new buildings.

This project measures any radioactive contaminants that are captured in precipitation and collected at each sampler. The analysis of the precipitation samples can show the presence of radioactive materials that may not be evident in the particulate samples collected by the co-located fugitive air monitors.

2.2.4 Goals

The goal of the TDEC *RadNet Precipitation Monitoring* project is to measure any radioactive

contaminants that are washed out of the atmosphere and reach the Earth's surface in precipitation on the ORR. This precipitation sampling data can be used as an additional indicator of the presence or absence of radiological contaminants that could potentially impact areas near the ORR.

2.2.5 Scope

Three precipitation samplers will be used to monitor precipitation for radiological contamination. Each precipitation sampler will be co-located with a DoR-OR Fugitive Radiological Air Emissions sampler. One precipitation sampler is located at the east end of Y-12. At this location, the sampler could indicate if any gamma radioisotopes have been moving off the ORR, towards the City of Oak Ridge. The other two samplers are at ORNL, with one in Bethel Valley and the other in Melton Valley. The latter sampler is near the High Flux Isotope Reactor (HFIR) and the Solid Waste Storage Area (SWSA) 5 burial grounds. Samples from the three locations will be collected weekly.

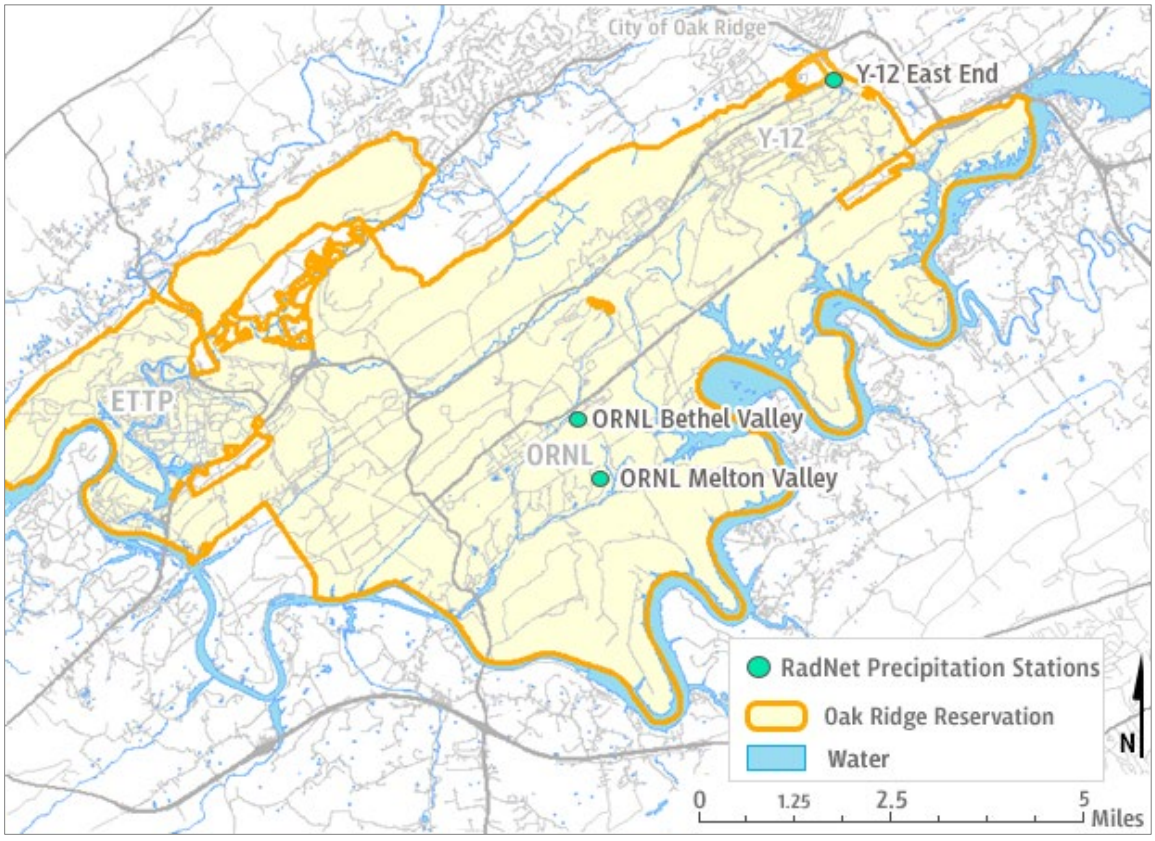

Figure 2.2.5.1: Locations of RadNet Precipitation Monitoring ORR Stations

2.2.6 Methods, Materials, Metrics

The three RadNet Precipitation sampler locations are shown in Figure 2.2.5.1. All the samplers

were provided by the EPA RadNet Program. Each sampler collects precipitation that falls on a 0.5 m^2 fiberglass collector and drains into a five-gallon plastic collection bucket. Each sample will be measured and then collected using a four-liter sample container per the TDEC RadNet Precipitation and EPA SOPs (TDEC, 2024; EPA, 1988; EPA, 2013). Precipitation samples are collected on a weekly basis, with each sample of at least two liters of precipitation shipped to NAREL for analysis. Any sample less than this is not sent and is stored for further collection. If the final sample of the month or any remaining sample at the end of the month is less than two liters, it is sent regardless of volume. Once at NAREL, each station will have its samples combined into a monthly composite sample. Analysis for gamma emitting radionuclides will then be performed on the composite sample from each station.

Since there are no regulatory limits for radiological contaminants in precipitation, the results of the gamma analysis will be compared to EPA drinking water limits, which are considered conservative reference values. EPA's *Radionuclides Rule* (EPA, 2001) outlines water quality parameters for drinking water. Gross alpha radioactivity levels are limited to 15 pCi/L (picocuries per liter). Beta and gamma emitters are limited to 4 millirem (mrem) per year and are radionuclide specific (EPA, 2015). Not all gamma isotopes have EPA drinking water limits, so only those that do and have been seen in RadNet Precipitation samples are used for comparison. The EPA's maximum contaminant levels (MCLs) for select beta and gamma emitters are listed in Table 2.2.6.1.

Table 2.2.6.1: EPA Drinking Water Limits (MCLs) for Select Isotopes

Isotope	EPA limit (pCi/L)
Beryllium-7 (Be-7)	6,000
Cobalt-60 (Co-60)	100
Cesium-137 (Cs-137)	200
Iodine-131 (I-131)	3

Note: From Derived Concentrations (pCi/l) of Beta and Photon Emitters in Drinking Water (EPA, 2015)

Previous and current results of NAREL's analyses are available in the EPA Envirofacts RadNet searchable database (EPA, 2025), including the results of TDEC's monitoring effort on the ORR. The data can be used to identify anomalies in radiological contaminant levels, to appraise conditions on the ORR as compared to other locations in the RadNet database, and to determine levels of local contamination. However, while the ORR stations are in areas near sources of radiological contaminants, most of the other stations in the nationwide EPA RadNet Precipitation monitoring program are located near major population centers, with no major sources of radiological contaminants nearby.

2.2.7 REFERENCES

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3.0 BIOLOGICAL MONITORING

3.1 BENTHIC COMMUNITY HEALTH

3.1.1 BACKGROUND

The *Benthic Community Health Project* monitors the current and changing conditions of benthic (i.e., stream-bottom) communities in streams on the ORR. These streams have been negatively impacted by historical Manhattan Project activities as well as current DOE operational activities. The purpose of this project is to document the macroinvertebrate taxa present in streams, assign Tennessee Macroinvertebrate Index (TMI) scores for stream sites, and note any changes from previous sampling years. Additionally, changes that coincide with ongoing CERCLA remedial activities are documented.

Aquatic macroinvertebrate species serve as quantitative (e.g., the number of species present) and qualitative (e.g., the type of species present) indicators to assess biotic responses to environmental stressors (Holt, 2010). Macroinvertebrates are tied to the stream bottom and generally do not move or migrate very far. These animals are continuously exposed to any adverse conditions caused by direct or indirect discharges to these waters. In addition, macroinvertebrates inhabit aquatic or semi-aquatic habitats during immature growth stages, before moving to a terrestrial environment as adults. The immature aquatic life stages are the longest-lived stages and are where macroinvertebrates would be most exposed to adverse conditions. Remaining in the same stream section for a significant portion of their lives allows these animals to be a good index of environmental changes over time.

The biodiversity of macroinvertebrates will be evaluated for four (4) main streams on the ORR. Unimpacted reference streams will be used to determine the typical composition of a healthy macroinvertebrate community from a similar environment. The macroinvertebrate taxa from each impacted stream will be compared to those found in the associated reference stream.

The four (4) main streams to be studied at the three (3) ORR campuses are:

1) ORNL: White Oak Creek
2) ETTP: Mitchell Branch
3) Y-12: East Fork Poplar Creek and Bear Creek

3.1.2 PROBLEM STATEMENTS

Past studies indicate that most of the ORR macroinvertebrate communities have been negatively impacted because of historical contamination. ORR communities are typically less diverse, have fewer sensitive species, and lower TMI scores, when compared to healthy communities in unimpacted reference streams (TDEC 2022, DOE 2022). When macroinvertebrate communities change, the project team attempts to determine whether the

migration of legacy waste, current operations, and/or another variable is responsible for this change. Below are specific considerations that arise when determining what variables may be responsible for the changes:

1) Contamination from legacy waste (Manhattan project) or from current operations could be impacting sampled communities.

2) Channelization of streams could be inhibiting the establishment of diverse, healthy stream bottom communities. Channelization involves altering physical stream characteristics thus reducing the number of preferred habitats.

3) Natural environmental variability (i.e., seasonal changes, year-to year fluctuations in weather). Effects of natural variability are accounted for, as much as possible, through long-term sampling.
4) Sampler bias due to the knowledge and experience of the sampler could result in variable results. Alleviated with ongoing long-term sampling.

5) Sample site relocation may be necessary due to habitat alterations (i.e., construction of beaver dam), severe weather events (i.e., flash flooding), or human activities that cause a loss or alteration in habitat.

6) Differences in methodology can lead to different results. DoR-OR sampling produces semi-quantitative data and ORNL's sampling produces quantitative data. Due to this difference DoR-OR must evaluate for qualitative similarities as opposed to direct, quantitative comparisons.

3.1.3 Related DOE Projects

ORNL conducts benthic macroinvertebrate sampling for DOE across the ORR. After completion of the taxonomy and relevant calculations, ORNL reports their findings in both the *Remediation Effectiveness Report (RER)* and the *Annual Site Environmental Report (ASER)* each year.

ORNL's Aquatic Ecology Group conducts benthic macroinvertebrate monitoring on some of the same streams as DoR-OR. The number of specific stream sites differs between the two agencies, but some sampling sites are shared. At shared sites, TDEC sampling serves as an independent check on ORNL's monitoring results. At sites that only TDEC samples, macroinvertebrates are collected to fill a gap in data.

3.1.4 Goals

1) Assess the benthic macroinvertebrate community health of the four (4) main ORR streams.

2) In FY26, analyze macroinvertebrate samples collected from tributaries of White Oak Creek (WOC) for radiological contamination (cesium-137 and strontium-90).

3) Maintain continuous sampling at impacted and reference sites to compare current stream health with previous years.

4) Identify any changes in biodiversity that may be due to contaminant migration and/or potential releases.

5) Provide a yearly quality check (QC) on ORNL's ORR macroinvertebrate data.

6) Draft monitoring recommendations and contaminant impact concerns based on the analysis of macroinvertebrate communities.

3.1.5 SCOPE

Four (4) main streams on the ORR will be sampled in FY26 (Figure 3.1.5.1). During the spring of 2025, thirteen (13) benthic macroinvertebrate samples will be collected from DOE impacted streams and five (5) samples will be collected from unimpacted reference streams (Table 3.1.5.1). Three (3) of the thirteen (13) samples will be collected for radiological analysis (MEK 0.3, FFK 0.2, FCK 0.1). Additional duplicate samples will be collected at two (2) sites (WCK 6.8 and MBK 1.6) for quality control data checks on field and laboratory methods. The total number of macroinvertebrate samples collected will be eighteen (18), from sixteen (16) sites.

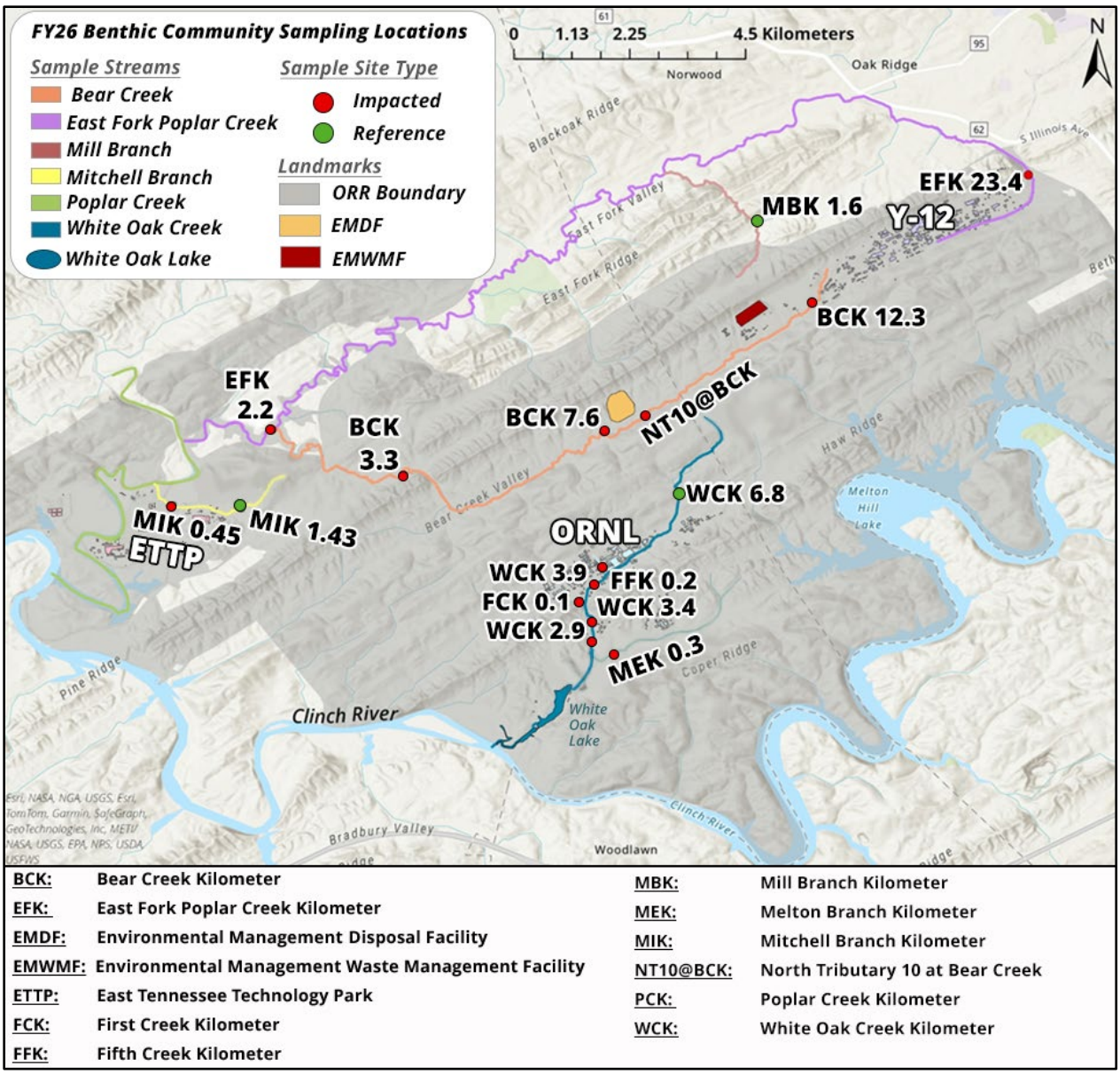
Table 3.1.5.1: Spring 2025 (FY26) Macroinvertebrate Samples

Site Description	Name	Latitude	Longitude	Sample #
Bear Creek Kilometer 3.3	BCK 3.3	35.943535	-84.349081	1
Bear Creek Kilometer 7.6	BCK 7.6	35.951122	-84.314085	1
North Tributary 10 at Bear Creek	NT10@BCK	35.953870	-84.306950	1
Bear Creek Kilometer 12.3	BCK 12.3	35.973325	-84.277700	1
East Fork Poplar Creek Kilometer 2.2	EFK 2.2	35.951471	-84.372062	1
East Fork Poplar Creek Kilometer 23.4	EFK 23.4	35.995928	-84.240062	1
Mitchel Branch Kilometer 0.45	MIK 0.45	35.938088	-84.389625	1
Mitchel Branch Kilometer 1.43	MIK 1.43	35.937840	-84.377470	1
First Creek Kilometer 0.1	FCK 0.1	35.921338	-84.318546	1*
Fifth Creek Kilometer 0.2	FFK 0.2	35.927370	-84.314290	1*
Melton Branch Kilometer 0.3	MEK 0.3	35.911785	-84.312175	1*
White Oak Creek Kilometer 2.9	WCK 2.9	35.914387	-84.316265	1
White Oak Creek Kilometer 3.4	WCK 3.4	35.917780	-84.316120	1
White Oak Creek Kilometer 3.9	WCK 3.9	35.924400	-84.315770	1
White Oak Creek Kilometer 6.8	WCK 6.8	35.940482	-84.300912	2**
Mill Branch Kilometer 1.6	MBK 1.6	35.987846	-84.287475	2**
Total Sites 16				**Total Samples** 18

Legend
Reference Sites
DOE Impacted Sites

*Sample will be collected for lab analysis of Cs-137 and Sr-90.

**Additional sample will be collected as a quality control for lab identification.



BCK:	Bear Creek Kilometer	MBK:	Mill Branch Kilometer
EFK:	East Fork Poplar Creek Kilometer	MEK:	Melton Branch Kilometer
EMDF:	Environmental Management Disposal Facility	MIK:	Mitchell Branch Kilometer
EMWMF:	Environmental Management Waste Management Facility	NT10@BCK:	North Tributary 10 at Bear Creek
ETTP:	East Tennessee Technology Park	PCK:	Poplar Creek Kilometer
FCK:	First Creek Kilometer	WCK:	White Oak Creek Kilometer
FFK:	Fifth Creek Kilometer		

Figure 3.1.5.1: Spring 2025 (FY26) Macroinvertebrate Sampling Locations

3.1.6 Methods, Materials, Metrics

All sampling methods will follow the TDEC DWR *Standard Operating Procedure for Benthic Macroinvertebrate Sampling* (DoR OR-T-260).

Macroinvertebrate Collection (for identification):

Sampling for this project requires two people at a minimum. One person, standing downstream, will set a one-square-meter kick net with a 500-micron mesh across a predetermined riffle. The other person, using their feet, disturbs approximately 1 m^2 area of the stream substrate directly upstream of that net. The organisms, sediment, and detritus flow into

the net. The net is then carefully lifted out of the water and carried horizontally to the streambank. The bottom of the net is positioned in a 500-micron sieve bucket. The net is thoroughly rinsed into the sieve bucket. Organisms still clinging to the net after rinsing are collected and placed into the bucket using forceps. This process is repeated using a second riffle upstream of the previous sample collection. The two square-meter kick collections are then composited, placed in a plastic container, and preserved with 95% ethanol.

MACROINVERTEBRATE COLLECTION (FOR RADIOLOGICAL ANALYSIS):

Macroinvertebrates will be collected using a Surber sampler. The Surber is placed on the bottom of the stream and sediment in front of the Surber is disturbed. The disturbed sediment, detritus, and macroinvertebrates all flow into the Surber's collection bag. The Surber is then moved to a different location and the process is repeated. A total of three areas will be disturbed. The Surber bag's contents are emptied into a sieve bucket. The bag is rinsed into the sieve and remaining organisms are transferred into the sieve with forceps. The sample is then transferred to a clean plastic bag (labelled with site, date, and time) and placed on ice until it can be frozen in the -20˚C freezer in the DoR-OR lab.

PROCESSING SAMPLES (FOR IDENTIFICATION):

The processing of benthic samples will occur at the DoR-OR Laboratory and consist of two major steps. The first step is sample sorting, where benthic organisms are removed from almost all the detritus collected. The benthic organisms and any remaining detritus are transferred into a numbered tray and evenly distributed. Four random numbers are selected using a random number generator. The corresponding numbers in the tray are then selected as subsamples.

The four subsamples are processed using a binocular dissecting microscope to remove benthic macroinvertebrates from the remaining detritus. During sorting of the subsamples, macroinvertebrates are placed into a separate vial with 95% ethanol and a running count of collected organisms is maintained. If more than 240 macroinvertebrates are counted after processing all four original subsamples, then another subsampling is performed. During a second subsample, organisms and ethanol are transferred to a gridded petri dish. Four grids are selected using a random number generator and macroinvertebrates are sorted and again counted. If the second sorting produces less than ~160 individuals, additional grid numbers are randomly selected and counted. Grid numbers are selected until the required number, between 160 and 240, of macroinvertebrates are collected. Typically, more than four grids are needed to achieve the desired number of organisms in the second subsample.

Once sorting and subsampling of all samples is completed, macroinvertebrates without the potential for radiological contamination are sent to Third Rock Consultants to be identified. Macroinvertebrates with potential for radiological contamination are sent to a laboratory with

the appropriate radiological license, CG Services. Macroinvertebrates are identified to genus when possible.

PROCESSING SAMPLES (FOR RADIOLOGICAL ANALYSIS):

Macroinvertebrates, collected for radiological analysis, are sorted from the detritus and stream sediment and delivered to Eberline for activity analysis of cesium-137 and strontium-90. During processing, only a small portion of the sample (sub-sample) is removed from the freezer and placed in a petri dish. The macroinvertebrates are removed from the detritus and placed in a clean sample jar. Sub-samples being sorted are kept as cold as possible during this process. Portions of the sample are removed from the freezer and sorted until the entire sample is processed. Only the macroinvertebrates are sent to the lab for analysis.

DATA ANALYSIS:

After receiving taxa identification results, the data is transcribed into the Division of Water Resources (DWR) macroinvertebrate template and the DoR-OR's database template. Data is sent to DWR and uploaded to TOReis, an internal data repository. DWR calculates various biometrics and scores them to produce the final TMI scores for each site. A description of the calculated biometrics and the expected response to environmental stressors are listed in Table 3.1.6.1.

A numerical score is calculated for each individual biometric. Those scores are used to determine the TMI score. A TMI score of 32 to 42 meets all bio-criteria for a healthy benthic macroinvertebrate community with no impairment to the system. A TMI score below 32 falls below bio-criteria guidelines and indicates macroinvertebrate community impairment. TMI scores for impacted sites are compared to the unimpacted reference sites. Further information about sampling procedures and biometric calculations can be found in the *Quality System SOP for Macroinvertebrate Stream Surveys* published by DWR (TDEC DWR, 2021).

After receiving the concentrations of cesium-137 and strontium-90 from Eberline, the results will be uploaded to TOReis and compared to the reference site's concentrations (WCK 6.8; sampled in spring 2024).

Table 3.1.6.1 Biometrics Used to Calculate TMI Score

Description of Biometrics and Expected Responses to Stressors			
Category	**Metric**	**Description**	**Response to Stress**
Richness	Taxa Richness	Measures overall diversity of the macroinvertebrate assemblage	Number Decreases
	EPT Richness	Number of taxa in the orders *Ephemeroptera, Plecoptera*, and *Trichoptera*	Number Decreases
Composition	%EPT-Cheum	% of EPT abundance excluding *Cheumatopsyche* taxa	% Decreases
	%OC	% of *Oligochaetes* and *Chironomids* present	% Increases
Tolerance	North Carolina Biota Index (NCBI)	Incorporates richness and abundance with a numerical rating of tolerance	Number Increases
	% TNUTOL	% of Nutrient Tolerant organisms, those with NCBI scores > 3.0	% Increases
Habitat	%Clingers	% of organisms with fixed retreats or attach themselves to substrate	% Decreases

3.1.7 References

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3.2 ORR Roving Creel Survey Project

3.2.1 Background

The three main ORR streams, White Oak Creek (WOC), Bear Creek (BC), and East Fork Poplar Creek (EFPC), are impacted by both historical and ongoing DOE activities. The confluence zone of Grassy Creek with the Clinch River was added to the scope of this project in FY25, due to detections of cesium-137 (Cs-137) in the Clinch River near the confluence point. These areas contain contaminants of concern (COCs) that have been shown to bioaccumulate in fish tissue (Stahl et al, 2008). Since these streams discharge into publicly accessible waters (Clinch River and Poplar Creek), fish consumption is a likely pathway for human exposure to COCs. The Roving Creel Survey (RCS) is an ongoing project that measures angling effort on waterways just outside the ORR boundaries. Measuring angling effort will provide more quantitative information on potential human exposure.

BC and EFPC originate within the confines of the Y-12. Both streams are fed by springs and numerous outfalls from the Y-12 National Security Complex. Uranium in BC and mercury (Hg) in EFPC are the main COCs in these streams. Considering the risk posed by these COCs on human and environmental health, it's important to monitor fishing and recreational activities in the

lower reaches of BC and EFPC that are publicly accessible. The North Boundary Greenway (NBG) is a popular recreation attraction for Oak Ridge citizens and parallels stretches of both BC and EFPC. Based on previously submitted surveys, fishing occurs in both BC and EFPC. Surveying along the NBG remains important because COCs have continued to be found in higher concentrations here than in the Clinch River.

White Oak Creek (WOC) originates just north of ORNL and eventually empties into the Clinch River (CR) via White Oak Lake (WOL). Radionuclides released from ORNL to WOC are a result of leaks from ponds and waste disposal areas and include contaminants such as strontium-90 (Sr-90) and cesium-137 (Cs-137), as well as other byproducts from nuclear and industrial activities (DOE, 1988). These are significant because of their radiotoxicity, their mobility in the environment, and the quantities released. Other radionuclides of significance include tritium and transuranics (DOE, 1988).

In 2020, Cs-137 was detected at 15 pCi/g in a sediment sample taken in the Clinch River near the mouth of Grassy Creek (OREIS, 2024). Additionally, there were mulitple dections of Cs-137 in and around the K-1515 Water Treatment Plant, specifically the K-1515-F Lagoon that is next to the Clinch River (DOE, 2007). The availability of Cs-137 for biological uptake is a public health concern, as it can be transferred to humans through food webs. Even in the most mobile aquatic habitats (i.e., flowing rivers), Cs-137 may persist in a biologically available form for several years after release (Rowan DJ, 1994; Sakai MT et al, 2016). The RCS project monitors angler activity where WOL discharges into the Clinch River (the WOL-CR confluence) and where Grassy Creek discharges into the Clinch River (the GC-CR confluence).

Measuring fish tissue concentrations is an important step to connecting known concentrations of COCs in fish and potential human exposure through angler surveys. In addition to surveys, FY26 will include a corresponding collection of fish tissue samples from the GC-CR confluence. This is an area with high angler activity, determined from previously collected survey data. Analysis for COCs will be performed on fish species that are popular among anglers in the GC-CR confluence.

3.2.2 Problem Statements

1) Fish have been shown to bioaccumulate mercury and other contaminants (Murphy, 2004). If contaminated, ingestion of these fish could harm people and other fish-eating organisms.

2) Fish consumption warning signs and postings are often either not visible, not legible, or are missing. In addition, residents who have fished these waters for many years may disregard warnings.

3.2.3 Related DOE Projects

No DOE investigations have taken place for over 20 years on or near the ORR to ascertain the level of human exposure risk through angling efforts and/or recreational activities. The RCSs and NBG surveys seek to fill a gap in the environmental monitoring of DOE.

DOE collects fish tissue samples at locations downstream of the confluence points of WOL-CR and Poplar Creek with the Clinch River (PC-CR), where dilution of ORR discharges has significantly reduced contaminant concentrations. Surface water contaminant concentrations at DOE sampling locations fall below the human health risk limits. While both DOE and DoR-OR sample fish tissue data using similar methodology, DoR-OR will collect fish tissue samples from an area of high angler activity at the confluence of GC-CR. DOE does not sample fish in this area. Additionally, DoR-OR will target species that anglers in the area commonly catch and consume. DOE's sampling efforts focus on target species identified in the associated RODs and watershed comprehensive monitoring plans, which may not directly reflect the species that recreational anglers report as target species in recent years (e.g. striped bass and crappie). Data collected by DoR-OR will supplement DOE's monitoring and fill the data gap of fish tissue concentrations of COCs at the GC-CR confluence.

3.2.4 Goals

1) Quantify the angling effort at six key locations just outside ORR boundaries (EFPC and BC along the NBG, confluence points of EFPC-PC, PC-CR, WOL-CR, and GC-CR).

2) Determine if recreational fishing adjacent to the ORR is a significant pathway for human exposure to contaminants.

3) Provide data that is pertinent to CERCLA requirements and future ORR decisions regarding human health and environmental protection.

4) Document the amount of human recreational activity in the lower reaches of BC and EFPC within the North Boundary Greenway.

5) Analyze the levels of specific COCs in fish tissue collected from an area with high angling activity (GC-CR).

3.2.5 Scope

During FY26, angler interviews will be conducted via boat at the following four confluence zones: (1) East Fork Poplar Creek-Poplar Creek (EFPC-PC), (2) Poplar Creek-Clinch River (PC-CR), (3) White Oak Lake-Clinch River (WOL-CR), and Grassy Creek-Clinch River (GC-CR) (Figure 3.2.5.1). Anglers encountered while traveling between the confluences will also be interviewed.

There will be 15 survey events throughout the fiscal year, excluding the cooler months (November through February). These months are excluded due to decreases in fish and angler activity. Specific survey dates are randomly selected. There is also a survey drop box at the Gallaher boat ramp to passively collect data from anglers via paper or digital surveys.

Recreational activities along the public NBG will be monitored through passive efforts to better understand public interactions with natural resources potentially impacted by DOE activities and contaminants. There are three survey drop boxes along the NBG to collect paper and digital surveys from recreators (Figure 3.2.5.1).

Fish tissue samples will be collected from the fourth zone (GC-CR), in which high angler activity has been documented. During FY25, fish tissue samples were collected from the other three zones and a representative reference zone (Melton Hill Lake). The GC-CR confluence is the only remaining zone left to sample for fish tissue. DoR-OR staff will attempt to collect fish species that anglers typically target in this area. Samples will be sent to a contracted laboratory for analysis of COCs (Table 3.2.6.1).

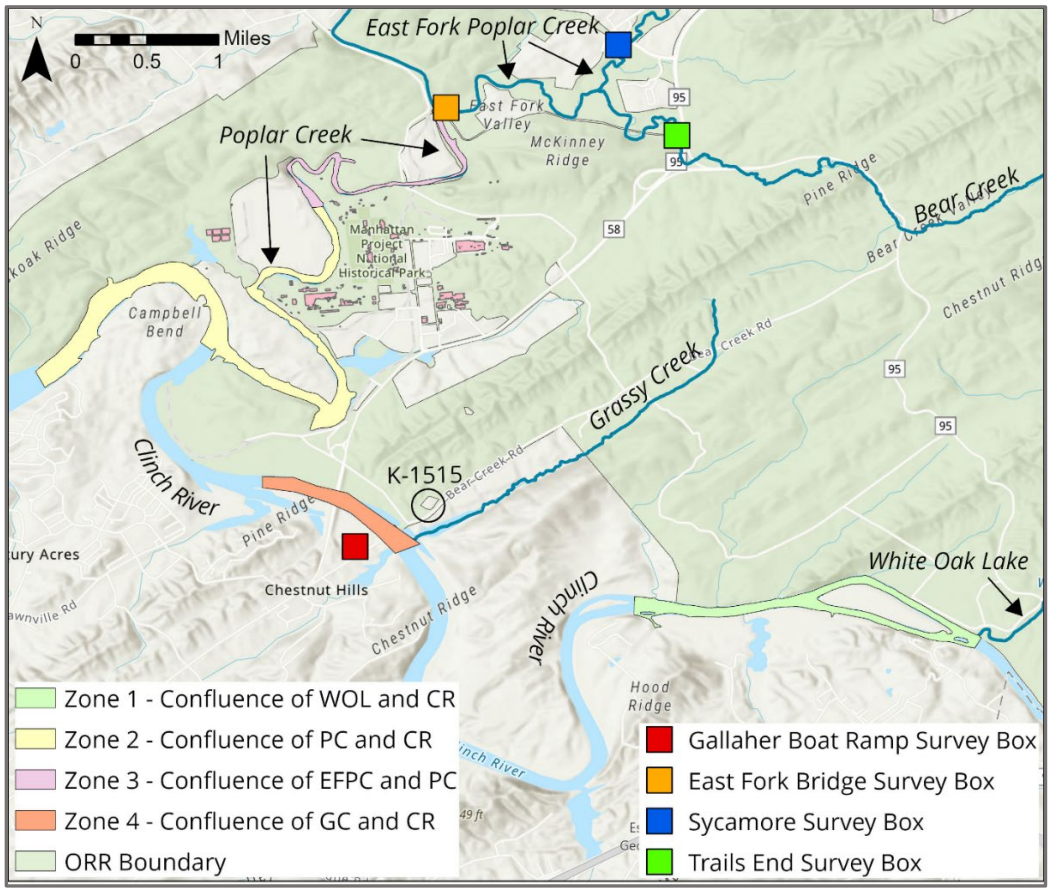

Figure 3.2.5.1 Map of Study Zones and Drop Box Locations

3.2.6 METHODS, MATERIALS, METRICS

Angler Surveys

DoR-OR staff will conduct angler interviews at and between the four study zones (Figure 3.2.5.1). Angler interviews will use active, on-site methods whereby anglers are interviewed before, during, or immediately after fishing trips. Methods are outlined in the standard operating procedure, *Roving Creel Survey – Angler Interviews* (TDEC, 2023). Additionally, angler information will be collected, voluntarily, via digital surveys using Survey123 and/or paper surveys posted year-round at the Gallaher Boat Ramp. Survey information that will be collected is listed below.

OBSERVABLE DATA COLLECTED FROM ANGLERS INCLUDES:

1. Date/Time
2. Type – boat/bank fishing, private/commercial
3. Location – Lat/Long
4. Number of people in party

ANGLER REPORTED DATA INCLUDES:

1. County and state residence
2. Total amount of time spent fishing for that trip
3. An estimate of days spent fishing per month
4. Target species of fish
5. Consumption of fish harvested from the areas of concern
6. Provision of fish to sensitive populations (i.e., pregnant women, nursing mothers, or children) for consumption
7. Knowledge of posted signage in these areas of concern

NBG Recreator Surveys

Recreational activities along the NBG will be monitored using drop boxes with paper surveys and digital surveys accessible via QR codes posted on boxes. Surveys will be available year-round to recreators posted at the three locations on Figure 3.2.5.1.

RECREATOR REPORTED DATA INCLUDES:

1. Date/Time
2. Recreation activity – hiking, biking, fishing, kayaking…etc.
3. Number of people in party
4. County and State residence
5. Total amount of time spent recreating for that trip
6. Estimate of time spent fishing per month along the NBG (days/month)
7. Target species of fish

8. Consumption of fish harvested from the areas of concern
9. Provision of fish to sensitive populations (i.e., pregnant women, nursing mothers, or children) for consumption
10. Knowledge of posted signage in these areas of concern

Fish Tissue Analysis

Fish for tissue analysis will be collected via boat electro-shocker, or other DWR or TWRA approved methods. Fish species that are commonly targeted by anglers for consumption in the GC-CR zone will be analyzed for COCs. If standard fish sampling methods do not yield sufficient sample sizes angling with a fishing pole may be considered to mimic the recreational activities on the CR. Captured fish will be filleted and sent to a contracted laboratory for analysis of specific COCs. A total of five fish of a single species will be harvested and analyzed for the contaminants in Table 3.2.6.1. Fish tissue concentrations will be compared to relevant AWQC or other regulatory limits where appropriate.

Table 3.2.6.1: Analysis of COCs at Grassy Creek – Clinch River Confluence

Analytes	Laboratory Method
Strontium (metal)	EPA 6020
Low-level mercury	EPA 1631
Methylmercury	EPA 1630
Gamma Spectroscopy (Cs-137)	EPA 901.1 Modified
Strontium-89/90	EPA 905.0
PCBs	EPA 8082

3.2.7 REFERENCES

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3.3 Contaminant Uptake in Biota

3.3.1 Background

Mercury (Hg), among other contaminants, is found in elevated levels throughout the ORR from processes and spills dating back to Manhattan Project and Cold War era activities (Brooks et al, 2017). Mercury in ORR streams and wetlands often undergoes methylation and is transformed into toxic methylmercury (MeHg) in conjunction with the activity of specific microorganisms (Kalisinska et al, 2013). MeHg is especially bioavailable to wildlife (and humans) and, if ingested, may cause serious neurological, reproductive, and other physiological damage (Standish, 2016). For example, decreases in reproductive success of 35–50% have been observed in birds with high dietary methylmercury uptake (USDI, 1998; Hallinger and Cristol, 2011) including reduced hatching and fledging success (Chin et al, 2017).

MeHg biomagnifies throughout the food web. Organisms at higher levels in the food web, such as songbirds and snakes, might accumulate increasingly larger body burdens of MeHg through consumption of prey items. Small invertebrates, small mammals, stream-bottom larval-stage biota, terrestrial spiders, and emergent flying insects are examples of possible local prey items. (Scheuhammer et al, 2007).

Evidence of bioaccumulation provides key links between aquatic and terrestrial systems (Cristol et al, 2008; Pant et al, 2010). Based on previous bioaccumulation studies, key species from

multiple chains or links within the food web should be monitored to document any movement of these contaminants. By sampling songbirds, adult flying insects, and snakes, the pathways of the bioaccumulative transfer of mercury and other contaminants may become clearer.

Additionally, there are concerns that contaminants could potentially migrate away from the known point sources via highly mobile biota (Cristol et al, 2012). Some migratory birds and snakes may even spread these contaminants over a larger area. Monitoring the migration of heavy metal contaminants through environmental biotic media helps inform potential human exposure risks.

DoR-OR staff have encountered homeless encampments within ORR impacted watersheds. As homeless citizens are more transient, they have higher potential to encounter contaminants that occur within these stream systems. In such cases, ecological receptors may potentially act as a proxy to assess human exposure risk.

3.3.2 Problems Statements

1) Mobile ORR biota, like migratory songbirds, could bioaccumulate and spread contaminants offsite.
2) Many adult flying insects on the ORR began life in contaminated water as nymphs. They accumulate contaminants from aquatic environments and are consumed by terrestrial predators as adults (e.g., songbirds and bats), transferring contaminants up the food chain.

3) Studies have demonstrated a correlation between contaminant levels in herpetological species and humans (Pelallo-Martinez et al, 2011), supporting the use of snakes to assess potential exposure risks to humans within those areas. Little to no data has been collected on the ORR in the last 10–15 years on the role(s) of snakes in mercury bioaccumulation, and ORNL/DOE does not monitor higher level predators. As an intermediate and top-level consumer, snakes have the potential to accumulate higher levels of Hg and MeHg through the consumption of exposed prey items. Additionally, with their larger home ranges, snakes have the capacity to disperse contaminants over larger distances.

4) The recent encounters with homeless encampments along East Fork Poplar Creek (EFPC) suggest that the human exposure risk to Hg and MeHg may be higher than previously thought. Investigation of how much Hg and MeHg is travelling through trophic levels is relevant to assess protectiveness in these areas for both human health and the environment.

3.3.3 Related DOE Projects

During the CERCLA-driven Five Year Review, selected biota such as turtles, spiders, earthworms,

and select adult insects were sampled by DOE and analyzed for mercury and other contaminants (DOE, 2021).

3.3.4 GOALS

Sampling goals for Fiscal Year 2026 (FY26) are:

1) Document the bioaccumulation of Hg, MeHg, and other contaminants through the trophic levels in biota species living along EFPC and White Oak Creek (WOC).

2) Support the WOC Holistic Watershed Assessment Project (Chapter 9.1). Provide biota (songbird egg, adult flying insect) data to supplement the findings of the watershed assessments and better understand both ecological and human health risks.

3) Augment a growing body of evidence through snake and songbird data to support future remedial decisions for EFPC.

3.3.5 SCOPE

Biota specimens will be collected from eight sites, including three impacted WOC study areas, three impacted EFPC study areas, and two reference sites (i.e. upstream WOC, Freels Bend) (Figure 3.3.5.1-3.3.5.2).

Beginning in spring 2025, samples will be collected from all study areas over a one-year period or until enough biomass has been collected for laboratory analysis.

Site Descriptions

White Oak Creek

To ensure enough biomass is obtained without impacting local populations, WOC is divided into the following sampling zones (Figure 3.3.5.1).

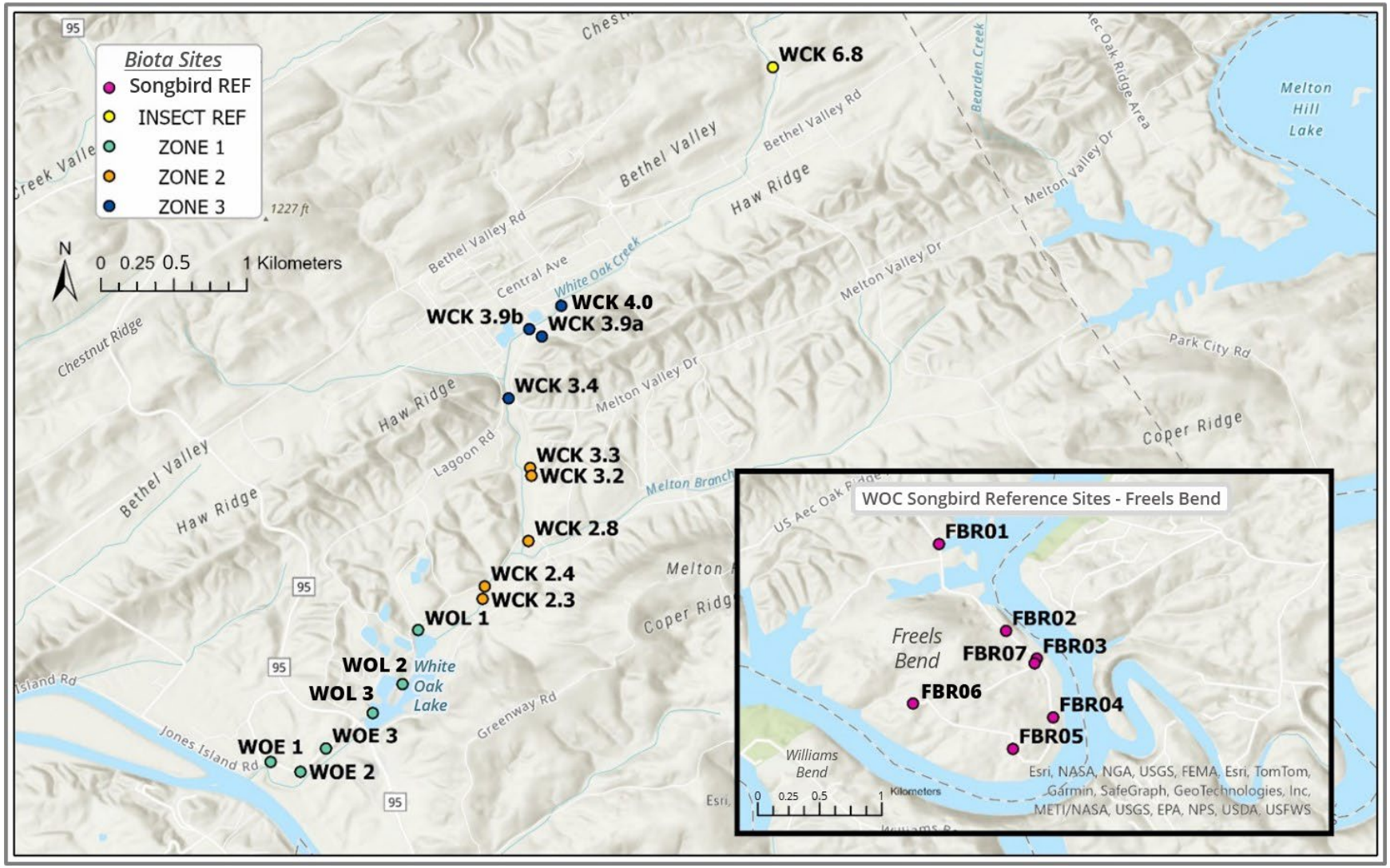

Figure 3.3.5.1: Biota Sampling Sites Along WOC.

1) **WOC Zone 1**: White Oak Embayment (WOE) and White Oak Lake (WOL) comprise Zone 1 of the WOC watershed, which is the most downstream reach. DoR-OR personnel will collect songbird egg and insect samples from five sites within the WOE and WOL reaches.

2) **WOC Zone 2**: Zone 2 includes the lower reaches of WOC, encompassing Melton Valley. TDEC DoR-OR personnel will collect songbird egg and insect samples from five sites from end of WOL to WCK 3.4.

3) **WOC Zone 3**: Zone 3 includes the upper reaches of WOC that flow through Bethel Valley. TDEC DoR-OR personnel will collect songbird egg and insect samples from three to four sites from WCK 3.4 to WCK 4.2.

4) **WOC Insect Reference Zone:** Zone 4 contains the WOC reference site, WCK 6.8. This site is located upstream of ORNL inputs into WOC. This site is not within the contaminated floodplain of WOC and has not been affected by radionuclide contaminants. WCK 6.8 will be used as a reference site for insect samples.

5) **WOC Bird Reference Zone – Freels Bend**: This reference zone is comprised of seven sites within Freels Bend, a peninsular area along the Clinch River. These sites are not within the floodplain of WOC and have not been affected by radionuclide or heavy metals contamination associated with ORNL and WOC. These reference sites will be used to provide reference samples for songbird eggs.

East Fork Poplar Creek

EFPC is also divided into sampling zones to obtain adequate amounts of biomass without impacting local populations. The EFPC zones are as follows (Figure 3.3.5.2):

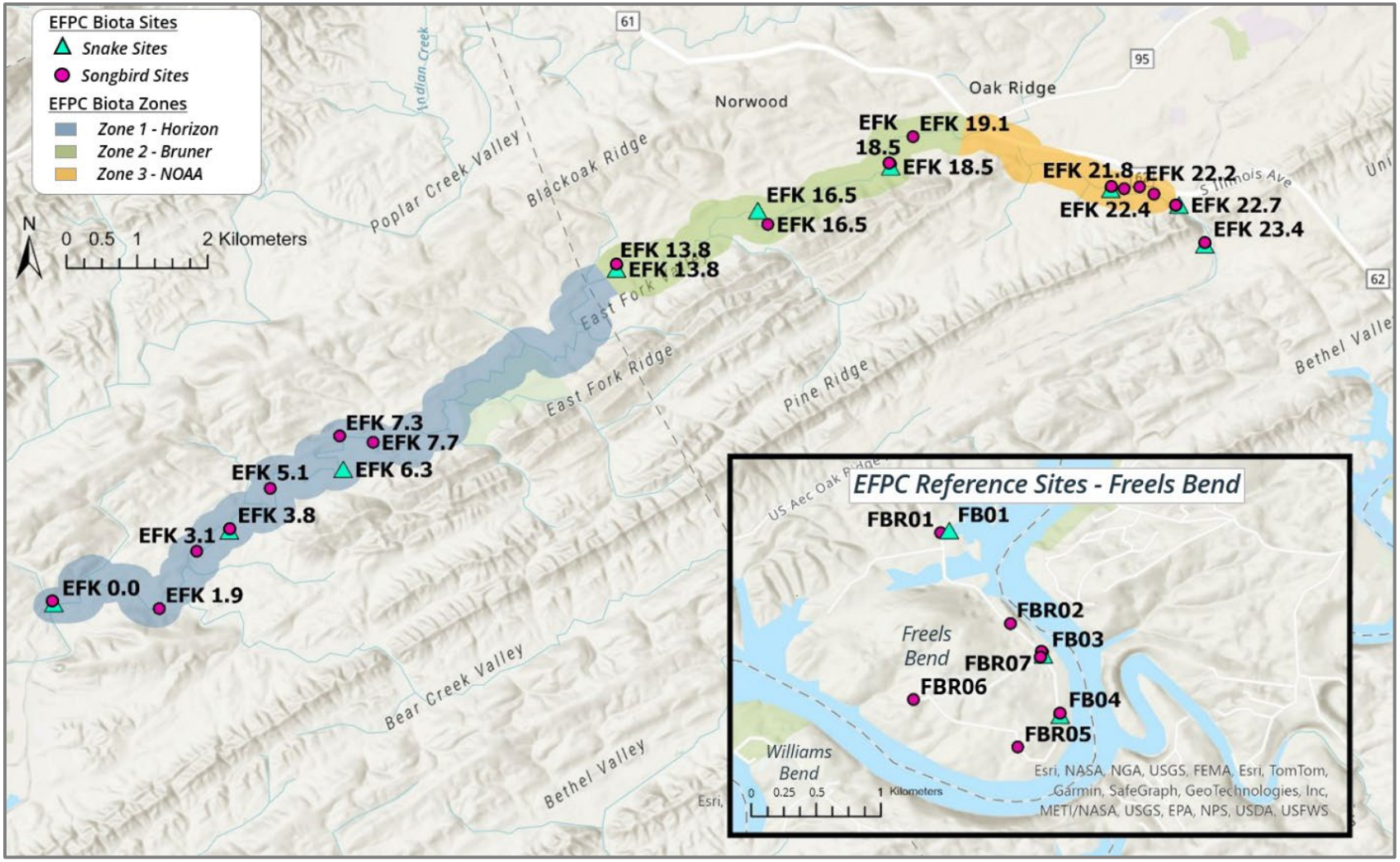

Figure 3.3.5.2: EFPC Snake and Songbird Sampling Sites and Freels Bend Reference Sites.

1) **EFPC Zone 1**: *Horizon Center* is the most downstream reach of EFPC. DoR-OR personnel will collect snake specimens at three sites and songbird egg samples from multiple sites on EFPC from EFPC kilometer EFK 0.0 to EFK 13.7.

2) **EFPC Zone 2**: This reach, containing the *Bruner Site*, flows through the City of Oak Ridge, following closely to the Oak Ridge Turnpike. The project team will collect specimens at three sites on EFPC from EFK 13.8 to EFK 19.1.

3) **EFPC Zone 3**: The *NOAA Site* reach is the most upstream reach of EFPC, in closest proximity to Y-12, and flows through the City of Oak Ridge. DoR-OR personnel will collect specimens at three sites on EFPC from EFK 19.2 to EFK 23.4.

4) **Reference Locations**: Comprised of sites within Freels Bend, a peninsular area along the Clinch River. These sites are not within the floodplain of EFPC and have not been affected by industrial mercury or methylmercury contamination.

3.3.6 METHODS, MATERIALS, METRICS

Terrestrial biota collected to obtain biomass for contaminant testing are listed below. All sampling is completed in accordance with TDEC's Health and Safety Plan (TDEC 2020) and in accordance with TDEC's QAPP (TDEC 2024).

SONGBIRD EGGS:

Songbird nest boxes have been installed along WOC, EFPC, and at reference locations (Figure 3.3.5.1 and 3.3.5.2) following *TDEC SOP: Songbird Nest Box Construction and Deployment. DoR-OR-T-290B* (TDEC, 2023a). Songbird nest boxes will be checked weekly from February - April 2025 and February – April 2026 to determine occupancy. Once a nest box is confirmed to have an occupant, the box will be checked twice per week to collect the first laid eggs of the clutch for analysis following *TDEC SOP: Egg Sampling for Mercury and Radionuclide Bioaccumulation. DoR-OR-T-291* (TDEC, 2023b). The breeding season for songbirds runs from March through June, and this protocol will allow songbirds time to produce a second brood. Eggs collected from sites within the same zone along WOC will be composited into one sample. Eggs collected along EFPC will remain separated by site. During spring 2025, four total composite songbird egg samples will be collected along WOC for radionuclide analysis. During spring 2026, four composite songbird egg samples will be collected from WOC for heavy metal and organic chemical analysis. A maximum of 25 EFPC samples will be collected for total mercury (HgT) analysis.

ADULT INSECTS:

Adult insects will be collected from WOC and reference sites (Figure 3.3.5.1) between April and

August 2025 following *TDEC SOP: Insect Sampling Using Light Traps. DoR-OR-T-331* (TDEC, 2023d). The SOP has been modified to include the use of Malaise and Lindgren Style funnel traps to accommodate safety concerns associated with potential radiation exposure at WOC. Insects will be trapped in a combination of Lindgren Style funnel traps and Malaise traps. Traps will be set and checked weekly; any insects in the traps will be collected and traps reset for the following collection. All insects collected from sites within the same zone will be composited into one sample. There will be four total composite insect samples for WOC sent for heavy metal and organic chemical analysis.

SNAKES:

From April to October 2025, snakes will be sampled along EFPC and at reference sites (Figure 3.3.5.2) following *TDEC SOP: Herpetofauna Trapping and Sampling. DoR-OR-T-312.* (TDEC, 2023c). Snake boards will be used to attract snakes. Snakes resting under boards will then be captured by hand. Trained staff will record morphological measurements to assess snake body condition and collect blood samples from captured snakes (University of Tennessee, Knoxville IACUC 2987-0623). Snakes will be released unharmed at the site of capture. Due to safety concerns, venomous snakes will not be handled or sampled. Opportunistic snake skin shed samples will also be collected, if available.

Species that are State or federally listed as greatest conservation need, threatened, endangered, or deemed in need of management will not be sampled. State or federally listed species (if encountered) will be reported to TWRA and USFWS within 5 working days.

BIOTA SAMPLING AND HANDLING PROTOCOL FOR TDEC DOR-OR LAB:

1) Biota samples will be weighed to the nearest 0.01 gram and recorded on the laboratory sample log.

2) Bird egg and flying insect biota samples will be placed into separate Level 2 pre-cleaned glass jars with labels and screw-top plastic lids. These sample jars will be stored at -20ºC in the TDEC DoR-OR lab freezer until shipped to an external lab for analysis. Analysis for bird eggs will vary by site, but can include radionuclides, gross alpha radiation, gross beta radiation, metals, PCBs, and dioxin/furans. Insects will be analyzed for metals and PCBs.

3) Upon assessment of total biomass per zone, snake samples will either remain in original collection tubes or be composited into Level 2 pre-cleaned glass vials with labels and screw-top plastic lids. These samples will be stored at -20ºC in the TDEC DoR-OR lab freezer until shipment to an external laboratory for processing. Snake samples will be analyzed for Hg and MeHg; if enough biomass is collected, they will also be analyzed for other heavy metals (As, Cd, U) and PCBs.

DATA ANALYSIS:

1) Biota data results will be compared to available DOE biota datasets in OREIS.

2) The Hg, MeHg, and radiological analytical data results will be normalized to account for differences in body mass, where applicable, within and between species.

3) Total Hg and MeHg concentrations and radiological contaminants will be compared among feeding guilds, as possible: insectivores, omnivores, herbivores, carnivores.

4) Results from the monitoring zones will be compared with results from the reference zone(s) for each respective biota group.

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3.4 Terrestrial Invertebrate Community Health

3.4.1 Background

As a direct result of historical releases from the Y-12 Complex, mercury (Hg) remains a focal contaminant of concern (COC) in East Fork Poplar Creek (EFPC) (Brooks et al, 2017). Today, this stream's headwaters are fed by surface water runoff and groundwater exposed to mercury-contaminated structures. Hg in streams and wetlands around Y-12 undergoes methylation and is transformed into toxic methylmercury (MeHg) through microbial activity (Kalisinska et al, 2013). MeHg is detrimental to local biota (e.g. wildlife and humans). If ingested, MeHg may cause serious neurological, reproductive, and other life-altering physiological damage (Standish, 2016). Hg and MeHg contamination and its migration through ORR streams and into terrestrial food webs continues to elevate the potential exposure risks to humans and other biota living in and around EFPC.

Bioindicators, generally, are organisms that can qualitatively describe the health of their environment (Avgin and Luff 2010). Key bioindicator species from multiple levels of the food chain should be assessed for a better understanding of the impacts of mercury subsidies in the environment. A critical first step for this process is evaluating impacts of contaminants on habitat quality and organismal community health. For example, benthic macroinvertebrate species are key bioindicators used to monitor stream health and assess impacts of human disturbance to aquatic environments. Extrapolating from the role of aquatic bioindicators, terrestrial bioindicators should be monitored for a better understanding of ORR impacts to the surrounding terrestrial environment. This project plans to address the terrestrial biota sampling gap and will focus on ground beetles (carabids).

Carabids are ideal bioindicators given their close contact with contaminants present in soils and leaf litter (Hunter et al, 1987; Pizzolotto et al, 2013; Ghannem et al, 2018). Contaminated soils and leaf litter provide a link between aquatic and terrestrial environments. Carabids are

ground-dwelling arthropods during the entirety of their life cycle. Considering that they have an increased exposure time to contaminated sources (e.g., soils) during the larval stage, these beetles have a stronger potential to accumulate mercury and other heavy metals in their immediate environment (Ghannem et al, 2016). Also, carabids are generalist consumers that occupy multiple trophic levels and could potentially be impacted through multiple contaminant pathways. Additionally, they are ideal bioindicators due to their sensitivity to environmental change. Carabids exhibit relatively rapid and measurable changes within species and community composition in response to anthropogenic impacts on local environments (Pearce and Venier, 2006; Avgin and Luff, 2010; Ghannem et al, 2018).

To date, heavy metals and other contaminant concentrations have been analyzed in limited terrestrial invertebrate communities along EFPC at sites downstream of the ORR. However, no ORR studies have evaluated the impacts of contaminants on terrestrial invertebrate community composition. More specifically, no study has looked at carabid communities to evaluate heavy metal impacts on community composition.

In addition to filling a data gap in terrestrial systems monitoring, this project will contribute to a separate, larger EFPC Holistic Watershed Assessment (EFPCAP). The EFPCAP aims to complete a comprehensive evaluation of the ecological health of the entire watershed. As a valuable data gap project, ground beetle community assessments will establish a more complete analysis on watershed ecological health.

To further aid in the success of this project, open-sourced data from the National Ecological Observatory Network (NEON) will be leveraged. NEON has collected data on carabids from multiple unimpacted sites around the ORR for 8 years. This database will serve as a robust reference data source.

3.4.2 Problems Statements

1) Hg inputs into EFPC from Y-12 continue to be a concern, especially as it becomes bioavailable through methylation.

2) Quantification of impacts from Hg and MeHg have mainly focused on biotic groups tied to aquatic environments and assessment of terrestrial biotic groups is absent.

3) DOE does not directly monitor Hg and MeHg pathways from aquatic to terrestrial habitats.

4) Terrestrial bioindicators equivalent to aquatic bioindicators (i.e. benthic macroinvertebrates) have not yet been analyzed for contaminant migration.

5) DoR-OR has accumulated two years of community data which is insufficient for a robust analysis.

3.4.3 Related DOE Projects

During the CERCLA Five-Year Review, biota such as turtles, spiders, earthworms, and adult insects are sampled by DOE and analyzed for mercury and other contaminants. However, there are no projects that sample or monitor terrestrial invertebrate assemblages to evaluate environmental health.

Considering the lack of terrestrial community health analysis, the data from this DoR-OR project will provide important information. Data will also supplement DOE's current dataset and fill a data gap.

3.4.4 Goals

1) Establish biometrics for ground beetle diversity (i.e. community health) that indicate contaminant impacts on terrestrial biota communities, equivalent to aquatic community health biometrics.

2) Support the DoR-OR EFPCAP by providing data that identify areas that continue to be impacted by historical Hg contamination and focus future sampling efforts.

3) Provide novel community health data to augment DOE contaminant investigations of terrestrial biota.

3.4.5 Scope

Carabid specimens will be collected from three main impacted study zones along EFPC and from one reference zone in Freels Bend (Figure 3.4.5.1). Sampling will take place from April – August 2025. Each zone will consist of three sample sites with three invertebrate pitfall traps per site (i.e. nine traps per four zones). Results from each of the three impacted zones will be compared to results from the reference zone. Carabid community data collected by NEON Domain 07 (NEON, Released-2024) will be utilized to strengthen data collected from the Freels Bend reference zone and provide additional reference data for sites that represent similar habitat to those from the EFPC impacted zones.

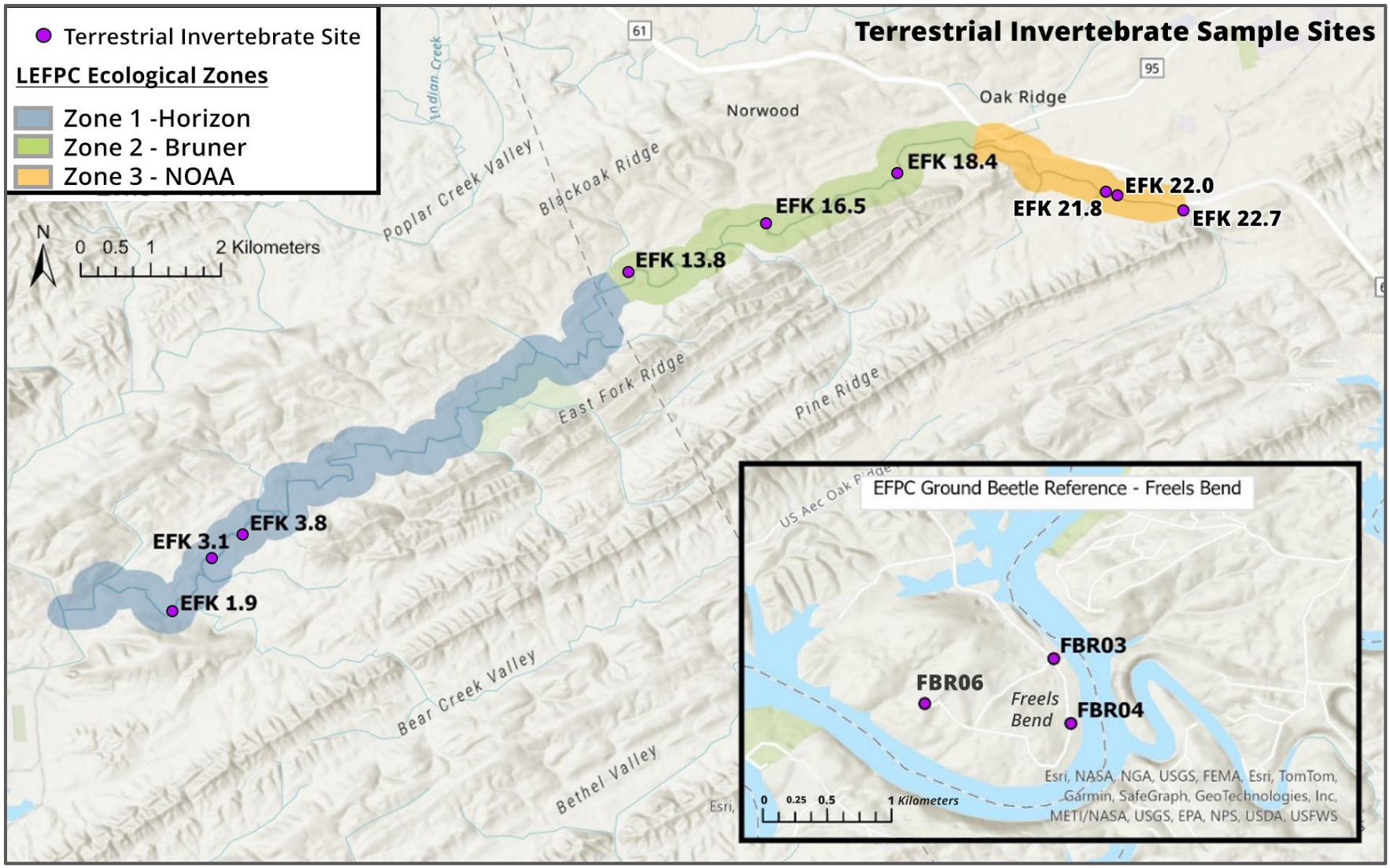

Figure 3.4.5.1: East Fork Poplar Creek Terrestrial Invertebrate Sampling Sites

3.4.6 METHODS, MATERIALS, METRICS

Sampling is conducted in accordance with TDEC health and safety procedures (TDEC 2020) and the TDEC Quality Assurance Project Plan (TDEC 2024).

TERRESTRIAL INVERTEBRATE FIELD SAMPLING:

Insect pitfall traps will be installed along EFPC and at the corresponding reference zone (Figure 3.4.5.1) (TDEC 2023, Levan 2022). These traps will contain propylene glycol (PG), a preservative that is non-toxic to wildlife and people. Pitfall traps are designed to collect samples that are representative of the local populations but do not significantly impact them. All specimens trapped in the preservative will be collected in solution from each trap every two weeks. New unused propylene glycol will be added during each field event to reset the pitfalls traps until the removal of the traps at the end of the sampling season. The pitfall traps from all sites will be left open from April through August 2025. State or federal listed species (if encountered) will be reported to TWRA within five working days.

TDEC DOR-OR LABORATORY PROCESSING:

Samples will be removed from PG and stored in 95% ethanol at the DoR-OR Lab until sorting is complete. Sorting will involve separating carabid beetles from invertebrate bycatch for taxonomic identification to species-level where possible. Once identified, samples will be composited by taxonomic groups (carabids or bycatch) by site and stored at the DoR-OR Lab.

DATA ANALYSIS:

1) Carabid communities will be assessed by various diversity metrics (Table 3.4.6.1) along with comparisons between impacted sites and reference zones.

2) Graphs will be used to compare ORR sites to references sites.

3) Mean Individual Biomass (MIB), Shannon Diversity, and Simpson's Diversity metrics (Table 3.4.6.1) will be evaluated to identify measurements that can be used to describe environmental health.

Table 3.4.6.1: Biodiversity Metrics Used to Analyze Carabid Communities

Biodiversity Metrics	
Metric	**Description**
Richness	Number of unique species in a community
Abundance	Number of individuals within a population for a given species
Evenness	Distribution of the number of individuals across species
Diversity	**Shannon Diversity** – measure of diversity that accounts for richness and evenness
	Simpson Diversity – measure of diversity through the abundance of a single species versus abundance of the whole community.
Mean Individual Biomass (MIB)	Average biomass of a single individual within a species

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3.5 Radiological Uptake in Food Crops

3.5.1 Background

As a result of historical contamination on the ORR, there is the potential for radionuclides to impact nearby communities. This project helps to determine if there is evidence of environmental contamination by accumulation of radionuclides in foods grown and consumed by local residents. The TDEC DoR-OR *Radiological Uptake in Food Crops* project was initially requested by DOE, with the first samples collected by TDEC the summer of 2019. TDEC Food Crop data will both supplement and provide for comparison to DOE sampling data published in the ASER each year. Each agency will conduct a separate radiological analysis on locally grown and harvested food crops, hay, and animal products (as available) to look at any possible uptake of radiation. Reference locations that are not impacted by ORR activities will also be sampled for comparison.

After FY26, TDEC DoR-OR plans to start sampling less frequently, likely every 2-3 years. TDEC has amassed a representative database of food crops data for comparison to DOE's annual analysis. Periodic checks performed by TDEC will continue to verify that no elevated values are being seen in the surrounding communities.

3.5.2 Related DOE Projects

DOE food crops sampling has changed over the years but has generally been used to confirm that the public was not being exposed to radiological contaminants by consuming locally grown vegetables or milk from cows consuming local hay. DOE initially conducted vegetable sampling at their perimeter monitoring stations on the ORR from 1992 to 1996. Starting in 1997, the focus shifted to sampling at farms and gardens near the ORR. DOE hay sampling later shifted from multiple locations on and near the ORR to one location at the far eastern edge of the ORR that is also harvested for hay by an offsite operation. Prior to 2017, cow milk was sampled from a dairy in Claxton, near the ORR, and at a few farther dairies as reference sites. Milk has not been sampled by DOE since 2016 because the Claxton Dairy shut down. There have been no other dairy options found near the ORR by DOE staff, although they check each year (DOE, 2023).

Currently, DOE conducts sampling of locally grown food crops and hay to look for the uptake of radiological contaminants in these products due to previous and ongoing ORR activities. Sampling is performed to verify that the health of residents is not being negatively impacted by consuming such products directly (vegetables, milk) or indirectly (hay as animal forage leading to animal products such as milk). According to the 2023 DOE *Environmental Monitoring Plan for the Oak Ridge Reservation* (DOE, 2022), DOE intends to sample vegetables from broad-leaf systems (lettuce, turnip greens, etc.), root-plant-vegetable systems (tomatoes), and root-system

vegetables (turnips, potatoes, etc.). Sampling is planned for three potentially impacted sites and one reference site. If harvested and available, hay is sampled annually from the southeastern edge of the ORR. Hay and vegetable samples are analyzed for gross alpha, gross beta, gamma emitting radionuclides, and isotopic uranium. DOE checks for dairy farms near the ORR annually, and if found, would conduct milk sampling again. (DOE, 2023).

In 2022, DOE sampling consisted of tomato samples from three locations near the ORR and a background location in addition to one 2022 hay sample (DOE, 2023). In comparison, TDEC DoR-OR sampling has sampled a wider variety of plant types and animal products (eggs or goat milk, if cow milk is not available) as well as hay or grasses at more locations around the ORR. DoR-OR has collected and analyzed a large number of samples over the last five years to get a better understanding of results from locations around the ORR. Future DoR-OR sampling will likely be less intensive and less frequent but will still be used to further augment the DoR-OR Food Crops sampling database and for comparison to DOE results.

3.5.3 Problem Statements

- ORR radiological contaminants have been released into the atmosphere, groundwater, surface water, soils, and sediment and present a possible risk for plant uptake of these COCs.

- Any contaminated airborne releases from DOE ORR activities can be transported beyond the boundaries of the ORR, where they could be deposited on soils and plants for uptake into the food chain.

- Members of the public have the potential to be exposed to doses of ORR radiological contaminants through the consumption of locally grown food crops or animal products.

3.5.4 Goals

- Collect and analyze samples to determine if there is radiological contamination in food crops, hay, or animal products on or near the ORR.

- Compare TDEC DoR-OR results to the corresponding DOE ORR sampling results.

- Supplement DOE food crops, hay, and animal products data.

3.5.5 Scope

This project will collect and analyze food products within a five-mile radius of the ORR boundary (Figure 3.5.5.1) for radiological contaminants. These samples will be compared to samples taken from unimpacted reference locations; the reference locations are considered unimpacted

by ORR operations and will be collected at locations greater than five miles from the ORR. FY26 samples will be collected starting in July 2025, and continuing through the primary summer growing season, or as available.

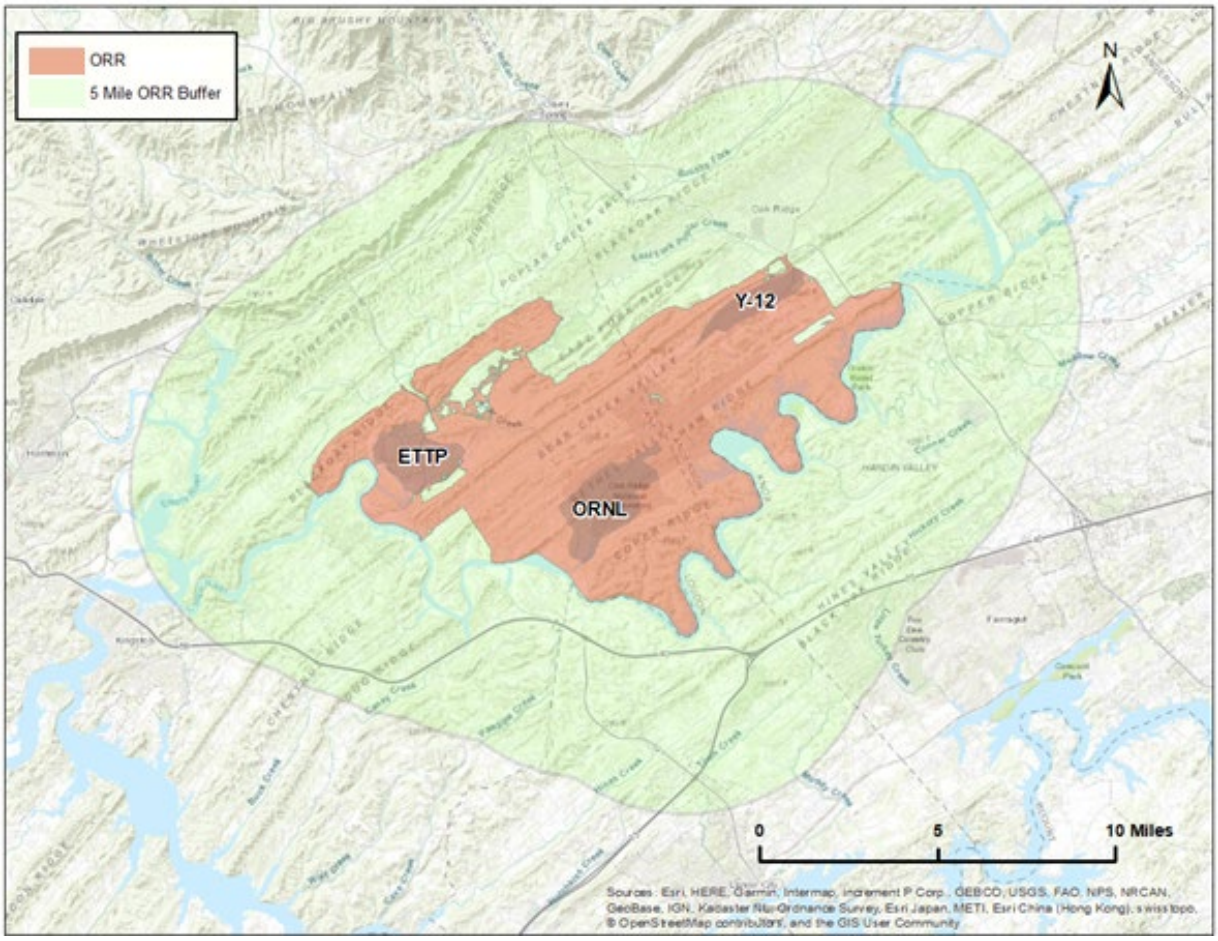

Figure 3.5.5.1 Food Crop Sampling Area

3.5.6 METHODS, MATERIALS, METRICS

Project staff will collect samples of hay, animal products (eggs or milk), and vegetables (root vegetables, fruiting vegetables, or leafy vegetables) from within five miles of the ORR and at reference locations greater than 5 miles (Figure 3.5.5.1). The actual sampling locations will not appear in the project report because many locations are at private residences. Locations will be generally described, but otherwise not specified due to privacy concerns. Sampling will be conducted according to the DoR-OR SOP for Food Crops, *SOP T-342* (TDEC, 2024).

Each of the above sample types includes one corresponding sample from a reference location (Table 3.5.6.1). While multiple types of samples may be collected at a single garden or farm,

multiple sampling locations will be used within the main sample collection area of within five miles of the ORR boundary.

Table 3.5.6.1: Sample Quantities

Sample	Type	Number of Samples *
vegetables	leafy, fruiting, root	11
livestock forage	hay/grasses	3
animal products	eggs, milk	6
**Includes at least one reference sample of each type*		

Vegetable, hay, and animal product samples will be analyzed for gross alpha, gross beta, and gamma emitting radionuclides by the contracted lab.

The analytical results for this project will be reviewed and compared to DOE's most recent food crop data as published in the *Oak Ridge Reservation Annual Site Environmental Report* (ASER*)*.

3.5.7 REFERENCES

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4.0 Groundwater Monitoring

4.1 Offsite Groundwater Monitoring

4.1.1 Background

The ORR is an area with complex bedrock containing many faults and carbonates that exhibit a karst terrain with large sinkholes. Research has established that groundwater can move long distances rapidly in all fractured-rock settings (Worthington, 2001) and in channels and conduits. Due to the nature of the geology and presumed subsurface connectivity, any water flowing underground through, or proximate to, the ORR could potentially mix with legacy contaminants present in ORR water and/or soils. Each campus has numerous associated groundwater contaminant plumes which have been documented by DOE mission activities. Many contaminant plumes are not well defined, and little is understood about the contaminant flow paths within the bedrock. Further investigation would be required to evaluate these flow pathways and delineate their vertical and horizontal extents. Without plume extent defined, it is unclear the distances that onsite contamination may have traveled and how much has traveled offsite (outside the ORR).

Due to the potential risk of contaminant migration into water wells and springs, downgradient groundwater is monitored by both DoR-OR and DOE. The monitoring includes the collection of water samples, recording field parameters, and performing laboratory analyses for chemicals of concern. The overarching purpose of the *Offsite Groundwater Monitoring Project* is to evaluate potential impacts to human health and the environment through the monitoring of groundwater that could be used by area residents. This evaluation is accomplished by monitoring select private groundwater wells and springs offsite of the facility.

Over the past few years, the DoR-OR offsite program rotated to cover different offsite areas around the ORR each fiscal year. Site selection was generally guided by ORR activities and TDEC mission support such as the current holistic watershed project. The previous sampling plan generally included attempting to sample all wells in the DoR-OR's database within the selected subarea. This strategy resulted in proposing to sample more wells than was possible due to access restrictions, non-operational wells, or other reasons.

This year, in FY26, the proposed offsite groundwater sampling will include a selected list of wells from each of the offsite areas surrounding the reservation. The proposed goal is to establish a network of monitoring locations to sample on a regular basis (annually or semi-annually) utilizing known wells and springs that are intact and property owners that are cooperative with the sample program. This selected "short" list of sites will be expanded as needed based on ongoing site activities or observations.

4.1.2 Related DOE Projects

Within the last ten (10) years, DOE has completed, or is in the process of completing, the following offsite groundwater activities:

1) 2017 – DOE submitted the *Offsite Groundwater Assessment Remedial Site Evaluation* (DOE, 2017) which documents the collection of water samples between FY14 and FY16 at 34 private water wells and 15 springs located outside the ORR boundary.

2) 2022 – DOE completed field activities as outlined in the *Remedial Site Evaluation Phase 2 Offsite Detection Monitoring Work Plan* (DOE, 2018). These field activities included three (3) years of annual sampling conducted during the wet season at 14 offsite private water wells/springs within all four subareas (Figure 4.1.5.1). Measurements were taken for water quality parameters in the field (i.e. temperature, pH, specific conductivity [SpC], dissolved oxygen [DO], oxidation-reduction potential [ORP], and turbidity). In addition, the water samples were also analyzed for potential contaminants like volatile organic compounds (VOCs), gross alpha, gross beta, uranium-233/234, uranium-235/236, uranium-238, and select fission products/transuranic elements. DOE documented the results of these monitoring efforts in the *Phase 2 Offsite Detection Monitoring Remedial Site Evaluation* (DOE, 2022a). DOE plans to conduct annual monitoring at these same 14 locations moving forward (DOE, 2023).

3) DOE collects groundwater samples from exit pathway wells and springs, specifically those within Bear Creek Valley and Melton Valley (DOE, 2020). The purpose is to monitor groundwater water quality within the western boundary of the ORR. These exit pathway wells and/or springs contained concentrations of VOCs and manmade radionuclides which suggests westward contaminant migration (DOE, 2022b). Numerous private wells and springs in the Melton Valley offsite subarea were closed by the DOE, and the owners were provided with city water.

4) Offsite migration of VOCs is occurring on the east end of Y-12. DOE operates a groundwater extraction system to control offsite migration of the East End Volatile Organic Compound (EEVOC) Plume (DOE, 2022b).

4.1.3 Problem Statements

1) Delineation of the nature and the extent of groundwater contamination is incomplete in many areas within each ORR campus (DOE, 2022b).

2) Each of the ORR facilities have numerous groundwater contaminant plumes associated with them due to past DOE mission activities. Many contaminant plumes are either not defined

or not well defined and require ongoing investigation to evaluate their vertical and horizontal extent.

3) The complex bedrock geology of the area adds an additional unknown for offsite migration of groundwater contamination. This geology can cause contamination to migrate in unexpected directions and quantities.

4.1.4 GOALS

1) The primary goal of this project is to evaluate potential risk associated with well and spring water to human health and the environment through sampling and analysis of groundwater offsite of the ORR.

2) Obtain access and collect groundwater samples from up to 27 private water wells and up to 13 springs.

3) Form a rapport with private well and spring owners for continuous sampling access.

4) Establish a set list of wells that are functional and accessible that can be used as a supplement for the DOE offsite groundwater monitoring program.

4.1.5 SCOPE

The proposed locations of offsite sampling efforts for Fiscal Year 2026 (FY26) include selected private water wells and springs located downgradient, to the southwest and along strike (the general cardinal direction that a geologic unit trends), of the four (4) main offsite subareas. These subareas include the ETTP, Bear Creek, Bethel Valley, and Melton Valley Offsite Subareas.

These offsite subarea boundaries were defined by DOE (DOE/OR/01-2715&D2_R[1]) and described in later documents (Figure 4.1.5.1). Several wells and/or springs within each subarea have been proposed for sampling. Wells and springs selected for FY26 sampling include those where access and contact information are generally known, and samples have been previously collected with no noted access issues. If a well owner for a listed well does not respond or does not grant permission to sample, an alternate well from the same area will be selected. A list of proposed wells and springs is provided in Table 4.1.8.1. Proposed alternate wells are listed in Table 4.1.8.3.

[1] Offsite Groundwater Assessment Remedial Site Evaluation, Oak Ridge, Tennessee. Prepared by the Water Resources Restoration Program URS, CH2M Oak Ridge LLC. Prepared for U.S. Department of Energy Office of Environmental Management. October 2017.

This project will focus on obtaining access and collecting groundwater samples from twenty-seven (27) private water wells and thirteen (13) springs (Figure 4.1.5.2 and Figure 4.1.5.3) and submitting them for laboratory analysis of inorganics, volatile organic compounds (VOCs), radionuclides, and metals using the analytical methods specified in Table 4.1.8.2.

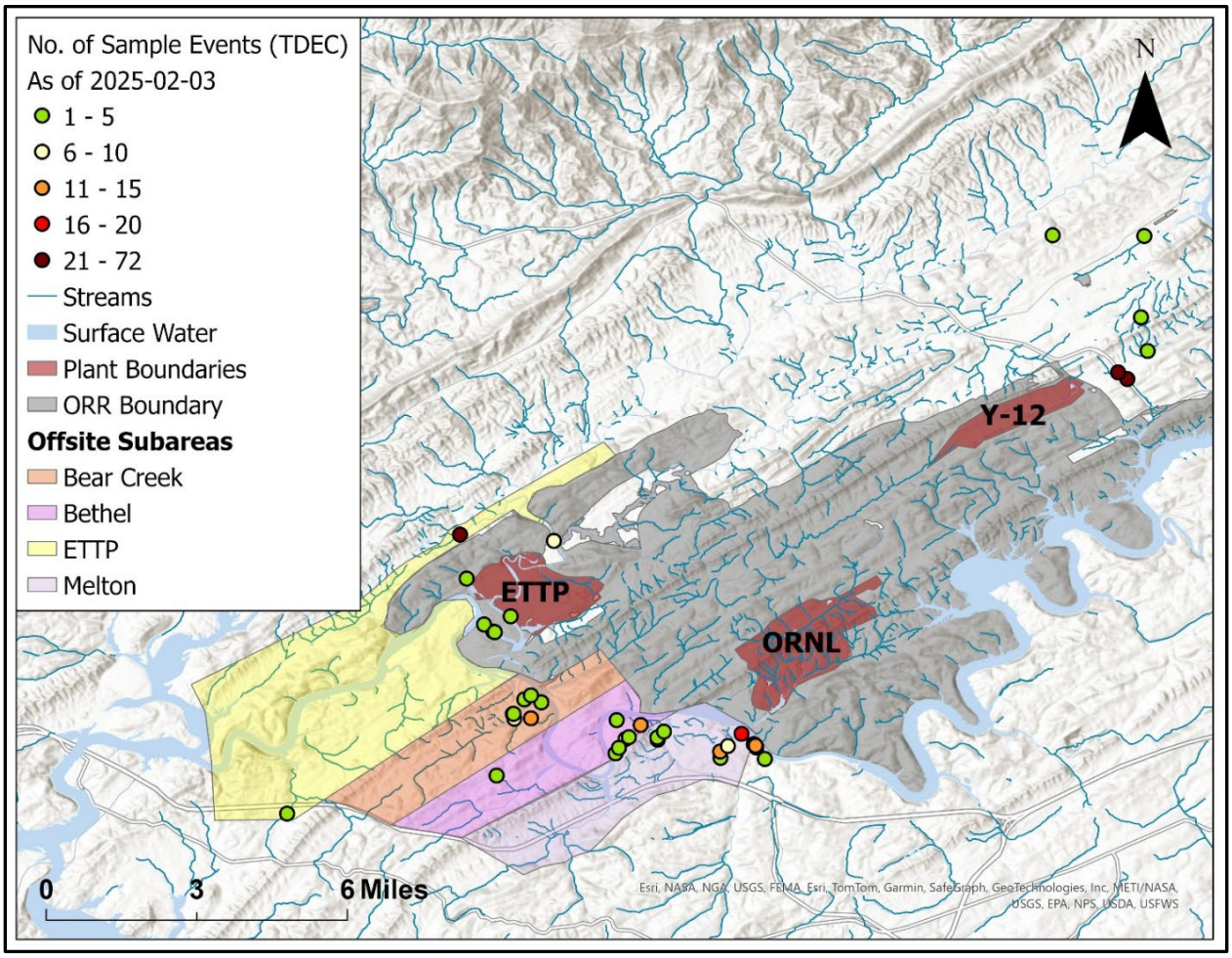

Figure 4.1.5.1: Historical Counts of Proposed Offsite Subarea Private Wells and Springs

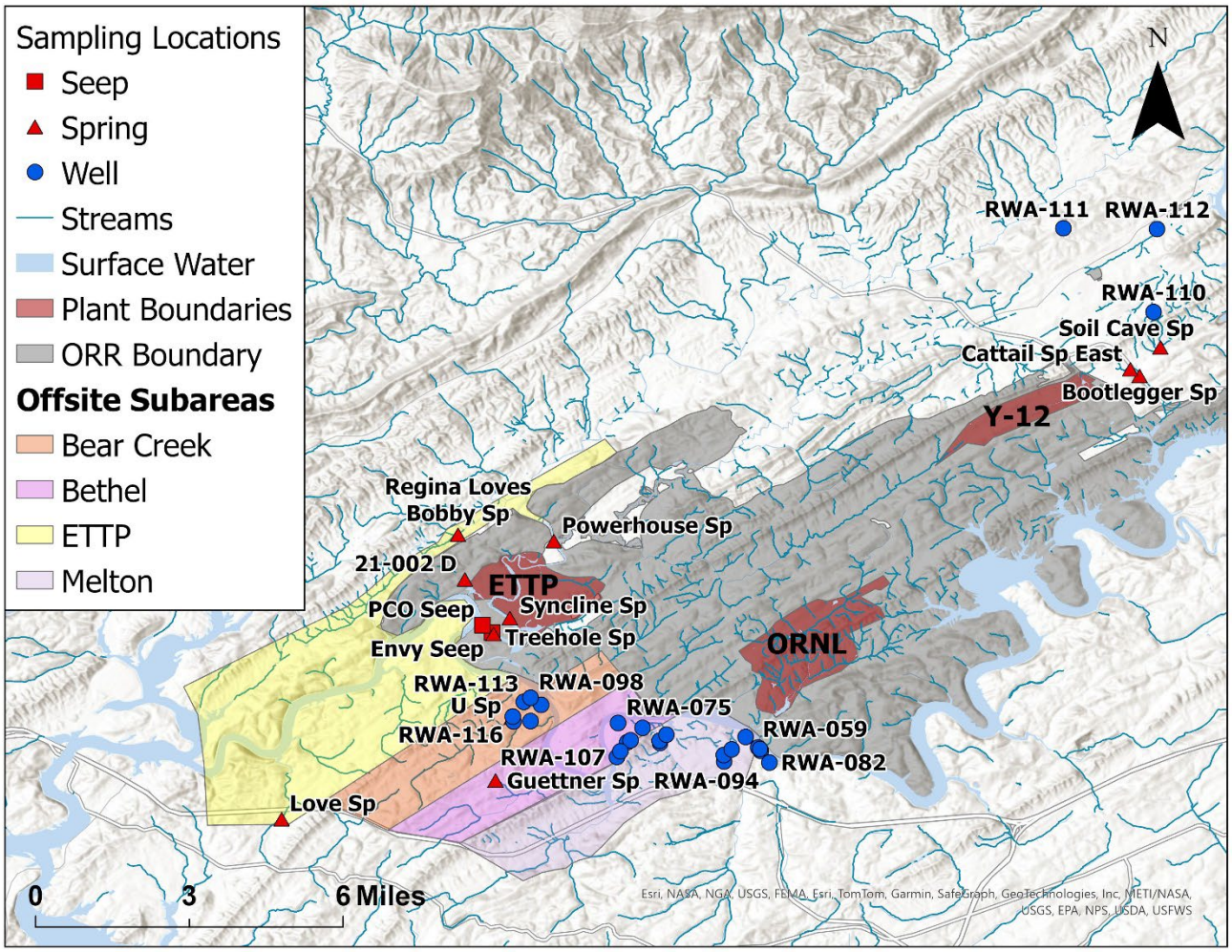

Figure 4.1.5.2: FY26 Proposed Offsite Groundwater Monitoring Locations

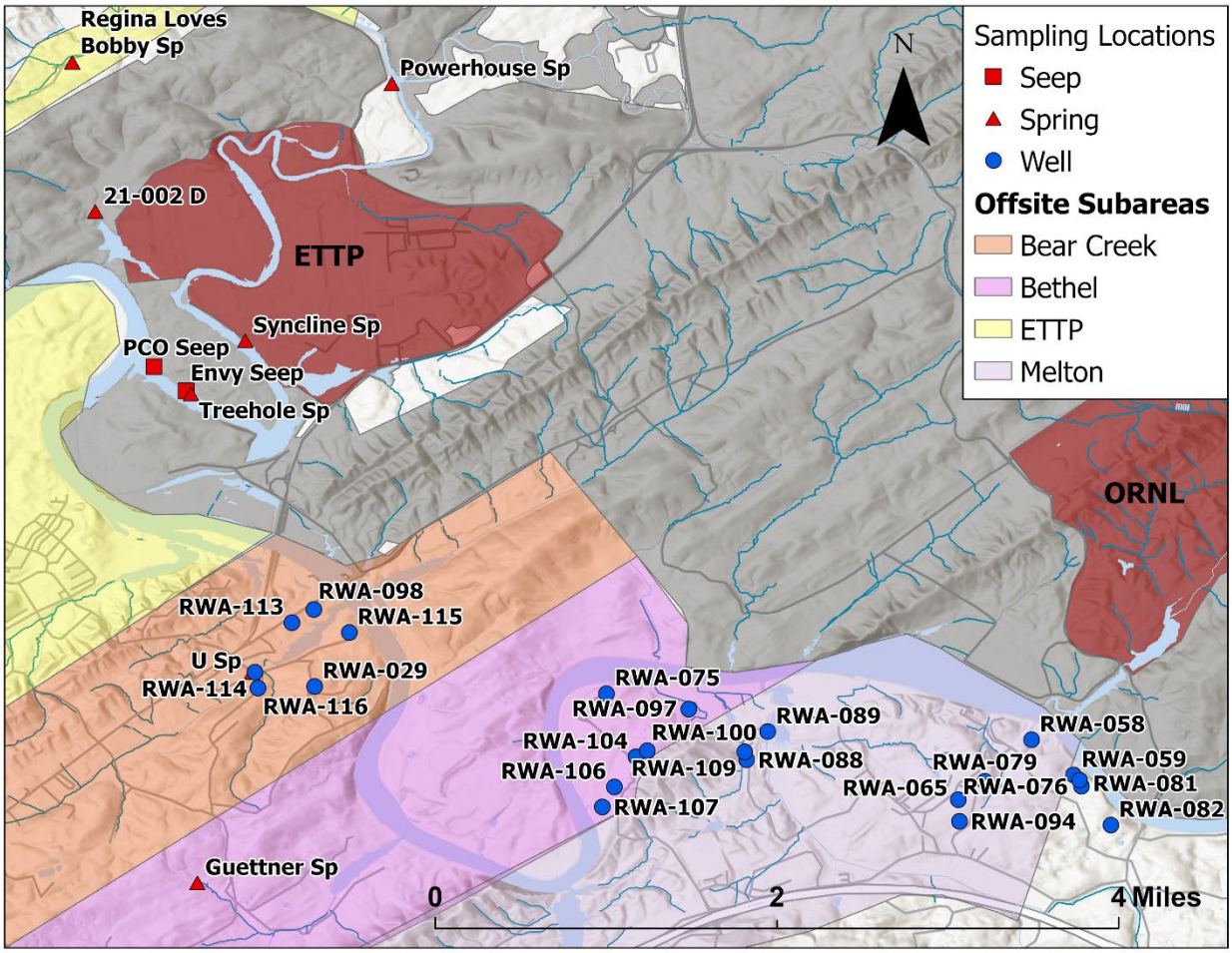

Figure 4.1.5.3: FY26 Proposed Offsite Groundwater Sites: Southwest Locations

4.1.6 Methods, Materials, Metrics

The project will focus on obtaining access and collecting groundwater samples from private water wells (Figure 4.1.5.1 and Figure 4.1.5.2) and springs. The sampling will take place during the groundwater high season (January, February, March). A supplemental spring monitoring event will occur sometime during the groundwater dry months (August, September, October) and will only consist of measuring water quality parameters and documenting flow conditions (Table 4.1.6.1).

The wells will be sampled in accordance with the TDEC SOP for sampling of wells with pumps already in place (TDEC, 2023a). Per this protocol, samples will be collected by using the homeowners existing submersible well pump from an outside tap. This tap needs to be located as close to the well as possible, and ideally, the spigot placement is before water passes through any filtration and/or water softener systems. The volume of water purged prior to sample collection will depend on frequency of use for each well. Once the appropriate volume of water has been purged, and water quality parameters have stabilized for three consecutive

readings, a groundwater sample will be collected. This field parameter stabilization protocol is specified in Table 4.1.6.2.

At the springs, the field water quality parameter measurements and laboratory samples will be collected using a peristaltic pump. The springs will be sampled in accordance with the TDEC SOP for sampling of Seeps and Springs (TDEC, 2023b). During the sampling event, a minimum of five springs will be sampled. Additional water quality measurements will be taken during a second event during the dry season at those sites with ample flow.

The water samples collected from the private water wells and springs will be analyzed for volatile organic compounds (VOCs), gross alpha/beta, inorganics, and metals using the analytical methods specified in Table 4.1.6.2 or equivalent analytical methods. If gross alpha activity is detected in any of the groundwater samples at a concentration greater than or equal to (≥) 5 picocuries per liter (pCi/L), then those groundwater sample(s) will be analyzed for isotopic uranium. To ensure that water is available from each site for possible isotopic uranium analysis, a dedicated sample bottle will be filled during each sampling event. The project team will note on the COC for the lab to hold the sample pending the results of the gross alpha activity (≥ 5 pCi/L).

Quality control (QC) samples will be collected at a frequency of 10% of samples (e.g. 35 samples, 4 QCs/duplicates). For planning purposes, it is assumed that 4 field duplicates and 4 field blanks will be collected and analyzed. At least one trip blank will be included in each batch of samples submitted to the laboratory. Quality control samples help determine if measured results are valid and not from equipment or procedural contamination.

The analytical groundwater data will be compared against numerical standards set forth in *TDEC's General Water Quality Criteria Chapter 0400-40-03-.03* (TDEC, 2019) and *U.S. Environmental Protection Agency's (EPA) National Priority Drinking Water Regulations* (EPA, 2009) to evaluate potential risk to human health and to provide current conditions of water quality for the private water wells in this area. These regulatory standards are not enforceable for private water wells but are relevant for comparison purposes. Although not all the constituents identified in Table 4.1.8.1 have a numerical standard, these additional data will be used to display and compare the major ion chemistry between the groundwater samples (e.g., Stiff diagram or similar). The results of the groundwater sampling will be incorporated into the TDEC's FY26 *Environmental Monitoring Report (EMR)*.

Table 4.1.6.1: Groundwater Sampling Plan

Station Name[1]	Offsite Subarea	No. of Sample[1]Events - Historical	Analytical Parameters[2]				
			VOCs	Inorganics	Metals	Strontium 89/90	Gross Alpha/ Gross Beta
RWA-029	BCV	14	1	1	1	0	1
RWA-098	BCV	2	1	1	1	0	1
RWA-113	BCV	1	1	1	1	0	1
RWA-114	BCV	4	1	1	1	0	1
RWA-115	BCV	1	1	1	1	0	1
RWA-116	BCV	8	1	1	1	0	1
RWA-075	BV	5	1	1	1	0	1
RWA-088	BV	3	1	1	1	0	1
RWA-089	BV	3	1	1	1	0	1
RWA-097	BV	14	1	1	1	0	1
RWA-100	BV	3	1	1	1	0	1
RWA-104	BV	9	1	1	1	0	1
RWA-106	BV	4	1	1	1	0	1
RWA-107	BV	1	1	1	1	0	1
RWA-109	BV	1	1	1	1	0	1
RWA-058	MV	18	1	1	1	1	1
RWA-059	MV	2	1	1	1	1	1
RWA-065	MV	15	1	1	1	1	1
RWA-076	MV	14	1	1	1	1	1
RWA-079	MV	9	1	1	1	1	1
RWA-081	MV	2	1	1	1	1	1
RWA-082	MV	2	1	1	1	1	1
RWA-094	MV	2	1	1	1	1	1
RWA-109	S. of MV	1	1	1	1	0	1
RWA-110	Upgradient	2	1	1	1	0	1
RWA-111	Upgradient	2	1	1	1	0	1
RWA-112	Upgradient	1	1	1	1	0	1
Cattail Sp.	Y12	53	1	1	1	0	1
Bootlegger Sp.	Y12	72	1	1	1	0	1
U spring	Y12	5	1	1	1	0	1
Soil Cave Sp.	Y12	5	1	1	1	0	1
Guettner Sp.	BV	1	1	1	1	0	1
Love Sp	ETTP	5	1	1	1	0	1
Regina Loves Bobby Sp[4]	ETTP	25	1	1	1	0	1
21-002D	ETTP	1	1	1	1	0	1
Syncline Sp.	ETTP	5	1	1	1	0	1
Treehole Sp.	ETTP	3	1	1	1	0	1
Envy Seep	ETTP	2	1	1	1	0	1
PCO Sp	ETTP	3	1	1	1	0	1
Powerhouse Sp.	ETTP	9	1	1	1	0	1
Totals	**40**	**40**	**40**	**8**	**40**		

Table 4.1.6.1 *(Continued):* Groundwater Sampling Plan

Sample Summary	***Analytical Parameters[2]***				
	VOCs	***Inorganics***	***Metals***	***Strontium 89/90***	***Gross Alpha/ Gross Beta***
Total Primary Samples	*40*	*40*	*40*	*8*	*40*
Field Blank	*4*	*4*	*4*	*1*	*4*
Field Duplicate	*4*	*4*	*4*	*1*	*4*
Trip Blanks[3]	*10*	*--*	*--*	*--*	*--*
Total Samples (FY26)	***58***	***48***	***48***	***10***	***48***

Notes:

All water samples will be collected during the FY26 dry season (June, July, August). Spring samples months will be collected in later during wet months (December, January, February) depending on flow conditions.

Offsite Subarea Acronyms:

BCV – Bear Creek Valley
BV – Bethel Valley
MV – Melton Valley
ETTP - East Tennessee Technology Park
Y12 – Area East of Y12

[1] – Total number of sampled events conducted by TDEC.

[2] – The list of analytes and their analytical methods are defined in Table 1.

[3] - Assumes 10 trip-blanks.

[4]- This spring will also be analyzed for Tritium using method shown in Table 1

Table 4.1.6.2: Analytical Test Suite

Parameter Type	Analytes	Analytical Method/ Stabilization Criteria
Inorganics	*alkalinity*	*SM 2320-B*
	ammonia as N	*EPA Method 350.1*
	***nitrate/nitrite** as N*	*EPA Method 353.2*
	chloride	*EPA Method 300.0*
	fluoride	*EPA Method 300.0*
	sulfate	*EPA Method 300.0*
	total dissolved solids (TDS)	*SM 2540-C*
Metals	*calcium, iron, magnesium, potassium, sodium, total hardness*	*EPA Method 200.7*
	*aluminum, **antimony**, **arsenic**, **barium**, **beryllium**, boron, **cadmium**, **chromium**, **copper**, **lead**, lithium, manganese, **nickel**, **selenium**, silver, strontium, **thallium**, **uranium**, vanadium, zinc*	*EPA Method 200.8*
	low level mercury	*EPA Method 1631*
Volatile Organic Compounds	***EPA 8260B full list VOCs***	*EPA Method 8260B Low Level*
Radionuclides	***gross alpha**/gross beta*	*D7283-17*
	Sr-89/90	*EPA Method 905.0*
	Isotopic Uranium	*HSL-300*
	Tritium	*Beta Liquid Scintillation, EPA 906.0*
Field Water Quality Parameters	*pH*	*±0.1*
	temperature (°C)	*±10%*
	specific conductivity (µS/cm)	*±5%*
	dissolved oxygen (mg/L)	*NA*
	oxidation-reduction potential (mV)	*±10 mV*
	turbidity (NTU)	*±10%*

Notes: ***Bolded** values have a numerical standard.*
°C – degrees Celsius *mV - millivolt*
µS/cm – microSiemens per centimeter *mg/L – milligram per liter*
NA – not applicable *NTU – nephelometric turbidity unit*

Table 4.1.6.3: Proposed Alternate Wells

Well/Spring ID	Offsite Subarea	No. of Sample[1] Events - Historical
RWA-035	*BCV*	*10*
RWA-047	*BCV*	*10*
RWA-118	*BCV*	*13*
RWA-132	*BCV*	*7*
RWA-137	*BCV*	*3*
RWA-159	*BV*	*3*
RWA-160	*MV*	*5*
RWA-143	*MV*	*1*
RWA-129	*ETTP*	*4*
RWA-127	*ETTP*	*3*
JA Jones Sp	*ETTP*	*5*
W0003	*ETTP*	*0[2]*
Fallen Tree Sp	*Y12*	*3*

Notes:
Offsite Subarea Acronyms:
BCV – Bear Creek Valley
BV – Bethel Valley
MV – Melton Valley
ETTP - East Tennessee Technology Park
Y12 – Area East of Y12
[1] – Total number of sampled events conducted by TDEC.
[2] – This well has not been sampled by TDEC but has historically been by DOE.

4.1.7 REFERENCES

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5.0 LANDFILL MONITORING

5.1 EMDF SURFACE WATER SAMPLING AND MONITORING

5.1.1 BACKGROUND

The Environmental Management Disposal Facility (EMDF) is a new landfill planned for the disposal of low-level radioactive waste, hazardous waste, and toxic waste generated by remediation activities on the ORR and will be operated under the authority of CERCLA and DOE directives. While the EMDF will hold no permit from the State of Tennessee, the landfill will be required to comply with DOE Orders and substantive portions of Applicable or Relevant and Appropriate Requirements (ARARs) listed in the *CERCLA EMDF Record of Decision* (ROD). The EMDF will be located within the Central Bear Creek Valley (CBCV) area; specifically, about 1.5 miles west of the existing Environmental Management Waste Management Facility (EMWMF). TDEC DoR-OR will monitor surface water along the portion of Bear Creek where the proposed EMDF landfill will be constructed: up-stream, down-stream, and two tributaries.

During FY26, DoR-OR personnel will monitor and sample surface water along the portion of Bear Creek where the planned EMDF landfill will be constructed. This project's monitoring of surface water and one up-gradient spring will support the Bear Creek Assessment Project (BCAP), as well as anticipated future data collection efforts by DoR-OR in the CBCV.

5.1.2 PROBLEM STATEMENTS

- Contaminants in the waste materials from CERCLA remediation activities will be buried in the EMDF and may leach out into the environment.

- Surface water or groundwater may carry contaminants off site in concentrations or radiological activities above approved limits.

- Understanding the EMDF baseline conditions to assist with final discharge limits and unsampled emerging contaminants.

5.1.3 RELATED DOE PROJECTS

DOE currently monitors Bear Creek and some of its northern tributaries (NT-3, NT-4, and NT-5) for potential releases from the EMWMF landfill. An aliquot of wastewater released from the EMWMF sediment basin is collected by DOE's automatic sampler using a weekly flow-weighted composite sample. Annually, the results from these sampling efforts are published in the EMWMF *Phased Construction Completion Report* (PCCR).

The DoR-OR EMDF monitoring project is intended to complement and supplement DOE's monitoring of the surface water in the CBCV area.

5.1.4 GOALS

- Collect continuous water quality monitoring data with In-Situ multi-parameters water quality probes installed at BCK 7.6 and BCK 8.63.

- Semi-annually and continuously measure physical parameters of surface water.

- Conduct independent monitoring of potential impacts from construction activity at the EMDF to assess compliance with associated ROD ARARs.

- Gather information to assist DOE in establishing spring/surface water background levels using physical parameters and analytical measurements prior to landfill operation.

- Sample analytical parameters listed in the Ambient Water Quality Criteria (AWQCs) semi-annually at five locations to support post-ROD decisions.

- Provide data to support information intended to delineate potential contributions from three (3) primary contribution areas: up-stream, down-stream, and tributaries, to Bear Creek.

5.1.5 SCOPE

DoR-OR personnel will measure water quality field parameters in EMDF discharges at five (5) locations: SF-3, SF-6, BCK 7.6, BCK 8.63 and Spring D10W (Figure 5.1.5.1). The rationale for the location selection is detailed in Table 5.1.5.1: EMDF Sampling and Monitoring Rationale. The measured water quality field parameters will be temperature, pH, specific conductivity (COND), dissolved oxygen (DO), oxidation reduction potential (ORP) and turbidity. The project team will monitor parameters at these locations at least semi-annually. Continuous water monitoring equipment will be left in-stream at two locations (BCK 7.6 and BCK 8.63).

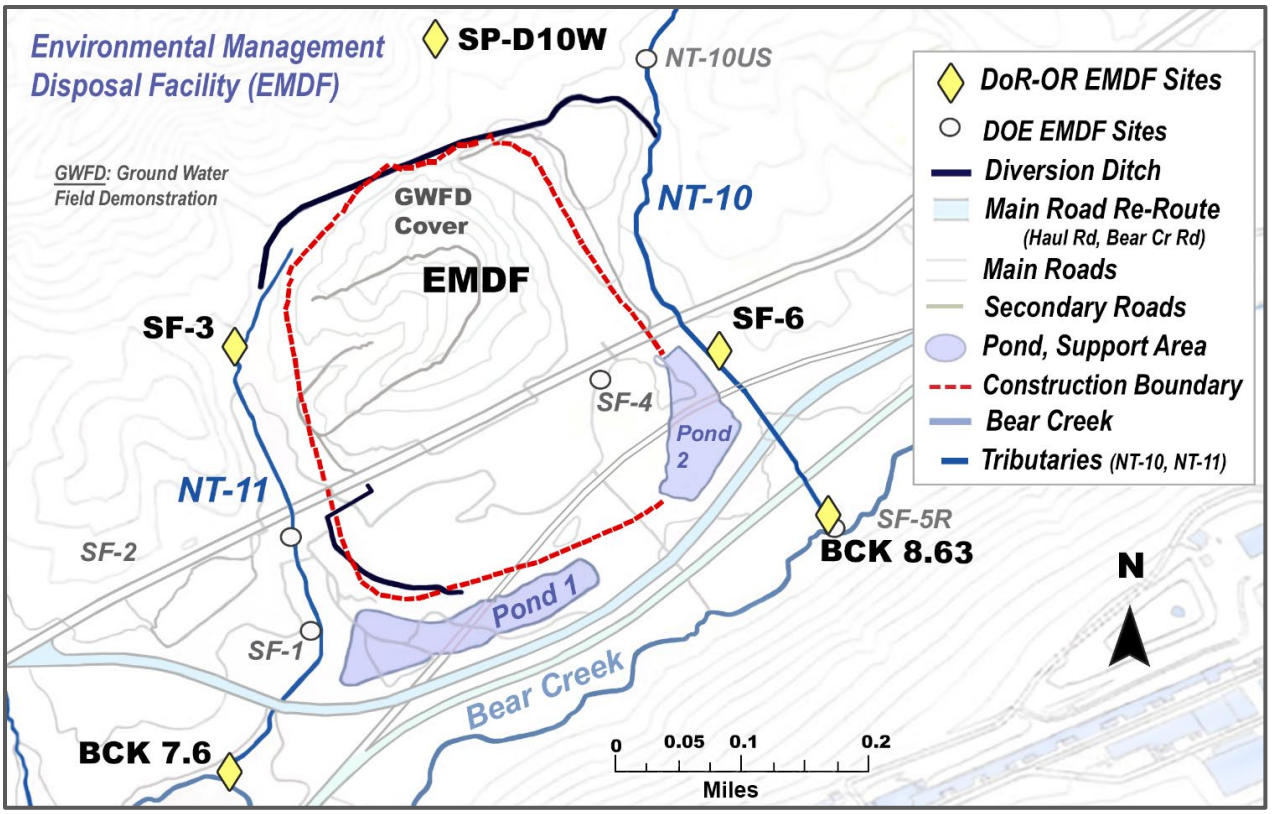

Figure 5.1.5.1: EMDF Surface Water Project Site and Monitoring Locations

Table 5.1.5.1: EMDF Sampling and Monitoring Rationale

DoR-OR Site ID	Frequency		Site Description/Sampling Rationale
	Analytical	*Parameters*	
BCK 7.6	*semi-annually*	*Continuous: Monthly download * In-Situ probe*	*Site is most downstream point of NT-11, samples at this site will capture surface water and groundwater.*
BCK 8.63			*Site is downstream point on NT-10 and upstream of NT-11, samples at this site will capture water along the eastern landfill footprint flowing from NT-10 into Bear Creek*
SF-3	*semi-annually*	*Semi-annually at sampling event*	*Site is the most upstream point of NT-11 and captures surface water and groundwater flowing into Bear Creek (NT-11 is a tributary).*
SF-6	*semi-annually*	*Semi-annually at sampling event*	*Site is an upstream point of NT-10 capturing surface water potentially not impacted by the landfill (NT-11 tributary).*
SP-D10W			*Site is a background spring, the source of NT-D10W*

5.1.6 Methods, Materials, Metrics

Sample Collection

Grab samples will be collected semi-annually from all five (5) sites listed in Table 5.1.5.1 and as illustrated in Figure 5.1.5.1. Samples will be analyzed in accordance with Tennessee water quality criteria (AWQCs) listed in *Tennessee Rule 0400-40-03* for both recreation and fish and aquatic life (TDEC, 2019). Table 5.1.6.1 below summarizes the proposed analytes and their respective methods. PFAS samples will only be analyzed annually. Quality assurance/quality

control (QA/QC) samples will be collected during each event, and a duplicate sample will be collected and analyzed. Surface water sampling will follow internal procedures including *DoR-OR T-704 Standard Operating Procedures (SOP) Collection of Surface Water Samples* (TDEC, 2023).

Field Parameter Measurements

This program includes monitoring water quality parameters at five (5) locations: two (2) stream discharge flumes, SF-3 and SF-6, two (2) stream locations, BCK 7.6 and BCK 8.63, and one spring, SP-D10W (Figure 5.1.5.1). At all sites, field parameter measurements will be recorded on a semi-annual basis using a properly calibrated multiple parameter water quality meter, YSI Professional Plus water quality meter or its equivalent. The parameters will be measured for conductivity (COND, µS/cm), dissolved oxygen (DO, mg/L), pH, temperature (°C), Oxidation-Reduction Potential (ORP, mV), and turbidity (NTU) and will be recorded along with the time and date of measurement. Measurements will be taken in accordance with *DoR-OR T-703 SOP Field Use for Water Quality Parameters Instrument* (TDEC, 2023b). Calibration and/or a confidence check of this instrument will be performed prior to field use and a drift check will be performed after field work concludes. In addition, instream multi-parameter probes (In-Situ Aqua Troll 600 Multiparameter Sondes) will be used to continuously monitor the stream at BCK 7.6 and BCK 8.63 on a more frequent basis (hourly). Data from the continuously monitoring probes will be downloaded monthly.

As part of the visual monitoring component, the project team will note discharges, water conditions, observe the condition of the banks, and note any concerns. Any concerns will be brought to the attention of DOE. Field notes will be recorded in a dedicated field book, and events will be documented in a monthly internal project report.

Data Evaluation

Data collected from these key locations by DoR-OR and DOE will be entered into an Excel database for evaluation. Evaluation will include the construction of tables and graphs illustrating ranges, limits of constituents and parameters, and identifying potential trends throughout the project. For archival and other evaluation purposes, the data will be entered into DoR-OR's TOREIS database. The analytical test suite is presented in Table 5.1.6.1 Pertinent water quality regulatory criteria from the EPA and TDEC will be included in the graphs. Results will be compared with any available DOE sampling data or historical TDEC data. Data will be screened using TDEC AWQCs as listed in TN 0400-40-03(4)(j) for protection of recreation and TN 0400-40-03 (3)(g) for protection of fish and aquatic life to determine if there is a potential impact to human health and the environment (TDEC, 2019). Any exceedances may invoke further investigation.

Table 5.1.6.1: EMDF Analyte List

Analyte / Parameter	Method
Hardness	*EPA 130.1*
Antimony	*EPA 200.8*
Arsenic	
Beryllium	
Cadmium	
Chromium	
Copper	
Lead	
Mercury	
Nickel	
Selenium	
Silver	
Thallium	
Uranium	
Zinc	
Chromium, Hexavalent	*EPA 218.6*
PFAS	*EPA 537.1*
Mercury (Low Level)	*EPA 1631*
PCBs	*SW846-8082A*
VOCs	*SW846-8260*
SVOCs	*SW846-8270*
Dioxins	*SW846-8290*
PCBs (Low Level)	*1668C*
Cyanide	*9012B*
HCH (Hexachlorocyclohexane Technical)	*8081*
Pesticides	*8141*
Dissolved Solids (TDS)	*2540 C-2011*

Mercury, radionuclides, and volatile organics are potentially constituents of concern. The analytical results data from the collected water samples may identify more constituents of concern.

5.1.7 REFERENCES

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5.2 EMWMF Surface Water Monitoring

5.2.1 Background

The Environmental Management Waste Management Facility (EMWMF) is located in Bear Creek Valley west of the Y-12 National Security Complex (Y-12). EMWMF is a landfill operated by DOE under the *Comprehensive Environmental Response, Cleanup and Liability Act* (CERCLA) and was constructed for the disposal of low-level radioactive and hazardous wastes generated by remedial activities on the Oak Ridge Reservation (ORR). The EMWMF is comprised of six disposal areas, or cells, that have a total capacity of approximately 2.3 million cubic yards.

Materials that are shipped to the EMWMF include soil, sediment, building demolition debris, personal protective equipment, and scrap equipment. Currently, only CERCLA low-level

radioactive solid waste is approved for disposal in the EMWMF. Disposal requirements for this type of waste are defined in *TDEC 0400-20-11-.16(2) (Licensing Requirements for Land Disposal of Radioactive Waste,* "Performance Objectives"), with radiological concentrations below limits imposed by Waste Acceptance Criteria and agreed upon by the FFA tri-parties (DOE, EPA, and TDEC).

The potentially contaminated stormwater (contact water) is the only authorized discharge allowed from EMWMF following established release criteria. Clean Water Act discharge limits are currently in development. Contact water collects in the disposal cells above the leachate collection system and is routinely pumped from the disposal cells to holding ponds and tanks (Figure 5.2.1.1). It is then sampled and analyzed for Contaminants of Concern (COCs). If contaminant levels exceed release criteria limits, the contact water is treated offsite at the Liquid Gaseous Waste Operation (LGWO).

Figure 5.2.1.1: Aerial Photo of the EMWMF (DOE, 2025)

Once all contact water levels are below release criteria, the water is discharged into the stormwater sedimentation basin, which discharges into NT-5, a tributary of Bear Creek. Contact water monitoring is conducted to evaluate compliance with limits required by EMWMF ARARs *10 CFR 20.1301(a)* (*Standards for Protection Against Radiation,* "Dose Limits for Individual Members of the Public"), *10 CFR 20.1301(a)* (As Low As Reasonably Achievable, ALARA), and *TDEC 0400-20-11-.16(2)* (formerly *TDEC 1200-2-11-.16(2)*) to verify performance objectives for the

disposal of radioactive waste. Additionally, monitoring is performed to ensure compliance with *TDEC 0400-40-03-.03(3)* (formerly *TDEC 1200-04-03-.03(3))* under the General Water Quality Criteria, "Criteria for Water Users," as specified in the SAP/QAPP.

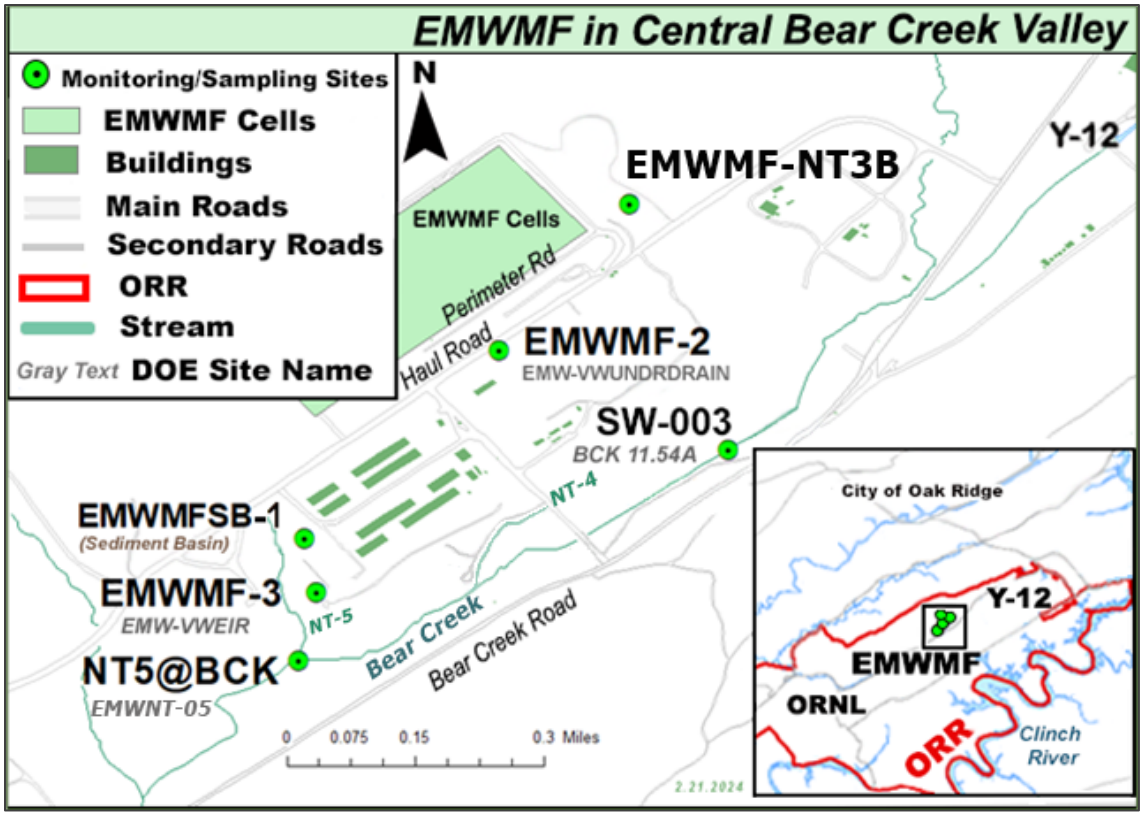
TDEC DoR-OR (DoR-OR) began water monitoring at the EMWMF in 2006 and continues to do so. Since 2006, surface water, groundwater, and sediment samples have been collected, analyzed, and published in the DoR-OR *Environmental Monitoring Reports* (EMRs). This monitoring provides independent regulatory oversight and verification that EMWMF operations are protective of human health and the environment.

5.2.2 Problems Statements

In Spring and Fall 2018, chromium VI (Cr^{6+}) levels in contact water exceeded the release criteria of 16 µg/L (DOE, 2022). Additionally, DOE environmental monitoring reports identified groundwater concentrations of U-233/234, U-238, barium, boron, calcium, magnesium, molybdenum, strontium, and Cl-36 exceeding threshold values (DOE, 2022). Contaminants in the waste materials from CERCLA remediation activities are buried in the EMWMF and could potentially leach out of the landfill , enter the surrounding environment, and go offsite via surface water and/or groundwater. Water can serve as the medium to transport contaminants offsite at concentrations exceeding agreed-upon limits.

5.2.3 Related DOE Projects

At the EMWMF, DOE conducts contact water and surface water monitoring in accordance with the SAP/QAPP to evaluate compliance with ARARs specified in the ROD. DOE monitors Bear Creek tributaries NT-5 and NT-3 quarterly for potential releases from the landfill. Additionally, water samples are collected from the underdrain (EMWMF-2) and the V-weir (EMWMF-3). DOE collects water discharged from the sediment basin at the EMWMF-3 using an automatic sampler programmed for Volumetric Weighted Composite (VCOMP) sampling. This method better represents contaminant concentrations over time by proportionally weighting each subsample based on the flow rate at the time of collection. The composite sample is collected on a weekly basis as the water is discharged. Additional DOE sampling of surface water takes place at EMWNT-03B, EMWNT-05, NT-4 (Bear Creek Tributary) and the V-weir semi-annually after a qualifying precipitation event (> 0.1 inches). DOE's monitoring data were published in the *Phased Construction Completion Report* (PCCR) available on the DOE Information Center (DOEIC) and the data can be downloaded from the DOE Oak Ridge Environmental Information System (OREIS).



5.2.3.1: DOE Sampling Sites

Compared to DOE's EMWMF surface water sampling plan, DoR-OR will analyze a broader range of COCs. For the water quality parameter monitoring, DoR-OR's in-situ probe will monitor water quality parameter at a higher frequency. Additionally, DoR-OR will establish an in-situ continuous monitoring site at downstream NT-5, providing additional data for assessment of EMWMF discharge impacts on Bear Creek. This monitoring plan will help address potential gaps in DOE's monitoring of EMWMF water discharges to the environment.

5.2.4 GOALS

The goals of the water monitoring at the EMWMF include:

- Monitor surface water parameters to identify changes in physical parameters in EMWMF discharges and to assess potential environmental impact on Bear Creek.

- Collect water samples from landfill discharges to complement DOE's monitoring efforts.

- Conduct independent surface water monitoring at similar locations as DOE's EMWMF monitoring program to provide comparable sampling results.

5.2.5 SCOPE

In FY26, DoR-OR's EMWMF surface water monitoring project will consist of three components: EMWMF water quality monitoring, in-situ continuous monitoring, and surface water sampling.

1) DISCHARGE WATER QUALITY MONITORING:

In FY26, DoR-OR will measure water quality parameters monthly at four locations: EMWMF-2 (underdrain), EMWMF-3 (sediment basin V-weir discharge), SW-003 (upstream of EMWMF at BCK 11.54), and NT5@BCK (confluence of NT-5 and Bear Creek) (Figure 5.2.5.1 & Table 5.2.5.1)

2) IN-SITU CONTINUOUS MONITORING:

In-Situ® multiparameter probes were installed at site NT-5@BCK and EMWMF-3. These probes collect water quality parameters on an hourly basis. Water quality parameter data will be downloaded by DoR-OR on site monthly.

Figure 5.2.5.1: DoR-OR EMWMF Sampling Sites

3) SURFACE WATER SAMPLING:

DoR-OR will collect routine water grab samples at site EMWMF-3 to evaluate potential downstream impacts to the environment and human health. Water samples will be collected quarterly from July 2025 to June 2026. Detailed COCs are listed in Table 5.2.6.3. The summary of the monitoring and sampling for FY26 is listed in Table 5.2.5.1.

Table 5.2.5.1: EMWMF sampling frequency and site description

DOE Station ID	DoR-OR Sample ID	Frequency			Site Description & Sampling Rationale
		Water Quality Parameter	In-Situ Continuous Parameter	Surface Water Sampling	
EMW-VWEIR	**EMWMF-3**	**Monthly**	**Continuous**	**Quarterly**	*EMWMF effluent discharge. Provides potential contaminant levels being discharged from the sediment basin.*
EMW-VWUNDRDRAIN	**EMWMF-2**	**Monthly**	None	None	*NT-4 discharge below the landfill. The underdrain was installed below Cell 3, and it is hypothesized that if cells 1, 2, and 3 were to leak contaminants, they would first be observed at the underdrain (DOE, 2022).*
BCK 11.54A	**SW-003**	**Monthly**	None	None	*Upstream of EMWMF at BCK 11.54 location to be used as a water quality reference.*
BCK 10.60	**NT5@BCK**	**Monthly**	**Continuous**	None	*Downstream surface water location along western landfill footprint; confluence of NT-5 and Bear Creek.*

5.2.6 METHODS, MATERIALS, METRICS

1) DISCHARGE WATER QUALITY MONITORING:

The water quality parameters measured in this portion of the project include temperature, pH, specific conductivity, dissolved oxygen, turbidity and oxidation-reduction potential. DoR-OR personnel will monitor parameters monthly with a YSI-Professional Plus water quality instrument or equivalent. Field measurements will be collected following the *DoR-OR T-703 Field Use for Water Quality Parameters Instrument* (TDEC, 2023a) and *DoR-OR T-153 Water Quality Field Instrument Calibration and Maintenance* (TDEC, 2023b).

2) IN-SITU CONTINUOUS MONITORING:

Continuous water quality data at EMWMF-3 and NT5@BCK will be automatically collected on hourly intervals by installed multiparameter probes. The water quality parameters include temperature, pH, specific conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential. Data will be downloaded monthly on site using the VuSitu® app.

Table 5.2.6.2: EMWMF Water Quality Field and Analytical Methods

Field Measurement	Instrument	Parameters	Units
Discharge Water Quality Monitoring	*YSI-Professional Plus® water quality instrument*	*1. pH* *2. Temperature* *3. Specific conductivity* *4. Dissolved oxygen* *5. Oxidation-reduction potential* 6. *Turbidity*	*STD Units* *^{o}C* *µS/cm* *mg/L* *mV* *NTU*
In-situ® Continuous Monitoring	*Multiparameter Probes*		
	VuSitu® App		

3) SURFACE WATER SAMPLING:

DoR-OR will collect surface water grab samples at EMWMF-3 quarterly. Collected samples will be analyzed for radionuclides, metals, inorganics, and organics (Table 5.2.6.3). Water samples will be collected following *DoR-OR T-704 Collection of Surface Water Samples* (TDEC 2023c). Surface water analytical results will be compared to applicable EPA and TDEC criteria.

Table 5.2.6.3: Surface Water Analytes and Laboratory Methods

Parameter Type	*Analytes*	*Lab Analysis Method*
Radionuclides	*Gross Alpha/Beta*	*EPA 900.0*
	** Gamma*	*EPA 901.1*
	*** Transuranics*	*DOE HASL 300*
	Carbon-14	*EPA EERF*
	**** Isotopic Uranium*	*DPE HASL 300*
	Strontium-89/90 (Sr-89/90)	*EPA 905.0*
	Radium-226/228 (Ra-226/228)	*EPA 904.0*
	Technetium-99 (Tc-99) / Tritium (H-3)	*EPA 906.0*
Metals	*Arsenic*	*Method 6020*
	Barium	
	Cadmium	
	Chromium (Total)	
	Cobalt	
	Copper	
	Lead	
	Nickel	
	Uranium	
	Vanadium	
	Zinc	
	Low-Level Mercury (LLHg)	*EPA 1631*
Organics	*Pesticides*	*SW846-8081*
	Low-level PCBs	*EPA 1668*
	PFAS	*EPA 537M*
Inorganics	*Nitrite/Nitrate*	*EPA 300.0*

Notes:
** **Gamma**: Cs-137, Co-60, Pb isotopes, Np-237, Am-241, and others*
*** **Transuranics**: Pu isotopes, Am-241, Np-237, and others*
**** **Isotopic Uranium**: U-234, U-235, U-238*

Analytical results data will be uploaded into the TDEC Oak Ridge Environmental Information System (TOREIS) database. Data evaluation will include review of the ranges and limits of constituents over the course of the project. The EPA human and aquatic life criteria, along with the State of Tennessee aquatic life criteria, will be used to assess the potential environmental impacts of EMWMF discharged surface water.

5.2.7 REFERENCES

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TDEC. 2023c. *Tennessee Department of Environment and Conservation SOP: Collection of Surface Water Samples.* TDEC DoR, Oak Ridge, TN. DoR-OR T-704.

6.0 RADIOLOGICAL MONITORING

6.1 HAUL ROAD SURVEY

6.1.1 BACKGROUND

In 2004, contaminated waste was lost from a DOE subcontractor's dump truck on a state highway in Tennessee. DOE conducted an Accident Investigation to determine preventative measures (DOE, 2004). This investigation resulted in an agreement with the State of Tennessee to construct a separate transportation route for these dump trucks. The Haul Road was constructed and is reserved solely for trucks transporting CERCLA low-level radioactive and hazardous waste.

DoR-OR staff perform surveys of the Haul Road and other waste transportation routes to account for waste or material that may have fallen from the trucks in transit to the Environmental Management Waste Management Facility (EMWMF). DoR-OR staff perform walk over inspections of different segments of the nine-mile-long Haul Road and associated access roads on a bimonthly basis. Anomalous items noted along the roads are scanned for radiation, logged, marked with contractor's ribbon, and their descriptions and locations submitted to the DOE for disposition.

6.1.2 PROBLEMS STATEMENTS

Throughout the history of the Haul Road surveys project, numbers of anomalous items have been identified such as waste debris, personal protection equipment, tarp patches, waste stickers, steel pipe, etc., that could potentially be contaminated.

6.1.3 RELATED DOE PROJECTS

DOE conducts radiological surveys of the Haul Road using a tractor with radiological detection instrumentation attached. There is some concern that the distance from the road surface to the radiation detectors on the tractor is too far for effective detection of beta radiation. The tractor does not stop to survey anomalous objects found on or beside the road.

6.1.4 GOALS

The primary goal of the project is to conduct independent oversight to identify potentially contaminated items along the Haul Road and associated access roads.

In particular, the objectives include the following:

- Assess the radiological conditions of the Haul Road and objects that may have fallen from trucks.

- Ensure, through monitoring and oversight, that DOE and their contractors continue waste

transportation in a manner that limits potential environmental impacts to the Haul Road and the surrounding areas.

6.1.5 SCOPE

The Haul Road project includes routine radiation walk over surveys of nine, approximately one-mile-long segments of the Haul Road, Reeves Road, and associated access roads used for transportation of CERCLA waste to the EMWMF.

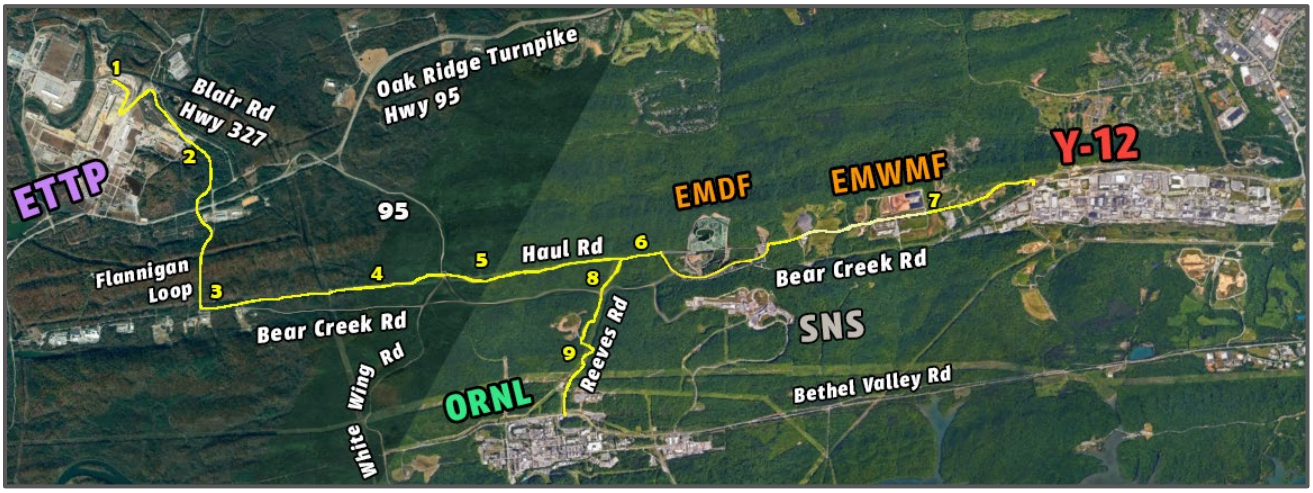

Figure 6.1.5.1: Haul Road Monitoring Sections

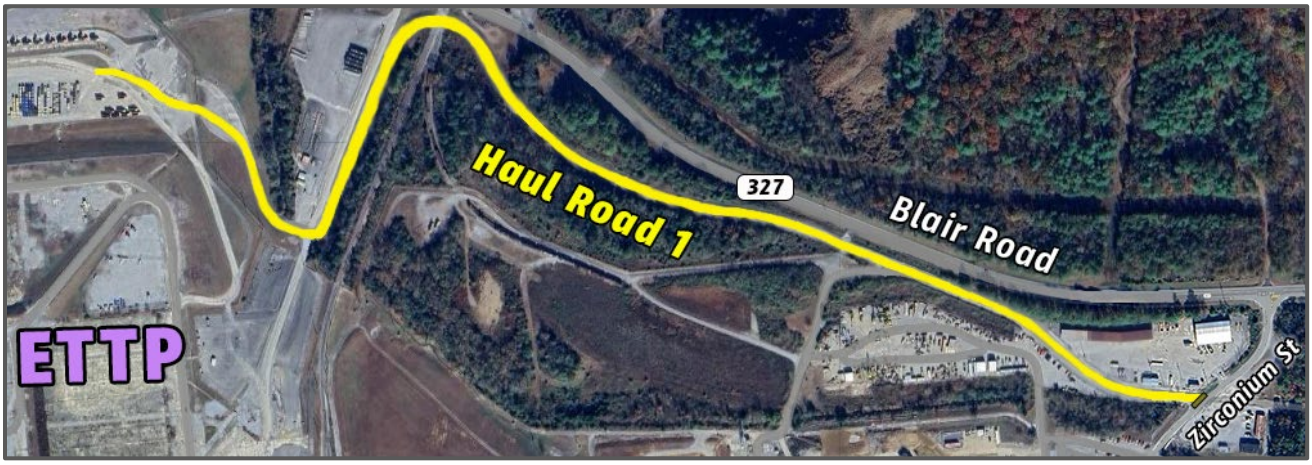

Figure 6.1.5.2: Haul Road Section 1

Figure 6.1.5.3: Haul Road Section 2

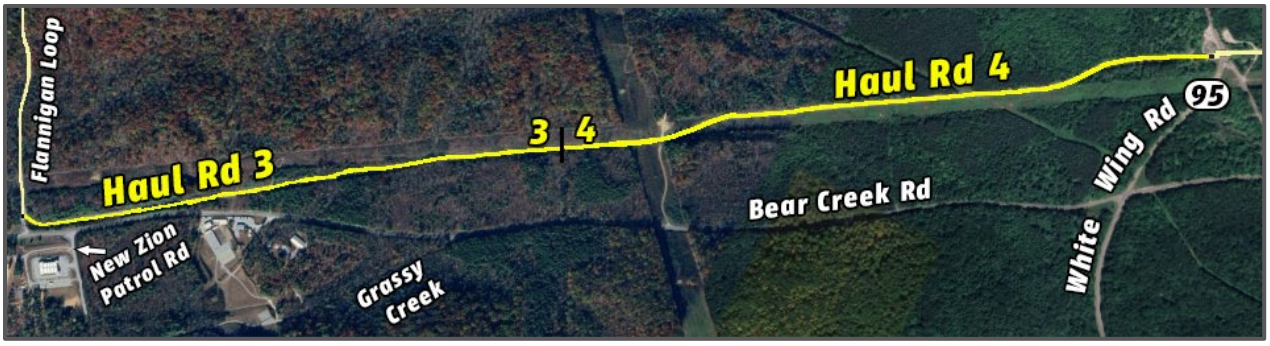

Figure 6.1.5.4: Haul Road Sections 3 & 4

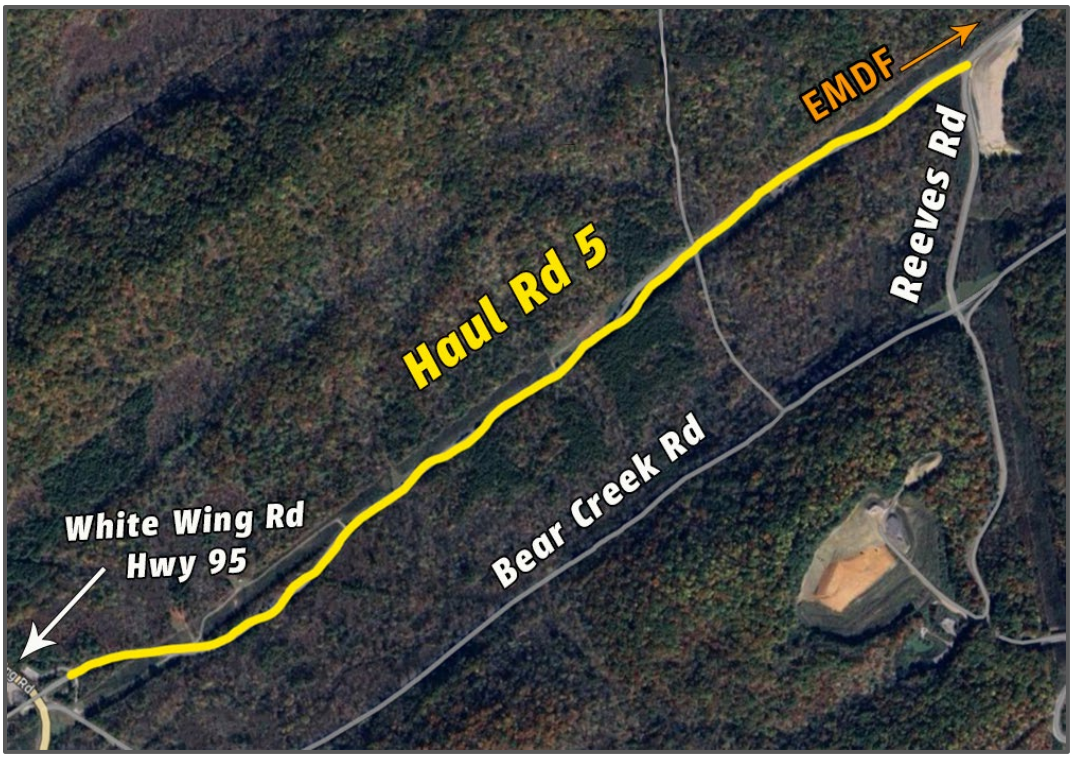

Figure 6.1.5.5: Haul Road Section 5

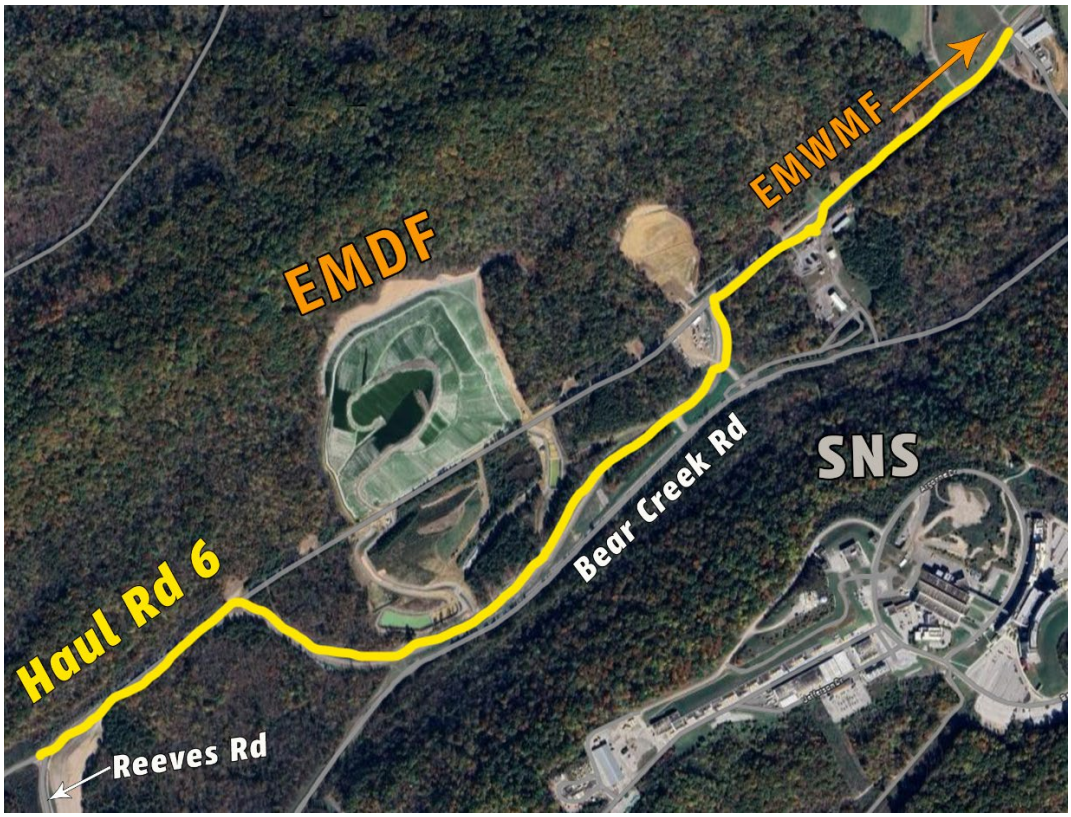

Figure 6.1.5.6: Haul Road Section 6

Figure 6.1.5.7: Haul Road Section 7

Figure 6.1.5.8: Haul Road Section 8 & 9

6.1.6 Methods, Materials, Metrics

The nine-mile length of Haul Road is surveyed in segments, typically consisting of approximately one mile. Prior to arriving on site to conduct each survey, the project team will notify the DOE contractor about the scheduled event. The DOE contractor will provide safety and status briefings on road conditions to DoR-OR. When excessive traffic presents a safety concern, the survey will be rescheduled.

When conducting a radiation walk over survey, the project team will perform the survey in accordance with TDEC procedures. The NaI Meter will be used to scan for radioactive contaminants that may have fallen from a truck on the road (TDEC, 2023c). If elevated radiation is detected or anomalous items are found, an Alpha/Beta dual detector will be used to investigate potential surface contamination. Any road areas or items with contamination levels exceeding action levels that require further investigation are noted, and DOE's contractor is notified for disposition.

The planned Haul Road surveys are generally conducted on a monthly basis, evaluating one Haul Road section per month, unless otherwise indicated by site operations.

Table 6.1.6.1 Haul Road Survey Coordination

Haul Road Survey Coordinators	Affiliation/Job Title	Email Address
Courtney Thomason	TDEC DoR-OR	Courtney.Thomason@tn.gov
Roger Parker	DOE Contractor (Haul Rd)	Roger.Parker@ettp.doe.gov
Christopher Lehman	DOE/DOE Contractor	Christopher.Lehman@ettp.doe.gov
Steven Foster	DOE/DOE Contractor	Steven.Foster@ettp.doe gov
Steven Stone	DOE/DOE	Steven.Stone@npo.doe.gov

6.1.7 References

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6.2 AMBIENT GAMMA RADIATION MONITORING

6.2.1 BACKGROUND

During early operations, leaks and spills were common at industrial facilities within the three ORR campuses. Contaminants, including radioactive materials, were released from operations as gaseous, liquid, and solid effluents, sometimes with little to no treatment (ORAU, 2003). These legacy contaminants have already settled into older structures, soils, and other media on the ORR, and these deposits are monitored for migration by DOE.

Recently, DOE has increased its ORR remedial activities. Their goal is to remove known contamination and contaminated buildings, making land available for reuse. The immediate concern is that demolition could potentially disturb legacy radiological contamination. For example, ORNL and Y-12 campuses are currently undergoing D&D and demolition, which has the potential to change local dose rates.

Due to these concerns, the continuous and consistent gamma dose rate monitoring within proximity to D&D structures, as well as near operational facilities with the potential for variable dose rates, will be a valuable assessment tool. Because both D&D and active operations can create areas with elevated or variable radiological dose rates, locations on the ORR with such activities represent areas of special concern that are most likely to contribute dose to the environment or human receptors and could benefit from additional monitoring. Results of this monitoring effort will help ensure that BMPs are protective of human health and the environment.

6.2.2 PROBLEMS STATEMENTS

- Facilities on the ORR have the potential to emit variable amounts of gamma radiation. These emissions can fluctuate substantially over relatively short periods of time and cannot be predicted.

- D&D, subsequent demolition, isotope production, research and development, and other current operations have the potential to increase this variability to the radiological dose in nearby areas.

- Continuous monitoring is needed to accurately measure potential dose in areas with more variable dose rates throughout a year.

6.2.3 Related DOE Projects

DOE conducts ambient gamma exposure rate monitoring near the ORR perimeter. The perimeter is monitored to ensure that the primary dose limit for protecting members of the public does not exceed 100 mrem/year (1 mSv/year).

DOE also conducts radiological monitoring at remediation and D&D sites to monitor radiation exposures to the industrial workers. Radiation safety training plus individual dosimetry is required for staff in areas of possible exposure.

6.2.4 Goals

- The DoR-OR *Ambient Gamma Radiation Monitoring* project will allow TDEC to monitor gamma emissions closer to internal ORR source areas.

- TDEC ambient gamma exposure rate monitoring will supplement DOE's ORR perimeter monitoring by providing on-site continuous monitoring near current and D&D work at ORNL & Y-12 with expected dose fluctuations.

- The project data will accurately track gamma exposure rate at specific areas of concern within the ORR.
    - Areas of concern include locations with active D&D work or other active operations.

- Improve collaboration between DOE and the State, through increased communication of gamma emissions data.

- Evaluate TDEC verification data to identify potential concerns in select public areas at ORR.

6.2.5 Scope

Continuous ambient gamma monitoring, using GammaTRACERs®, will be conducted at six ORR stations and one background location, described below and shown in Figure 6.2.5.1. These stations were placed near areas where D&D, remediation, waste disposal, or active operations are most likely to contribute exposure to the environment or human receptors.

Of note, as additional Gamma TRACER® monitors become available, more stations will be added to active D&D sites within the ORNL campus.

1) **FORT LOUDOUN DAM (BACKGROUND):** record naturally occurring data, use for comparison to monitoring stations located within the ORR.

2) **EMWMF:** in Bear Creek Valley, landfill for waste disposal from CERCLA activities.

3) **ORNL BUILDING 3026**: monitor potential radiological releases during the demolition of high-risk facilities (Hot Cells Facility), centrally located on ORNL's main campus and in proximity to pedestrian and vehicular traffic.
   - Monitoring at this location in FY26 is intended to understand pre-demolition conditions to better identify environmental changes that may occur as a result of demolition activities once they begin.

4) **MSRE (MOLTEN SALT REACTOR EXPERIMENT):** the major source of the measured gamma radiation exposure above background may be a result of a salt probe being temporarily stored in the radiation area, adjacent to the monitoring station.

5) **SNS (SPALLATION NEUTRON SOURCE):** the exposure rate monitor was previously located near the central exhaust stack used to vent air from process areas inside the linear accelerator. Exposure rates vary based on the operational status of the accelerator. During periods when the accelerator is offline, the rates are similar to background measurements. However, much higher levels are recorded during operational periods. Starting in FY26, the monitor will be located on a perimeter fence.

6) **ORNL BUILDING 3038:** monitor potential radiological releases during the demolition of high-risk facilities associated with the "Isotope Row" complex, centrally located on ORNL's main campus and in proximity to pedestrian and vehicular traffic.

7) **ORNL BUILDING 3042:** monitor potential radiological releases during the demolition of high-risk facilities (Oak Ridge Research Reactor), centrally located on ORNL's main campus and in proximity to pedestrian and vehicular traffic.

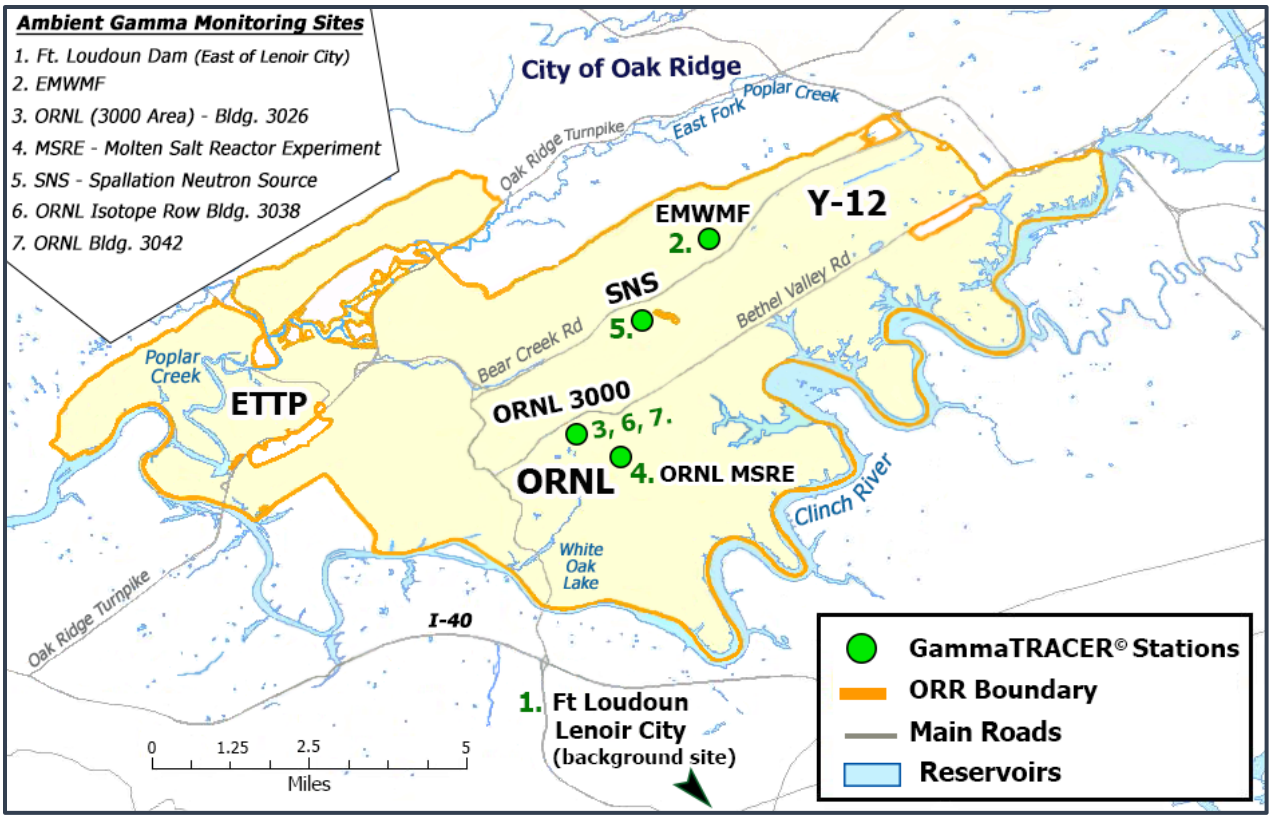

Figure 6.2.5.1: DOE and DoR-OR Ambient GammaTRACER® Stations

6.2.6 Methods, Materials, Metrics

The GammaTRACER® collects data continuously, 24-hours per day and 365 days per year, which equates to 8,766 hours. For the purpose of TDEC's review, the following parameters are assumed. An average worker would only spend up to 2,000 hours per year (i.e. 40 hours per week for 50 weeks a year) at the ORR. Per NUREG-1556, using an Occupancy Factor of 1/20, it is conservatively assumed that a member of the public would only spend up to 100 hours per year at the ORR. To calculate the estimated annual exposure to Members Public, the annual exposure, based on the daily average, is divided by 8,766 hours. The resulting number is the average hourly dose, which is then multiplied by 100 hours for annual dose.

The gamma exposure rate detectors have already been deployed at five of the six locations. Each of these *Genitron Instruments GammaTRACER® Units* contain two Geiger-Mueller tubes for gamma detection, a microprocessor-controlled data logger to store exposure rates, and lithium batteries, all sealed in a weather resistant case to protect its internal components. The detectors are programmable and will be recording at a 5-minute interval, with an automatic shift to 1-minute intervals above a set threshold of radiological activity based on site-specific parameters. Data will be downloaded at least once per month following established DoR-OR protocols (TDEC, 2023).

The results will be derived by averaging the gamma exposure rates and examining daily minimum and maximum exposure rates for each location. ORR detector data will be quantified in accordance with NUREG-1556, Appendix G (NRC, 2017), to determine the total exposure per station. ORR results will also be compared to the background station at Fort Loudoun Dam, which is co-located with the DOE background gamma monitor.

The results will be compared to the State and DOE primary dose limits for protecting members public to ensure the 100 mrem/year limit (i.e. consecutive 12-month period) is not exceeded.

Table 6.2.6.1: Radiation Dose Limits Per Agency

Regulation	Occupation	Dose Limits
DOE Order 458.1	Employee	**100** mrem/yr. whole body **1,500** mrem/yr. lens of eye **5,000** mrem/yr. skin or organ
10 CFR 835C **§ 835.208**	*Member Public*	**100** mrem in a year (in controlled area)
https://www.directives.doe.gov/directives-documents/400-series/0458.1-BOrder/@@images/file https://www.ecfr.gov/current/title-10/chapter-III/part-835/subpart-C/section-835.208		

6.2.7 REFERENCES

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6.3 Surplus Sales Verification

6.3.1 Background

As remediation and clean-up work continues, there is a continual need for DOE to update and replace existing equipment as it becomes worn and/or is no longer ideal for a project. Operating under the goal to recycle and reuse equipment and materials whenever possible, DOE staff collects ORR surplus items for resale at auction. Verification that ORR surplus materials are safe to be sold to the public is an important protective measure. When requested by DOE, DoR-OR conducts an independent radiological survey of specified ORR surplus items.

DOE Radiation Control Personnel (RCPs) are tasked with the initial survey of all items. The goal is to isolate any equipment with elevated radiation levels or removable contamination. Radiological detection meters are used for these thorough scans by RCPs. DOE seeks to prevent the spread of contaminants from surplus equipment to members public.

Once items are checked, and cleaned if warranted, they are displayed for resale. DoR-OR is then invited to perform an additional scan on surplus items. Finally, DOE staff invite contractors that have been pre-approved to bid on surplus materials.

DoR-OR will work collaboratively with DOE to verify assessments of surplus materials through spot checks and secondary surveys.

6.3.2 Related DOE Projects

As mentioned above, DOE RCTs scan materials being auctioned from ORNL and Y-12 before they are submitted for auction.

6.3.3 Problem Statements

Items for auction resale have a potential to have been used in radiologically controlled areas. Prior to release to the public, DOE and TDEC DoR-OR strive to verify that no radiologically contaminated equipment is accidentally sold.

6.3.4 Goals

The overarching goal of this project is to screen surplus items for potential radiological surface contamination and prevent contaminated items from being sold to the public.

6.3.5 Scope

Upon request, DoR-OR staff will perform pre-auction radiological screening verification surveys for surplus items from ORNL and Y-12. On average, no more than eight (8) events occur during the fiscal year.

6.3.6 Methods, Materials, Metrics

Upon receiving a survey request from the DOE Property Excessing Team, DoR-OR project staff will schedule a verification survey. Calibration checks of radiological detection instruments will be performed just prior to the survey appointment. The intent of a DoR-OR radiological verification survey is to spot check items that have been identified and cleared for sale by DOE. Accordingly, not all items or surfaces of a specific item will be surveyed for potential radioactive contamination. Biased measurements will be used, where specific attention is paid to well-used items. Surplus items with damaged, unclean, or stained areas will be targeted by checks. Well-maintained items will be scanned based on their prior usage and former location.

If radiological activity (alpha or beta/gamma) is detected above the contamination limits, that item will be flagged, and the Property Excessing Staff will be notified.

Based on previous experiences, the Property Excessing Staff will then decide whether to have an item rechecked by ORNL RCTs. DoR-OR does not attempt to determine if an item meets DOE release criteria.

6.3.7 References

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7.0 SURFACE WATER MONITORING

7.1 AMBIENT SURFACE WATER PARAMETERS

7.1.1 BACKGROUND

Legacy waste across the ORR is responsible for a large portion of the contamination to surface water via releases of hazardous wastes (e.g. metals, organics, and radioactive materials). Current projects and processes on these campuses also have the potential to significantly contribute to surface water contamination (DOE, 2021; DOE, 2022; Pickering et al, 1970; Turner et al, 1999). DOE performs environmental surveillance around the ORR facility boundaries to comply with their internal requirements to protect the public and the environment from undue risks associated with DOE activities (DOE, 2023). As part of the *Environmental Surveillance Oversight Agreement (ESOA)* between DOE and TDEC, the State can perform additional monitoring in and around the ORR. The TDEC DoR-OR *Ambient Surface Water Parameter Project* was first implemented in 2005 to supplement DOE's monitoring effort by helping to measure general physical water quality parameters of several streams that exit the ORR. By measuring water quality parameters (e.g. conductivity, dissolved oxygen, pH, turbidity, and temperature), a general understanding of stream health and positive or negative trends can be gained. This project provides a benchmark from which to determine significant changes in water quality that may be impacted from DOE activities. For FY26 (July 2025-June 2026), DoR-OR proposes to continue to measure stream water quality parameters monthly. The overall goal is to establish and build upon a database of physical stream parameters on three ORR exit-pathway streams (Bear Creek, East Fork Poplar Creek, and Mitchell Branch) and one background stream (Mill Branch).

7.1.2 PROBLEM STATEMENTS

ORR exit-pathway streams and the Clinch River are subject to contaminant releases from previous and current activities at ETTP, ORNL, and Y-12. These releases can be detrimental to the environment and to human health.

Identified concerns include, but are not limited to, the following:

- Approximately 100 metric tons of Mercury (Hg) was released from Y-12 into East Fork Poplar Creek (EFPC) from 1950 to 1963. Mercury exited Y-12 via spills, leakage from subsurface drains, purposed discharge of wastewater, and leaching from contaminated building foundations and soils (Turner et al, 1999).

- Other metals (e.g. cadmium, chromium, lead, nickel, silver, and zirconium) are present in elevated concentrations in exit pathway streams (DOE, 1992).

- Uranium contaminated nitric acid wastes and other liquid wastes (amount of roughly 7.5

million L/yr) were disposed of in the S3 ponds from 1951 to 1984 near the headwaters of Bear Creek (Moss et al. 1999).

- Solid and liquid wastes, including approximately 18 million kg of uranium metal and 1 million L of waste oils and chlorinated solvents, were disposed of in the unlined Bear Creek Burial Grounds (BCBG) between 1955 and 1989. BCBG is adjacent to Bear Creek (Moss et al. 1999).

- The ORR has a history of undesired releases of contaminants such as chlorine and mercury from DOE activities. Documented early in the CERCLA clean-up effort in November 1986 and July 1987, fish kills related to chlorine and mercury extended over a period of 2 to 3 weeks killing 1,148 and 747 fish, respectively (ORNL, Etnier et al., 1994). Additionally on June 8, 2013, a high-volume release of chlorinated water from a line break occurred leading to a fish kill where 8,318 dead fish were counted (DOE, 2013). Again, a large fish kill occurred during June through August of 2018 due to releases of mercury to East Fork Poplar Creek from demolition activities at Y-12 (DOE, 2020). More recently, fish kills from chlorine leaks or releases occurred on January 10, 2021, March 9, 2021, and March 15, 2021, where 2,186 dead fish, 376, and 1,346 dead fish were identified respectively (ORNL, 2023).

7.1.3 Related DOE Projects

DOE conducts surface water monitoring quarterly which includes sample collection and analysis from various locations on the Clinch River. This DOE project has a goal of assessing impacts of past and current DOE operations on the quality of surface water. As part of this program, stream water quality parameters are measured at the time of sampling (DOE, 2022). However, the DOE program focuses on the Clinch River (CR), and many ORR surface water exit-pathway streams that flow into the Clinch River remain infrequently monitored or are only monitored when part of a CERCLA investigation or action (DOE, 2022). The TDEC-DoR-OR *Ambient Surface Water Parameters* project seeks to fill part of this surface water quality monitoring data gap while complementing the DOE environmental monitoring program.

7.1.4 Goals

The goal of DoR-OR's *Ambient Surface Water Parameters* project is to measure surface water quality parameters in EFPC, Bear Creek, and Mitchell Branch on the ORR. Project staff will collect and provide data that can assist in the evaluation of site activities and supplement DOE's surface water monitoring program. In addition, a record of ambient conditions will also be compiled for future use as a benchmark in the event of unexpected releases that may impact surface water. While water quality parameters are taken in conjunction with other DoR-OR surface water projects (e.g. *Ambient Surface Water Sampling*), this project will serve to maintain

routine monthly monitoring, which is more conducive to analyzing statistical trends on ORR streams.

7.1.5 Scope

This project is limited to the characterization of physical stream parameters of three (3) ORR exit-pathway streams, East Fork Poplar Creek (EFPC), Bear Creek (BC), and Mitchell Branch (MI) and one (1) offsite background stream, Mill Branch (MB). Ten (10) stream locations (EFK 24.4, EFK 23.4, EFK 13.8, MBK 1.6, BCK 12.3, BCK 9.6, BCK 9.2, BCK 7.6, BCK 4.5, and MIK 0.1) will be measured monthly during the July 2025 – June 2026 period (Figure 7.1.5.1).

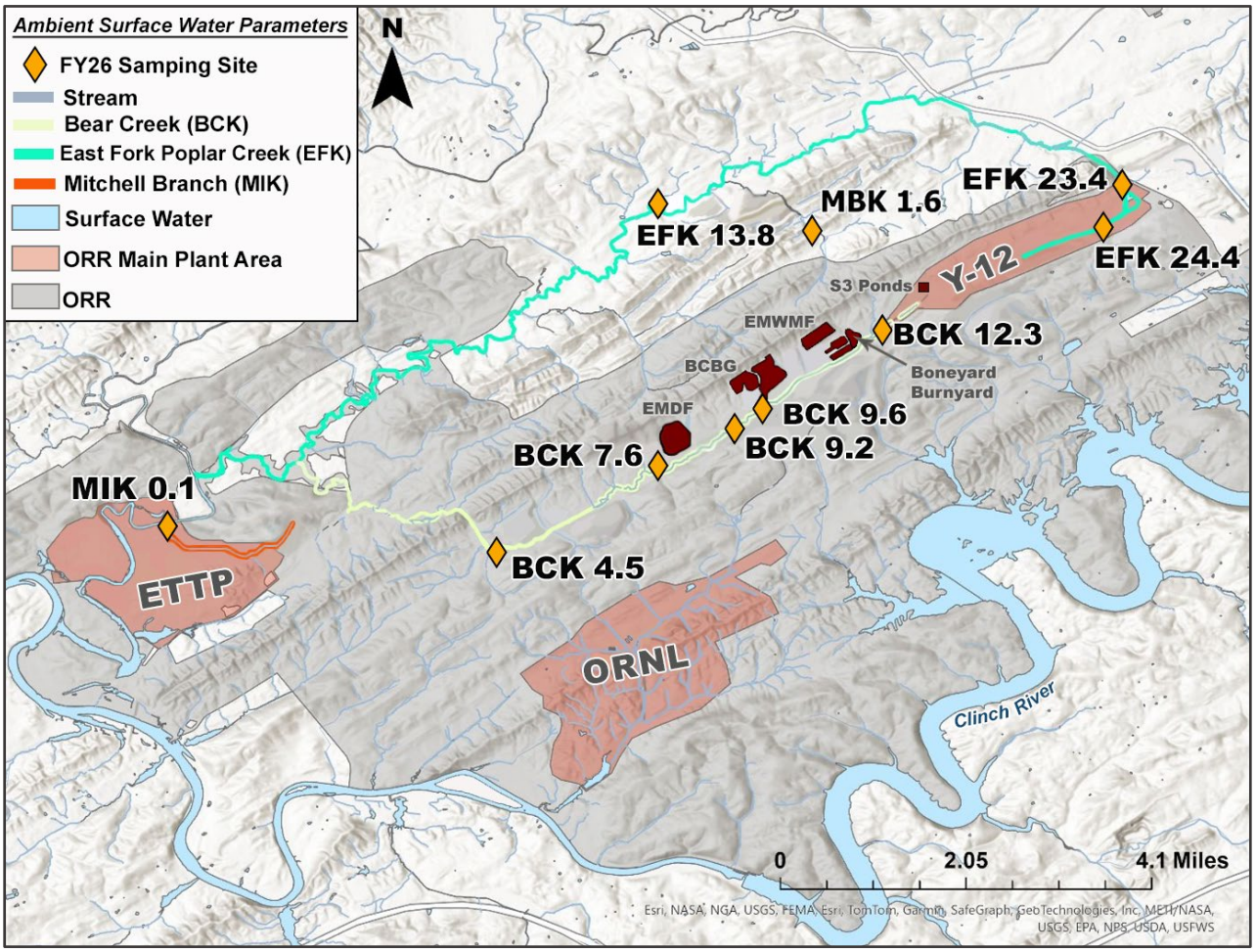

Figure 7.1.5.1: DoR-OR Proposed Surface Water Parameter Sites

7.1.6 Methods, Materials, Metrics

Field Parameter Measurements

At each site, physical water parameters will be measured and recorded. Physical parameters will be measured using a YSI multiple parameter water quality meter. Conductivity (µS/cm),

dissolved oxygen (mg/L), pH, turbidity (NTU), and temperature (°C) will be recorded along with the time of measurement. Measurements will be taken in accordance with internal *DoR-OR T-703 SOP Field Use for Water Quality Parameters Instrument* (TDEC, 2023).

DATA EVALUATION

Recorded measurements will be stored in a database. Trend analysis will be performed using linear regression to identify any increasing or decreasing trends in data. Anomalous data will also be identified. Basic descriptive statistics (mean, median, minimum, maximum, etc.) will be assessed. The three ORR streams will be compared to the MB background stream. Project staff will use statistical approaches, such as an analysis of variance, to determine if corresponding water quality measurements are significantly similar. Data will also be compared to TN general water quality criteria (TDEC, 2019).

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7.2 Ambient Surface Water Sampling

7.2.1 Background

Activities at the three ORR campuses have resulted in the discharge of hazardous substances (e.g., metals, organics, and radioactive materials) causing contamination of waterbodies on the ORR and in the surrounding areas (DOE, 1992; DOE, 2022; Pickering, 1970; Turner & Southworth, 1999). While legacy waste across the ORR may be responsible for a large portion of contamination to surface water, current projects and processes at these sites also have the potential to significantly contribute to surface water contamination. TDEC evaluates current contamination impacts from the ORR under the *Environmental Surveillance Oversight Agreement* (ESOA).

The DoR-OR *Ambient Surface Water Sampling Project* has been implemented each year since 1993. Sampling locations may change from year to year, where necessary, in order to provide additional evaluation of DOE activities. During the FY25, surface water monitoring focused on ambient water quality in exit-pathway streams of the ORR. In FY26, this project will shift towards a more rigorous analysis of the Clinch River (CR).

The Clinch River is an essential water body for the citizens of East Tennessee that provides drinking water to many people surrounding the ORR. In addition, the CR is important for recreation and is often used by boaters and for fishing. Current contamination from the ORR has the potential to migrate directly to this important water body and impact these uses and activities.

DOE has monitored the CR quarterly through surface grab samples from the top few inches of water over many years. These samples are often collected from docks and from the shoreline, and do not capture the majority of flow within the river. This sampling approach and scope may be limited and potentially does not provide a representative sample of the CR. Further sampling is warranted to help understand potential contamination impacts to the CR from the ORR.

7.2.2 PROBLEMS STATEMENTS

The ORR is located within the Clinch River watershed. Therefore, all contamination introduced to smaller exit-pathway streams in turn flows into the important drinking water source, the CR. As discussed above, the Clinch River and its tributaries on the ORR are subject to (1) legacy contaminants and (2) current operational contaminant releases. Identified concerns related to these contaminants include, but are not limited to, the following:

- Approximately 100 metric tons of ***Mercury (Hg)*** was released from Y-12 into East Fork Poplar Creek (EFPC) from 1950 to 1963. Mercury exited Y-12 via spills, leakage from subsurface drains, purposed discharge of wastewater, and leaching from contaminated building foundations and soils (Turner and Southworth, 1999).

- Other ***metals*** (e.g. cadmium, chromium, lead, nickel, silver, and zirconium) are present in elevated concentrations in exit pathway streams that flow into the CR (DOE, 1992).

- ***Uranium (U)*** contaminated nitric acid wastes and other liquid wastes (roughly 7.5 million L/yr) were disposed of in the S3 ponds from 1951 to 1984 near the headwaters of Bear Creek (Moss et al. 1999).

- Solid and liquid wastes, including approximately 18 million kg of ***uranium metal*** and 1 million L of ***waste oils and chlorinated solvents***, were disposed of in the unlined Bear Creek

Burial Grounds (BCBG) between 1955 and 1989. BCBG is adjacent to Bear Creek (Moss et al. 1999). This has resulted in ongoing uranium loading to Bear Creek at levels upwards of 90 kg/year or more (DOE, 2024).

- The ORR has had several instances of undesired releases of contaminants such as ***chlorine, strontium-90,*** and ***mercury*** from activities on the ORR.
    - In November 1986 and July 1987, fish kills related to chlorine and mercury extended over a period of 2 to 3 weeks killing 1148 and 747 fish, respectively (ORNL, Etnier D, et al., 1994).

    - On June 8, 2013, a high-volume release of chlorinated water from a line break occurred leading to a fish kill where 8,318 dead fish were counted (DOE, 2013).

    - In 2015, a ruptured pipe at the Process Waste Treatment Complex at ORNL released high concentrations of strontium-90 directly to soils and the groundwater, ultimately flowing to White Oak Creek and to the CR (DOE, 2018). In addition, general releases of strontium-90 from Outfall 304 have been ongoing at average levels of 1,825 pCi/L directly to White Oak Creek (DOE, 2021). This strontium, in addition to other unknown sources, is a potential concern for water quality of the CR.

    - A large fish kill occurred during June through August of 2018 due to releases of mercury to East Fork Poplar Creek from demolition activities at Y-12 (DOE, 2020).

    - Additionally, fish kills from chlorine leaks or releases that consequently dissolve and mobilize mercury, occurred on January 10, 2021, March 9, 2021, and March 15, 2021, where 2186 dead fish, 376, and 1346 dead fish were identified, respectively (ORNL, 2021).

In addition to contamination concerns, the sampling approach taken by DOE may not capture the migration of contamination within the CR. At DOE's monitoring locations, samples are collected from the top few inches of the water column. In large rivers such as the CR, contamination may not be solely transported at the top of the water column but may present itself at different depths and at different regions within the river. The USGS states, "to understand water properties of the whole river it is necessary to obtain individual samples at set increments across the river" (USGS, 2018). Historical sampling approaches of singular grab samples may not be providing a representative sample.

7.2.3 Related DOE Projects

DOE conducts surface water monitoring quarterly which includes sample collection and

analysis from various locations on the Clinch River. This DOE project has a goal of assessing impacts of past and current DOE operations on the quality of surface water. Data from this project are reported within the DOE *Annual Site Environmental Report* (DOE, 2022). However, while this DOE program focuses on the Clinch River (CR), many ORR surface water exit-pathway streams that flow into the Clinch River remain infrequently monitored or are only monitored when part of a CERCLA investigation or action. Most site related surface water sampling efforts focus on major contamination from legacy waste and not on contamination from current projects.

7.2.4 GOALS

The goals for this project include:

- Sample surface water at multiple depths along several transects of the Clinch River to provide a more representative sample of the river.

- Sample to help understand contaminant transport zones over different seasons and in different CR flow zones

- Sample similar locations as DOE's monitoring program to provide a comparison between sampling results

- Compare results to TN ambient water quality criteria (AWQCs) and/or drinking water maximum concentration levels (MCLs) where appropriate

7.2.5 SCOPE

Sampling will be conducted near four DOE monitoring locations along the CR (CRK 66, CRK 58, CRK 32, and CRK 16.1). These locations are adjacent to the ORR and were selected by DOE due to their proximity to public water intakes or their location relative to pertinent ORR inputs (see Figure 7.2.5.1; Table 7.2.5.1).

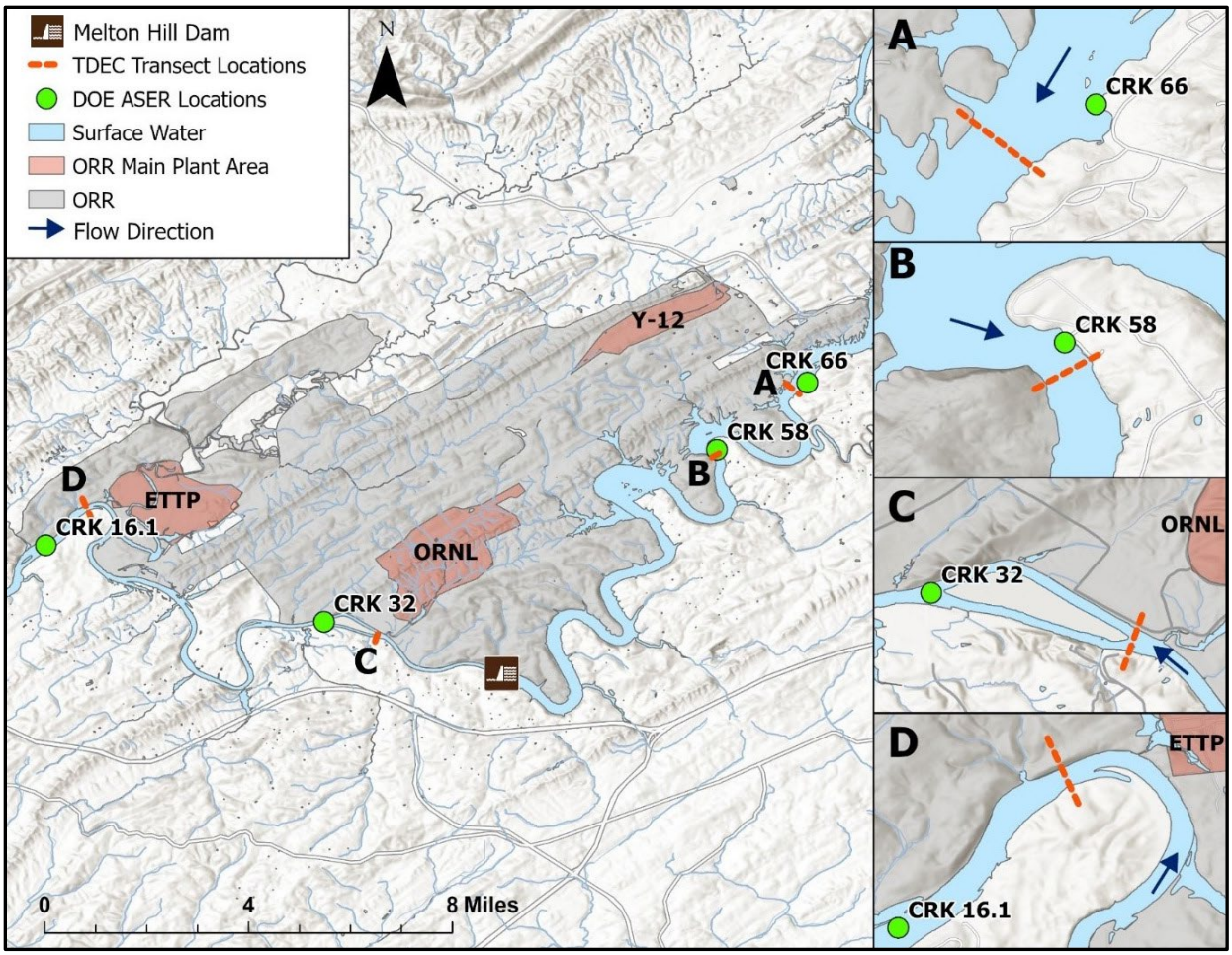

Figure 7.2.5.1: Sample Transect Locations

Sampling will occur twice at all four locations. This will include one event in the warmer months (July-September) during TVA's higher lake levels, and one event in the colder months (Dec-Feb) during lower lake levels. (see Table 7.2.5.1).

Table 7.2.5.1: Sample Sites and Frequency

River	*Site*	*Description*	*Parameters*	*# Sampling Events**
Clinch River	CRK 66	Melton Hill Reservoir near Oak Ridge water intake	Gross Alpha/Beta, Gamma, Tritium, Mercury, and Methylmercury	2
	CRK 58	Near water supply intake for Knox County	Gross Alpha/Beta, Gamma, Tritium, Mercury, and Methylmercury	2
	CRK 32	Downstream of ORNL WOC inputs	Gross Alpha/Beta, Gamma, Strontium-90, Tritium, Mercury, and Methylmercury	2
	CRK 16.1	Downstream of ETTP and all DOE ORR inputs	Gross Alpha/Beta, Gamma, Tritium, Mercury, and Methylmercury	2
*Note: *Each sampling event includes 9 samples + 10% quality control samples for each river transect (see Figure 7.2.6.1 for sampling layout at each transect)*				

7.2.6 METHODS, MATERIALS, METRICS

Sampling Approach

Sampling will occur along each river transect (see Figure 7.2.5.1 above). Each CR transect will be equally divided into thirds. Analytical samples and field measurements will be taken at the top, middle, and bottom from the center of each river division (Figure 7.2.6.1). Samples will be collected using a Kemmerer sampler, or similar device, which allows collection of water from selected depth intervals. Sampling sites will be accessed by boat. A GPS anchor will be set with an electric trolling motor at each sampling location to ensure the boat remains at the desired location during sampling. Surface water sampling protocols will follow internal standard operating procedures (SOPs) (TDEC, 2023a; TDEC, 2023b).

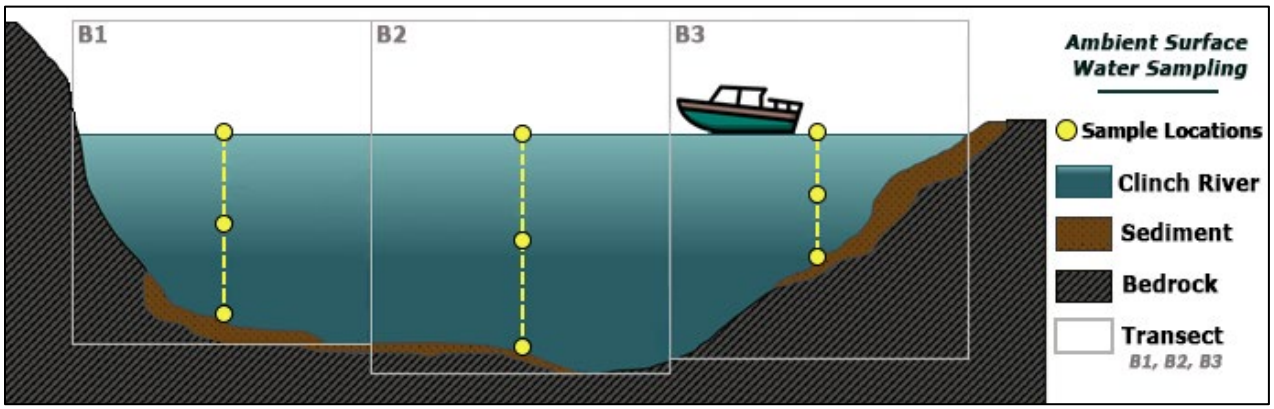

Figure 7.2.6.1: Conceptual CR Model: Cross-sectional Transect Sampling Illustration

Samples will be sent off to appropriate laboratories for analytical analysis. In addition, field parameters will be measured at each depth interval using an appropriate water quality meter and will be recorded at the time of sampling (Table 7.2.6.1).

Table 7.2.6.1: Proposed Field and Analytical Methods

Field Parameters		
Analyte	**Method**	**Description**
Conductivity	Field Measurement	YSI ProDSS or similar
Dissolved Oxygen	Field Measurement	YSI ProDSS or similar
Oxidation-reduction potential	Field Measurement	YSI ProDSS or similar
pH	Field Measurement	YSI ProDSS or similar
Temperature	Field Measurement	YSI ProDSS or similar
Turbidity	Field Measurement	YSI ProDSS or similar
Metals		
Analyte	**Method**	**Description**
Mercury, Low Level	EPA 1631	Mercury in Water CVAF Spectrometry
Methylmercury	EPA 1630	Methylmercury in Water CVAF Spectrometry
Radionuclides		
Analyte	**Method**	**Description**
Gross Alpha/Beta	EPA 900.0	Gas Proportional Counting
Gamma	EPA 901.1	HPGe Gamma Spectroscopy
Strontium-90	EPA 905	Gas Proportional Counting
Tritium	EPA 906.0	Beta Liquid Scintillation

DATA ANALYSIS

Following sample collection and laboratory analysis, data will be analyzed to better understand the results. These analyses may include, but are not limited to the following:

- Compare results with any available DOE data from co-sampling or with historical TDEC DoR-OR datasets.

- Statistical analysis using applicable methods such as analysis of variance (ANOVA) or the Kruskal-Wallis test to better understand if project results are statistically significantly different from available data sets.

- Use of basic descriptive statistics (e.g. mean, median, minimum, maximum, etc.) to evaluate data across different flow zones as well as collectively for each transect.

- Data comparison to TDEC AWQCs as listed in TN 0400-40-03(4)(j) for protection of recreation and TN 0400-40-03 (3)(g) for protection of fish and aquatic life to determine if there is a potential impact to human health and the environment (TDEC, 2019).

- Data comparison to EPA drinking water MCLs where appropriate to help identify any presence of elevated radionuclide concentrations (EPA, 2024).

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7.3 White Oak Creek Radionuclides Sampling Project

7.3.1 Background

The *Ambient Surface Water Sampling Project (ASWSP)* has been implemented each year since 1993 to help monitor potential ORR stream contamination. The project originally began with the investigation of water quality along the Clinch River (CR) at locations near the ORR. The sampling locations have been modified as needed throughout the years, sometimes adding,

and sometimes discontinuing sampling at specific locations.

One ORR stream, White Oak Creek (WOC), was previously monitored under the *ASWSP* through 2019. Beginning in 2020, DoR-OR separated this project from *ASWSP* to focus solely on WOC's surface water monitoring. The focus on WOC, along with the subsequent expansion of monitoring sites, has been largely due to specific concerns regarding the elevated concentrations of the radionuclide strontium-90 (Sr-90) in the stream. The WOC Sediment Retention Structure (SRS) was built as one of the first remedial actions implemented on the ORR. This barrier was meant to prevent sediments contaminated with Sr-90 from entering the Clinch River, however Sr-90 continues to be measured in water at the CR-WOC confluence (i.e. CRK 33.5), immediately downstream of the WOC Embayment (WOE) SRS (Figure 7.3.3.1). This area is publicly accessible and, therefore, Sr-90 remains a contaminant of concern (COC).

WOC has historically, and is currently, being subjected to contaminant releases from activities at ORNL. Monitoring WOC will help provide a better understanding of surface water contamination and may provide insight into helping protect human health and the environment, especially with respect to an important resource, the CR. These independent monitoring data results will also be available to supplement DOE's ongoing investigations, especially as DOE works towards final RODs for Melton Valley and Bethel Valley.

7.3.2 Problem Statements

It is estimated, based on the 2020 U.S. census data, that nearly 1.1 million people live in the counties surrounding the ORR (DOE, 2020). A large portion of these people have the potential of being affected by streams that flow through the ORR and eventually empty into the Clinch River, which is an important drinking water source for the surrounding communities. Furthermore, the DoR-OR *Roving Creel Survey Project* (Section 3.2) has determined that the Clinch River near the CR-WOC confluence is used for recreational fishing. As such, monitoring of WOC is important to better understand the ORR's impact on this widely used resource.

Legacy contaminant migration along with continued industrial releases from the ORR into WOC can be detrimental to the environment and to human health. Identified concerns for WOC include, but are not limited to the following:

- ORNL has been releasing low-level radioactive liquid wastes to the Clinch River via White Oak Creek since 1943. (Pickering, 1970).
- The Clinch River received approximately 665 curies of Cs-137 from WOC between 1954 and 1959. (DOE, 1992). Based on data collected from this project, Cs-137 migration into the CR from WOC is ongoing.
- Groundwater containing elevated levels of strontium-90 is collected by DOE from the solid waste storge areas in Melton Valley and transferred to the Process Waste Treatment

Complex (PWTC) in Bethel Valley for treatment. The PWTC does not entirely remove strontium-90 from the waste stream and ultimately discharges treated wastewater containing elevated levels of strontium-90 into White Oak Creek at Outfall X12 (Figure 7.3.3.1) (DOE, 2022c).

- Historic and ongoing discharges of Sr-90 and Cs-137 into White Oak Creek is impacting surface water quality. Known sources include, but are not limited to, impacted floodplain soils from the former Surface Impoundment Operable Unit area (Figure 7.3.3.1), baseflow groundwater seepage into White Oak Creek (DOE, 2022), and baseflow seepage into Melton Branch (DOE, 1994a; DOE, 1994b).

- Recent (FY24) anomalous conductivity readings have been observed in Melton Branch, specifically at MEK 0.3. The increased readings appear to be associated with decreased concentrations of Sr-90. As this area of Melton Branch has had documented seepage and underflow into the creek, this area is identified as an area needing further evaluation.

7.3.3 Related DOE Projects

DOE has implemented a surface water monitoring program for several years that consists of monitoring surface water at a few locations along the Clinch River (DOE, 2022a). The purpose of DOE's surface water monitoring project is to assess impacts of site operations, both past and present, on surface water bodies. Other DOE projects specific to WOC include the following:

1) Sampling WOC at the 7500 Bridge (Bethel Valley Watershed Integration Point) as part of the *Record of Decision (ROD) for Interim Actions in Bethel Valley Watershed, Oak Ridge, Tennessee*, DOE/OR/01-1862&D4. (DOE, 2020).

2) Investigating source(s) of ungauged Sr-90 contributions to WOC (flow/flux study) to evaluate potential remedial actions to offset ungauged Sr-90 discharges (DOE, 2022b).

3) Investigating source(s) of ungauged Sr-90 and other radionuclide contributions to Melton Branch (flow/flux study) and to evaluate proposed removal actions to address ungauged Sr-90 discharges to Melton Branch from SWSA 5 (DOE, 1994a; DOE, 1994b).

4) Evaluating potential Sr-90 surface water impacts to Fifth Creek if the sump pump at Building 3042 is turned off. Sampling along Fifth Creek (5TH CR) and First Creek (FFK 0.2) has been conducted since at least 1987, with semi-annual sampling currently being conducted (DOE, 2022c).

While the current DOE projects only sample surface water in the CR and one location along WOC, this DoR-OR Project will complement DOE's sampling by monitoring specific points along

WOC and its tributaries. The intent is to provide a more representative evaluation of the contaminants entering WOC, and ultimately the CR.

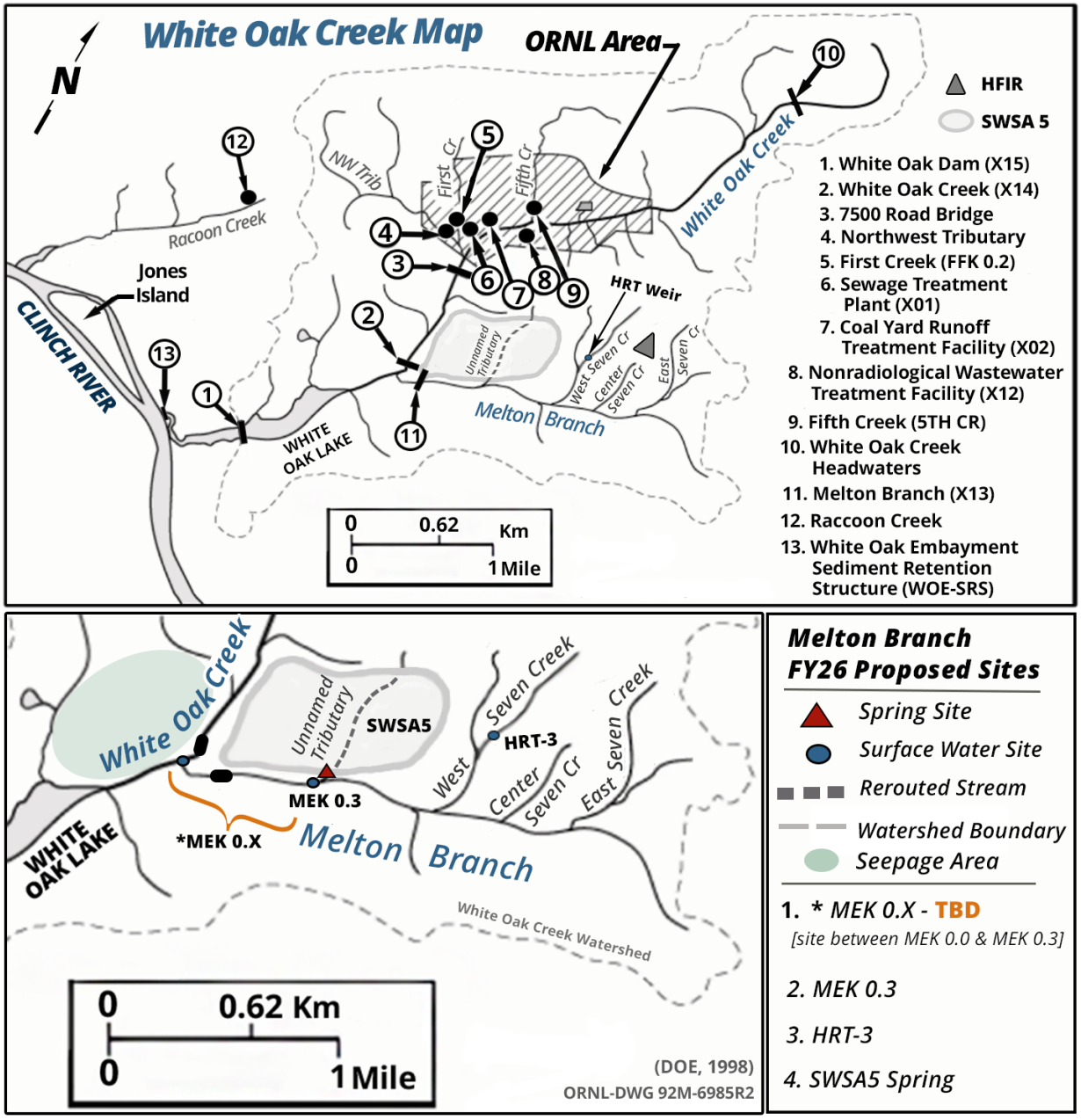

Figure 7.3.3.1: DOE ORNL Facilities at White Oak Creek

7.3.4 Goals

The overall goal of the *White Oak Creek Radionuclides Monitoring Project* is to evaluate the impacts of DOE ORR contamination to WOC, its tributaries, and the CR at the WOC confluence. This goal is accomplished by the continued monitoring of surface water through sampling and collection of field parameters. In FY26, one new goal will be to evaluate anomalous conductivity and Sr-90 concentrations in a section of Melton Branch upstream and downstream of sample

location MEK 0.3. As part of this goal, a temporary sample location on the Melton Branch downstream of MEK 0.3 will be established and sampled. The second additional goal will be the calculation of mass flux of radionuclides (specifically Sr-90 and Cs-137) at the CR-WOC confluence.

7.3.5 SCOPE

Sampling events will include collecting: (1) surface water samples quarterly and (2) water parameter measurements monthly at nine (9) monitoring locations. During the quarterly sampling events, both water samples and parameter measurements will be taken in tandem, along with the collection of QA/QC samples (one duplicate sample each quarter). The surface water collection sites include four WOC monitoring locations (WCK 6.8, WCK 3.9, WCK 3.4, WCK 2.3), one Clinch River (CR) monitoring location (CRK 33.5) at the confluence (WOC-CR) (Figure 7.3.5.1), and the remaining four monitoring locations (FFK 0.2, HRT-3, MEK 0.3, MEK 0.X) are on tributaries of WOC (Figure 7.3.5.1).

The proposed parameter evaluation along Melton Branch will focus on the stream reach immediately upstream and downstream of MEK 0.3. The proposed reach runs from the confluence of the Melton Branch with West Seven Creek (MEB-WSC), upon which HRT-3 (HRT Weir) is located, and downstream to the confluence of Melton Branch with WOC (WOC-MEB). As part of this evaluation, a temporary surface water sample location, designated here as MEK 0.X, will be established and sampled for the same parameters and analytes as the other surface water samples. The actual stream designation will be based on the standard naming method (i.e. the distance in kilometers from the confluence of the Melton Branch with WOC). The approximate area of the evaluation and the proposed location of the additional sample is shown on Figure 7.3.5.2. Ten (10) sites will be sampled across two sampling events for this focused monitoring effort on Melton Branch.

The final proposed task is to estimate radionuclide flux into the CR. DOE flow data from WC7500 and WCWeir along with radionuclide concentrations will be used to calculate radionuclide (specifically Sr-90 and Cs-137) mass flux at the WOE-SRS (CRK 33.5) location. Flow data will be downloaded from the DOE OREIS database and used for this task.

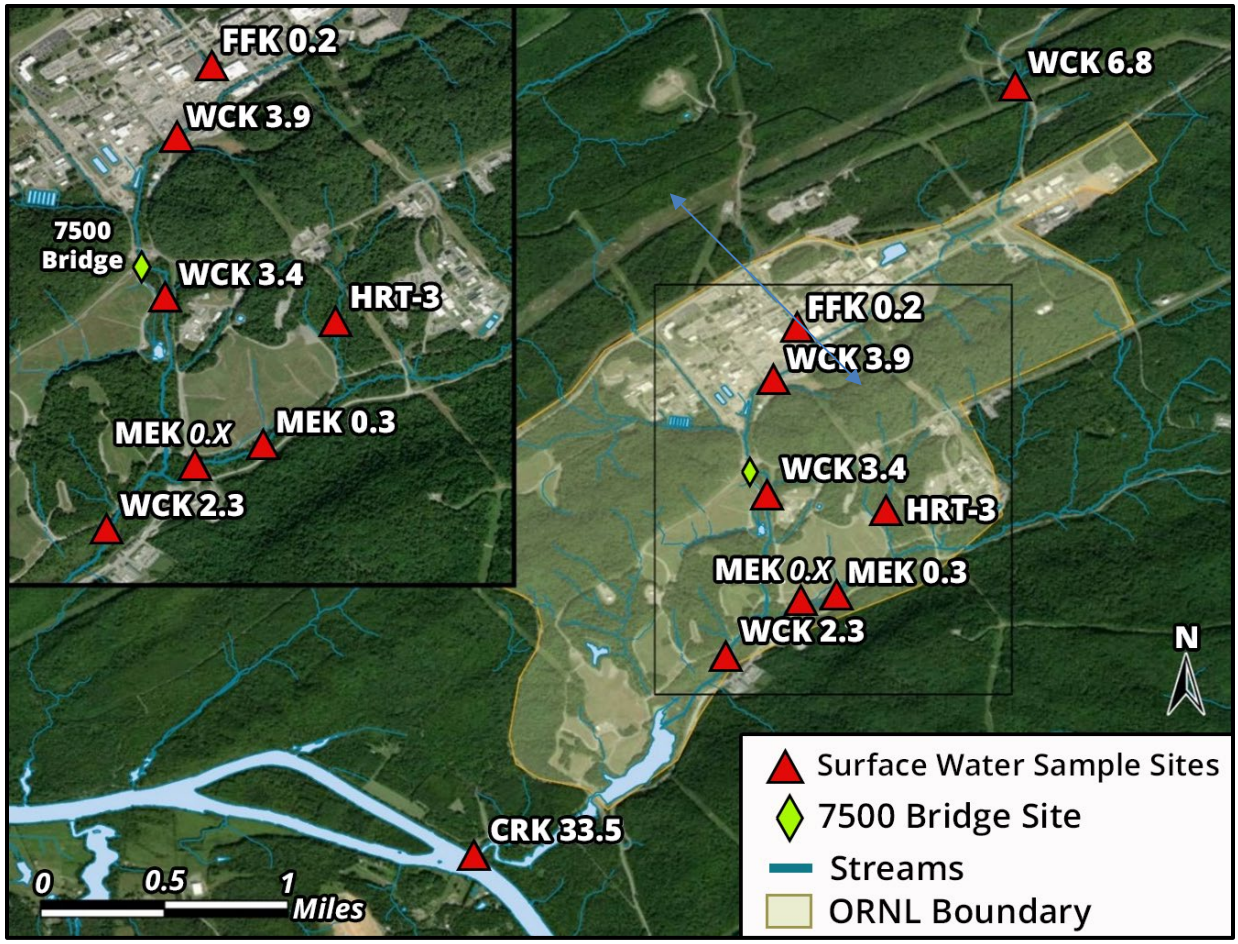

Figure 7.3.5.1: FY26 DoR-OR White Oak Creek Surface Water Sampling Locations

7.3.6 Methods, Materials, Metrics

Surface Water Analytical & Parameter Monitoring

1) Surface Water Sampling

This project includes collecting surface water samples at the nine (9) monitoring sites mentioned above (Figure 7.3.5.1). Surface water samples will be collected quarterly (Table 7.3.6.1) and in accordance with TDEC DoR-OR T-704 *Standard Operating Procedure for Collection of Surface Water Samples* (TDEC, 2023).

Table 7.3.6.1: Surface Water Sampling Plan

Station Name	Stream Name	*Analytical Parameters*[1]	
		Sr-89/90	***Gamma***
WCK 6.8	White Oak Creek	4	4
WCK 3.9	White Oak Creek	4	4
WCK 3.4	White Oak Creek	4	4
WCK 2.3	White Oak Creek	4	4
CRK 33.5	Clinch River	4	4
FFK 0.2	Fifth Creek	4	4
HRT-3	West Seven Creek	4	4
MEK 0.3	Melton Branch	4	4
MEK 0.X[2]	Melton Branch	4	4
Total Primary Samples		36	36
Total Contingency Samples		2	2
Field Duplicate		4	4
Total Samples (FY26)		**42**	**42**

Notes:
All water samples will be collected quarterly.
[1] – The list of analytes and their analytical methods are defined in Table 7.3.6.2.
[2]– This sample location name will be determined based on field conditions. Location not yet established.

Samples will be submitted for analysis of strontium-90, and gamma radionuclides using the analytical methods specified in Table 7.3.6.2 (or equivalent analytical methods). At each site, water quality parameters will be measured in the field at the time of sampling (*see Section 2*). Quality assurance/quality control (QA/QC) samples (field duplicates) will be collected at a frequency of no less than 10%.

2) MONTHLY FIELD PARAMETER COLLECTION

This project also includes monthly measurement of surface water parameter readings at the same nine (9) monitoring sites using a properly calibrated multi-parameter water quality meter. At each site (Figure 7.3.5.1), water quality parameters will include pH, temperature, specific conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity. Monthly field parameter readings will be inclusive of the quarterly sampling events (12 events total).

Table 7.3.6.2: Analytical Laboratory and Field Methods

Parameter Type	***Analytes***	***Analytical Method or Equivalent***
Radionuclides	**strontium-89/90**	EPA Method 905.0
	gamma radionuclides	EPA Method 901.1
Field Water Quality Parameters	pH	YSI DSS Meter Monthly field measurements (inclusive of each sample event) Melton Branch Parameter Evaluation
	temperature (°C)	
	specific conductivity (µS/cm)	
	dissolved oxygen (mg/L)	
	oxidation-reduction potential (mV)	
	Turbidity (NTU)	

Notes: ***Bolded*** *values have a numerical standard.* *mg/L – milligram per liter* *NA – not applicable*
°C – degrees *NTU – nephelometric turbidity unit Celsius* *µS/cm – microSiemens per centimeter* *mV – millivolt*

3) MELTON BRANCH SURFACE WATER PARAMETER EVALUATION

Surface water parameters will be measured and recorded from the WOC-MEB confluence upstream to the MEB-WSC confluence. recorded upstream and downstream of surface water sample location MEK-0.3. The proposed extent is upstream to the confluence of the Melton Branch with the unnamed tributary upon which HRT-3 is located, and downstream to the confluence of Melton Branch with WOC. Approximately ten (10) temporary surface water parameter locations will be established along this reach. At the junction of MEB and WSC, a parameter collection location will be established just upstream of this confluence on each stream. The other eight (8) locations will be approximately evenly spaced along the remainder of the proposed section. The number of locations may vary based on field conditions. Each location will be marked with flagging material and the GPS coordinates will be recorded. Parameter readings will include those listed in Table 7.3.6.2. Parameter readings in this area will be taken only during the March and September sampling events. The approximate location of the evaluation area is shown on Figure 7.3.5.1.

4) MELTON BRANCH ADDITIONAL SAMPLE LOCATION

As part of the Melton Branch parameter evaluation, an additional sample location will be established on Melton Branch downstream from location MEK 0.3. The approximate location is shown on Figure 7.3.6.1 as *MEK 0.X*. Surface water samples will be collected from this location on a quarterly basis and parameter readings will take place monthly. During FY26, two (2) additional surface water samples may be collected from Melton Branch on a contingency basis. The contingency samples may be collected at any location along Melton Branch based on field observations or data gaps.

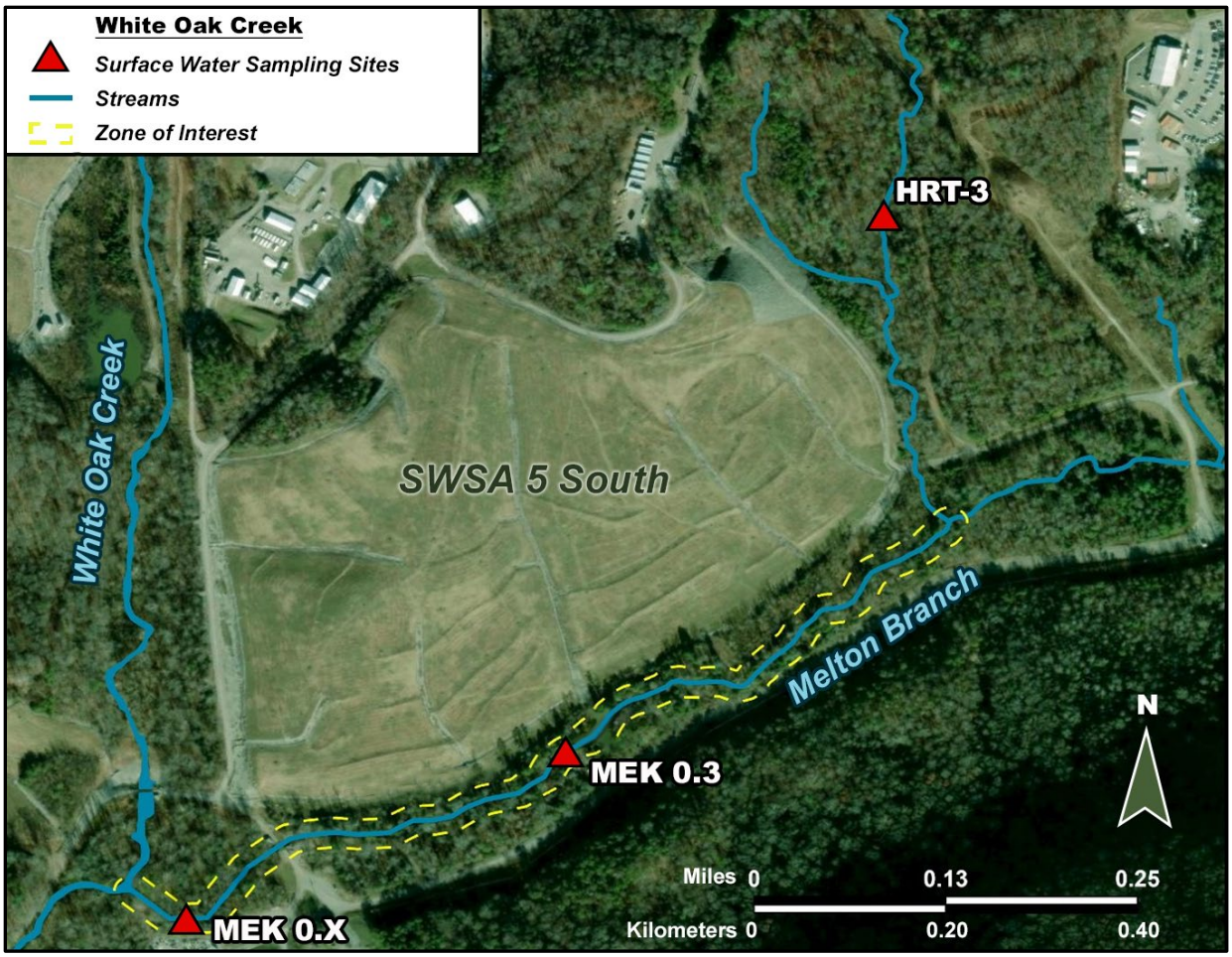

Figure 7.3.6.1: Proposed Parameter Evaluation Area & Additional Melton Branch Site

~~5)~~ *Analytical and Parameter Data Evaluation*

The resulting analytical data will be evaluated and compared against numerical standards set forth by the EPA's *National Priority Drinking Water Regulations* (EPA, 2024). EPA has established a maximum contaminant level (MCL) of 4 millirems per year for beta particle and photon radioactivity from manmade radionuclides in drinking water. For strontium-90, a derived concentration of 8 picocuries per liter (pCi/L) is assumed to yield 4 millirems per year. If other radionuclides that emit beta particles and photon radioactivity are present, the resulting concentration will be compared to the corresponding derived concentrations of the detected radionuclide. All field and analytical data will be uploaded into the DoR-OR TOREIS database. The results of the surface water sampling will be incorporated into the TDEC's FY26 *Environmental Monitoring Report* (EMR).

RADIONUCLIDES MASS FLUX CALCULATION

DOE flow data from WC7500 and WCWeir along with radionuclide concentrations will be used to calculate radionuclide (specifically Sr-90 and Cs-137) mass flux at the SRS (CRK 33.5) location. Flow data will be downloaded from the DOE OREIS database and used for this task. It should be noted that data from these two locations could possibly be delayed by up to a year. In the interim, the mass flux calculations will be made by utilizing historic flow data available and will be estimated for the current project year.

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7.4 CERCLA Stormwater Monitoring and BMP Evaluation

7.4.1 Background

ORR stormwater runoff has the potential to transport various contaminants, including sediments, nutrients, organic and inorganic chemicals, metals, and bacteria, into waterways. This unmitigated runoff causes water quality issues and environmental degradation (Marsalek, 2002). Elimination, or at least reduction, of these negative impacts on surface water and groundwater requires sufficient best management practices (BMPs). BMPs should be implemented prior to and throughout building demolition and all related remediation activities on the ORR.

During FY26, the project team will perform sampling to evaluate DOE's adherence to CERCLA regulations, requirements, and associated SOPs. DoR-OR will conduct stormwater investigations which will include, (1) the quantification of the water quality of stormwater runoff, (2) the identification of potential pollution sources, and (3) the evaluation of the effectiveness of relevant BMPs.

The stormwater monitoring sites will include D&D sites at the ORNL and Y-12 campuses. Sampling events are planned during three (3) stages of demolition, which are the pre-demolition, demolition, and post-demolition periods. During FY26, the stormwater assessment

will be performed at five D&D sites: (1) ORNL Building (Bldg.) 3003, (2) ORNL Isotope Row Facilities, (3) ORNL Bldg. 3544, (4) Y-12 Alpha-2 and (5) Y-12 Beta-1.

In addition to D&D impacts, construction activities introduce sediments, debris, and other chemicals by disturbing the land. These potential freed contaminants are either transported by stormwater directly into nearby surface water. In FY26, turbidity levels, along with other water quality parameters, were monitored in Bear Creek which receives stormwater from the Environmental Management Disposal Facility (EMDF) construction site.

ORR STORMWATER INVESTIGATION:

FIVE D&D SAMPLING SITES AND ONE CONSTRUCTION SITE

1) Bldg. 3003

Location: Bldg. 3003 is located at the north side of ORNL (Figure 7.4.1.1). Bldg. 3003 is part of the OGR (Oak Ridge Graphite Reactor) Support Facilities. The nearest surface water conveyance is Fifth Creek, which is located approximately 500 ft. east of Bldg. 3003. Fifth Creek flows southward and eventually discharges to White Oak Creek (WOC).

Figure 7.4.1.1: ORNL Bldg. 3003

Purpose: Bldg. 3003 was constructed in 1943 as the Fan House for the Graphite Reactor (Bldg. 3001). Cooled air from the graphite reactor was filtered and drawn through underground ducts into 3003 and then released through the graphite reactor stack (DOE, 2022).

Demolition: June 2025.

COCs: The potential COCs for this site include radionuclides (U-isotopes, gross alpha/beta, gamma), metals (beryllium, lead, cadmium, copper, zinc, low-level mercury), suspended solids, and polychlorinated biphenyls (PCBs).

2) Isotope Row Facilities

Location: The Isotope Row Facilities include ten buildings: 3029, 3030, 3031, 3032, 3033, 3033A, 3034, 3036, 3093, and 3118 (Figure 7.4.1.2). The facilities have a combined total floor area of 10,388 square feet and are single story buildings. Fifth Creek is about 50ft east of the facilities (DOE, 2022b).

Figure 7.4.1.2: ORNL Isotope Row Facilities

Purpose: The Isotope Row Facilities were constructed for isotope production and distribution in late 1940s and early 1950s. Table 7.4.1.1 summarizes building numbers, descriptions, dates of operation, and size (DOE, 2022b).

Table 7.4.1.1 Isotope Row Facilities Units Description

Building Number	Building Description	Dates of Operation	Size (ft^2)
3029	*Source Development Laboratory*	1952-1980s	3200
3030, 3031, 3032, 3118	*Radioisotope Production Laboratory*	1950-1980s	830
3033	*Radioactive Gas Processing Facility*	1940s-1990	830
3033A	*Radioactive Production Laboratory Annex*	1960-1990	900
3034	*Radioisotope Services Building*	1950-1980s	1130
3036	*Isotope Area Storage and Services Building*	1950-2011	1430
3093	*Krypton Storage Cubicle*	1950-1990	190
3118	*Radioisotope Production Laboratory*	1960s-1980s	890

Demolition: Winter 2025.

COCs: The potential COCs for the Isotope Row Facilities include radionuclides (alpha/beta, U-isotope, gamma, transuranics, Sr-90, tritium, carbon-14), metals (antimony, arsenic. barium, beryllium, cadmium, chromium, lead, mercury, nickel, potassium, selenium, silver, sodium, thallium, uranium, zinc), suspended solids, and PCBs (DOE, 2022b).

3) Bldg. 3544

Location: Bldg. 3544 is the Process Waste Treatment Plant. It is located on the south side of ORNL and is adjacent to WOC (Figure 7.4.1.3).

Figure 7.4.1.3: ORNL Building 3544

Purpose: Bldg. 3544 is composed of an Office and Control Room (contains an instrument panel), Chemical Make-up Area (chemical storage and laboratory facility where titrations were performed), and shielded area (contains ion-exchange equipment and concentrated waste tank).

Demolition: Starting in December 2025.

COCs: The potential COCs at this site include rad (alpha/beta, U-isotopes, gamma, transuranics, Sr-90, tritium, carbon-14), metals (antimony, arsenic. barium, beryllium, cadmium, chromium, lead, mercury, nickel, potassium, selenium, silver, sodium, thallium, uranium, zinc), suspended solids, and PCBs (DOE, 2024).

4) Alpha-2 (9201-2)

Location: The Alpha-2 complex is a three-story building located north of Upper East Fork Poplar Creek (Figure 7.4.1.4).

Purpose: Alpha-2 was initially used for uranium separation, lithium production, and then used for groundwater treatment in the mid-1990s.

Demolition: The demolition of Alpha-2 has been ongoing since November 2024. In FY26, stormwater collection will be conducted during the demolition period.

Figure 7.4.1.4: Alpha-2 (9201-2) at Y-12

COCs: Initial DOE stormwater monitoring at this site indicated potential environmental concerns related to contaminants such as copper, mercury, lead, thallium, zinc, suspended solids, and PCBs (DOE, 2023a).

5) Beta-1 (9204-1)

Location: Beta-1 facility is located in the central portion of Y-12. Beta-1 is a multiple-level brick building with approximately 210,491 sq ft surface area of floor. The nearest surface water conveyance is Upper East Fork Poplar Creek (UEFPC), located at the south of the Beta-1 building (Figure 7.4.1.5).

Purpose: Beta-1 was constructed in 1944 and was originally used for electromagnetic separation of uranium. Beta-1 was formally placed in shutdown in 2011.

Demolition: Starting in January 2027.

COCs: Beta-1 contained asbestos containing material, hazardous and universal wastes, loose

legacy waste, and combustibles. The COCs for the Beta-1 based on process knowledge include rad (alpha, beta, U-isotopes), metals (mercury, copper, lead, iron, chromium, aluminum), suspended solids, and PCBs (DOE, 2023b).

Figure 7.4.1.5: Beta-1 (9204-1) at Y-12

EMDF LANDFILL CONSTRUCTION*:*

6) EMDF

Stormwater may carry construction debris and sediments from the EMDF site and discharge into the nearby streams.

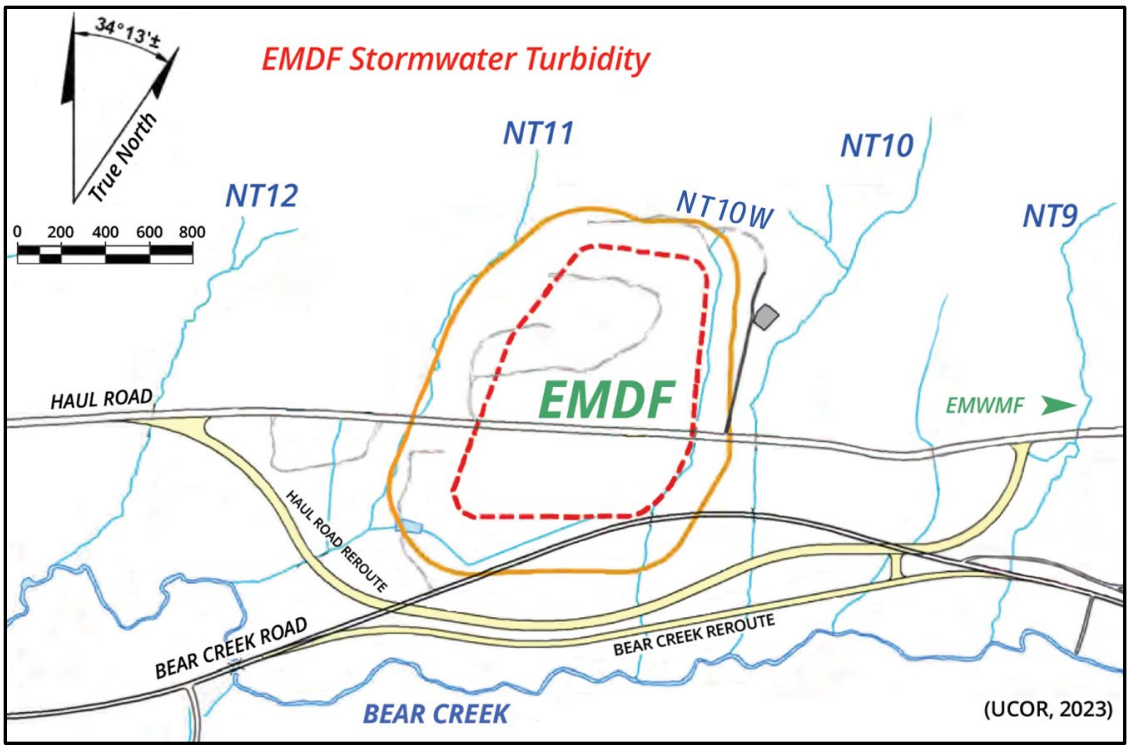

Figure 7.4.1.6: EMDF and Surrounding Streams

In FY26, the turbidity survey in Bear Creek near EMDF will be continued. Turbidity is used as an indicator of water quality changes from both physical and chemical constituents.

7.4.2 Problem Statements

For D&D activities, Alpha-2 and Beta-1 are adjacent to EFPC, while Isotope Row Facilities and Bldg. 3544 are closer to Fifth Creek and WOC, respectively. Given the historical use of these facilities, the debris and waste generated by D&D activities may contain radioactive and hazardous materials. These contaminants could be carried by stormwater into the surrounding environment and water resources, posing environmental risks and health concerns.

For EMDF, water turbidity and any contaminants released or mobilized by construction activities could negatively impact water quality in Bear Creek.

7.4.3. Related DOE Projects

At Y-12, DOE operates under a *National Pollutant Discharge Elimination System* (NPDES) permit. This permit emphasizes stormwater management controls that should be implemented to eliminate, or at least reduce, the discharge of pollutants. These requirements are reflected in the Y-12 *Stormwater Pollution Prevention Plan* (SWPPP). DOE is required to perform the following tasks:

1) Characterization of stormwater by sampling during storm events.
2) Implementation of measures to reduce stormwater pollution.

3) Execution of facility inspections.
4) Employee training.

With regards to ORNL, the NPDES permit also requires DOE to operate under a *Water Quality Protection Plan* (WQPP), which, related to this work, includes a SWPPP and the NPDES radiological monitoring plan (DOE, 2023c). DOE conducts internal evaluations of compliance with the NPDES permit. The evaluation includes environmental monitoring procedural compliance, work planning, and controls. Compliance results will be discussed in the DOE *Annual Site Environmental Reports* (ASERs).

For D&D activities, DOE establishes environmental monitoring plans for each facility. To supplement DOE's environmental monitoring at these D&D and construction sites, stormwater monitoring conducted by TDEC DoR-OR in FY 26 will sample a wider range of COCs, providing a broader assessment of stormwater quality at each site. Additionally, DoR-OR's sampling sites remain consistent throughout the pre-demolition, demolition and post-demolition periods, ensuring more continuous and reliable monitoring.

7.4.4 GOALS

This project has the following main objectives:

- Conduct stormwater assessments at various D&D and construction project locations across the reservation.

- Review DOE or Contractor stormwater sampling plans associated with D&D and construction activities.

- Create assessment documents/checklists for evaluation of compliance with documented or proposed BMPs.

- Conduct site visits to observe and assess field activities for consistency with DOE's sampling plans and BMPs.

- Review DOE sampling results to evaluate compliance with negotiated and agreed-to release criteria.

- Co-sample and compare against DOE's sampling results at selected locations.

7.4.5 Scope

The scope of this project is to conduct supplemental sampling at five ORR D&D sites (Figure 7.4.5.1 and 7.4.5.2). Additionally, turbidity and water quality data will be measured at one ORR landfill construction site, EMDF.

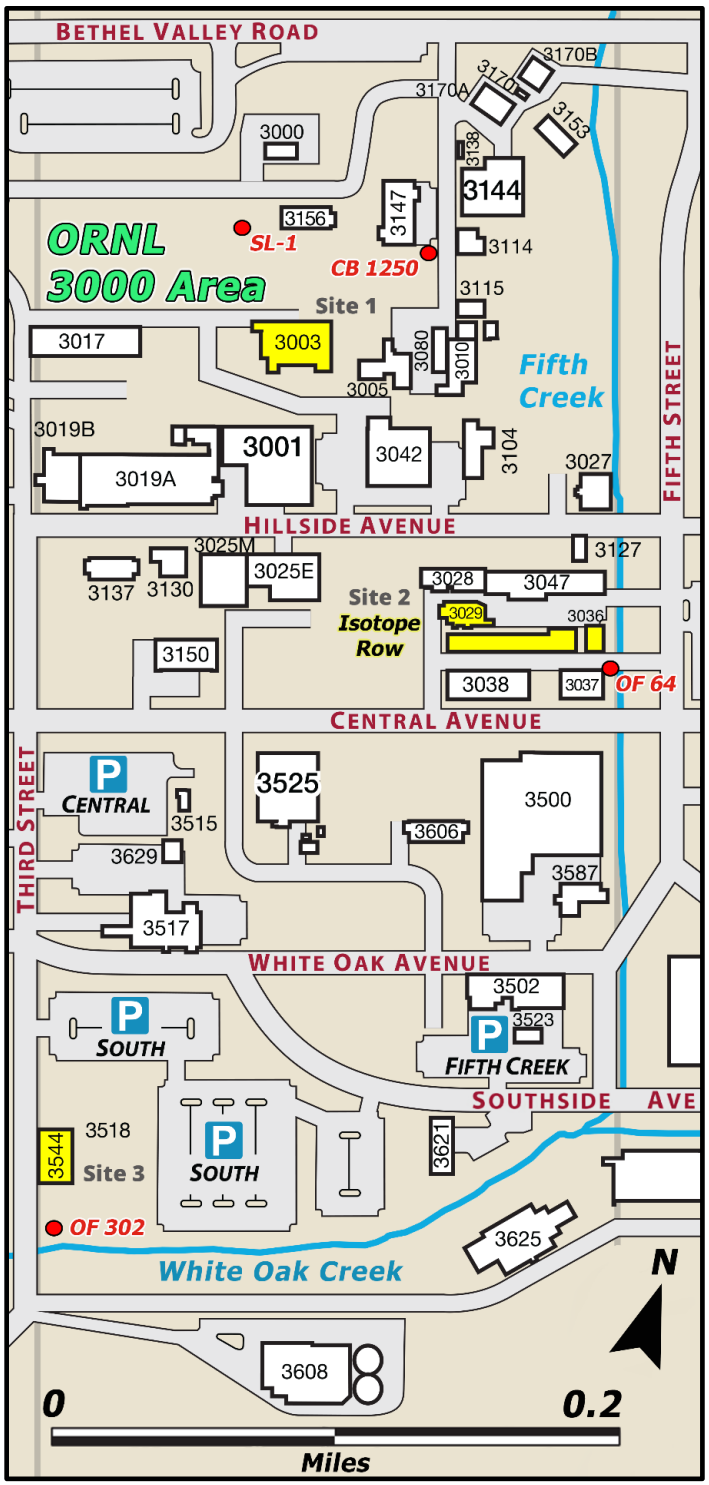

Figure 7.4.5.1: ORNL Stormwater Sample Sites (DOE, 2025)

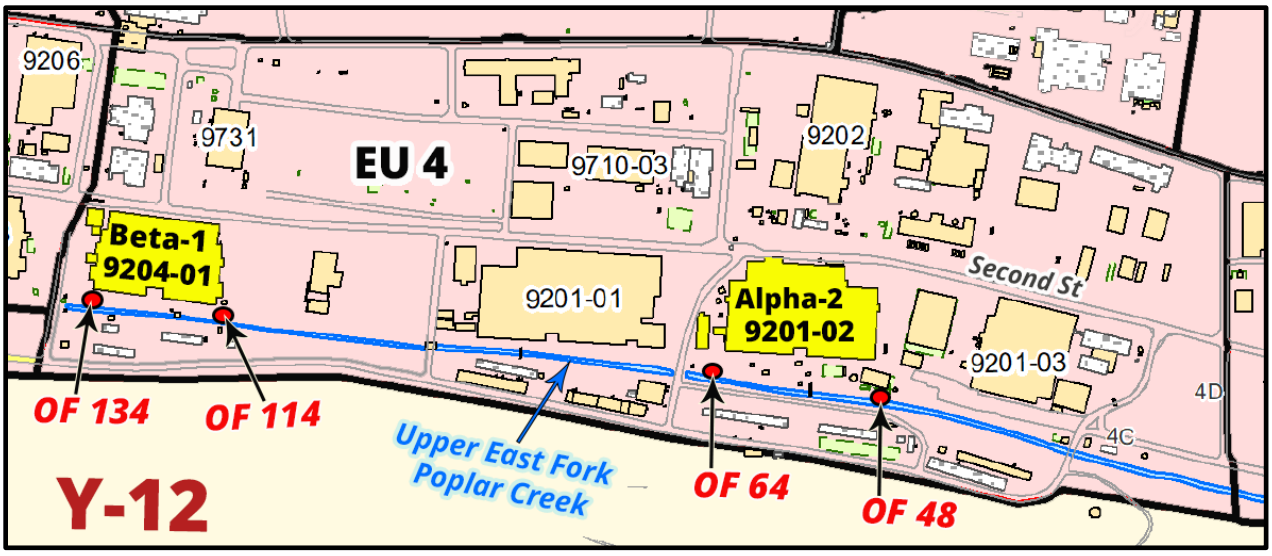

Figure 7.4.5.2: Y-12 Sites: Alpha-2 and Beta-1 Complexes

The independent data analysis at D&D sites will be used to evaluate the COC concentrations in stormwater runoff, which discharges to nearby surface water. Data will be collected and compared across three phases: pre-demolition, demolition, and post-demolition periods.

For the EMDF site, the turbidity and water quality parameter data will be measured from NT-9 to NT-12 along Bear Creek after each qualified storm, as defined in Section 7.4.6.

Specific sampling locations (red dots) for each site are listed in the figures below (Figures 7.4.5.3, 7.4.5.4, 7.4.5.5, 7.4.5.6, 7.4.5.7, and 7.4.5.8).

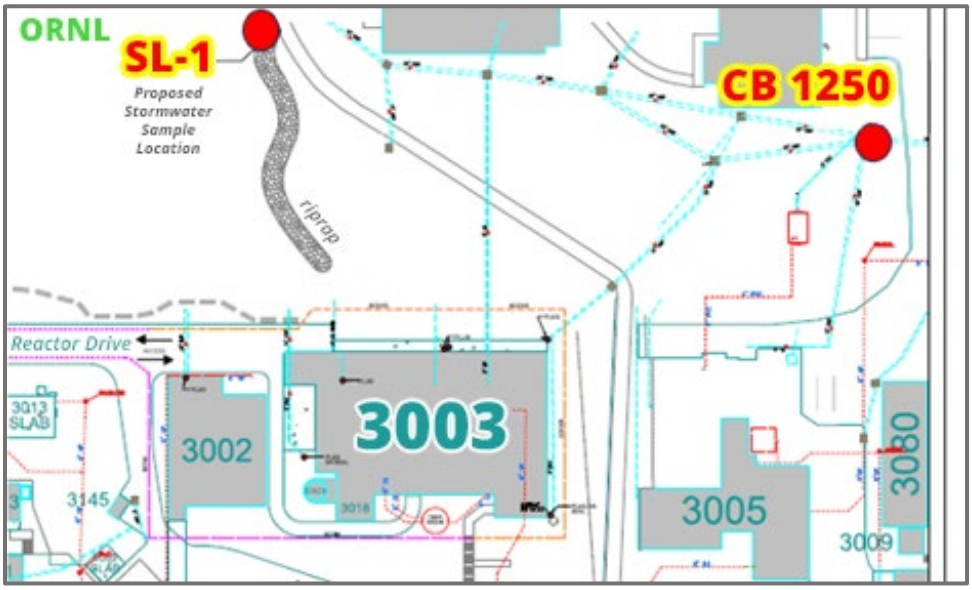

Figure 7.4.5.3: Bldg.3003 Proposed Sampling Sites

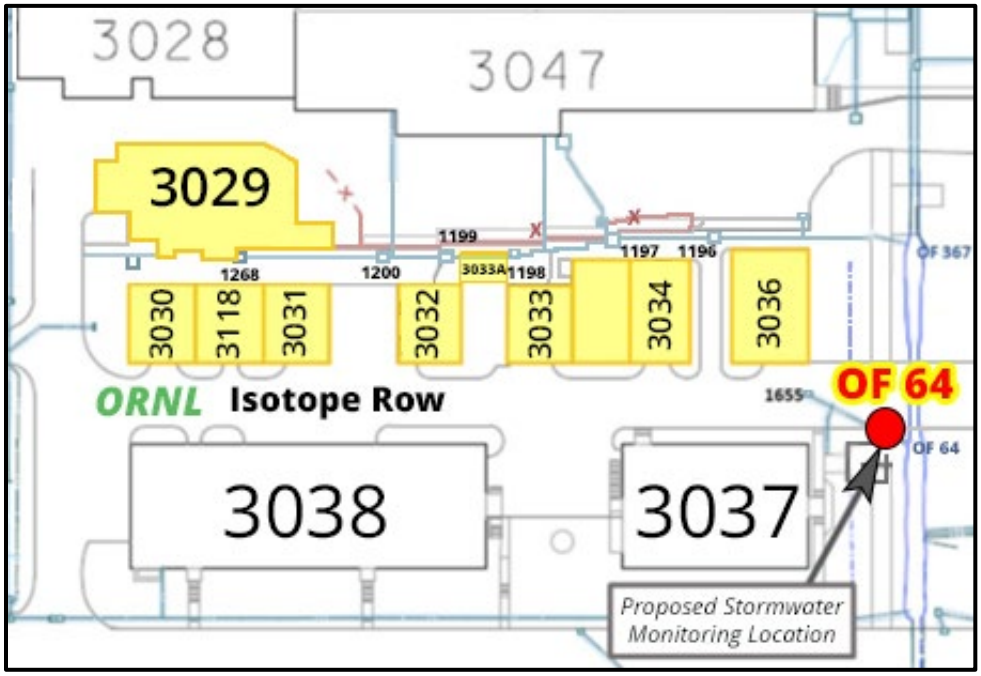

Figure 7.4.5.4: Isotope Row Facilities Sampling Sites

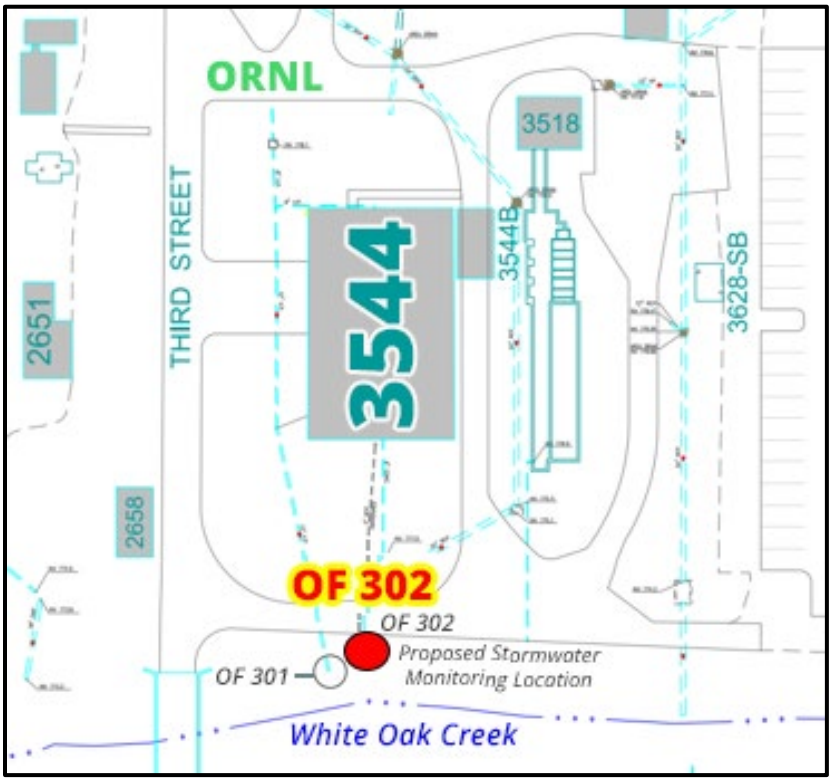

Figure 7.4.5.5: Bldg. 3544 Sampling Site

Figure 7.4.5.6: Sampling Sites of Alpha-2

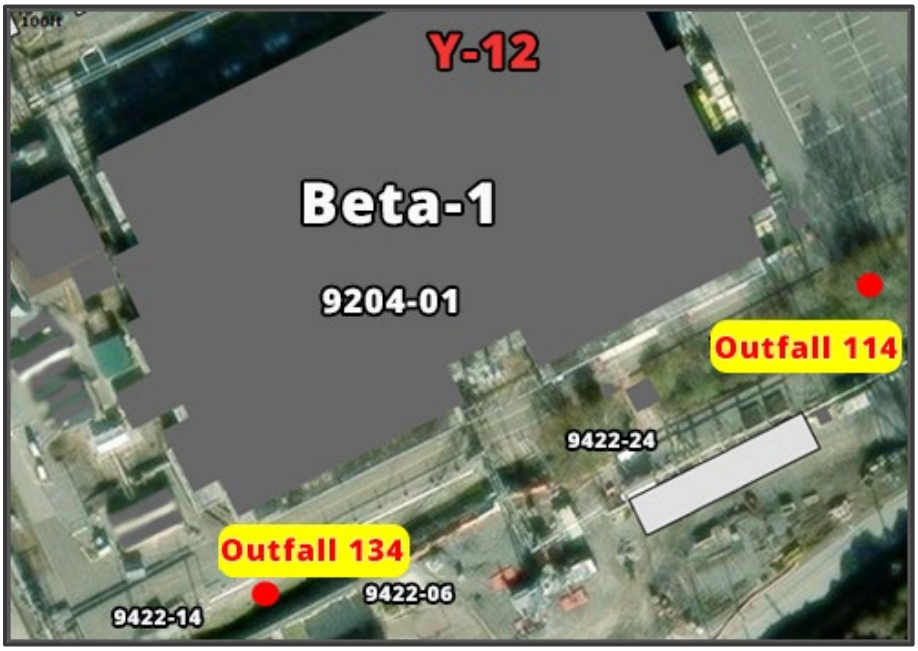

Figure 7.4.5.7: Sampling Sites of Beta-1

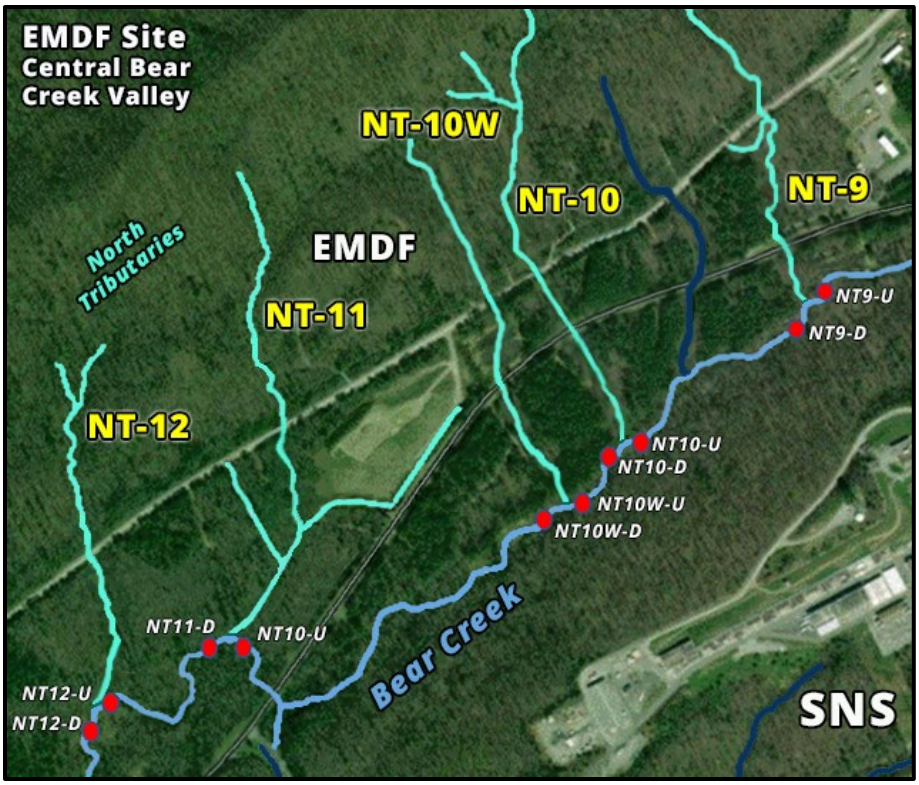

Figure 7.4.5.8: EMDF – Bear Creek Turbidity and Parameters

7.4.6 Methods, Materials, Metrics

CERCLA Sites Stormwater Investigation:

Sampling protocols, site selection, sampling intervals, and sample sizes will follow the *DoR-OR T-710 SOP Stormwater Sampling* and *UCOR Pre-Demolition and Demolition Activities Program Stormwater Management Plan (UCOR, 2022)*. QA/QC measures, safety protocols, and data analyses will follow the procedures outlined in the site-specific monitoring reports (DOE, 2023d; (TDEC, 2022).

The analytes, analytical methods, and field measurements are listed in Table 7.4.6.1. The stormwater sampling plans for ORNL and Y-12 D&D locations are listed in Tables 7.4.6.2 and 7.4.6.3, respectively. Water quality measurements will be collected following the *DoR-OR T-703 SOP Field Use for Water Quality Parameters Instrument* (TDEC, 2023b) and *DoR-OR T-153 SOP Water Quality Field Instrument Calibration and Maintenance* (TDEC, 2023c). Stormwater and surface water samples will be collected following the *DoR-OR T-704 SOP Collection of Surface Water Samples* (TDEC, 2023d).

Table 7.4.6.1: Analytes and Field Water Quality Parameters

Parameter Type	Analytes	Analytical Method
Radionuclides	Strontium-89/90	EPA Method 905.0
	Gamma radionuclides	EPA Method 901.1
	Isotopic uranium	DOE-HASL-300
	Isotopic plutonium	DOE HASL 300
	Gross alpha/beta	EPA Method 900.0
	Carbon 14	EPA EERF
	Tc-99	EPA Method 906.0
Organics	PCBs	EPA 1668
Metals	Cadmium	EPA-200.8
	Copper	EPA-200.8
	Lead	EPA-200.8
	Low-level Mercury	EPA-1631
	Mercury	SW846-7470, SW846-7471
	Zinc	EPA-200.8
	Beryllium	EPA-200.8
	Chromium	EPA-200.8
	Uranium	EPA-200.8
	Thorium	EPA-200.8
Inorganics	Total Suspended Solids	SM-2540-D
Field Water Quality Parameters	*pH*	*Field measurements*
	Temperature	
	Specific conductivity	
	Dissolved oxygen	
	Oxidation-reduction potential	

Table 7.4.6.2: FY26 ORNL D&D Stormwater Sampling Plan

BLDG.	***FY26*** *Sample Events / Demolition Stage*			***Sample Sites***	***COCs***			
	Pre	*Demo*	*Post*		***RADS***	***Metals***	***Organics***	***Inorganics***
3003		*1*	*1*	*CB 1250 SL 1*	*U-isotopes, Gross Alpha, Gross Beta, Gamma*	*Beryllium, Lead Cadmium, Copper, Zinc, LL Hg*	*PCBs*	*Total Suspended Solids*
Isotope Row Facilities	*1*	*1*		*OF 64*	*U-isotopes, Gross Alpha, Gross Beta, Gamma, Transuranics, Sr-90, Tritium, Carbon-14*	*Antimony, Arsenic., Barium, Beryllium, Cadmium, Chromium, Lead, Mercury, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Uranium, Zinc*		
3544	*1*	*1*		*OF 302*				

Table 7.4.6.3: FY26 Y-12 D&D Stormwater Sampling Plan

Demo Period	***FY26** Sample Events / Demolition Stage*			***Sample Sites***	***COCs***			
	Pre	*Demo*	*Post*		***Metals***	***Rad***	***Organics***	***Inorganics***
Alpha-2		*3*		*Outfall 64 Outfall 48*	*Mercury Lead Copper Thallium Zinc*	*No collection*	*PCBs*	*Total Suspended Solids*
Beta-1	*1*			*Outfall 134 Outfall 114*	*Mercury, Copper, Lead, Iron, Chromium, Aluminum*	*U-isotopes Gross Alpha Gross Beta*		
*Notes: Total number of sampling events for Y-12: **1** pre-demo and **3** demo.*								

EMDF TURBIDITY & PARAMETER MEASUREMENTS

For the EMDF turbidity survey, there are 10 sampling sites along Bear Creek tributaries. This project will compare the turbidity and other stream parameter differences upstream and downstream of each Bear Creek tributary from NT-9 to NT-12 after each qualified rain event. Sampling sites include NT-9-U, NT-9-D, NT-10-U, NT-10-D, NT-10W-U, NT-10W-D, NT-11-U, NT-11-D, NT-12-U, and NT-12-D (Table 7.4.6.4). Measurements will be taken in accordance with the *DoR-OR T-703 SOP Field Use for Water Quality Parameters Instrument* (TDEC, 2023a) and *DoR-OR T-153 SOP Water Quality Field Instrument Calibration and Maintenance* (TDEC, 2023b).

Table 7.4.6.4: FY26 EMDF – CBCV Watershed Parameter Survey Plan

Sample Medium	***Measurement Frequency***	***Measurement Site IDs***	***Parameters***
Surface Water	Each qualifying rain event *(July 2025-June 2026)*	• NT-9-U • NT-9-D • NT-10-U • NT-10-D • NT-10W-U • NT-10W-D • NT-11-U • NT-11-D • NT-12-U • NT-12-D	• DO • Conductivity • pH • ORP • Temperature • Turbidity

7.4.7 REFERENCES

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Laboratory, Oak Ridge, TN. DOE/OR/01-2905&D3

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TDEC. 2023c. *Water Quality Field Instrument Calibration and Maintenance.* DoR-OR-T-153, State of Tennessee Department of Environment and Conservation, Division of Remediation, Oak Ridge Office

TDEC. 2023d. *Collection of Surface Water Samples*. DoR-OR-T-704, State of Tennessee Department of Environment and Conservation, Division of Remediation, Oak Ridge Office.

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8.0 SEDIMENT SAMPLING

8.1 SUSPENDED SEDIMENT SAMPLING

8.1.1 BACKGROUND

Stream-bottom (benthic) communities reside in stream sediment and can be negatively impacted by contamination present in the sediment surrounding them (De Lange *et al*., 2004). Contaminated sediments can inversely impact benthic organisms and can also indirectly impact terrestrial biota, including humans. These detrimental effects stem from bioaccumulation and subsequent transfer of contaminants through the food web (EPA, 1994).

Contaminated sediments have been detected at various stream sites across the ORR. The contaminants present at these sites can be attributed to past and current DOE operations (EPA, 2017). Contaminated sediments are an important, ongoing environmental problem that impacts the uses of many ORR streams. To assess the degree of contamination at the benthic level, TDEC DoR-OR will collect sediment samples for chemical and radiological analysis from streams that ultimately drain into the Clinch River.

This project monitors suspended stream sediment contaminants transported in impacted waterways (Bear Creek and East Fork Poplar Creek). The sediment traps used for this project collect suspended sediment particles from each stream at multiple sites. This project is unique because it captures mobile stream sediment instead of sediment that has simply settled at the stream's bottom. The information gathered from the chemical and radiological analysis of these sediments will help reveal any contaminants being transported downstream and then offsite. The sediment traps are an additional means for detecting any changes in sediment-associated contamination.

8.1.2 PROBLEMS STATEMENTS

Sediment is an integral component of stream ecosystems but often serves as a sink for many contaminants (Mulligan *et al.*, 2009). The following statements list the main issues that are addressed by this project:

1) Contaminated stream sediments are highly mobile and could potentially be transported offsite.

2) Contaminated stream sediments have negative impacts on aquatic and terrestrial organisms through bioaccumulation.

3) Mercury contaminated soils surrounding East Fork Poplar Creek (EFPC) are being washed into the stream during rain and flooding events.

4) DOE's monitoring relies on grab samples, which reflect localized, settled sediment. This project addresses that data gap by capturing suspended sediments continually over six months to better evaluate contaminant mobility and potential offsite transport.

8.1.3 Related DOE Projects

DOE does not currently sample suspended stream sediments. DOE only collects grab sediment samples at specific stream sites of concern.

8.1.4 Goals

The goals of this project are as follows:

1) Detect contaminants in suspended stream sediment at sites along Bear Creek (BC) and East Fork Poplar Creek (EFPC).

2) Use the collected data to assess the extent of sediment transported contamination in these two streams.

3) Provide a benchmark of contamination in BC and EFPC stream sediment to support future CERCLA decisions and assess remedial effectiveness of past decisions.

4) Assess the potential impacts contaminated stream sediment in BC and EFPC has on benthic communities.

5) In FY26, an additional sediment trap will be added along EFPC at EFK 16.5, which is located near a hot spot of floodplain soils contaminated with mercury. This trap will monitor for increases in mercury concentrations that may be attributed to rain and flooding events.

8.1.5 Scope

During FY26, suspended sediment traps will be monitored at six impacted ORR sites and one reference site. The number of sampling sites per stream are as follows: three sites in EFPC, two sites in BC, one site in North Tributary 5 (NT5), and one site in the reference stream, Mill Branch (Table 8.1.5.1 and Figure 8.1.5.1). An additional sampling location will be added during April 2025 at East Fork Poplar Creek kilometer 16.5 (EFK 16.5) and sampled during the first sampling event for FY26 (October 2025). A second trap at EFK 23.4 provides a field-duplicate sample to verify field sampling techniques are replicable. The NT5 trap monitors contaminated sediment originating from the Environmental Management Waste Management Facility (EMWMF) which accepts low-level mixed waste. The furthest downstream site, EFK 2.2, is located below the confluence of BC with EFPC, and provides data on combined stream sediment from both streams. The other EFPC and BC sites are used to monitor the movement of sediment-bound contamination leaving Y-12 and potential sediment deposition in floodplain soils downstream.

Table 8.1.5.1: Suspended Sediment Trap Locations

Site Name	Site Description	Latitude	Longitude
EFK 23.4	East Fork Poplar Creek Kilometer 23.4	35.99596	-84.24004
EFK 23.4 Dup	East Fork Poplar Creek Kilometer 23.4 (Field Duplicate)	35.99596	-84.24004
EFK 16.5	East Fork Poplar Creek Kilometer 16.5	35.999042	-84.297644
EFK 2.2	East Fork Poplar Creek Kilometer 2.2	35.95169	-84.3716
NT5	North Tributary 5 of Bear Creek	35.966026	-84.290237
BCK 7.6	Bear Creek Kilometer 7.6	35.95096	-84.31395
BCK 3.3	Bear Creek Kilometer 3.3	35.943538	-84.349114
MBK 1.6	Mill Branch Kilometer 1.6	35.98886	-84.28935

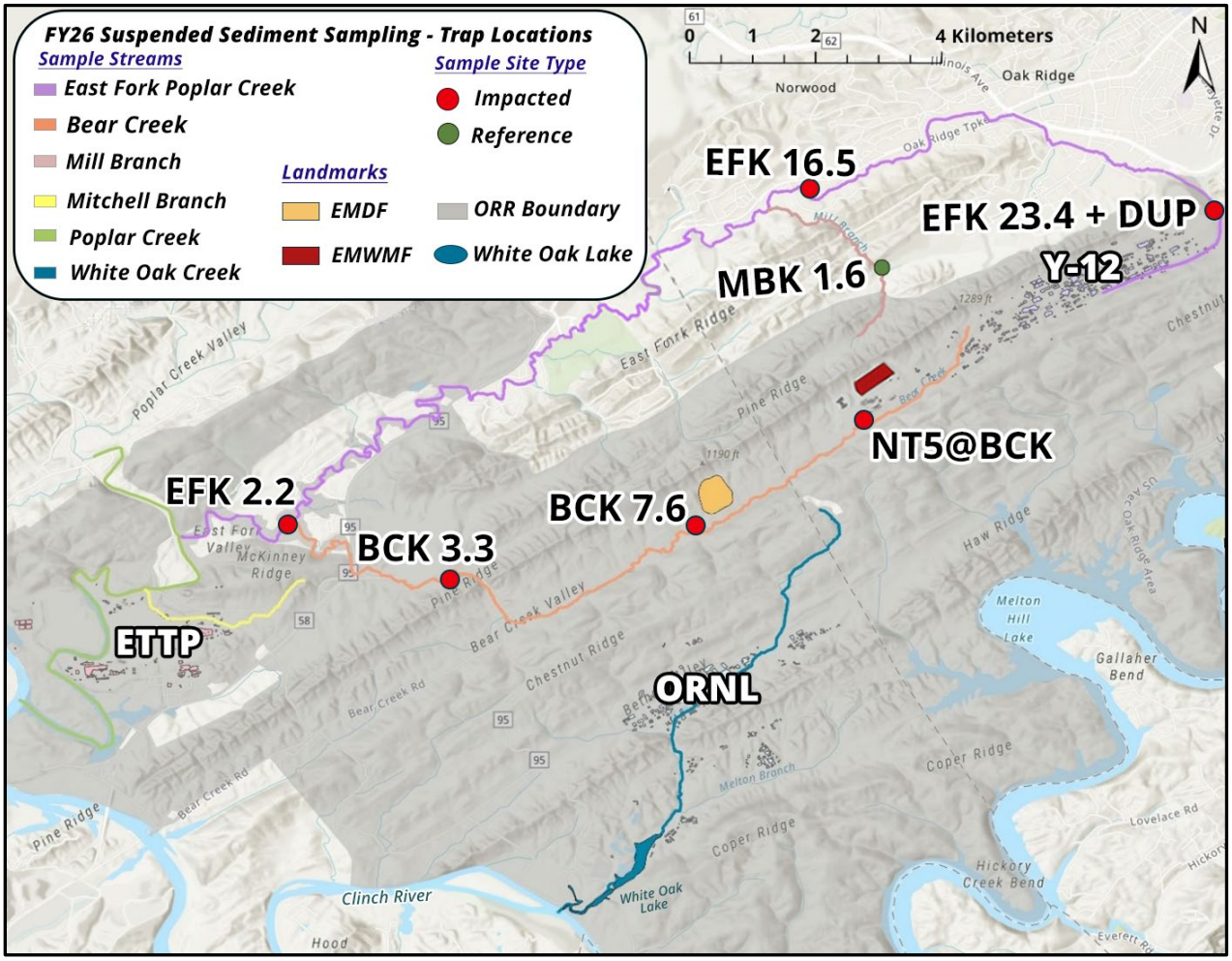

Figure 8.1.5.1: Sediment Trap Locations

8.1.6 Methods, Materials, Metrics

Passive sediment traps will be used to monitor changes in sediment contamination levels that flow through EFPC and BC. Sediment samples will be collected from each sediment trap twice

during FY26, once in October 2025 and once during April 2026. Each sample will be submitted for analysis based on contaminants of concern (COCs) (Table 8.1.6.1). The written procedure used for this project is *DoR-OR-T-600 Standard Operating Procedure for Sediment Sampling* (TDEC DoR-OR, 2023).

Sediment traps are placed on the stream bed and held down with sandbags. The traps are oriented so that considerable water flows through them. Modeled after Phillips *et al*. (2000), these passive samplers provide a longer-term measure of contaminant transport, capturing trends that grab samples might miss. Following a collection period of a minimum of six months, the sediment and water is emptied from a sediment trap and transferred to a clean bucket allocated for an individual site. The bucket is then surrounded by ice for 48 to 72 hours to allow the sediment to settle at the bottom of the bucket. After the sediment settles, the water on top of the sediment is carefully drawn off each sample with a peristaltic pump and clean tubing. Sediment samples are transferred into sample containers using a clean spoon and sent to the appropriate analytical laboratory for analysis.

Sediment samples will be analyzed for metals (cadmium, lead, uranium, and mercury), radiological activity (gross alpha/beta, gamma, isotopic uranium, total calculated uranium), and polychlorinated biphenyls (PCBs) at four sites where PCBs are a COC. In October of 2025, samples collected from traps at BCK 3.3, BCK 7.6, NT5, and MBK 1.6 will be analyzed for PCBs in addition to the other listed COCs. Particle size distribution will be calculated for each site to determine the mobility of contaminants in each stream. Due to their high mobility and binding potential with contaminants, clays and silt have the potential to transport greater quantities of contaminants offsite than gravel and sand (Ong, 2016). Suspended sediment samples typically contain more clays and silt than a grab sample which are mostly gravel and sand.

Table 8.1.6.1: Suspended Stream Sediment Analyses

Analysis	Laboratory Method	# of Samples
Cadmium	ICP-MS	8
Lead	ICP-MS	8
Uranium	ICP-MS	8
Mercury	Mercury in Sediment	8
% Solids	Total Solids	8
Particle Size Distribution	--	8
Gross Alpha/Beta	EPA 900.0	8
Gamma	EPA 901.1	8
Isotopic Uranium	DOE HASL 300	8
Total Uranium	Calculated	8
PCBs*	SW846-8082	4
**PCBs will only be analyzed at BCK 3.3, BCK 7.6, NT5, and MBK 1.6 in October 2025*		

The metals and PCB data will be compared to the Consensus-Based Sediment Quality Guidelines (CBSQGs) (MacDonald et al, 2000). Radiological data will be compared to data from background locations (Mill Branch) and risk-based screening levels. The sediment data collected from Mill Branch (reference stream) will serve as a representative sediment sample and be used to compare to sediment samples collected from streams impacted by DOE activities (BC, NT5, EFPC).

8.1.7 REFERENCES

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9.0 WATERSHED ASSESSMENTS (HOLISTIC) MONITORING

TDEC DoR-OR completes comprehensive watershed assessments around the ORR to provide the citizens of the State of Tennessee a comprehensive evaluation of that watershed, assessing the interconnectedness of all the environmental media over an entire watershed collectively at a given point in time. The holistic understanding of all contaminants and their multiple inputs into one watershed allows for enhanced understanding of the health of the system and supports discussions regarding prioritization of remediation project goals. Prior TDEC watershed assessments evaluated Bear Creek Valley and East Fork Poplar Creek. This fiscal year, the focal watershed is White Oak Creek (WOC).

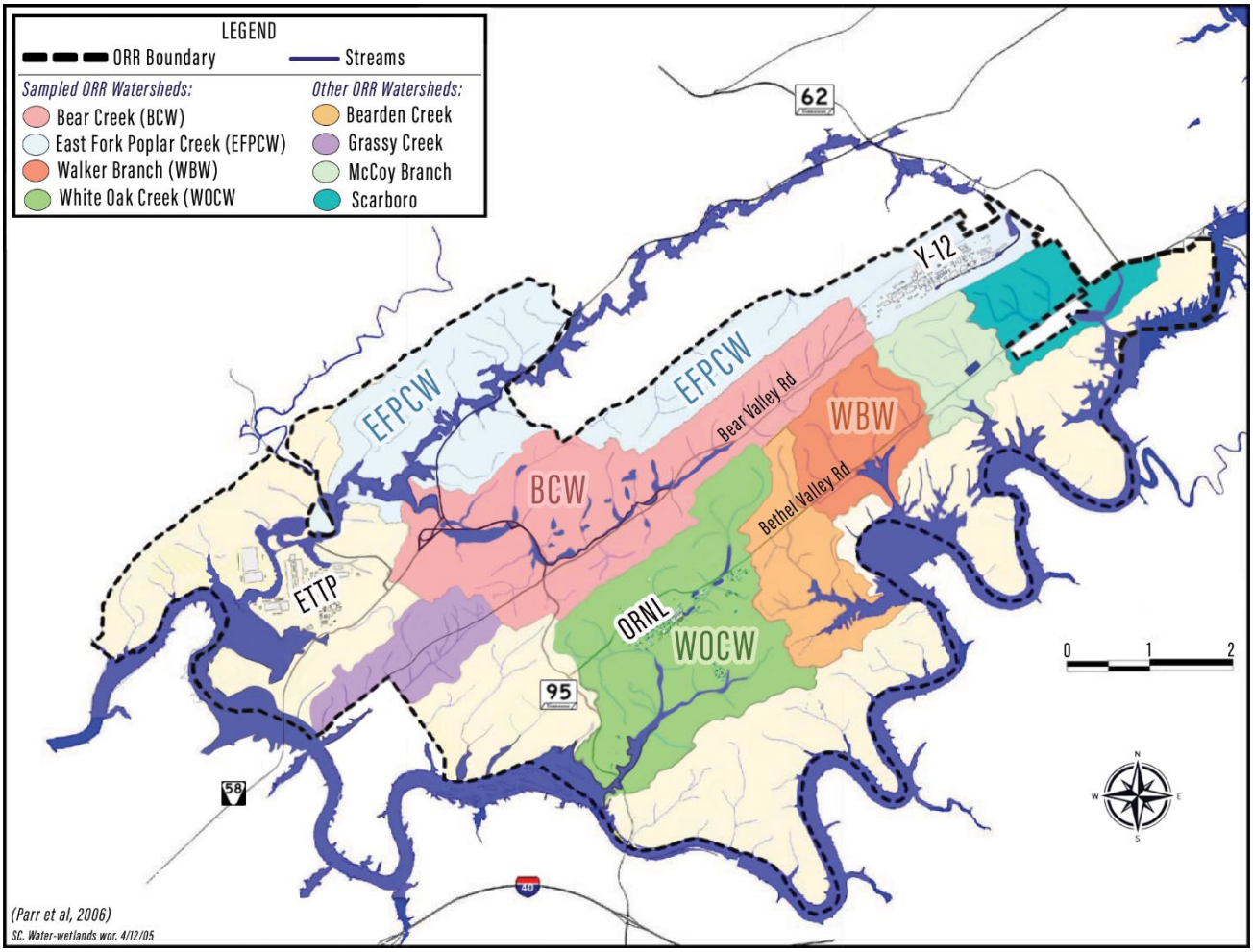

Figure 9.0.1: ORR Watersheds

9.1 WHITE OAK CREEK ASSESSMENT PROJECT (WOCAP) – PHASE 2B

9.1.1 BACKGROUND

The ORR resides in the Valley and Ridge physiographic province. This province is distinguished by a series of northeast-southwest trending ridges and interceding valleys (Miller, 1974).

White Oak Creek (WOC) is located in the south-central part of the ORR. The stream originates on the slope of Chestnut Ridge and flows into Bethel Valley and ORNL. From there it travels through the gap in Haw Ridge and enters Melton Valley. Next, WOC proceeds through Melton Valley before emptying into the Clinch River (i.e. CRK 33.5, CRM 20.8). The WOC watershed drainage area is 6.45 square miles (Figure 9.1.5.1) (USGS, 2024).

The *White Oak Creek Assessment Project* (WOCAP) is intended to establish a current benchmark of environmental conditions in this watershed. DOE's *White Oak Creek Remedial Investigation Report: Melton Valley Area* describes an assessment of the Melton Valley segment of the WOC watershed (DOE, 1996). Although comprehensive, this assessment is outdated, and a new holistic assessment is warranted to support TDEC evaluations moving forward. The environmental data generated by the FY26 sampling and analysis of various environmental media will help to establish benchmarks that can be used to evaluate future impacts and support decisions for final Bethel Valley and Melton Valley RODs.

There are multiple data gaps that this WOCAP will address. WOC data in the Oak Ridge Environmental Information System (OREIS) is limited. More specifically, monitoring data are scarce for the following:

1) Whole Effluent Toxicity (WET) testing
2) Radiological uptake in WOC vegetation
3) Bioaccumulation of known contaminants in terrestrial organisms.

The four primary contaminants of concern (COCs) within WOC are tritium (H-3), strontium-90 (Sr-90), cesium-137 (Cs-137), and cobalt-60 (Co-60). The WOCAP involves a comprehensive evaluation of the ecological health of this entire watershed and will focus on the primary COCs. To accomplish this holistic assessment, the WOCAP has been organized into several progressive phases.

1) **Phase 1** (FY24) involved researching and compiling existing data.
   a. Data acquisition, review, summarization, and interpretation of historical data for the WOC Watershed.

   b. Examination and compilation of available types of environmental data including: (1) surface water, (2) groundwater, (3) sediment, (4) soils, (5) toxicity/biomonitoring, (6) fish tissue, (7) benthic macroinvertebrates, (8) terrestrial biota.

2) **Phase 2** (FY25 and FY26) includes new sampling and subsequent analysis of monitoring data collected in Phase 1.
   a. In Phase 2a, new sampling and analysis projects included (1) surface water, (2)

toxicity/biomonitoring, (3) fish tissue, (4) benthic macroinvertebrate community health, (5) benthic macroinvertebrate chemical analysis, (6) terrestrial biota (flying insects), and (7) vegetation.

b. **Phase 2b** will include continued sampling in WOC and the remaining sampling that could not be completed during Phase 2a: (1) surface water, (2) benthic macroinvertebrate community health, (3) benthic macroinvertebrate chemical analysis, (4) terrestrial biota (songbird eggs and flying insects), and (5) gamma walk-over surveys as a preliminary soils analysis.

3) **Phase 3** (FY27) will use the analytical data obtained from Phases 1 and 2 to produce a comprehensive report. If data gaps are present after Phase 2, there will be further sampling and analysis.

4) **Phase 4** (FY27 and FY28) will address any areas requiring additional field sampling for a more comprehensive analysis and interpretation of all watershed data.

9.1.2 Problem Statements

Melton Valley is a major waste storage area on the ORR. Contaminant releases from Melton Valley become mobilized via surface water, which flows into WOC and ultimately empties into the Clinch River (DOE, 2023). The primary contaminants of concern (COCs) are H-3, Sr-90, Cs-137, and Co-60. In the early years of ORNL operations, these COCs were discharged to nearby streams. Industrial waste disposal areas also contributed to the contamination of the watershed through leaks, spills, and subsurface leaching (DOE, 1995).

As a result, WOC floodplain soils and sediments have extensive deposits of Cesium-137 (Cs-137). Cs-137 is of particular concern because of its high potential for mobility with sediment to downstream areas of WOC and to the Clinch River (DOE, 2023).

These COCs also resulted in elevated gamma radiation activity along WOC from ORNL to the WOC Embayment (WOE) at the Clinch River confluence (WOC-CR). In previous years, Melton Branch, a tributary of WOC, has had lower levels of gamma radiation in the reach that spans from the High Flux Isotope Reactor (HFIR) to the confluence with White Oak Creek (MB-WOC).

9.1.3 Related DOE Projects

DOE has projects with data that can be incorporated into the WOCAP Phase 2 assessment. For example, ORNL's Environmental Sciences Division samples fish and benthic macroinvertebrates in WOC. Also, DOE samples WOC surface water at the 7500 Bridge (Bethel Valley Integration Point) as part of the *Record of Decision (ROD) for Interim Actions in Bethel Valley Watershed* (DOE

2020). At several other locations on WOC, including Fifth Creek (a tributary of WOC), DOE investigates source(s) of ungauged Sr-90 contributions to the watershed from areas like SWSA 5 and Building 3042 (DOE, 1994a; DOE, 1994b; DOE, 2022a; DOE, 2022b).

9.1.4 GOALS

The goals of this **Phase 2b** project include the following:

- To conduct a comprehensive evaluation of WOC to provide a current benchmark help inform future remedial decisions.

- To assess the impacts that historical and ongoing contamination of WOC may be having on wildlife in the watershed. Data from this assessment can also be used to assess ongoing human health risk.

- To provide a benchmark to gauge the effectiveness of future remediation activities in the WOC watershed.

- Report to the public the current status of the WOC watershed.

9.1.5 SCOPE

WOC sample sites are represented on Figure 9.1.5.1 and cover the length of WOC from the headwaters to the confluence with the Clinch River, as well as major tributaries of WOC. Except for the gamma walk-over surveys, all **Phase 2b** sampling will occur as components of separate monitoring projects. Monitoring data used to support this holistic watershed assessment will be collected and provided by the following projects: *Benthic Community Health* (community metrics and chemical analysis), *White Oak Creek Radionuclides* surface water sampling, *Contaminant Uptake in Biota* (songbird eggs and flying insects), and the *Roving Creel Survey* (fish).

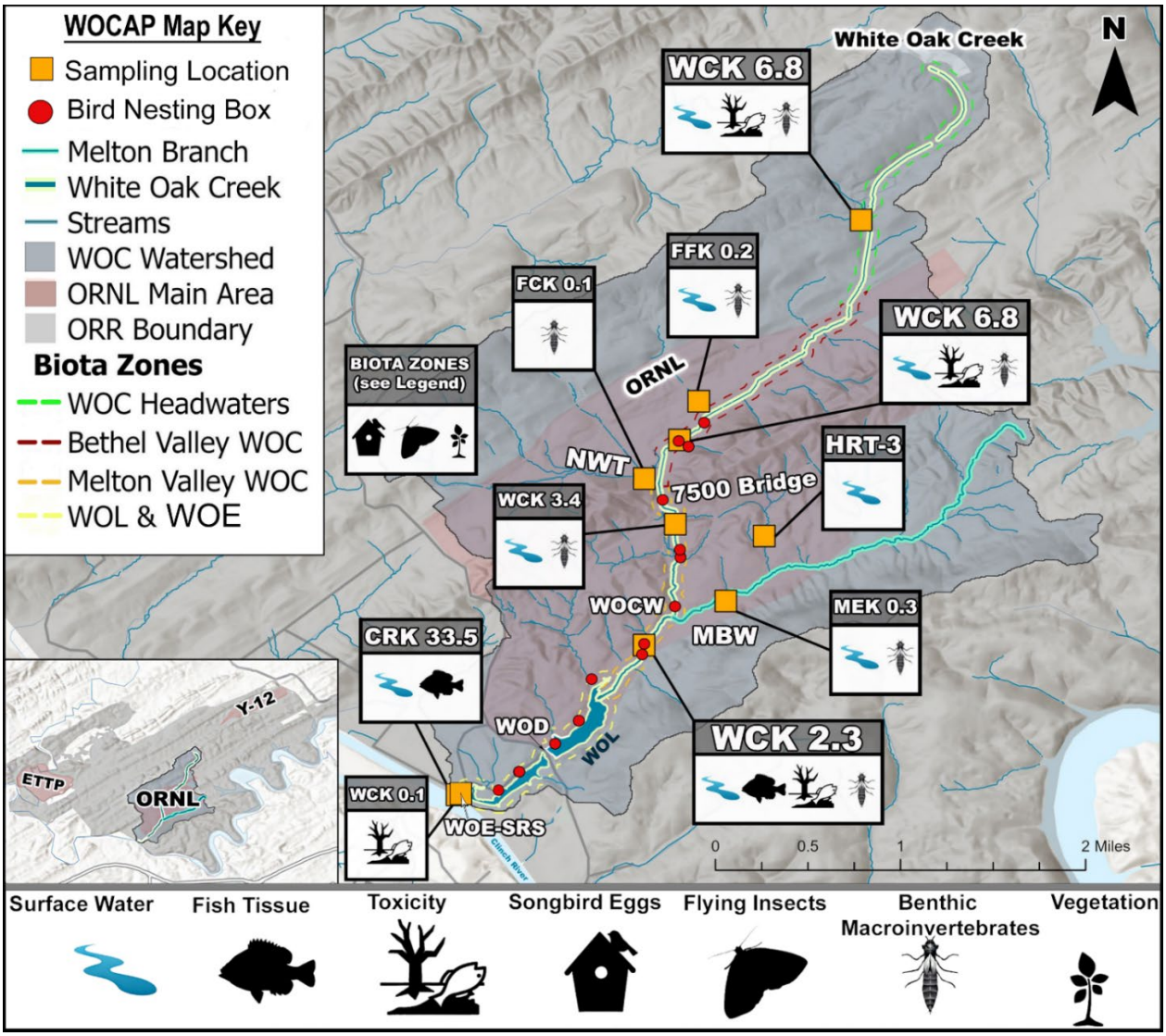

Figure 9.1.5.1: Phase 2 Sampling Sites

9.1.6 Methods, Materials, Metrics

Surface water samples will be collected quarterly at multiple sites along WOC, its tributaries, and the confluence with the Clinch River. The most upstream site on WOC (WCK 6.8) will be used as the reference stream site. Surface water samples from WOC will be analyzed for Sr-90 and gamma radionuclides. For information about the WOC surface water sampling project, refer to the *White Oak Creek Radionuclides Surface Water* EMP in this document (Chapter 7.3).

Benthic macroinvertebrates will be sampled in the spring of 2025 at seven (7) locations in the WOC watershed (Figure 9.1.5.1). For additional information, refer to the Benthic Macroinvertebrate sampling project section of this EMP document (Chapter 3.1). Samples

collected from these sites will be used to assess benthic community health, and a subset will be analyzed for Cs-137 and Sr-90.

Biota samples will be collected within four specified biota zones in the WOCW (Figure 9.1.5.1) during the spring and summer of 2025 (songbird eggs and flying insects) and spring 2026 (songbird eggs). These zones are WOC Headwaters (reference), Bethel Valley WOC, Melton Valley WOC, and White Oak Lake (WOL) & White Oak Creek Embayment (WOE). Songbird eggs collected in spring 2025 will be sampled and analyzed for gross alpha/gross beta, gamma radionuclides, Sr-89/Sr-90, tritium, and dioxin/furans. Adult insects will be collected and analyzed for mercury/methylmercury, arsenic, uranium, and PCBs. Adult insects will not be analyzed for radionuclides as that sampling occurred in FY25. Songbird egg samples collected in spring 2026 will be analyzed for mercury/methylmercury, arsenic, uranium metal, and PCBs. For additional information, refer to the Contaminant Uptake in Biota section of this EMP (Chapter 3.3).

Gamma walk-over surveys will also be conducted as part of the Phase 2b sampling. Identified areas of the WOC floodplain will be scanned for gamma radiation and isotopes identified in the soils (TDEC SOP in progress). Gamma walk-over surveys will identify localized contamination in floodplain soils that are likely derived from stream sediments and likely to impact terrestrial ecological systems. Once hotspots have been identified, consideration will be given to the collection of soil samples for further analysis.

Table 9.1.6.1: FY26 Field Sampling Timeline

Media	*Surface Water*	*Benthic Macroinvertebrates*	*Flying Insects*	*Songbird Eggs*	*Gamma Walk-Over*
Schedule	*Quarterly*	*Spr. 2025*	*Spr./Su '25*	*Spr. '25/26*	*Winter '25*
arsenic (As)		X	X	X	
mercury (Hg)		X	X	X	
low-level mercury (LLHg)					
methyl mercury (MeHg)			X	X	
uranium (U)		X	X	X	
polychlorinated biphenyls (PCBs)			X	X	
dioxins/furans				X	
strontium-89/90 (Sr-89/90)	X	X		X	
alpha and beta activity				X	X*
gamma radionuclide activity	X	X		X	X
tritium (H-3)		X		X	
biodiversity		X			

*alpha and beta activity measured through soil samples collected from areas of interest identified through the gamma walk-over surveys.

9.1.7 REFERENCES

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END OF EMP FY26