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OF

ENVIRONMENT AND CONSERVATION

DOE OVERSIGHT DIVISION

ENVIRONMENTAL MONITORING PLAN

JANUARY through DECEMBER 2012

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LIST OF COMMON ACRONYMS AND ABBREVIATIONS

ASER	Annual Site Environmental Report (written by DOE)
ASTM	American Society for Testing and Materials
BCK	Bear Creek Kilometer (station location)
BFK	Brushy Fork Creek Kilometer (station location)
BJC	Bechtel Jacobs Company
BMAP	Biological Monitoring and Abatement Program
BNFL	British Nuclear Fuels Limited
BOD	Biological Oxygen Demand
BWXT	Y-12 Prime Contractor (current)
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAP	Citizens Advisory Panel (of LOC)
CCR	Consumer Confidence Report
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	Contaminants of Concern
COD	Chemical Oxygen Demand
CPM (cpm)	counts per minute
CRM	Clinch River Mile
CROET	Community Reuse Organization of East Tennessee
CWA	Clean Water Act
CYRTF	Coal Yard Runoff Treatment Facility (at ORNL)
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DOE-O	Department of Energy-Oversight Division (TDEC)
DWS	Division of Water Supply (TDEC)
<i>E. coli</i>	<i>Escherichia coli</i>
EAC	Environmental Assistance Center (TDEC)
ED1, ED2, ED3	Economic Development Parcel 1, Parcel 2, and Parcel 3
EFPC	East Fork Poplar Creek
EMC	Environmental Monitoring and Compliance (DOE-O Program)
EMWMF	Environmental Management Waste Management Facility
EPA	Environmental Protection Agency
EPT	<i>Ephemeroptera, Plecoptera, Trichoptera</i> (May flies, Stone flies, Caddis flies)
RadNet	EPA Ambient Monitoring Radiation Network (RadNet), Formally ERAMS
ET&I	Equipment Test and Inspection
ETTP	East Tennessee Technology Park
FDA	U.S. Food and Drug Administration
FRMAC	Federal Radiation Monitoring and Assessment Center
g	gram
GHK	Gum Hollow Branch Kilometer (station location)
GIS	Geographic Information Systems
GPS	Global Positioning System
GW	Ground Water
GWQC	Ground Water Quality Criteria

HAP	Hazardous Air Pollutant
HCK	Hinds Creek Kilometer (station location)
IBI	Index of Biotic Integrity
IC	In Compliance
“ISCO” Sampler	Automatic Water Sampler
IWQP	Integrated Water Quality Program
K-####	Facility at K-25 (ETTP)
K-25	Oak Ridge Gaseous Diffusion Plant (now called ETTP)
KBL	Knoxville Branch Laboratory
KFO	Knoxville Field Office
L	liter
LC ₅₀	Lethal Concentration at which 50 % of Test Organisms Die
LMES	Lockheed Martin Energy Systems (past DOE Contractor)
LOC	Local Oversight Committee
LWBR	Lower Watts Bar Reservoir
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MBK	Mill Branch Kilometer (station location)
MCL	Maximum Contaminant Level (for drinking water)
MDC	Minimum Detectable Concentration
MEK	Melton Branch Kilometer (station location)
µg	microgram
mg	milligram
MIK	Mitchell Branch Kilometer (station location)
ml	milliliter
MMES	Martin Marietta Energy Systems (past DOE Contractor)
µmho	micro mho (mho=1/ohm)
MOU	Memorandum of Understanding
mR	microrentgen
mrem	1/1000 of a rem – millirem
N, S, E, W	North, South, East, West
NAAQS	National Ambient Air Quality Standards
NAREL	National Air and Radiation Environmental Laboratory
NAT	No Acute Toxicity
NEPA	National Environmental Policy Act
NIC	Not In Compliance
NOAEC	No Observable Adverse Effect Concentration (to Tested Organisms)
NOV	Notice of Violation
NPDES	National Pollution Discharge Elimination System
NRWTF	Non-Radiological Waste Treatment Facility (at ORNL)
NT	Northern Tributary of Bear Creek in Bear Creek Valley
OMI	Operations Management International (runs utilities at ETTP under CROET)
OREIS	Oak Ridge Environmental Information System http://www-oreis.bchteljacobs.org/oreis/help/oreishome.html
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Association
OSL	Optically Stimulated Luminescent (Dosimeter)
OU	Operable Unit
PACE	Paper, Allied-Industrial, Chemical, and Energy Workers Union
PAM	Perimeter Air Monitor

PCB	Polychlorinated Biphenol
pCi	1×10^{-12} curie (picocurie)
PCM	Poplar Creek Mile (station location)
pH	Proportion of Hydrogen Ions (acid vs. base)
PWSID	Potable Water Supply Identification “number”
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion
PRG	Preliminary Remediation Goals
QA	Quality Assurance
QC	Quality Control
R	Roentgen
RBP	Rapid Bioassessment Program
RCRA	Resource Conservation and Recovery Act
REM (rem)	Roentgen Equivalent Man (unit)
RER	Remediation Effectiveness Report
ROD	Record of Decision
RSE	Remedial Site Evaluation
SLF	Sanitary Landfill
SNS	Spallation Neutron Source
SOP	Standard Operating Procedure
SPOT	Sample Planning and Oversight Team (TDEC)
SS	Surface Spring
STP	Sewage Treatment Plant
SW	Surface Water
TDEC	Tennessee Department of Environment and Conservation
TDS	Total Dissolved Solids
TIE	Toxicity Identification Evaluation
TLD	Thermoluminescent Dosimeter
TOA	Tennessee Oversight Agreement
TRE	Toxicity Reduction Evaluation
TRM	Tennessee River Mile
TRU	Transuranic
TSCA	Toxic Substance Control Act
TSCAI	Toxic Substance Control Act Incinerator
TSS	Total Suspended Solids
TTHM’s	Total Trihalomethanes
TVA	Tennessee Valley Authority
TWQC	Tennessee Water Quality Criteria
TWRA	Tennessee Wildlife Resources Agency
U.S.	United States
UT-Battelle	University of Tennessee-Battelle (ORNL Prime Contractor)
VOC	Volatile Organic Compound
WCK	White Oak Creek Kilometer (station location)
WM	Waste Management
WOL	White Oak Lake
X-####	Facility at X-10 (ORNL)
X-10	Oak Ridge National Laboratory
Y-####	Facility at Y-12
Y-12	Y-12 Plant (Area Office)

INTRODUCTION

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy (DOE) Oversight Division (the division), is providing an annual environmental monitoring plan for the calendar year 2012 under terms of the Tennessee Oversight Agreement (TOA) Section A.7.2.1. Individual work plans describing independent environmental monitoring and surveillance make up the 2012 Environmental Monitoring Plan. Monitoring of chemical and radiological emissions in the air, water, biota, and sediment on the Oak Ridge Reservation and its environs is emphasized. A description of TDEC's Oversight of DOE's environmental monitoring and surveillance programs is also included. The goal is to assure that DOE's Oak Ridge Operations have no adverse impact to public health, safety, or the environment. Results from monitoring and findings of the quality and effectiveness of the DOE's environmental programs are reported in the quarterly and annual status reports. Each spring an annual environmental monitoring report is provided that details the technical results of these studies.

This plan offers the Department of Energy the opportunity to review and consult on the division's monitoring activities and to take split-samples as needed. The division may perform short-notice or no-notice sampling for situations such as storm events, non-permitted discharges, emergencies or spills. DOE will be informed as soon as a decision is made to take short-notice or no-notice samples. Environmental monitoring is a dynamic process and will periodically change. Major changes to this plan will be made in writing to DOE.

Judicious use of cost cutting strategies will be used to complete our projects with the monies available. The strategies include the compositing of samples, use of only critical sampling stations, decreasing the frequency of sampling, and decreasing the number of analytes to only those critical for the projects. In some cases samples may be held as contingency, in case of accidental release. Project monies will be closely tracked for efficiencies.

This division or the Tennessee Department of Health, Environmental Laboratory and Microbiological Laboratory Organization (Laboratory Services or the state lab) will process quantitative chemical samples. Laboratory Services has expertise in a broad scope of services and analyses. Certain analyses and quality assurance/quality control (QA/QC) samples are subcontracted out by the state lab to independent certified laboratories. Bench level QA/QC records and chain-of-custody records are maintained by the state for all samples collected by the division. The *Laboratory Services Standard Operating Procedures* are followed and also serve as a guide to the division's laboratory procedures. General sampling and analysis methods follow EPA guidelines.

Benthic macroinvertebrates and other biological samples are taxonomically identified at the state lab, in the division's laboratory, or by Laboratory Services subcontractors. Common water quality measurements and radiological readings are done in the field with calibrated instruments. Environmental dosimeters are analyzed by outside vendors. All work follows EPA, state, and instrument manufacturer's protocols as appropriate. Data loggers are used to reduce transcription errors.

Air Quality Monitoring

The division's integrated air quality monitoring is designed to verify and enhance DOE monitoring of the air quality on the Oak Ridge Reservation and in surrounding areas which may be impacted from DOE Oak Ridge Operations. The division implements EPA's ambient monitoring system, RadNet. Radiological surveillance of ambient air quality in the vicinity of the ORR is provided and compared to the results of the national RadNet program. Three precipitation monitors are now included in the Oak Ridge Reservation RadNet system from which radiological contaminants in rain and snow will be assessed. TDEC performs oversight of the ORR perimeter program. In fact, the division has arranged to use DOE's pre-filter media for its own radiological analysis and direct trend comparisons. Portable samplers are also set up to measure hazardous and radioactive contaminants around selected DOE demolition and remediation projects. The EMWFM location was added in 2005 as an air-sampling site for fugitive emissions. Results are used to verify that DOE keeps contamination contained during cleanup and disposal activities. In the event of a large catastrophic release, any of these data could be used for consequence assessment and to guide recovery efforts, even in the community.

Biological Monitoring

To determine the impact of DOE operations the division provides independent biological monitoring and oversight on and off the Oak Ridge Reservation. It also works in conjunction with the Tennessee Wildlife Resources Agency (TWRA), the Tennessee Valley Authority (TVA), and with other Tennessee Department of Environment and Conservation offices to coordinate valley-wide monitoring efforts related to fishing advisories. Specific contaminant pathways are investigated on the Oak Ridge Reservation as well. Results are used to formulate recommendations on clean up and to measure potential human and/or environmental risk. The division is currently measuring impacts to aquatic biota, contamination in geese, and affects on other indicator species such as lichens, watercress and diatoms. Invasive plants are also being mapped on a 3000-acre conservation easement. TWRA is assisting us in a deer telemetry project that will determine how far deer in Melton Valley range.

Drinking Water Monitoring

Public water systems on the Clinch and Tennessee Rivers can be adversely impacted by DOE activities on the Oak Ridge Reservation. Independent drinking water monitoring supports the public water system's monitoring efforts related to releases from the Oak Ridge Reservation. The division implements EPA's RadNet Drinking Water Program. Results are compared to the national program. The division provides labor; EPA provides expendables and analysis. DOE plant water distribution systems operate at a fraction of historical capacity and can stagnate causing a loss of chlorine. Therefore, chlorine residuals in DOE facilities are also monitored. Sampling and analysis for possible chemical and radiological constituents may be accomplished during oversight of water main repairs and line-flushing activities. The comprehensive goal is to document trends and ensure that systems continue to be safe from radiological, chemical, and bacteriological contamination.

Groundwater Monitoring

The division's groundwater monitoring program provides information about Oak Ridge Reservation releases and potential impacts on health and the environment. Given the implications of contaminant transport off the Oak Ridge Reservation via groundwater, the

division will continue to emphasize the identification of groundwater pathways. This will be accomplished by monitoring water supplies, wells, and springs, both on and off the ORR and by conducting hydrogeological investigations such as aquifer evaluations and dye traces. Integration of groundwater and surface water sampling results allows concepts of groundwater behavior to be refined. Much groundwater tracing is opportunistic, as staff must take advantage of favorable weather, or discoveries made during construction or remediation, etc. Citizen reports of large springs in the ORR environs are useful and guide sample collection planning. Sampling efforts for 2012 will focus on the state review of the East Tennessee Technology Park (ETTP) Zone 1 Record of Decision (ROD).

Radiological Monitoring

The division's radiological monitoring is directed toward the development of a comprehensive radiological monitoring system as prescribed by the Tennessee Oversight Agreement, Attachment C.2 "Radiological Oversight." The primary focus of the program is the detection of radiological contamination with the potential to impact human health and the environment. Our radiological program contributes in all media areas and reviews CERCLA and NEPA documents, waste disposition, and other projects involving radionuclides. Autonomous monitoring includes facility surveys, gamma monitoring of the ORR, footprint reduction surveys, surplus sales surveys, and real-time gamma monitoring around active demolition and remediation sites. Automated gamma monitoring is being done at the Environmental Management Waste Management Facility (EMWMF) in Bear Creek Valley, for example. The DOE weigh scales database is compared to our gamma-monitoring data. Using time stamps to match data, the division monitors radiation readings on waste shipments delivered for disposal and assures that radioactive shipments are weighed and documented. The division has deployed its gamma radiation portal monitor at the EMWMF waste cell entrance. This instrument will measure gamma radiation levels of truck loads of waste entering the EMWMF on a real time basis. Previously used measurement instruments have only been able to display readings after manual downloads resulting in lengthy delays of relevant data. The portal monitor will allow the division to see gamma rates before waste is buried.

Surface Water Monitoring

The division measures trends in the quality of water and sediments in the Clinch River and Oak Ridge Reservation tributaries. Surface water is one of Tennessee's most important economic and environmental resources, but local waterways rarely unconditionally meet all designated uses. For example, there are advisories on fish consumption from local reservoirs and streams. Legacy pollution from DOE, other industries, and non-point source origins are continuing problems. Long term monitoring can define success or failure of clean-up actions, source controls, and attenuation. Specifically, the division is analyzing water from Bear Creek to isolate legacy source inputs. It is hoped that the long-term monitoring strategy for the new Environmental Management Waste Management Facility can be positively affected and that existing sources/pathways can be found, analytically isolated, trended, and remedied.

From another perspective, the Clinch and Tennessee Rivers are drinking water sources for several municipalities. Knowing the pollutant concentration is vital to the monitoring of those drinking water sources. In 2012, monitoring and investigation will continue in closer proximities to remediation projects and new construction.

Invitation for Public Comment

This plan is published to inform the public about state sampling on the ORR and environs. Any comments from the public on where or how future sampling should be done are greatly appreciated. Comments can be sent to:

Sonya Isabell
TDEC DOE-O
761 Emory Valley Road
Oak Ridge TN 37830

Comments can also be sent to sonya.isabell@tn.gov or faxed to (865) 482-1835.

AIR QUALITY MONITORING

Monitoring of Hazardous Air Pollutants on the Oak Ridge Reservation

Introduction

This independent monitoring project is conducted under authority of the Tennessee Oversight Agreement. The project was initiated in 1997 at the East Tennessee Technology Park (ETTP or K-25 site) in response to the heightened level of public concern regarding potential impacts to public health from the TSCA Incinerator emissions. Monitoring of hazardous metals in air expanded to the National Security Complex (Y-12) and the Oak Ridge National Laboratory (ORNL or X-10) in the following year. Following the closure of the TSCA Incinerator at ETTP, the project continues to monitor hazardous metals in fugitive emissions associated with demolition activities or other non-point sources at the three Oak Ridge Reservation (ORR) sites. Levels of arsenic, beryllium, cadmium, chromium, lead, nickel and uranium (as a metal only) in the ambient air are monitored.

A high-volume total suspended particulate (TSP) ambient air sampler is deployed at each site at one of several potential sampling locations. These locations were selected based on wind rose data, availability of electrical power, and co-location with DOE and TDEC radiological air monitors. The proposed sampling sites for next year have been in use since the 2004 calendar year. The sites are as follows:

- ORNL: X-10E, ERAMS station east of the main entrance to the site
X-10C, station at the corehole 8 remediation site
X-10W, station No. 3 west of the site (See Figure 1)
- Y-12: Y-12E, ERAMS station east of the plant entrance
Y-12W, ERAMS station west of the plant site (See Figure 2)
- ETTP: K-2, on Blair Road across from the TSCA Incinerator site
Station 42/TSCA-1, on Blair Road
Station 35/TSCA-2, on Gallaher Road (See Figure 3)

The current plan is to keep samplers located at the X-10C, Y-12E and K-2 sites throughout the coming year. DOE also maintains an air monitor for metals and radiological emissions at the K-2 site, so monitoring results from this site may be compared to data collected by DOE. The X-10C site is located adjacent to the ongoing Tank W1A (Corehole 8) soil removal project, which is a potential source of fugitive emissions, and samples are to be split with the radiological monitoring program. However, this sampler is mounted on a trailer and may be moved to either the X-10E or X-10W site if conditions at ORNL warrant a change in sample location. Power supply at the X-10E site is provided via a temperature sensitive source, making deployment at this site potentially problematic during the coldest months. Likewise, the Y-12 air monitor is mobile and may be deployed to the Y-12W site if needed.

Methods and Materials

On a weekly basis, sample filters will be collected from samplers and sent for analysis to the state Department of Health Environmental Laboratory in Nashville. Composite samples will be analyzed quarterly by the laboratory using inductively-coupled plasma and atomic absorption techniques. Some samples may be split for analysis by a sub-contractor of the state laboratory according to EPA Method IO-3.5, determination of metals in ambient air particulate using inductively coupled plasma/mass spectrometry (ICP-MS). The composite sample will be made using one quarter of each filter. This effectively gives each filter equal weight in the composite, even though the volume of air sampled may vary somewhat from filter to filter. To prevent the average quarterly concentrations in air computed for the composite from differing significantly from a true volume weighted composite, filters collecting particulate from air volumes differing from the quarterly mean sample volume by more than 20 percent will be sent to the state lab for individual analysis. Results from these filters (if any) and those obtained for the composite may then be weighted by volume of air sampled to more accurately determine the actual mean quarterly concentrations.

Methods and protocols for sampler maintenance and calibration have been developed based on high volume total suspended particulate (TSP) system maintenance manuals supplied by the manufacturer and sampling criteria tailored specifically to this project and DOE-O's mission and staffing levels (Thomasson, 2005 and Standard Operating Procedures developed for maintenance and calibration of TSP systems by the TDEC-DOE radiological monitoring program, 2010). Routine maintenance is generally limited to brush and motor changes. At intervals less than two months since the last brush change, the sampler motor will be disassembled and the motor's brushes inspected for condition and evaluated for longevity. When it is anticipated that the brushes may not last until the next site visit, they will be replaced. Based on experience with the typical lifetime of the sampler motor, it will be changed about twice annually. The sampler will also be inspected to ensure that the sampling orifice remains level and parallel to the ground. At each site visit the sampling cartridge will be removed and replaced with one holding a new filter. The cartridge will be covered both top and bottom for transport to the DOE Oversight laboratory. The sample will be removed at the DOE-O laboratory and placed in a zip-lock bag until the composite sample is made and sent to the Department of Health Environmental Laboratory for analysis. The 24-hour chart recording pressure differential will be removed and replaced weekly and its pen trace will be evaluated for average readings for the weekly period. Relevant information will be recorded on the reverse side of the chart. Date and time of sampling and elapsed time will be recorded, and readings of atmospheric pressure and ambient temperature may also be recorded on the chart. Proper chain of custody for samples will be maintained. DOE-O staff will maintain a quarterly calibration check that will be carried out in accordance with the manufacturer's specifications.

Reporting on the status of analytical results from each sampling location will be done annually. Comparison of mean values with reference to air concentrations from 40 CFR 266 and with sampling results from DOE monitors at the ETP site will be made. Annually, a report will be prepared presenting conclusions regarding current levels of HAPs metals in ambient air and included in the DOE-O environmental monitoring report.

Materials required for this project include:

hi-volume sampler	filters
sampler replacement parts	calibration kit
level	flow charts
extension cords	waterproof marking pens
tool kit	project data/custody forms
motor brushes	plastic sample bags

References

Boiler and Industrial Furnace Regulations, Title 40 CFR Part 266 Appendix V.

New York State Department of Environment Control, *Guidelines for the Control of Toxic Ambient Air Contaminants*, Draft New York State Air Guide-1, Appendix B of Air Guide-1, Ambient Air Quality Impact Screening Analyses, 1994 Edition.

Operations Manual for GMW Model 2000H Total Suspended Particulate Sampling System, Graseby GMW Variable Resistance Calibration Kit # G2835. 1998.

Tennessee Department of Environment and Conservation, TDEC DOE-O Procedure Number: SOP-ES&H-004 Air Monitoring/Air Sampling.

Tennessee Department of Environment and Conservation, *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*. DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Yard, C.R., *Health, Safety and Security Plan*, Tennessee Department of Environment and Conservation, DOE Oversight Division, Oak Ridge, Tennessee. 2011.

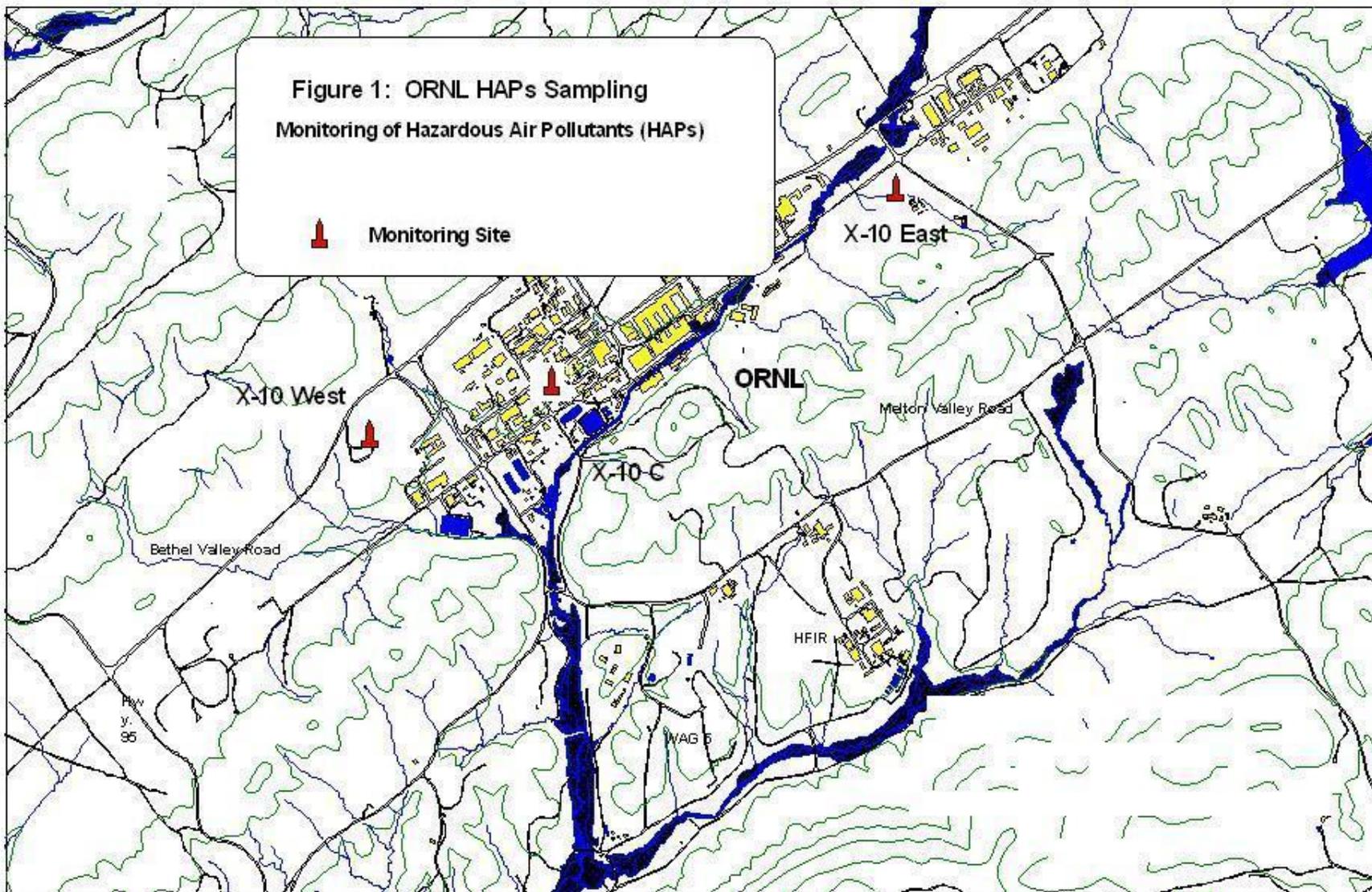


Figure 1: ORNL HAPs Sampling Locations

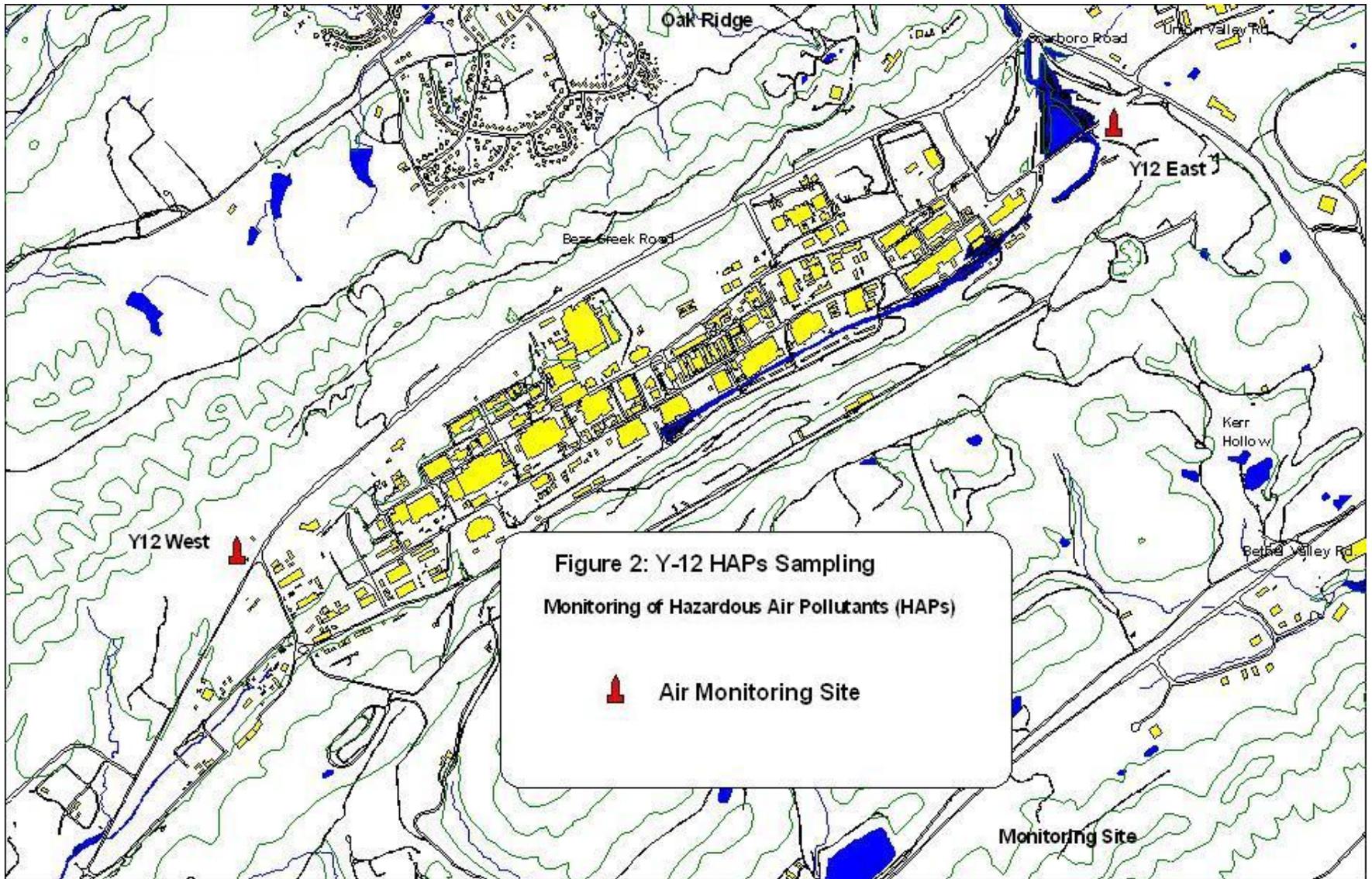


Figure 2: Y-12 HAPs Sampling Locations

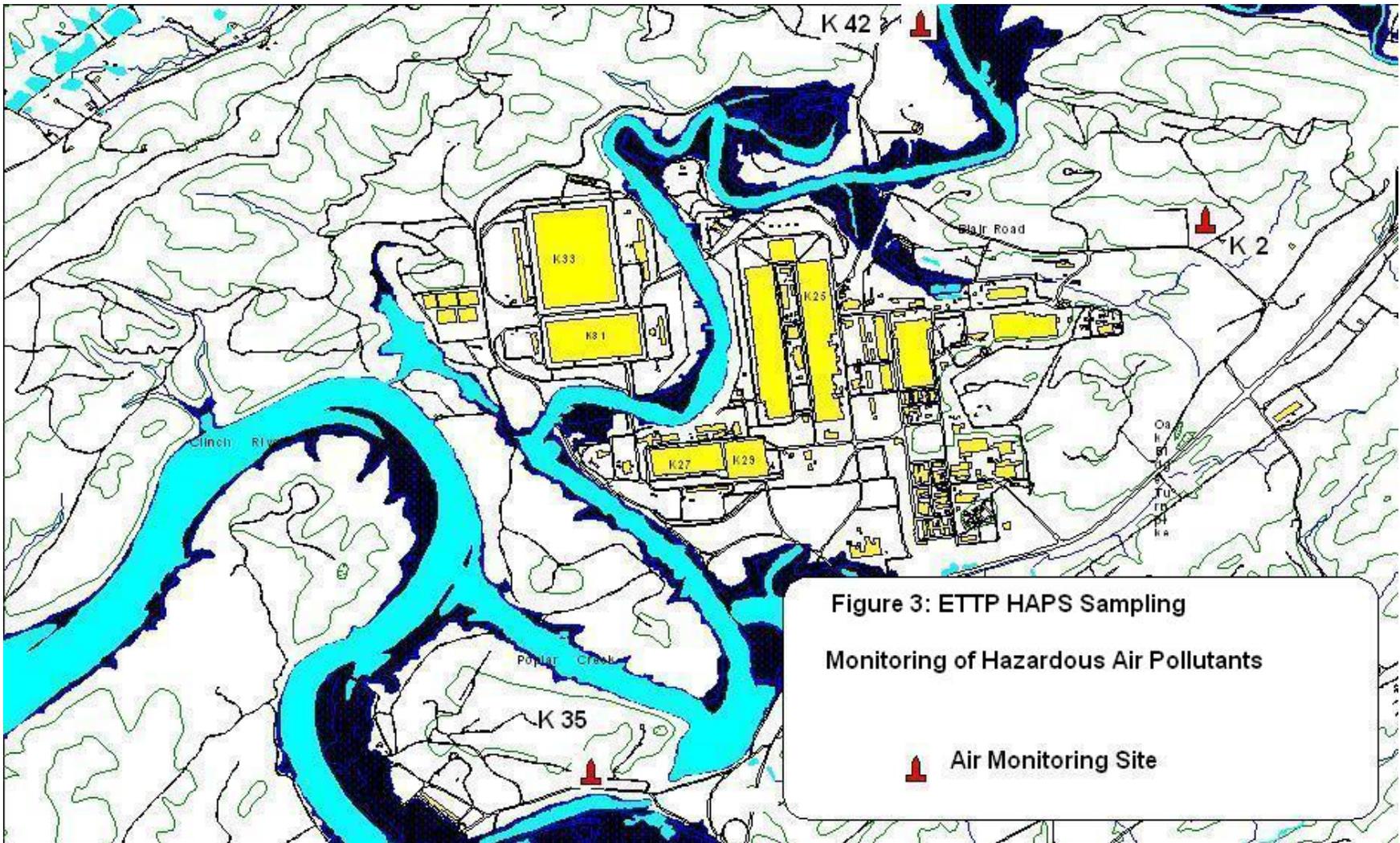


Figure 3: ETTP HAPS Sampling Locations

RadNet Air Monitoring on the Oak Ridge Reservation

Introduction

The Tennessee Department of Environment and Conservation, DOE Oversight Division (the division), will continue to monitor the air at five locations on the Oak Ridge Reservation (ORR) in 2012 with EPA's RadNet Air Monitoring Program. This is one of three main air-monitoring programs used by the division to assess the impact of ORR air emissions on the surrounding environment. The program also assesses the effectiveness of DOE controls and monitoring systems. The other two air-monitoring programs, Perimeter Air Monitoring and Fugitive Air Monitoring (described in associated plans) focus on monitoring at exit pathways, diffuse emissions, and sites of special interest (e.g., remedial sites). There is an additional air-monitoring program, which samples the air indirectly via precipitation (described in the RadNet Precipitation Monitoring plan). The division's participation in EPA's RadNet Air Program targets specific operations (e.g., the High Flux Isotope Reactor and D&D at ETTP and Y-12) and provides verification of state and DOE monitoring, via independent third party analysis.

Methods and Materials

The five RadNet air monitors use synthetic fiber filters (ten centimeters in diameter) to collect particulates as air is pulled through the units at approximately 60 cubic meters per hour (about 35 cubic feet per minute). The monitors are operated continuously and the filters will be changed twice weekly (Monday and Thursday) by division staff. The quantity of radioactivity on each filter will be estimated by staff, using a radiation detector, in accordance with the RadNet Standard Operating Procedure. The filters will then be mailed to EPA's National Air and Radiation Environmental Laboratory (NAREL) in Montgomery, Alabama for analysis. Each RadNet air monitor will undergo calibration verification quarterly and undergo full calibration at least annually. The sampling results received from NAREL will be compared to data collected in the fugitive air monitoring program (to verify the quality of state analysis) and to the Clean Air Act (to assess compliance with applicable standards). Analytical parameters and frequencies for the RadNet Air Monitoring Program are provided in Table 1. Results from these analyses will be provided to the division and will be available on EPA's RadNet website (<http://www.epa.gov/enviro/facts/radnet/index.html>) via a link, or directly via the EPA searchable Envirofacts database (http://iaspub.epa.gov/enviro/erams_query_v2.simple_query). The approximate locations of the five RadNet air monitoring stations are depicted in Figure 1.

Table 1: EPA Analysis of RadNet Air Samples

ANALYSIS	FREQUENCY
Gross Beta	Twice weekly on each sample
Gamma scan (conditional)	When samples are found to have > 1 pCi/m ³ in the gross beta analysis
Plutonium-238, Plutonium-239, Plutonium-240 Uranium-234, Uranium-235, Uranium-238	Annually on composites of the air particulate filters

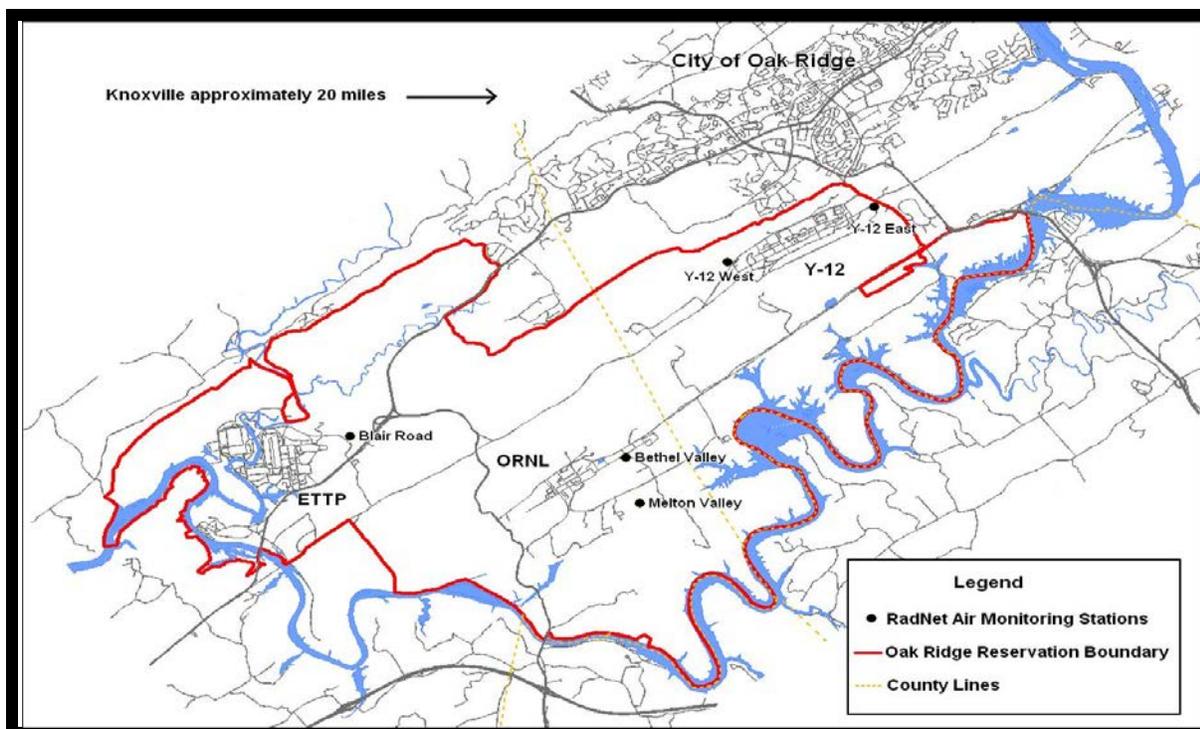


Figure 1: Approximate Locations of Air Stations Monitored in Association with EPA’s RadNet Air Program on the Oak Ridge Reservation

References

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement between the U.S. Department of Energy and the State of Tennessee*, DOE Oversight Division. Oak Ridge, Tennessee, 2011.

United States Environmental Protection Agency, *Environmental Radiation Ambient Monitoring System (ERAMS) Manual*, Doc. EPA 520/5-84-007, 008, 009. Washington: GPO. May 1988.

United States Environmental Protection Agency, National Air and Radiation Environmental Laboratory. http://iaspub.epa.gov/enviro/erams_query_v2.simple_query (Last updated August 24, 2011).

United States Environmental Protection Agency, National Air and Radiation Environmental Laboratory. <http://www.epa.gov/enviro/facts/radnet/index.html> (Last updated March 31, 2011).

United States Environmental Protection Agency, *RadNet Standard Operating Procedure 3, RadNet/SOP-3*. National Air and Radiation Environmental Laboratory, Monitoring and Analytical Services Branch. Montgomery, Alabama. June 2006.

Yard, C.R., *Health and Safety Plan*, Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Monitoring Fugitive Radioactive Air Emission on the Oak Ridge Reservation

Introduction

In 2012, the Tennessee Department of Environment and Conservation, Department of Energy (DOE) Oversight Division, with the cooperation of the DOE and its contractors, will continue monitoring for fugitive radioactive air emissions on and in the vicinity of the Oak Ridge Reservation. This program uses mobile high-volume air samplers to supplement air monitoring performed at fixed locations. The high-volume air monitors, along with more frequent sampling and analysis, provide greater measurement sensitivity and resolution than can be achieved with the low-volume monitors used in the division's Perimeter Air Program. Monitoring performed with the mobile units will primarily focus on nonpoint sources of air emissions and sites of special interest.

Methods and Materials

Currently, the division is deploying seven high-volume air monitors with a potential to deploy an eighth station around the Oak Ridge Reservation. The seven fugitive monitoring stations for 2012 are listed in Table 1. A potential eighth location could be placed near the Jack Case Center and east of Building 9212. The eighth location is a replacement for perimeter air (low volume) monitoring location number 5 at Y-12, which was abandoned in 2011. A decision on the eighth station will be made pending a review of all the low volume data and planned remedial activities in the immediate vicinity.

Table 1: Current Fugitive Monitoring Station

Station Identification	Activities Monitored
Fort Loudoun	Background
ETTP Portal 4	K-25, K-27, K-33 remedial activities
K-25 K-11	K-25, K-33, and K-1073-B remedial activities
EMWWMF	Disposal activities at EMWWMF
Y-12 B9223-28	Primary downwind direction of Y-12 facility reduction activities
ORNL B4007	Primary downwind direction of the central campus remedial activities
ORNL Corehole 8	Corehole 8 and the central campus remedial activities

The high-volume monitors use 8x10-inch glass fiber filters to collect particulates as air is pulled through the system at a rate of approximately 35 cubic feet per minute. The filters will be collected weekly and shipped to the State of Tennessee's Environmental Laboratory in Nashville, Tennessee, for analysis in accordance with the procedures outlined in Standard Operating Procedure (SOP) 201: Fugitive High Volume Sample Collection. Instrument calibrations will be performed quarterly in accordance to SOP 202: Calibrating High Volume Total Suspended Particulate Samplers. Instrument maintenance will be performed in accordance to SOP 203: High Volume Total Suspended Particulate System Maintenance.

Analytical parameters will include gross alpha, gross beta, and gamma spectrometry. The results will be compared to background values to determine if releases are occurring. Since the Clean Air Act (CAA) does not provide limits for gross activities, radionuclide specific analysis will be

performed where the gross results indicate significant spikes, upward trends, consistently elevated results, and/or exceeded screening levels. The screening levels for gross measurements will be based on CAA limits for uranium-235 for alpha emitters ($9.9 \text{ E-15 } \mu\text{Ci/ml}$ above background) and strontium-90 for beta emitters ($40.9 \text{ E-15 } \mu\text{Ci/ml}$ above background). Any gross measurements exceeding these criteria will require isotopic analysis to identify the major radionuclides present in the sample and each radionuclide's concentration. These concentrations will then be used to assess compliance with the CAA.

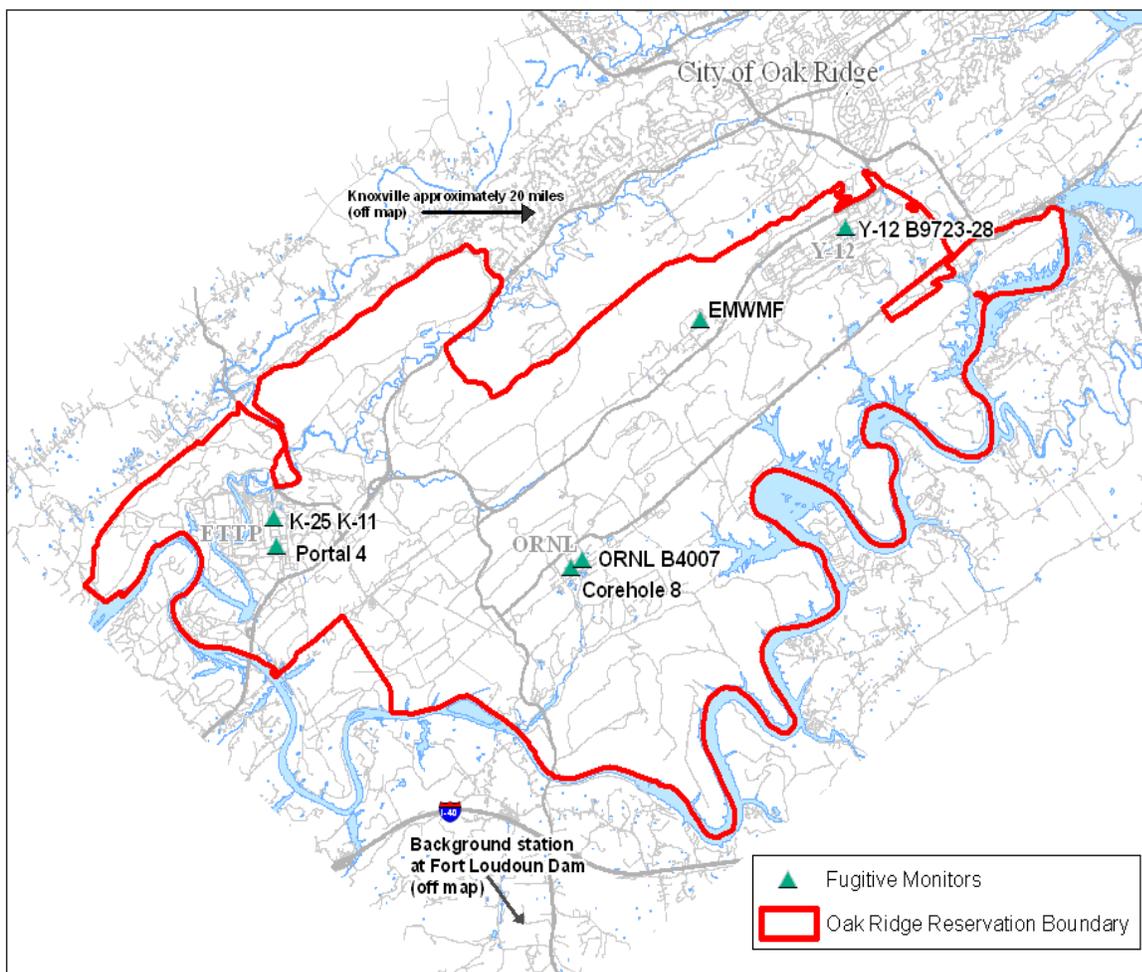


Figure 1: Fugitive Air Monitoring Locations

References

National Emissions Standards for Hazardous Air Pollutants (NESHAPS), Clean Air Act, Title 40 CFR Part 61, Subpart H. U.S. Environmental Protection Agency, 1994.

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*, DOE Oversight Division, Oak Ridge, Tennessee. 2011.

Yard, C.R., *Health and Safety Plan*, Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Perimeter Air (Low Volume) Monitoring on the Oak Ridge Reservation

Introduction

The Tennessee Department of Environment and Conservation, DOE Oversight Division, with the cooperation of DOE, will provide radiochemical analysis of air samples taken from eleven perimeter air (low-volume) air monitors placed at locations considered to be the most likely pathways for airborne contaminants migrating off the Oak Ridge Reservation (ORR). Data are used to:

- assess the impact of DOE activities on the public health and environment
- identify and characterize unplanned releases
- establish trends in air quality
- verify data generated by DOE and its contractors

Methods and Materials

The eleven air monitors used in the program are owned by the Department of Energy (DOE) and DOE contractors are responsible for their maintenance and calibration. Nine of the units are a component of DOE's ORR perimeter air monitoring system, which includes a background station. The two remaining monitors were previously used by the Y-12 complex in their perimeter air monitoring program. Each of the monitors use forty-seven millimeter borosilicate glass fiber filters to collect particulates as air is pulled through the units. The ORR perimeter monitors employ a pump and flow controller to maintain airflow through the filters at approximately two standard cubic feet per minute. The Y-12 monitors control airflow with a pump and rotometer set to average approximately two standard cubic feet per minute.

Air filters from the monitors will be collected bi-weekly and sent to the state's radiochemical laboratory in Nashville, Tennessee for analysis. Initial analysis will include gross alpha and gross beta on the biweekly samples and gamma spectrometry annually on composite samples. The results will be compared to background values to determine if releases have occurred. Radionuclide specific analysis will be performed where the gross results indicate significant spikes, upward trends, consistently elevated results, and/or results that exceed screening levels.

The screening levels for gross measurements will be based on Clean Air Act (CAA) limits for uranium-235 for alpha emitters (9.9 E-15 $\mu\text{Ci/ml}$ above background) and strontium-90 for beta emitters (40.9 E-15 $\mu\text{Ci/ml}$ above background). Any gross measurements exceeding these criteria will require isotopic analysis to identify the major radionuclides present in the sample and each radionuclide's concentration. These concentrations will then be used to assess compliance with the CAA.

The eleven air monitoring stations in the program are listed in Table 1 and their locations are depicted in Figure 1. Ten of these stations are located around the perimeter of the ORR and the Y-12 facility. The eleventh site is a background station located near Fort Loudoun Dam in Loudon County.

Table 1: Perimeter Air Monitoring Stations

Station	Location	County
4	Y-12 East at Portal 2	Anderson
8	Y-12 Portal 17 at Outbuilding 9990 (3 rd St and South Patrol Rd)	Anderson
35	East Tennessee Technology Park Southwest on West Connector Rd	Roane
37	Bear Creek at Y-12 / Pine Ridge	Roane
38	Westwood Community (Wisconsin Ave and Whippoorwill Dr)	Roane
39	Cesium Fields at Oak Ridge National Laboratory Services	Roane
40	Y-12 East (at entrance to Y-12)	Anderson
42	East Tennessee Technology Park North off Blair Rd	Roane
46	Scarboro Community (South Dillard Ave)	Anderson
48	Deer Check Station on Bethel Valley Rd	Anderson
52	Fort Loudoun Dam (Background Station)	Loudon

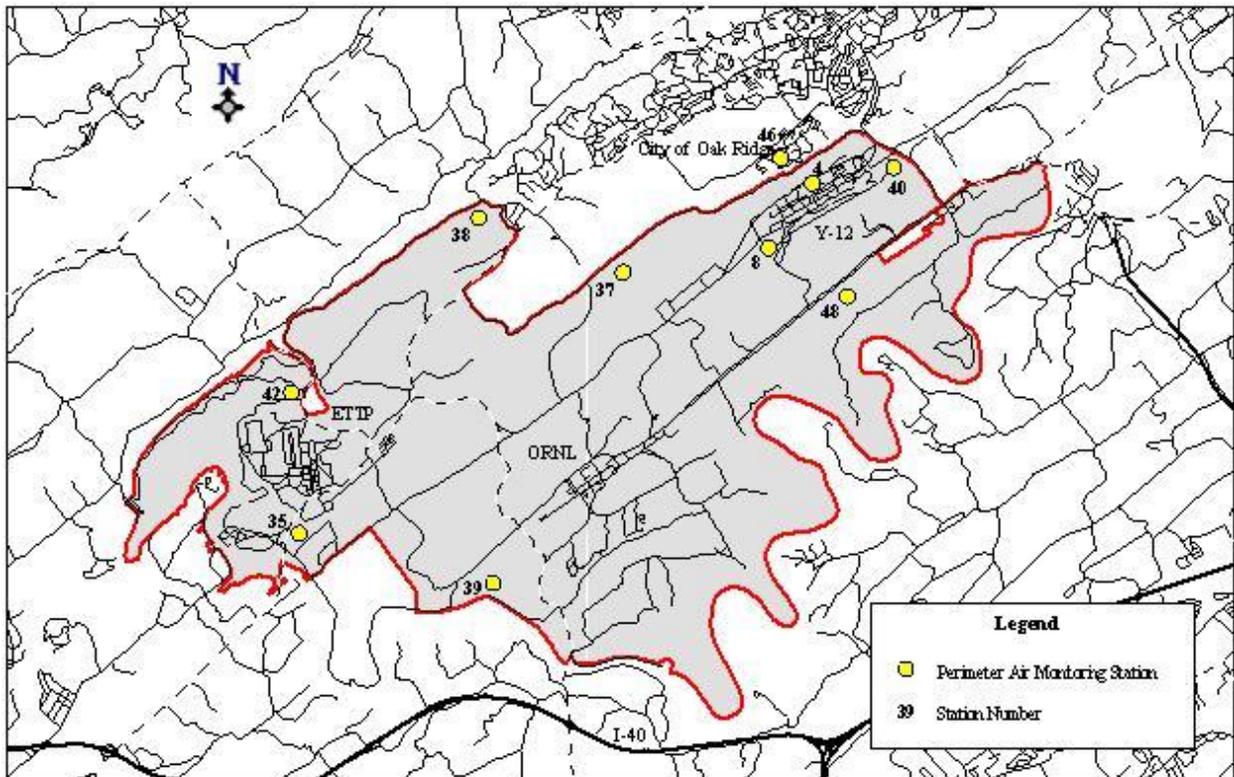


Figure 1: Approximate Locations of Y-12 Perimeter Air Monitoring Stations on the ORR

References

National Emissions Standards for Hazardous Air Pollutants (NESHAPS), Clean Air Act, Title 40 CFR Part 61, Subpart H. U.S. Environmental Protection Agency, 1994.

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*, DOE Oversight Division, Oak Ridge, Tennessee. 2011.

Yard, C.R., *Health and Safety Plan*, Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

RadNet Precipitation Monitoring on the Oak Ridge Reservation

Introduction

The Tennessee Department of Environment and Conservation, DOE Oversight Division (the division), will continue to monitor the air at three locations on the Oak Ridge Reservation in 2012 with EPA's RadNet Precipitation Monitoring Program. Precipitation monitoring was added to the RadNet program on the Oak Ridge Reservation in 2005. The project measures radioactive contaminants that are washed out of the atmosphere and carried to the earth's surface by precipitation. There are no standards that apply directly to contaminants in precipitation, but the data provide an indication of the presence of radioactive materials that may not be evident in the particulate samples collected by the division's air monitors. All precipitation samplers are co-located next to RadNet air monitoring locations (described in an associated report) on the Oak Ridge Reservation (Figure 1).

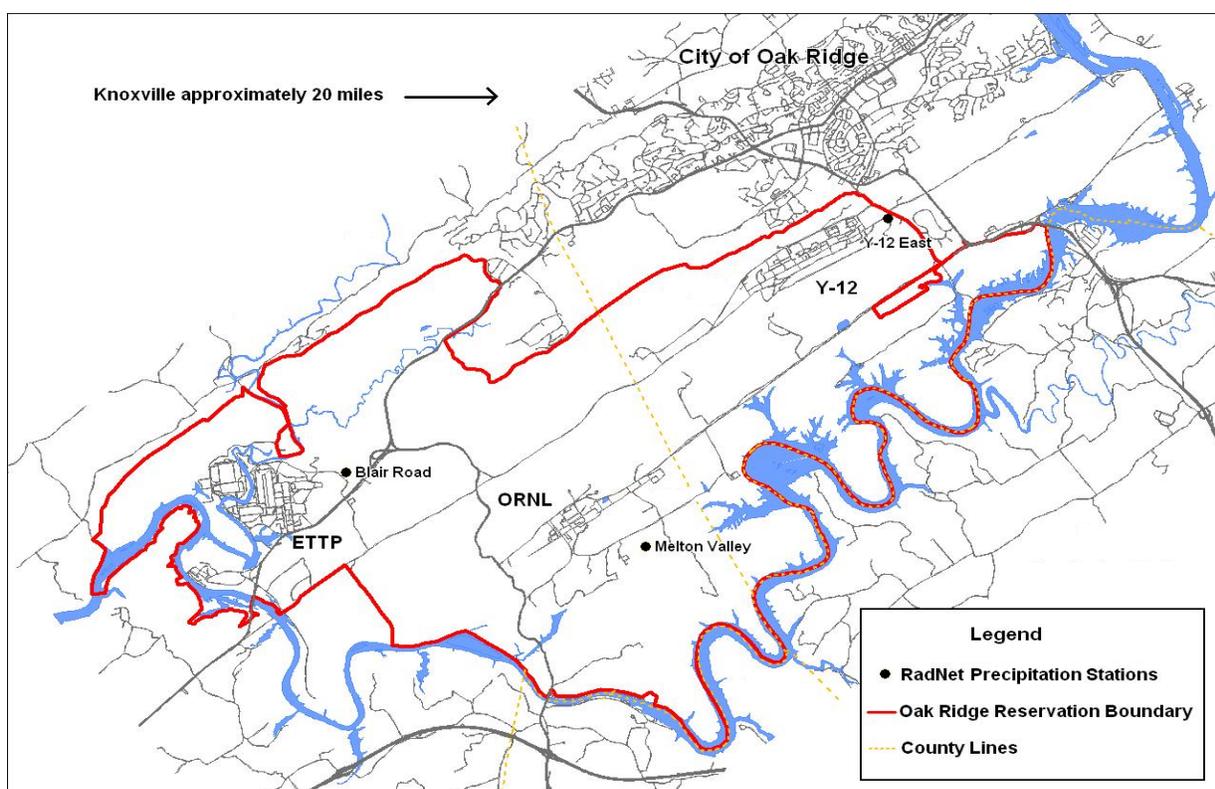


Figure 1: Approximate Locations of Precipitation Stations Monitored in Association with EPA's RadNet Precipitation Program on the Oak Ridge Reservation

One of the radioactive contaminants of concern in the atmosphere above the reservation is tritium. Small amounts of this radionuclide are produced naturally, but the isotope is also released as water vapor in reactor effluents and from evapotranspiration associated with buried wastes. In light of the above, the first precipitation monitor provided by EPA was placed co-located with the RadNet air station near ORNL's High Flux Isotope Reactor and the SWSA 5 (solid waste storage area) burial grounds, the major source area for tritium on the reservation. Tritium data received to date have been among the higher values reported for the RadNet monitoring stations across the nation. It should be noted, however, that Oak Ridge was the only station located near nuclear sources at the time. Another precipitation monitor was placed near

the TSCA Incinerator in April 2007 and is co-located with the Blair Road RadNet air station, east of ETTP. This sampler is now used to monitor D&D at ETTP. The third and final precipitation station is co-located with the RadNet station east of Y-12 and was deployed in March 2008. This station is used to monitor Y-12 and to provide an indication if any tritium is traveling towards the city of Oak Ridge from Melton Valley, where tritium levels are high.

Methods and Materials

The precipitation monitors provided by EPA's RadNet Program will be used to collect samples for the program. Each monitor collects precipitation that falls on a 0.5 square meter fiberglass collector which drains into a five-gallon plastic collection bucket. Each station will be checked twice a week and a sample will be collected from the bucket (using a four-liter cubitainer) when a minimum of one liter of precipitation has accumulated. The sample will then be processed as specified in the *Environmental Radiation Ambient Monitoring System (ERAMS) Manual* (U.S. EPA, 1988) and shipped to EPA's National Air and Radiation Environmental Laboratory in Montgomery, Alabama, for analysis. Results from the gamma and tritium analysis will be provided to the division and will be available on EPA's RadNet website via the EPA searchable Envirofacts database (http://iaspub.epa.gov/enviro/erams_query_v2.simple_query). More information on the program can be found on the EPA RadNet webpage (<http://www.epa.gov/radnet>). The data will be used to identify anomalies in radiological contaminant levels to assess the significance of precipitation in contaminant pathways, to evaluate associated control measures, and to appraise conditions on the Oak Ridge Reservation compared to other locations in the RadNet program.

References

- Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement between the U.S. Department of Energy and the State of Tennessee*. DOE Oversight Division. Oak Ridge, Tennessee. 2011.
- United States Environmental Protection Agency. *Environmental Radiation Ambient Monitoring System (ERAMS) Manual*. Doc. EPA 520/5-84-007, 008, 009. Washington: GPO. May, 1988.
- United States Environmental Protection Agency. National Air and Radiation Environmental Laboratory. http://iaspub.epa.gov/enviro/erams_query_v2.simple_query (Last updated August 31, 2011).
- United States Environmental Protection Agency. National Air and Radiation Environmental Laboratory. <http://www.epa.gov/radnet> (Last updated August 31, 2011).
- Yard, C.R., *Health and Safety Plan*, Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

BIOLOGICAL MONITORING

Benthic Macroinvertebrate Monitoring

Project Description

The objective of this monitoring program is to perform biological monitoring on streams affected by the U.S. Department of Energy (DOE) activities and practices on the Oak Ridge Reservation (ORR). Methods outlined in the *State of Tennessee Department of Environment and Conservation (TDEC), Division of Water Pollution Control (WPC) Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys* (TDEC 2011) will drive the project.

Introduction

Because benthic macroinvertebrates are relatively sedentary and long-lived, they are excellent indicators of the “overall health” of an aquatic system. In systems where the source of the toxicant is non-point (e.g. runoff or seeps) or where the combined effects of pollutants in a complex effluent exceed individual toxicity, benthic macroinvertebrate communities may be one of the only means of evaluation. Hence, macroinvertebrates are used by biologists as indicator organisms (i.e., habitat assessments) to determine if a stream is supporting fish and aquatic life

Benthic macroinvertebrates are collected from various ORR streams and analyzed to measure the degree of impact from past and present DOE operations. The division conducts annual semi-quantitative biomonitoring on the following ORR watersheds: Bear Creek, Mitchell Branch, White Oak Creek, Melton Branch, and East Fork Poplar Creek. Benthic samples are also collected from Clear Creek near Norris Dam which serves as an ecoregion reference site for all ORR test sites.

Methods and Materials

During 2012, benthic macroinvertebrate samples will be collected and processed following TDEC Water Pollution Control (WPC) standard operating procedures (SOP, TDEC 2011). The semi-quantitative Riffle Kick (SQKICK) collection technique for single habitat analysis will be used. This test method involves standing in a body of water, kicking up sediment and catching the suspended organisms in a 1-m square kick net. Two SQKICK samples will be collected at each station and combined into one sample. A riffle kick is done in relatively fast-moving water and a run kick in slower-moving water. Care will be taken to avoid losing sample material from the sides or bottom of the net. Another method is the undercut bank jab, done by sampling the sediment below water level in a bank area that may be partially obscured by brush or partially submerged tree roots.

Samples will be collected from two riffles at each site. Both samples will be combined and transferred into one sample container. The container will be labeled internally and externally with site-specific information and stored in the TDEC DOE-O laboratory for future processing. Standard methods will be altered when sampling lower White Oak Creek due to the presence of radioactive contamination in the stream sediment. The two kick samples will be combined in a five-gallon bucket, creek water will be added and the sample swirled to suspend the lighter material (invertebrates), which will then be poured through a sieve. This process will be repeated

five times, collecting the majority of organisms. Any material not used will be returned to the creek.

Water quality data will be collected at each sampling location including pH, temperature, dissolved oxygen, conductivity (YSI 556 MPS Multiprobe System), stream flow (Sontek Flowtracker), and photosynthetic light (densiometer). Benthic surface water quality samples will be collected during spring 2012 (Table 1). Habitat assessment forms will be recorded at each benthic sampling location per the methods prescribed by the TDEC Water Pollution Control Division (TDEC 2011). All work associated with this program will be in compliance with the division's *Health, Safety, and Security Plan* (Yard 2011).

Once collections have been made at all sites, the semi-quantitative samples will be processed in-house by division staff with expertise in macroinvertebrate taxonomy. Sample analyses will include the identification and enumeration of the benthic macroinvertebrates to genus. Using the raw benthic data from the semi-quantitative sub-samples, a numerical value will be generated for seven biometrics. These metrics include (1) EPT (*Ephemeroptera*, *Plecoptera*, and *Trichoptera*) richness, (2) taxa richness, (3) percent OC (oligochaetes and chironomids), (4) percent EPT (EPT abundance), (5) NCBI (North Carolina Biotic Index), (6) percent nutrient tolerant, and (7) percent clingers (contribution of organisms that build fixed retreats or that have adapted to attach to surfaces in flowing waters). After values have been calculated for the metrics, a score of 0, 2, 4, or 6 is assigned to each metric based on comparison to the ecoregion reference database. The seven scores are totaled and the site's biological condition is determined (i.e., fully supporting, etc). Metric equations and the biocriteria used to determine biological condition can be obtained by referring to the TDEC WPC SOP (TDEC WPC 2010). Division data will be compared to TDEC Protocol benthic sampling data compiled by biologists with the Oak Ridge National Laboratory Biological Monitoring and Abatement Program (ORNL BMAP). In order to validate species-level taxonomy, light trapping and other collection methods may be employed to trap adult insects in ORR streams and springs during 2012 (DeWalt and Webb 1998, Weinzierl et al. 2005, Nowinszky et al. 2010).

Sampling Locations in Kilometers (mile equivalents) for RBP III Semi-Quantitative Sites (Figures 1-5):

East Fork Poplar Creek: EFK 25.1 (15.6), EFK 24.4 (15.2), EFK 23.4 (14.5), EFK 13.8 (8.6), and EFK 6.3 (3.9). Reference site: Hinds Creek HCK 20.6 (12.8).

Bear Creek: BCK 12.3 (7.6) and BCK 9.6 (6.0). Reference sites: Gum Hollow Branch GHK 2.9 (1.7), Mill Branch MBK 1.6 (1.0).

Mitchell Branch Creek: MIK 0.71 (0.44) and MIK 0.45 (0.28). Reference sites: MIK 1.43 (0.89).

White Oak Creek: WCK 2.3 (1.4), WCK 3.4 (2.1), and WCK 3.9 (2.4). Reference site: WCK 6.8 (4.2).

Melton Branch: MEK 0.3 (0.2)

Clear Creek: CCK 1.45 (ecoregion reference site).

Weather permitting, field sampling will be completed within a four week time span in April and May 2012.

Table 1: List of Analytes for Surface Water Samples

Arsenic (As)	Gross beta
Cadmium (Cd)	Gamma spec
Chromium (Cr)	Nitrogen, NO ₂ , NO ₃ , & ammonia
Hexavalent Cr (Mitchell Br.)	Total Kjeldahl nitrogen
Copper (Cu)	Total phosphorus
Iron (Fe)	Dissolved residue
Lead (Pb)	Suspended residue
Manganese (Mn)	Hardness, total, as CaCO ₃
Zinc (Zn)	Sulfates (East Fork Poplar Cr.)
Gross alpha	

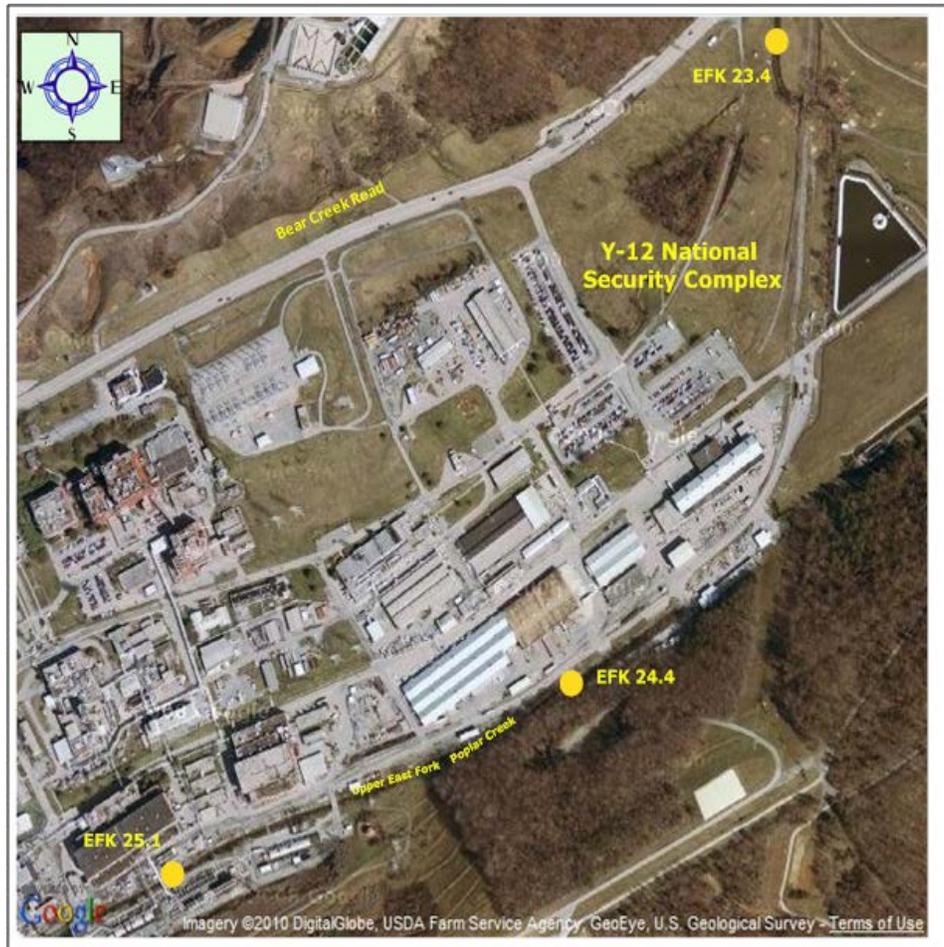


Figure 1: Upper East Fork Poplar Creek / Y-12 Plant

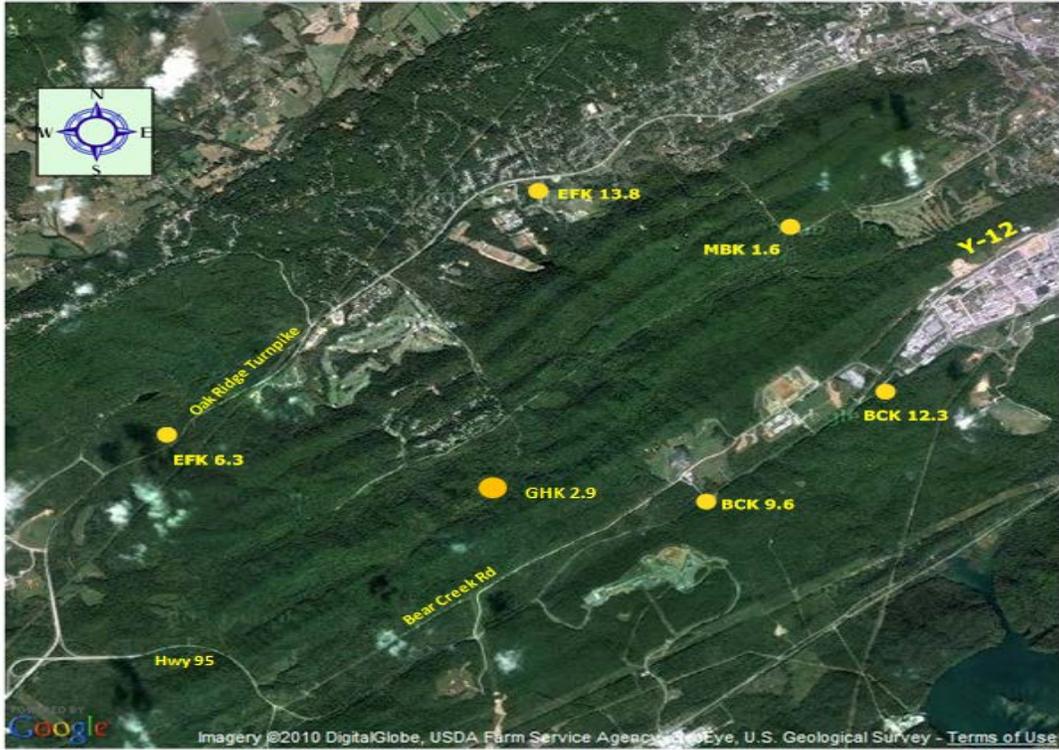


Figure 2: East Fork Poplar Creek / Bear Creek Watersheds



Figure 3: Clear Creek and Hinds Creek Reference Sites



Figure 4: White Oak Creek / Melton Branch Watersheds (ORNL)

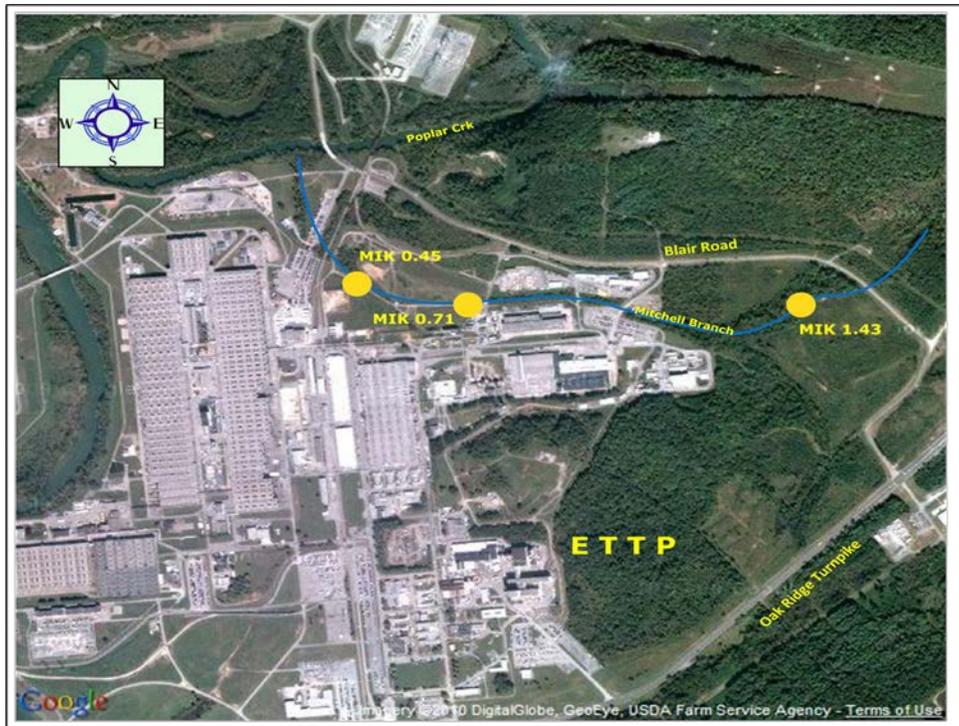


Figure 5: Mitchell Branch Watershed (ETTP)

References

Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, U.S. Environmental Protection Agency, Region IV, 960 College Station Road, Athens, Georgia. 1996.

Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys, Tennessee Department of Environment and Conservation, Division of Water Pollution Control, November 2003, Revision, July 2011.

Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee, Tennessee Department of Environment and Conservation DOE Oversight Division, Oak Ridge, Tennessee. 2011.

Yard, C.R. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Periphyton Monitoring

Introduction

During 2012, the division will continue efforts to characterize diatom assemblages for water quality assessment of impacted watershed streams on the Oak Ridge Reservation (ORR). The goal of this monitoring program is to monitor temporal changes in periphyton biomass and community composition in response to remedial actions affected by activities and practices on the ORR. Methodology for the project will follow periphyton survey as outlined in the Tennessee Department of Environment and Conservation (TDEC) Division of Water Pollution Control (WPC) *Regional Characterization of Streams in Tennessee with Emphasis on Diurnal Dissolved Oxygen, Nutrients, Habitat, Geomorphology and Macroinvertebrates* (Arnwine et al. 2005). Periphyton samples will be collected quarterly from natural substrates in the Bear Creek watershed and a reference site. The main objectives of the project include: (1) determine diatom composition and abundance of the periphyton community in the Bear Creek watershed, (2) investigate longitudinal variation in diatom populations downstream from DOE pollution sources, (3) complement the division's comprehensive and integrated monitoring and surveillance programs for all media (i.e., surface water, groundwater, sediments, biological communities) and emissions of hazardous substances on the ORR, and (4) support the TDEC WPC efforts with the development of a diatom pollution index for the State of Tennessee.

Because periphyton assemblages are attached to natural substrates, the benthic algae community responds to biological and physiochemical disturbances that occur longitudinally in a stream reach during algal colonization (Medley & Clements 1998). Benthic algae and diatoms are primary producers in the food web and the literature suggests they are excellent biological indicators for many types of pollution in aquatic systems (Dixit et al. 1992, Kelly et al. 1995, Stevenson & Pan 1999). Periphyton communities contain many diatom taxa with individual tolerances to anthropogenic stressors such as elevated concentrations of heavy metals and high nutrient loads (Deniseger et al. 1986, Takamura et al. 1989, Medley & Clements 1998). Thus, by examining diatom community assemblages, and determining shifts in species composition and structure over time, impaired water quality trends can be detected (Patrick 1973).

Methods and Materials

Periphyton will be sampled quarterly at six stream riffle zone sites (Figure 1) within the Bear Creek (BCK) watershed and associated reference locations [Figure 2, in stream kilometers (miles)]:

- Bear Creek: BCK 12.3 (7.6), BCK 9.6 (5.9), NT-3, NT-5 and NT-6.
- Reference site(s): Mill Branch / MBK 1.6 (1.0) or Gum Hollow Branch / GHK 2.9 (1.8).

The significance of the bioassessment of Bear Creek in 2012 is that clear diatom responses to Bear Creek impacts were documented in the data during 2006-07 monitoring of BCK 12.3 and BCK 9.6 sites (*see* 2007 TDEC Environmental Monitoring Report). Further, the outfall from the EMWMF site (NT-3, NT-4 & NT-5) into Bear Creek may generate additional variables impacting the periphyton community due to waste disposals since 2007.

Division staff will collect benthic algae samples from natural substrates (i.e., stream cobbles and sediments, small rocks). Water temperature, conductivity, total dissolved oxygen and pH measurements will also be determined during each sampling event (Horiba U-10[®] Water Quality Checker) and recorded in the field logbook. Additional real-time field data may be collected including stream flow velocity, water depths and photosynthetic light data.

In the field, three or four submerged rocks (size ~10-15 cm² each) with attached periphyton will be randomly selected at each stream site and later composited into one sample (W. R. Hill, *in* Adams et al. 1998, Barbour et al. 1999, Moulton II et al. 2002, Ponader & Charles 2005). Rocks will be placed in labeled, double-bagged one-gallon lockable baggies and then in an ice chest for transport. Volumetric determinations of algal biomass removed from the rocks will be determined by the aluminum foil gravimetric method (Carr et al. 2005, Ponader & Charles 2005).

Samples will be examined in-house by division staff using the Olympus[®] BH-1stereo microscope and the TrueVision[®] XSP15B stereo microscope (w/ PupilCam[®] digital camera), and the Zeiss[®] inverted microscope (on loan to TDEC). Identifications will be determined on both fresh sample material and cleaned diatoms. To clean diatoms, they must be boiled in an acid bath to clear their frustules of organic and intercellular material (Hill and Boston 1991, KDOW 2008). The cell wall structure, ornamentation, size, and shape of siliceous frustules are the main diagnostic characters for taxonomic keying of diatom taxa (Stoermer and Smol 1999). Taxonomic identification sources will include: Smith (1950), Patrick & Reimer (1966, 1975), and Wehr & Sheath (2003).

Enumeration of diatom cells in each sample will involve examining 2.45 ml of sample slurry in a settling chamber using the Zeiss[®] inverted microscope. For consistency, at least ten microscope FOVs (fields-of-view) will be counted to obtain a cell count of +500, or continue counting FOV until 500 cells are determined per sample. During enumeration, diatom taxa counts will be recorded on laboratory bench sheets and organized by genus. Non-diatom taxa (e.g., filamentous green algae, desmids, dinoflagellates) will also be recorded and counted following the protocol of the KDOW (2008). Periphyton samples with very low biomass may require counting up to a maximum of 100 FOV. The laboratory method for counting diatoms in microscope slides will follow the protocols of Hill and Boston (1991) and KDOW (2008).

The identification and counting of algal taxa will be used in a set of six metrics to compute a score for individual streams versus a reference. The reader is referred to TDEC WPC's *Quality System Standard Operating Procedure for Periphyton Stream Surveys* for details (TDEC WPC 2010).

Quality Control

Replicate samples will be collected and analyzed at 10% of the ORR monitoring sites to evaluate precision or repeatability of sampling technique and taxonomy. Quality assurance/quality control (QA/QC) samples should be counted by another taxonomist (or outside laboratory) to assess taxonomic precision and bias. These laboratory QA/QC procedures adhere to EPA methods for assessing periphyton communities in lotic systems as outlined in Barbour et al. (1999) and Moulton et al. (2002).

Protocol F – Rapid Periphyton Survey

New for 2012, the division will conduct the Rapid Periphyton Survey and a Multi-habitat Periphyton Sample for ORR streams. Methods and materials for these procedures can be found in TDEC Water Pollution Control’s *Quality System Standard Operating Procedure for Periphyton Stream Surveys* (TDEC WPC 2010). This method has been adapted from EPA’s *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (1999).



Figure 1: North Tributary and Bear Creek periphyton sampling locations.



Figure 2: Mill Branch and Gum Hollow periphyton reference streams.

References

- Adams, S. M., T. W. Beaty, C. C. Brandt, D. S. Cicerone, S. W. Christensen, M. S. Greeley, Jr., W. R. Hill, L. A. Kszos, J. F. McCarthy, M. J. Peterson, M. G. Ryon, J. G. Smith, G. R. Southworth, A. J. Stewart, & L. F. Wicker. *Biological Monitoring Program for East Fork Poplar Creek*. YTS-1194 (Rev.25). Oak Ridge National Laboratory, Environmental Sciences Division. Oak Ridge, TN. 1998.
- Arnwine, D. H., R. R. James, and K. J. Sparks. *Regional Characterization of Streams in Tennessee with Emphasis on Diurnal Dissolved Oxygen, Nutrients, Habitat, Geomorphology and Macroinvertebrates*. Tennessee Department of Environment and Conservation. Division of Water Pollution Control. Nashville, TN. 2005.
- Bahls, L. L. *Periphyton Bioassessment Methods for Montana Streams*. Department of Health and Environmental Sciences, Water Quality Bureau, Helena, MT. 1999.
- Barbour, M.T., J. Gerritsen, B. D. Snyder, & J. B. Stribling. *Rapid Bioassessment for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish*. Second Edition. EPA 841-B-99-002. U. S. Environmental Protection Agency. Office of Water. Washington, D.C. 1999.
- Brennan, S. R., and J. H. Withgott. *Environment: The Science Behind the Stories*. Pearson/Benjamin Cummings Publishers, San Francisco, California. 2004.
- Carr, G. M., A. Morin, & P. A. Chambers. *Bacteria and Algae in Stream Periphyton Along a Nutrient Gradient*. Freshwater Biology 50:1337-1350. 2005.
- Deniseger, J., A. Austin, and W. P. Lucey. *Periphyton Communities in a Pristine Mountain Stream Above and Below Heavy Metal Mining Operations*. Freshwater Biology 16:209-218. 1986.
- Dixit, S. S., J. P. Smol, J. C. Kingston, and D. F. Charles. *Diatoms: Powerful Indicators of Environmental Change*. Environmental Science Technology 26:23-33. 1992.
- Google Imagery 2010 *DigitalGlobe*, USDA Farm Service Agency. GeoEye, U.S. Geological Survey
- Hill, W. R., and H. L. Boston. *Community Development Alters Photosynthesis-irradiance Relations in Stream Periphyton*. Limnology and Oceanography 36:1375-1389. 1991.
- Kelly, M. G., C. J. Penney, and B. A. Whitton. *Comparative Performance of Benthic Diatom Indices to Assess River Water Quality*. Hydrobiologia 302: 179-188. 1995.
- Kentucky Department of Water (KDOW). *Methods for Assessing Biological Integrity of Surface Waters of Kentucky*. Natural Resources and Environmental Protection Cabinet. Kentucky Department of Environmental Protection. Division of Water. Water Quality Branch. Frankfort, KY. 2008.

- Lange-Bertalot, H. *Pollution Tolerance of Diatoms as a Criterion for Water Quality Estimation*. Nova Hedwigia 64: 285-304. 1979.
- Medley, C. N., & W. H. Clements. *Responses of Diatom Communities to Heavy Metals in Streams: The Influence of Longitudinal Variation*. Ecological Applications 8(3), 1998, pp. 631-644, Ecological Society of America. Dept. of Fishery & Wildlife Biology, Colorado State University, Fort Collins, CO. 1998.
- Moulton II, S. R., J. G. Kennen, R. M. Goldstein and J. A. Hambrook. *Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities as Part of the National Water-Quality Assessment Program*. Open-File Report 02-150. Department of the Interior U. S. Geological Survey. Reston, VA. 2002.
- Patrick, R., and C. W. Reimer. *The Diatoms of the United States, Exclusive of Alaska and Hawaii* Volume 1 Academy of Natural Sciences Monograph Number 13. Philadelphia, Pennsylvania. 1966.
- Patrick, R. *Use of Algae, Especially Diatoms, in the Assessment of Water Quality* Biological Methods for the Assessment of Water Quality (Edited by Cairns, J. and Dichson, K.I.), pp. 76-95. ASTM, Philadelphia. 1973.
- Patrick, R. and C. W. Reimer. *The Diatoms of the United States, Exclusive of Alaska and Hawaii* Volume 2, Part 1. Academy of Natural Sciences Monograph Number 13 Philadelphia, Pennsylvania. 1975.
- Ponader, K. and D. Charles. *New Jersey Periphyton Bioassessment Development Project—Trophic Diatom Interface Models and Index for New Jersey Wadeable Streams—Year 5*. New Jersey Department of Environmental Protection, Division of Science, Research and Technology (DRST). Trenton, NJ. 2005.
- Porter, S. D., T. F. Cuffney, M. E. Gurtz, & M. R. Meador. *Methods for Collecting Algal Samples as Part of the National Water-Quality Assessment Program (NAWQA)*. Department of the Interior. U.S. Geological Survey Open File Report 93-409. Raleigh, NC. 1993.
- Sabater, S., E. Navarro, & H. Guasch. *Effects of Copper on Algal Communities at Different Current Velocities*. Journal of Phycology 14:391-398. 2002.
- Smith, G.M. *The Freshwater Algae of the United States*. Second edition. McGraw-Hill Book Company. New York, New York. 1950.
- Stevenson, R. J., and Y. Pan. *Assessing Ecological Conditions in Rivers and Streams with Diatoms*. Pages 11-40 in E. F. Stoemer and J. P. Smol, editors. The Diatoms: Applications to the Environmental and Earth Sciences. Cambridge University Press, Cambridge, United Kingdom. 1999.

Stoermer, E.F., and Smol, J.P. *The Diatoms: Applications for the Environmental and Earth Sciences*. Cambridge University Press, Cambridge, U.K. 1999.

Takamura, N., F. Kasai, and M. M. Watanabe. *Effects of Cu, Cd, and Zn on Photosynthesis of Freshwater Benthic Algae*. Journal of Applied Phycology 1:39-52. 1989.

Tennessee Department of Environment and Conservation *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee* DOE-Oversight Division, Oak Ridge, Tennessee. 2011.

Tennessee Department of Environment and Conservation *Environmental Monitoring Report* DOE-Oversight Division, Oak Ridge, Tennessee. 2007.

Tennessee Department of Environment and Conservation *Quality System Standard Operating Procedures for Periphyton Stream Surveys* Division of Water Pollution Control, Nashville, Tennessee. 2010.

Vitousek, P. M., H. A. Mooney, J. Lubchenko, and J. M. Melillo. *Human Domination of Earth's Ecosystems*. Science 277:494-499. 1997.

Wehr, J. D., and R.G. Sheath, editors. *Freshwater Algae of North America: Ecology and Classification*. Academic Press (Elsevier Science). New York, New York. 2003.

Yard, C. R. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2010.

Canada Geese Monitoring

Introduction

A large population of Canada geese, both resident and transient, visits the Oak Ridge Reservation (ORR). While migratory geese have always visited East Tennessee, Tennessee Valley Authority (TVA) and the Tennessee Wildlife Resources Agency (TWRA) introduced the resident population to the Melton Hill region in 1972. Geese prefer to eat grass, but will also eat water plants including root nodules from bottom sediment. Studies in the 1980s demonstrated that geese associated with the contaminated ponds and lakes on the ORR can accumulate radioactive contaminants quickly and that contaminated geese frequent off-site locations. The thriving goose population in this area makes this animal an easily accessible food source for area residents. Although hunters are offered the opportunity for a radiological screening of their kills, not many take advantage of this service (TWRA, personal communication).

Geese with elevated levels of Cs-137 in muscle tissue have been found primarily in areas near ORNL. A study in September 1998 found elevated levels of Cs-137 in grass and sediment at two reaches of White Oak Creek south of the 3513 Pond and in grass around the 3524 Pond. Sediment in and around White Oak Lake (WOL) and White Oak Creek has elevated levels of Cs-137. Canada geese have been observed on WOL and throughout the ORNL area. After a flock of radioactive geese was found at ORNL in 1998, DOE took several measures to discourage the geese from using and feeding in contaminated areas. Flagging and fencing were improved and several areas were defoliated. These measures appear to have been successful, with no significantly contaminated geese being captured on or off the reservation from 1999 to 2001. State goose sampling would only take place if any of the geese captured in the 2012 “goose roundup” showed significantly elevated levels of radioactivity (above 5 pCi/g). This would indicate the possibility of radioactively contaminated geese leaving the reservation.

Methods and Materials

During the week preceding the goose roundup, areas around the perimeters of the ORR will be scouted to identify locations of possible populations of geese. This will facilitate activities on the day of collection by predetermining likely locations to sample.

Sampling would take place immediately after the annual ORR Goose Roundup with equipment and assistance from TWRA and ORNL. Geese are molting at this time of year and are nearly flightless. Sampling would take place over a one- to two-day period. Variables such as flock location and ease of capture will affect the schedule. The site selected should be near contaminated vegetation, water, and sediment. An optimum site is the Jones Island area in Loudon County. Geese from this area have access to White Oak Lake and other contaminated ORNL sites. Due to recent movements of populations, the most likely locations will be the Oak Ridge Marina and the Solway Park areas.

Geese would be captured using the same technique as the DOE goose roundup. Eight to fifteen people would slowly converge on a flock of geese forcing them into a temporary enclosure consisting of chicken wire and reinforcing bar. At least 15 individual geese would be captured to assure accuracy of the reading and a representative sample of the flock. Geese would be transported in cages to the TWRA check station for weighing, sexing, and a whole body count.

All activities would be carried out in compliance with the division's *Health, Safety, and Security Plan* (2011).

Results of the whole body count would determine the necessity for further analysis of the geese. If the whole body counts showed the radioactive contamination of the geese to be 5 pCi/g or greater, muscle tissue from the contaminated geese will be radiologically analyzed to confirm the results of the whole body counts and to determine if other contaminants are present. Additional analyses would be for cesium-137, mercury, cadmium, selenium, and lead in the breast and/or leg tissue of geese with whole body counts above 5 pCi/g. Up to six geese (two high, two medium, and two low whole body counts) would be analyzed from a contaminated flock.

Most material will be provided by TWRA. This includes:

- fencing
- cages
- tags

The whole body counters are the property of ORNL and would be operated by their personnel.

References

Tennessee Department of Environment and Conservation. *Standard Operating Procedures*. DOE Oversight Division. Oak Ridge, Tennessee 1996.

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement. Agreement Between the U.S. Department of Energy and the State of Tennessee*. DOE Oversight Division. Oak Ridge, Tennessee. 2011.

United States Environmental Protection Agency. *Environmental Compliance Standard Operating Procedures and Quality Assurance Manual*. Region IV, Environmental Services Division. Atlanta, Georgia. 1991.

United States Environmental Protection Agency. *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual*. Doc: EPA 823-B-01-002. Office of Water. Washington: GPO. 2001.

Yard, C. R. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Aquatic Biota Monitoring on the Oak Ridge Reservation

Introduction

The Tennessee Oversight Agreement (TOA) requires the state to perform monitoring to assess the effectiveness of DOE contaminant control systems on the Oak Ridge Reservation (ORR). If surface water bodies (springs and ponds) have been impacted by radiological contamination, certain aquatic organisms in the immediate vicinity may uptake radionuclides. This program will focus on the detection and characterization of radiological constituents that may be bioaccumulated by aquatic vegetation on and off the Oak Ridge Reservation.

Target vegetation for sampling will include, but will not be limited to: *Rorippa nasturtium-aquaticum* (watercress), *Sparganium americanum* (American bur-reed), and *Typha latifolia* (common cattail).

Locations considered as potential monitoring sites include springs, seeps, streams, creeks, wetlands, and ponds. Watersheds such as Bear Creek and its tributaries, White Oak Creek/Lake and its tributaries, Mitchell Branch, and East Fork Poplar Creek are all probable target locations for sampling.

In 2012, the monitoring will return to the previous sampling locations that had the highest results in order to determine if natural attenuation is occurring. Additionally, locations downstream of current D&D activities will be targeted for sampling in an effort to determine if radiological constituents are migrating into the environment.

Methods and Materials

Aquatic biota samples (watercress, whenever available) will be collected at sites both on and off the ORR, the latter for background data. When necessary, arrangements will be made in advance with appropriate TOA site coordinators to gain access to radiological areas, to obtain radiation worker permits and to arrange for the presence of health physics technicians on an as-needed basis.

At least one gallon of vegetation, including roots but minimal other debris, will be sent to the State of Tennessee Environmental Laboratory in Nashville, Tennessee, for analysis. Samples are analyzed for gross alpha, gross beta, and gamma radionuclides. Additional analysis may be performed if merited. Sampling protocol and quality control methods will follow the guidelines in the division's *Standard Operating Procedures* and *Health and Safety Plan*.

References

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement: Agreement between the U.S. Department of Energy and the State of Tennessee, DOE Oversight Division*. Oak Ridge, Tennessee. 2011.

U.S. Environmental Protection Agency. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, Region IV, Atlanta, Georgia. May 1996.

Yard, C.R., *Health and Safety Plan*, Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Threatened & Endangered Species Monitoring

Introduction

More than 30 rare animal species and twenty-one state-listed and federal-candidate plant species are known to be present on the ORR. More than 1000 different species of plants grow on the reservation, reflecting its diversity. The reservation supports a wide variety of wildlife species including 60 reptilian and amphibian species, 63 fish species, more than 120 species of terrestrial birds, 32 species of waterfowl, wading birds, and shorebirds, and about 40 mammal species (Salk 2004). Habitats supporting the greatest number of species are those dominated by hardwood forests and wetlands. The ORR's plant and animal life is situated in a relatively intact ecosystem that is highly diverse when compared with surrounding areas in the same physiographic province (Mann et al. 1996). All areas of the ORR are relatively pristine when compared with the surrounding region, especially in the Ridge and Valley province. The ORR, consisting of the Oak Ridge National Environmental Research Park and associated lands surrounding DOE facilities at Oak Ridge, Tennessee, is about 15,000 ha of mostly contiguous native forest in the valley and ridge province (Mann et al. 1996). Approximately 20 miles of greenway trails are available for hiking and bicycling on the Black Oak Ridge Conservation Easement (BORCE, Figure 1) which consists of about 3000 acres of mainly forested uplands including the Dyllis Orchard greenway trail (opened to the public in October 2007). About half of the BORCE has been surveyed for rare vascular plant species by TDEC personnel. Additional ORR geomorphic and topographic features supporting rare plant communities include wetlands, karst features (caves), rocky bluffs, limestone cedar barrens, and an area of old growth forest. About 70% of the ORR is in forest cover and less than 2% remains as open agricultural fields. The forests are mostly oak-hickory, pine-hardwood, or pine. Communities are generally characteristic of the intermountain regions of Appalachia (Mann et al. 1996). Oak-hickory forest, which is most widely distributed on ridges and dry slopes, is the dominant association. Minor areas of other hardwood forest cover types are found throughout the ORR; these include northern hardwoods, a few small natural stands of hemlock or white pine, and floodplain forests (Mann et al. 1996). Among these are numerous TDEC-designated natural areas on the ORR. Currently, most of the ORR is a wildlife management area (WMA), thus the BORCE site and the WMA is managed by the Tennessee Wildlife Resources Agency (TWRA).

This project will incorporate the division's oversight role of environmental surveillance and monitoring (TDEC 2011). Additionally, several federal and state laws support this effort: (1) the Federal Endangered Species Act of 1973 (ESA), as amended, provides for the inventory, listing, and protection of species in danger of becoming extinct and/or extirpated, and conservation of the habitats on which such species thrive, (2) the National Environmental Policy Act (NEPA), requires that federally-funded projects avoid or mitigate impacts to listed species, (3) the Tennessee Rare Plant Protection and Conservation Act of 1985 (Tennessee Code Annotated Title 11-26, Sects. 201-214), provides for a biodiversity inventory and establishes the state list of endangered, threatened, and special concern taxa, (4) National Resource Damage Assessments (NRDA) as directed by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by SARA (Superfund Amendments and Reauthorization Act of 1986), relates to damages to natural resources on the ORR.

For 2012, major functions and focus of the threatened and endangered species (T&E species) project planned for the ORR include: (1) provide botanical oversight and field support to the TDEC Division of Natural Areas as needed relating to ORR T&E species, (2) inventory and map the botanical diversity that exists on the ORR, (3) independently monitor and verify biological survey information provided by DOE, and comply with T&E species requirements per CERCLA and NEPA regulations, (4) identify and protect T&E species and TDEC-designated natural areas that represent biological diversity on the ORR, (5) provide field oversight during DOE subcontractor vascular plant surveys on ORR projects (i.e., road construction projects, land transfers, etc.), and (6) identify areas of the ORR infested with exotic pest plants (Drake et al. 2002, TEPPC 2002).

Methods and Materials

During 2012, monitoring of vascular plants on the ORR by division staff will follow a modified version of the methods and guidance outlined in Washington-Allen et al. (1995) and Awl et al. (1996). Additionally, field methods for documentation of pteridophytes (ferns and fern allies) will follow the field protocols of the All Taxa Biodiversity Inventory fern forays project in the Great Smoky Mountains National Park (ATBI 2007). Field mapping of native and invasive plant species will utilize field stations (50-foot diameter mini-plots) at pre-selected intervals (i.e., grid patterns, traverses, etc.) based on specific reconnaissance projects. Unusual or rare plants will be located and mapped, if found, between these intervals. Generally, field biodiversity inventories will begin with existing roads and trails, then transects will be walked cross-country (similar to a “timber cruise”) in generally north-south, east-west traverses to complete a grid pattern of coverage over the parcel. Habitats such as small drainage ravines, floodplains, wetlands, watersheds, sub-watersheds, sinkholes, cedar barrens, rock outcroppings, cliffs, springs, caves, etc. will be field surveyed for plant taxa. Field surveys are designed to locate and identify T & E plant species, invasive plant species, and aquatic and wetland taxa.

Each field station (mini-plot) will be mapped and located using a Global Positioning System (GPS) hand-held field unit (Garmin® Etrex). Each field station will be defined as a 50-foot circle from center point or circumference. Plant taxa will be organized and compartmentalized as: canopy, subcanopy, shrub, herbaceous, and groundcover layers. Digital camera images will be made at most field sites to record and document plant taxa. Additionally, the boundaries of the pine deadfall areas (pine-beetle devastated areas) will be mapped whenever possible in the field. These sites may become important ecological study areas to determine if native climax species or invasives will re-establish here.

Terrestrial plant species may be collected for preservation as herbarium specimens (vouchers). The sample will be collected as much as possible with either flower or fruit, then pressed and dried, and mounted on herbarium paper with appropriate identification labels. These are quite useful for training purposes but more importantly to properly document and confirm plant species (especially rare species) encountered in the field. Care will be taken while collecting plant specimens so as not to destroy or damage a rare plant colony.

Vascular plant identifications will require the use of the following sources and taxonomic keys: Radford et al. (1968), Prescott (1980), Cobb (1984), Lellinger (1985), Wofford (1989), Gleason

& Cronquist (1991), Chester et al. (1993), Chester et al. (1997), Carman (2001), Wofford & Chester (2002), University of Tennessee Herbarium (2007), and Weakley (2007).

Field data sheets (survey logs) will be recorded for each survey station and later placed in a database for inclusion in the annual environmental monitoring report. Maps will be prepared with available GIS software to illustrate locations of all field stations with plant data, geologic features and other pertinent biological habitat and field data.

Field monitoring methods and health and safety procedures will follow the guidelines in the division's *Health, Safety, and Security Plan* (Thomasson 2011).

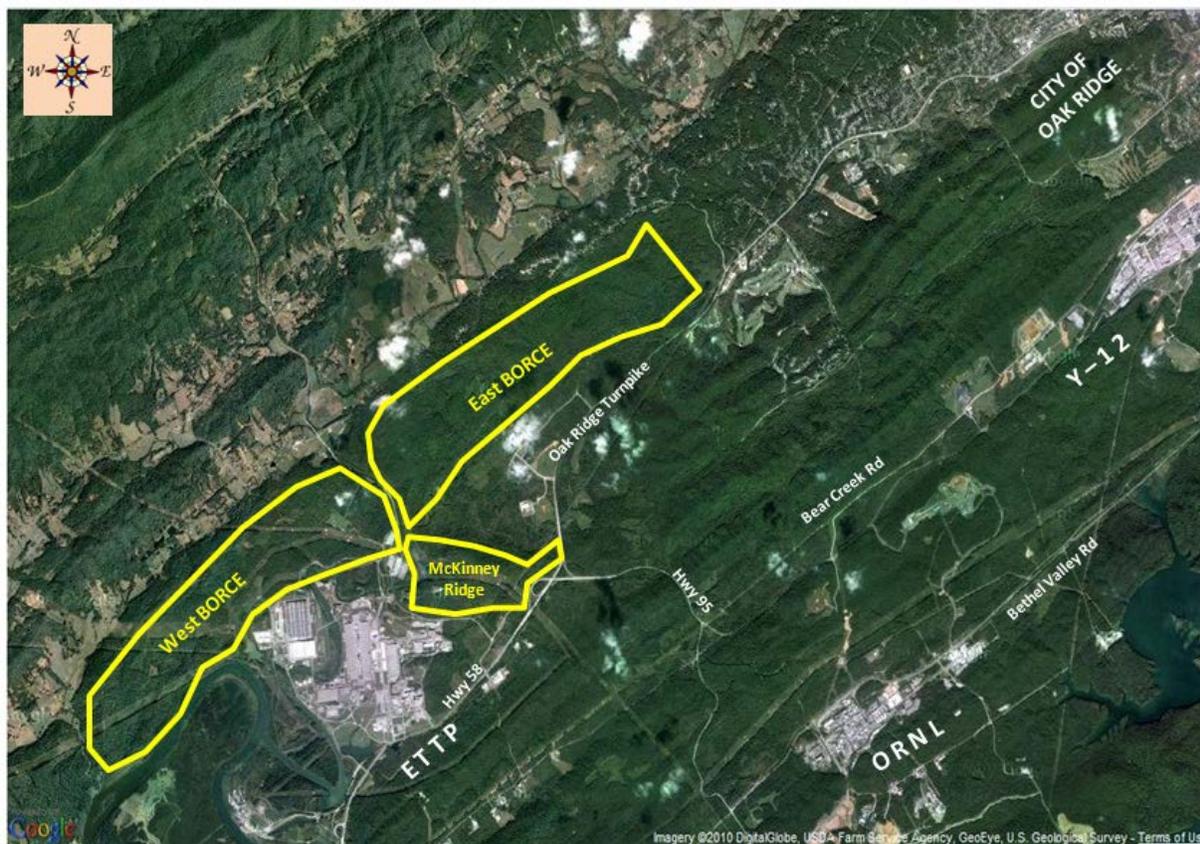


Figure 1: Black Oak Ridge Conservation Easement (BORCE)

References

All Taxa Biodiversity Inventory/Discover Life in America. Great Smoky Mountains National Park. http://www.dlia.org/atbi/methods/fern_foray.shtml 2007.

Awl, D. J. *Survey of Protected Vascular Plants on the Oak Ridge Reservation, Oak Ridge, Tennessee*. ORNL-Environmental Restoration Division. Lockheed Martin Energy Systems. ES/ER/TM-194. 1996.

Carman, Jack. *Wildflowers of Tennessee*. Highland Rim Press. Tullahoma, TN. 2001.

- Chester, E. W., B. E. Wofford, R. Kral, H. R. DeSelm, & A. M. Evans. *Atlas of Tennessee vascular plants-- Volume 1: Pteridophytes, Gymnosperms, Angiosperms, & Monocots*. Miscellaneous Publication No. 9. The Center for Field Biology. Austin Peay State University. Clarksville, TN. 1993.
- Chester, E. W., B. E. Wofford, & R. Kral. *Atlas of Tennessee vascular plants-- Volume 2: Dicots*. Miscellaneous Publication No. 13. The Center for Field Biology. Austin Peay State University. Clarksville, TN. 1997.
- Cobb, B. *Peterson Field Guide: Ferns*. Houghton Mifflin Company. New York, NY. 1984.
- Gleason, H.A. & Cronquist, A. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada*. The New York Botanical Garden, Bronx, New York. 1991.
- Drake, S. J., J. F. Weltzin, & P. D. Parr. *Assessment of Nonnative Invasive Pplants in the DOE Oak Ridge National Environmental Research Park*. ORNL/TM-2001/113. Environmental Sciences Division. Oak Ridge National Laboratory. Oak Ridge, TN. 2002.
- Lellinger, D. B. *A Field Manual of the Ferns and Fern Allies of the United States and Canada*. Smithsonian Institution Press. Washington, D.C. 1985.
- Mann, L. K., P. D. Parr, L. R. Pounds, & R. L. Graham. *Protection of Biota on Non-park Public Lands: Examples from the US Department of Energy Oak Ridge Reservation*. Environmental Management Vol. 20, No. 2, pp. 207-218. 1996.
- Prescott, G. W. *How to Know the Aquatic Plants*. 2nd edition. WCB McGraw-Hill Publishers. Boston, MA, New York, NY, San Francisco, CA, St. Louis, Missouri. 1980.
- Radford, A. R., H. E. Ahles, and C. R. Bell. *Manual of the Vascular Flora of the Blue Ridge*. The University of North Carolina Press. Chapel Hill, North Carolina. 1968.
- Salk, M. S. *Rare Plants on the Oak Ridge Reservation*. ORNL 2004-03050/tcc. Publishing/Design by ORNL Creative Media at Oak Ridge National Laboratory, managed by UT-Battelle, LLC, for the U.S. Department of Energy under contract DE-AC05-00OR22725. 2004.
- Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement. Agreement Between the Department of Energy and the State of Tennessee*. DOE Oversight Division. Oak Ridge, Tennessee. 2011.
- Tennessee Exotic Pest Plant Council (TEPPC). *Invasive Exotic Pest Plants in Tennessee. Journal of the Tennessee Academy of Science* 77(2): 45-48. 2002.

- University of Tennessee. University of Tennessee Herbarium Webpage. Department of Ecology and Evolutionary Biology. Knoxville, Tennessee. <http://tenn.bio.utk.edu/vascular> 2007.
- Washington-Allen, R. A., T. L. Ashwood, S. W. Christensen, H. Offerman, and P. Scarbrough-Luther. *Terrestrial Mapping of the Oak Ridge Reservation: Phase 1*. ES/ER/TM-152. Environmental Sciences Division. Oak Ridge National Laboratory. Oak Ridge, TN. 1995.
- Weakley, A. S. *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas*. Working Draft. North Carolina Botanical Garden. University of North Carolina. Chapel Hill, NC. 2007.
- Wofford, B. E. *Guide to the Vascular Plants of the Blue Ridge*. The University of Georgia Press. Athens, Georgia. 1989.
- Wofford, B. E. and E. W. Chester. *Guide to the Trees, Shrubs, and Woody Vines of Tennessee*. The University of Tennessee Press. Knoxville, Tennessee. 2002.
- Yard, C.R. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

White-tailed Deer Monitoring Program on the Oak Ridge Reservation

Introduction

It has been well documented that wildlife bioconcentrate metals such as arsenic (As), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), mercury (Hg) and its methylated form, methylmercury (MeHg), nickel (Ni), lead (Pb) and selenium (Se) in organs, hair, bone and tissue (Cumbie 1975, Niethammer et al. 1985, Wren et al. 1986, Born et al. 1991, Peles and Barrett 1997, Stevens et al. 1997, O'Hara et al. 2003). Large ungulates such as white-tailed deer and moose can be used as bioindicators of metals contamination in the environment (Kocan et al. 1980, Woolf et al. 1982, Sileo and Beyer 1985, Crête et al. 1987, O'Hara et al. 2001, Wilkinson et al. 2003). Because heavy metals and minerals are associated with the forage and mineral requirements of many ungulates (i.e., deer, caribou, reindeer, etc.), contaminated browse vegetation and mineral soils (deer licks) are the likely pathway of exposure to heavy metals in these mammals (Harrison and Dyer 1984, Niethammer et al. 1985, O'Hara et al. 2003, Beyer et al. 2007). Ashwood et al. (1994) reported the presence of radionuclides, Hg, Cd, Cr, Ni, and Pb in kidney, muscle, liver, feathers, bone and hair of mammals and birds collected on the ORR. They also reported the presence of As, Se, Hg, and radionuclides in twig, leaf and woody samples of potential deer browse vegetation. Hair (fur) samples of mammals are considered to be good indicators of exposure to metal contaminants (Wren 1986, Stevens et al. 1997, Rothschild and Duffy 2002, Duffy et al. 2005, Cardona-Marek et al. 2009). For example, Hg analysis of hair samples has been commonly used to assess accumulation of this toxic metal in wildlife (Born et al. 1991, Ben-David et al. 2001, Beckman et al. 2002, Harkins and Susten 2003). Huckabee et al. (1973) documented the concentration of mercury in the hair of coyote and rodents as a surrogate for internal Hg concentrations. Furthermore, Gerstenberger et al. (2006) demonstrated positive associations between hair-Hg and liver-Hg in small terrestrial mammals indicating that hair may be a suitable indicator of body burdens (i.e., internal Hg concentrations). Thus, one task will be to examine the potential bioaccumulation of metals in deer tissues, and further to determine if a correlation exists relating ORR deer hair-Hg concentrations to internal body burden concentrations of muscle-Hg and liver-Hg.

Wildlife researchers using radio-telemetry tracking methods have reported that ORR contaminated animals (e.g., Canada geese, white-tailed deer, kingfishers, turtles, fish, wild turkeys) with large home ranges have been collected at locations outside the boundaries of the reservation (Kitchings and Story 1979, 1982, 1984, Story and Kitchings 1979, 1982, 1985, Whitlock 1987, Ashwood 1992, Ashwood et al. 1994). Garten (1995) suggested that ORNL deer could forage in Melton Valley contaminated areas and then leave the ORR. Home ranges in white-tailed deer vary from 50-500 ha (123-1235 ac, Marchinton and Hirth 1984). The average home range for radio-collared deer examined on the ORR ($n= 15$ deer) was found to be 345 ha (852 ac), and dispersal distances of up to 33 km (20.5 mi) were recorded (Kitchings and Story 1979, Story and Kitchings 1982, 1985).

The primary task of the project will be the capture and collaring of deer (i.e., GPS collars) with the cooperation of the Tennessee Wildlife Resources Agency (TWRA). The objectives of this monitoring program are to track the movements and determine the home range of deer both on and off the ORR. At the request of the U.S. Department of Energy (DOE), the data quality objectives (DQO) are attached in the Appendix.

Methods and Materials

Store-on-board global positioning system (GPS) collars will be deployed on five deer during 2012. The collars have been preprogrammed to drop off these deer on January 15, 2014. Following that time, DOE-O staff will initiate efforts to locate and retrieve the collars with a VHF receiver. Once all collars have been recovered, then GPS data can be downloaded for analysis. Recovered collars will be returned to Telonics, Inc. (Mesa, Arizona) to be reprogrammed. Refurbished collars will be deployed on deer during 2012. It is anticipated deer collaring efforts will resume in late January 2012 (and continue until early spring) with the assistance of TWRA. The deer will be caught using a clover trap, TWRA will dart and tranquilize the deer, and then collars and numbered ear tags will be applied to each deer.

Procedures

Clover Trap and Collar Attachment Protocol

Handling of live animals will follow the recommendations and guidelines of the *Animal Care and Use Committee of the American Society of Mammalogists* (Gannon et al. 2007, Sikes et al. 2011). Trapping methods described herein have been modified from James and Stickles (2010) and recommendations of the Tennessee Wildlife Resources Agency.

Trap Set-up:

Clover trap installation and set-up will be demonstrated in the field using hands-on techniques during the set-up process and before actual trapping. At a minimum, nitrile gloves should be worn to minimize human scent while handling the trap. Coordinates should be recorded at each site with a hand-held GPS unit.

Trap Placement:

Clover traps will be strategically placed as to allow for “element of surprise” to the animal during the approach to trap by biologists and is accomplished using any available brush or woodland debris available. Trap site setups should be secluded to prevent human interference (i.e., “out-of-sight and out-of-mind”). The goal is to avoid as much stress to the animal as possible prior to and during handling.

Checking Traps:

A clover trap team consists of at least two biologists plus a qualified wildlife biologist who is certified to handle tranquilizing drugs and a dart gun (i.e., TWRA). One person is designated as the restrainer or handler (especially if tranquilizing drugs do not take effect on the deer). The second person is the designated data collector and equipment manager. The restrainer is responsible for subduing and controlling the deer as needed. The equipment person is responsible for carrying the capture kit, blindfolding the deer, checking age and sex, administering ear tags, making photographs and recording the data.

Bait should be placed past the trip wire, but also within the bounds of the trap walls to prevent feeding from outside the trap (see Figure 1). “Chumming” the trap at the door with some corn is encouraged. After setting and before leaving the trap site, verify that no vegetation will interfere with the operation of the door closing or movement of the “trip” wire. It is also recommended to remove larger branches and rocks from within the trap to reduce injury to animals or team

members. Otherwise, the trap should be adjusted as to avoid having objects/debris on the trap floor.



Figure 1: Baited clover trap (Photo credit: und.nodak.edu)

Typically, biologists drive a trap line in the early morning. Each trap is checked for animals, then re-baited and repaired as necessary. If the trap is sprung but has nothing in it, inspect the trip wires and replace them if necessary, inspect netting for holes, check to make sure the trap is still properly staked, and reset the door making sure all the cable sleeves are aligned and pointing away from the trap door. If there is a deer in the trap, then TWRA must be notified immediately such that they can arrive at the field site in a timely manner and dart the animal with tranquilizing drugs (Figure 2).



**Figure 2: Collaring sedated doe (i.e., “Booger-Baby”)
(Photo credit: TDEC DOE-O)**

Capture Procedure:

1. During deployment, the clover trap must be checked at least once per day (ideally early AM) for presence of deer or other animals (i.e., raccoon, skunk, etc.) in the trap.
2. If a predator, injured animal or rabid animal (i.e., bobcat, coyote, etc.) is inadvertently caught in the trap, then TWRA will be contacted to allow for the safe release or euthanization of the animal.

3. Check for presence of deer from a good distance with binoculars if necessary to avoid distressing the animal.
4. If deer is present in the clover trap, contact TWRA immediately to come out and sedate the animal with the dart gun.
5. After administration of tranquilizing drug to the deer, allow time for the drug to take effect and for the deer to calm down. Everyone must remain at a good distance from the trap during this time to minimize stress to the deer.
6. Double glove with nitrile and heavy leather or cotton gloves to avoid cuts from deer hooves and self- and cross-contamination during animal handling.
7. One biologist with protective gear (gloves, helmet and shin protection) will enter the trap, then the immediate goal is to quickly subdue the deer by restraining the body and legs (if necessary). If the drug has not brought the deer down, approach it from the side and wrap your arms around the front of the body. Grip the front legs below the “elbow” and tuck them into the chest of the deer. Then straddle the animal and slowly put your weight on its back. In doing this, the restrainer can use his/her body weight to gain control of and safely but slowly allow the animal’s legs to fold as the biologist body weight is applied. However, if the tranquilizing drug has taken full effect on the deer, restraint may not be necessary
8. Once the animal is subdued by the restrainer, the assisting person can enter the trap closing the door behind them to prevent escape. The assistant places the facemask (hood) over the animal’s head/eyes and processing can begin. The eyes of the animal must be covered to reduce stress. Also, make sure the animal’s breathing is not restricted in any way.
9. Fit the collar to the deer’s neck and trim excess collar material if necessary, attach the holding plate and tighten the nuts with 11/32 nut driver thus securing the collar around the deer’s neck. The second biologist will then affix the numbered ear tags to each ear per prescribed method, record field notes and vital data about the animal (i.e., age, sex, weight estimate, etc.), and also photograph events.
10. During processing of the animal, the capture data sheet must be filled out completely by the assistant or assigned data collector.
11. Using a curry comb, a 5-10g sample of deer hair (i.e., softball-size wad) will be collected from the mid-dorsal region of the deer’s back. Place the hair sample in a labeled Ziploc® baggie and then store in an ice chest for transport.
12. The clover trap door will be left open while the deer recovers from the drug. At least one biologist must remain within sight of the deer while it recovers from the drug and leaves the trap on its own power. This is to provide protection from predators while the deer is down.

Additional wildlife sample collection practices and methods used for this project will follow those of Sample et al. (1997), O’Hara et al. (2001, 2003), Kierdorf and Kierdorf (2005), Duffy et al. (2005), Gannon et al. (2007) and Sikes et al. (2011).

Required Equipment (Deer Trapping)

Clover trap	Aluminum foil
Heavy leather gloves	ZipLoc® / Whirl-Pak® bags
Hockey-style helmet & shin guards	Trap bait (i.e., corn, etc.)
Telonics GPS collars	Sample labels
Field notebook	Stainless-steel scalpels
Latex gloves (purple nitrile)	Stainless-steel scissors
Deionized water	Hand sanitizer
Rubber gloves	Curry combs
VHF receiver	Plastic vials (tissue samples)
Magic Marker (Sharpie®)	11/32 nut driver (affix collar)
Hand-held GPS unit (i.e., Garmin)	Ear tags (yellow numbered)
Deer eye mask/hood	Hole punch ear-tagger
Antibiotic ointment	Zip-ties
Flagging tape	Needle nose pliers
Extra 11/32 nuts (to affix collar)	Super shears (leather cutter)
Wire cutters/nippers	Toolbox
Dart gun/drugs (TWRA)	Blankets
Stakes / small sledge hammer	First Aid kit
Guy wire / rope	Cooler/ice packs

References

- Ashwood, T. L. *Ecological Assessment Plan for Waste Area Grouping 5*. ESD Publication No. 3777, Environmental Sciences Division, Oak Ridge National Laboratory. Martin-Marietta Energy Systems, Inc., Oak Ridge, Tennessee. 1992.
- Ashwood, T. L., B. E. Sample, M. G. Turner, G. W. Suter II, J. M. Loar, H. Offerman and L. W. Barnthouse. *Work Plan for the Oak Ridge Reservation Ecological Monitoring and Assessment Program*. ES/ER/TM-127&D1. Environmental Sciences Division Publication 4315, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1994.
- Beckman, K. B., L. K. Duffy, X. Zhang and K. W. Pitcher. *Mercury Concentrations in the Fur of Stellar Sea Lions and Northern Fur Seals from Alaska*. Marine Pollution Bulletin 44:130-1135. 2002.
- Ben-David, M., L. K. Duffy, G. M. Blundell, and R. T. Bowyer. *Natural Exposure to Mercury in Coastal River Otters: Age, Diet and Survival*. Environmental Toxicology and Chemistry 20:1986-1992. 2001.
- Beyer, W. M., G. Gaston, R. Brazzle, A. F. O'Connell and D. J. Audet. *Deer Exposed to Exceptionally High Concentrations of Lead Near the Continental Mine in Idaho, USA*. Environmental Toxicology and Chemistry 26:1040-1046. 2007.
- Born, E. W., A. Renzoni and R. Dietz. *Total Mercury in Hair of Polar Bears (Ursus maritimus) from Greenland and Svalbard*. Polar Research 9:113-120. 1991.

- Burger, J. and K. R. Campbell. *Species Differences in Contaminants in Fish On and Adjacent to the Oak Ridge Reservation, Tennessee*. Environmental Research 145-155. 2004.
- Burger, J., K. R. Campbell, T. S. Campbell, T. Shukla, C. Dixon and M. Gochfeld. *Use of Central Stonerollers (Cyprinidae: Campostoma anomalum) from Tennessee as a Bioindicator of Metal Contamination*. Environmental Monitoring and Assessment 110:171-184. 2005.
- Burger, J., K. R. Campbell, T. S. Campbell, S. Murray, K. F. Gaines, S. Burke, T. Shukla, C. Jeitner and M. Gochfeld. *Metal Levels in Blood, Muscle and Liver of Water Snakes (Nerodia spp.) from New Jersey, Tennessee and South Carolina*. Science of the Total Environment 373:556-563. 2007.
- Campbell, K. R., T. S. Campbell and J. Burger. *Heavy Metal Contamination in Northern Water Snakes (Nerodia sipedon) from East Fork Poplar Creek and the Little River, East Tennessee, USA*. Archives of Environmental Contamination and Toxicology 49:239-248. 2005.
- Cardona-Marek, T., K. K. Knott, B. E. Meyer and T. M. O'Hara. *Mercury Concentrations in Southern Beaufort Sea Polar Bears: Variation Based on Stable Isotopes of Carbon and Nitrogen*. Environmental Toxicology and Chemistry 28:1416-1424. 2009.
- Childs, Jr., H. E. and G. E. Cosgrove. *A Study of Pathological Conditions in Wild Rodents in Radioactive Areas*. American Midland Naturalist 76:309-324. 1966.
- Crête, M., F. Potvin, P. Walsh, J-L. Benedetti, M. A. Lefebvre, J-P. Weber, G. Paillard and J. Gagnon. *Pattern of Cadmium Contamination in the Liver and Kidneys of Moose and White-tailed Deer in Quebec*. The Science of the Total Environment 66:45-53. 1987.
- Cumbie, P. M. *Mercury in Hair of Bobcats and Raccoons*. Journal of Wildlife Management 39:419-425. 1975.
- Denton, G. M. *Mercury Levels in Tennessee Fish*. Tennessee Department of Environment and Conservation, Division of Water Pollution Control. 2007.
- Duffy, L. K., R. J. Hallock, G. Finstad and R. T. Bowyer. *Noninvasive Environmental Monitoring of Mercury in Alaskan Reindeer*. American Journal of Environmental Sciences 1:249-253. 2005.
- Dunaway, P. B. and S. V. Kaye. *Studies of Small-mammal Populations on the Radioactive White Oak Lake Bed*, p. 167-185. Transactions, Twenty-sixth North American Wildlife and Natural Resources Conference, Wildlife Management Institute, Washington, D.C. 1961.
- Dunaway, P. B. and S. V. Kaye. *Effects of Ionizing Radiation on Mammal Populations on the White Oak Lake Bed*, p. 333-338. In: V. Schultz and A. W. Klement, Jr. (eds.), Radioecology, Proceedings First National Symposium on Radioecology, Reinhold, N. Y. and AIBS, Washington. 1963.

- Gannon, W. L., R. S. Sikes, and the Animal Care and Use Committee of the American Society of Mammalogists. *Guidelines of the American Society of Mammalogists for the use of Wild Mammals in Research*. Journal of Mammalogy 88:809-823. 2007.
- Garten, Jr., C. T. *Dispersal of Radioactivity by Wildlife from Contaminated Sites in a Forested Landscape*. Journal of Environmental Radioactivity 29:137-156. 1995.
- Gerstenberger, S. L., C. L. Cross, D. D. Divine, M. L. Gulmatico and A. M. Rothweiler. *Assessment of Mercury Concentrations in Small Mammals Collected Near Las Vegas, Nevada, USA*. Environmental Toxicology 21:583-589. 2006.
- Giffen, N. R., J. W. Evans and P. D. Parr. *Wildlife Management Plan for the Oak Ridge Reservation*. ORNL/TM-2006/155. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 2007.
- Greenberg, C. H., M. R. Pelton and P. D. Parr. *Gray Fox Ecology in the Oak Ridge National Environmental Research Park: Food Habits, Home Range and Habitat Use*. ORNL/NERP-3. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1988.
- Han, F., Y. Su, D. L. Monts, C. A. Waggoner and M. J. Plodinec. *Binding, Distribution, and Plant Uptake of Mercury in a Soil from Oak Ridge, Tennessee, USA*. Science of the Total Environment 368:753-768. 2006.
- Han, F., S. Syiyab, Y. Su, D. L. Monts, C. A. Waggoner and F. B. Matta. *Stability and Bioavailability of Mercury Sulfide in Oak Ridge Soils*. Proceedings of the 2007 Waste Management Conference, February 25-March 1, 2007, Tucson, Arizona. 2007.
- Hardy, C. *A Comparison of Bird Communities in Loblolly vs. White Pine Plantations on the Oak Ridge National Environmental Research Park*. Masters' Thesis, University of Tennessee, Knoxville, Tennessee. 1991.
- Harkins, D. K. and A. S. Susten. *Hair Analysis: Exploring the State of Science*. Environmental Health Perspectives 111:576-578. 2003.
- Harrison, P. D. and M. I. Dyer. *Lead in Mule Deer Forage in Rocky Mountain National Park, Colorado*. Journal of Wildlife Management 48:510-517. 1984.
- Huckabee, J. W., F. O. Cartan, G. S. Kennington and F. J. Camenzind. *Mercury Concentration in the hair of Coyotes and Rodents in Jackson Hole, Wyoming*. Bulletin of Environmental Contamination and Toxicology 9:37-43. 1973.
- James, W. and J. Stickles. *White-tailed Deer Trapping and Telemetry Guide*. Deer and Elk Section, Bureau of Wildlife Management. Pennsylvania Game Commission, Harrisburg, Pennsylvania. 2010.

- Jean-Phillipe, S. *The Effects of Mercury Contamination on Tree, Fungal, and Soil Composition Along East Fork Poplar Creek, Anderson and Roane Counties, Tennessee*. Ph.D. Dissertation. Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, Tennessee. 2010.
- Johnson, R. M. *The Herpatofauna of the Oak Ridge Area*. ORNL-3653, Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1964.
- Kierdorf, U. and H. Kierdorf. *Antlers as Biomonitors of Environmental Pollution by Lead and Fluoride: A Review*. European Journal of Wildlife Research 51:137-150. 2005.
- Kitchings, J. T. and L. K. Mann. *A Description of the Terrestrial Ecology of the Oak Ridge Environmental Research Park*. ORNL/TM-5073, Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1976.
- Kitchings, J. T. and D. J. Levy. *Habitat Patterns in a Small Mammal Community*. Journal of Mammalogy 62:814-820. 1981.
- Kitchings, J. T. and J. D. Story. *White-tailed Deer (Odocoileus virginianus) on the Department of Energy's Oak Ridge Reservation*. Supplement 1: 1978 Status Report (ORNL/TM-6803/S1). Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1979.
- Kitchings, J. T. and J. D. Story. *White-tailed Deer (Odocoileus virginianus) on the Department of Energy's Oak Ridge Reservation*. Supplement 1: 1981 Status Report (ORNL/TM-6803/S4). Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1982.
- Kitchings, J. T. and J. D. Story. *Movement and Dispersal of Bobcats in East Tennessee*. Journal of Wildlife Management 48:957-961. 1984.
- Klein, J. A. *A Checklist of the Reptiles and Amphibians on the Department of Energy Oak Ridge Reservation, Anderson and Roane Counties, Tennessee*. Journal of the Tennessee Academy of Science 64:228-230. 1989.
- Kocan, A. A., W. C. Edwards, J. H. Eve and M. G. Shaw. *Heavy Metal Concentrations in the Kidneys of White-tailed Deer in Oklahoma*. Journal of Wildlife Diseases 16:593-596. 1980.
- Lewis, L.A. *Effects of Feeding Fish Collected Downstream from Oak Ridge Reservation on the Reproductive Performance of Mink*. M.S. thesis. Department of Animal Science, Michigan State University, East Lansing, Michigan. 1995.
- Loar, J. M. *State of East Fork Poplar Creek: Status of Ecological Recovery*. Oak Ridge: U.S. Department of Energy Mercury Workshop, Biological Monitoring and Abatement Program, Oak Ridge National Laboratory, Oak Ridge, Tennessee. 2004.
- Marchinton, R. L. and D. H. Hirth. *Behavior in White-tailed Deer: Ecology and Management*. Stackpole Books, Harrisburg, Pennsylvania, pp. 129-168. 1984.

- Mills, J. N., J. E. Childs, T. G. Ksiazek, C. J. Peters and W. M. Velleca. *Methods for Trapping and Sampling Small Mammals for Virologic Testing*. U. S. Department of Human Services, Public Health Service. Centers for Disease Control and Prevention, Atlanta, Georgia. 1995.
- Mitchell, J. M., E. R. Vail, J. W. Webb, J. W. Evans, A. L. King, and P. A. Hamlett. *Survey of Protected Terrestrial Vertebrates on the Oak Ridge Reservation: Final Report*. ES/ER/TM-188/R1. Environmental Restoration Division. Lockheed Martin Energy Systems, Inc., Oak Ridge, Tennessee. 1996.
- Moore, D.R.J., B. E. Sample, G. W. Suter, B. R. Parkhurst and R. S. Teed. *Risk-based Decision Making: the East Fork Poplar Creek Study*. Environmental Toxicity and Chemistry 18:2954-2958. 1999.
- Munson, L. *Necropsy of Wild Animals*. Wildlife Health Center, School of Veterinary Medicine. University of California—Davis. 2006.
- Niethammer, K. R., R. D. Atkinson, T. S. Baskett and F. B. Samson. *Metals in Riparian Wildlife of the Lead Mining District of Southeastern Missouri*. Archives of Environmental Contamination and Toxicology 14:213-223. 1985.
- O'Hara, T. M., G. Carroll, P. Barboza, K. Mueller, J. Blake, V. Woshner and C. Willetto. *Mineral and Heavy Metal Status as Related to a Mortality Event and Poor Recruitment in a Moose Population in Alaska*. Journal of Wildlife Diseases 37:509-522. 2001.
- O'Hara, T. M., J. C. George, J. Blake, K. Burek, G. Carroll, J. Dau, L. Bennett, C. P. McCoy, P. Gerard and V. Woshner. *Investigation of Heavy Metals in a Large Mortality Event in Caribou of Northern Alaska*. Arctic 56:125-135. 2003.
- Parr, P. D. and J. W. Evans. *Resource Management Plan for the Oak Ridge Reservation, Volume 27: Wildlife Management Plan*. Environmental Sciences Division Publication No. 3909. Oak Ridge National Environmental Research Park, Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1992.
- Peles, J. D. and G. W. Barrett. *Assessment of Metal Uptake and Genetic Damage in Small Mammals Inhabiting a Fly Ash Basin*. Bulletin of Environmental Contamination and Toxicology 59:279-284. 1997.
- Peterson, M. J., G. Southworth and T. Mathews. *Mercury in Fish – Status Report for the Oak Ridge Reservation*. Environmental Sciences Division, Biological Monitoring and Abatement Program, Oak Ridge National Laboratory/UT-Battelle. 2009.
- Pierce, A. M. *Spatial and Temporal Relationships Between Deer Harvest and Deer-vehicle Collisions at Oak Ridge Reservation, Tennessee*. M.S. thesis. Department of Forestry, Wildlife and Fisheries, University of Tennessee, Knoxville, TN. 2010.

- Revis, N. W., T. R. Osborne, G. Holdsworth and C. Hadden. *Distribution of Mercury Sites in Soil from a Mercury-contaminated Site*. Water, Air and Soil Pollution 45:105-113. 1989.
- Rothschild, R. F. N. and L. K. Duffy. *Methylmercury in the Hair of Subsistence Food Users in a Rural Alaskan village*. Alaskan Medicine 44:2-7. 2002.
- Ryon, M. G. and J. M. Loar. *Checklist of Fishes on the Department of Energy Oak Ridge Reservation*. Journal of the Tennessee Academy of Science 63:97-102. 1988.
- Sample, B. E., M. S. Aplin, R. A. Efroymson, G. W. Suter II and C. J. E. Welsh. *Methods and Tools for Estimation of the Exposure of Terrestrial Wildlife to Contaminants*. Environmental Sciences Division Publication No. 4650. Lockheed Martin Energy Research Corporation, Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1997.
- Sample, B.E., and G.W. Suter II. *Ecological Risk Assessment in a Large River-reservoir: 4. Piscivorous Wildlife*. Environmental Toxicology and Chemistry 18:610-620. 1999.
- Sample, B. E. and G. W. Suter II. *Screening Evaluation of the Ecological Risks to Terrestrial Wildlife Associated with a Coal Ash Disposal Site*. Human and Ecological Risk Assessment 8:637-656. 2002.
- Sikes, R. S., W. L. Gannon, and the Animal Care and Use Committee of the American Society of Mammalogists. *Guidelines of the American Society of Mammalogists for the Use of Wild Mammals in Research*. Journal of Mammalogy 92:235-253. 2011.
- Sileo, L. and W. N. Beyer. *Heavy Metals in White-tailed Deer Living Near a Zinc Smelter in Pennsylvania*. Journal of Wildlife Diseases 21:289-296. 1985.
- Southworth, G. R., R. R. Turner, M. J. Peterson and M. A. Bogle. *Form of Mercury in Stream Fish Exposed to High Concentrations of Dissolved Inorganic Mercury*. Chemosphere 30:779-787. 1995.
- Southworth, G. R., R. R. Turner, M. J. Peterson, M. A. Bogle and M. G. Ryon. *Response of Mercury Contamination in Fish to Decreased Aqueous Concentrations and Loading of Inorganic Mercury in a Small Stream*. Environmental Monitoring and Assessment 63:481-494. 2000.
- Stevens, R. T., T. L. Ashwood and J. M. Sleeman. *Mercury in Hair of Muskrats (*Ondatra zibethicus*) and Mink (*Mustela vison*) from the U. S. Department of Energy Oak Ridge Reservation*. Bulletin of Environmental Contamination and Toxicology 58:720-725. 1997.
- Story, J. D. and J. T. Kitchings. *White-tailed Deer (*Odocoileus virginianus*) on Department of Energy's Oak Ridge Reservation: Data on Road-killed Animals 1969-1977*. ORNL/TM-6803. Oak Ridge National Laboratory, Oak Ridge, Tennessee. 25 pp. 1979.

- Story, J. D. and T. J. Kitchings. *White-tailed Deer (Odocoileus virginianus) on the Department of Energy's Oak Ridge Reservation: 1981 Status Report*. (ORNL/TM=6803/S4). Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1982.
- Story, J. D. and T. J. Kitchings. *White-tailed Deer (Odocoileus virginianus) on the Department of Energy's Oak Ridge Reservation: 1982 Status Report*. (ORNL/TM=6803/S4). Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1985.
- Tasca, J. J. *The Use of White-tailed Deer as Biological Monitors of Heavy Metals*. M. S. Thesis. University of Tennessee, Knoxville. 1988.
- Taylor, Jr., F. G. and P. D. Parr. *Distribution of Chromium in Vegetation and Small Mammals Adjacent to Cooling Towers*. Journal of the Tennessee Academy of Science 53:87-91. 1978.
- Travis, C. C., B. G. Blaylock, K. L. Daniels, C. S. Gist, F. O. Hoffman, R. J. McElhaney and C. W. Weber. *Final Report of the Oak Ridge Task Force Concerning Public Health Impacts of the Off-site Contamination in East Fork Poplar Creek and Other Area Streams*. (ORNL/TM-11252). Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee. 1989.
- Turner, R. R., C. R. Olsen and W. J. Wilcox. *Environmental Fate of Hg and ¹³⁷Cs Discharged from Oak Ridge Facilities*. In: Trace Substances in the Environment. D. D. Hemphill, editor. Elsevier/New Holland Biomedical Press, New York, NY. 1985.
- U. S. Environmental Protection Agency. *Environmental Compliance Standard Operating Procedures and Quality Assurance Manual*, Region 4, Environmental Services Division. Atlanta, Georgia. 1991.
- U. S. Environmental Protection Agency (USEPA). *Guidance on Systematic Planning Using the Data Quality Objectives Process*. EPA QA/G-4. (EPA/240/B-06/001). Office of Environmental Information, Washington, D.C. 2006.
- Whitlock, S. *Radio-tracking of a Pair of Coyotes in Oak Ridge, Tennessee*. Report for Special Problems WFS 4500, Department of Forestry, Wildlife and Fisheries, The University of Tennessee, Knoxville (unpublished report). 1987.
- Widner, T. E., T. R. Mongan, G. M. Bruce and S. M. Flack. *Task 2 Report: Mercury Releases from Lithium Enrichment at the Oak Ridge Y-12 Plant – a Reconstruction of Historical Releases and Off-site Doses and Health Risks*. ChemRisk, A Service of McLaren/Hart Environmental Services, Inc., Alameda, California. 1999.
- Wilkinson, J. M., J. Hill and C.J.C. Phillips. *The Accumulation of Potentially-toxic Metals by Grazing Ruminants*. Proceedings of the Nutrition Society 62:267-277. 2003.
- Wobeser, G. *Forensic (Medico-Legal) Necropsy of Wildlife*. Journal of Wildlife Diseases 32:240-249. 1996.

Woolf, A., J. R. Smith and L. Small. *Metals in Livers of White-tailed Deer in Illinois*. Bulletin of Environmental Contamination and Toxicology 28:189-194. 1982.

Wren, C. D. *Mammals as Biological Monitors of Environmental Metal Levels*. Environmental Monitoring and Assessment 6:127-144. 1986.

Yard, C. R. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation, DOE Oversight Division, Oak Ridge, Tennessee. 2011.

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DRINKING WATER MONITORING

Sampling of Oak Ridge Reservation Potable Water Distribution Systems

Introduction

The water distribution systems at each of the DOE ORR sites are regulated by the *Tennessee Safe Drinking Water Act*, (T. C. A. 68-13-701), and by the *Regulations for Public Water Systems and Drinking Water Quality* (Chapter 1200-5-1). The Tennessee Department of Environment and Conservation, Department of Energy Oversight Division (the division) may conduct oversight of sampling for total coliform bacteria and free chlorine residuals at various sites throughout the potable water distribution systems on the Oak Ridge Reservation (ORR). In addition, the division will oversee ORR line-flushing practices, water main repairs, cross-connection control programs, and water-loss/leak detection activities in order to identify potential threats to the potable water supply. If potential threats are identified, then additional chemical and radiological sampling may be conducted during 2012 to insure that the quality of the potable water is maintained.

The division, through a memorandum of understanding (MOU) with the TDEC Division of Water Supply (DWS), reviews chemical and bacteriological sampling results from the drinking water distribution systems on the ORR. Review of these sampling results will be combined with:

- knowledge of localized plant populations and water demand
- backflow device location
- testing and maintenance procedures
- line repairs or maintenance

When evidence exists of possible shallow subsurface plume infiltration, cross connections, low chlorine residuals, line breaks/leaks, or other upset conditions, the division will use site maps to identify the proximity of water lines to radiological or non-radiological contaminant sources. This will be used as a basis for independent sampling.

Confirmation of any positive results reported can dictate additional sampling or split samples. Continued positive results may justify increased monitoring for that compound.

In addition, review of Cross Connection Control Programs will be conducted to evaluate the effectiveness of such plans and the degree of protection afforded by them. This will be checked by verifying inspection dates on backflow prevention (BFP) devices, by reviewing records of BFP devices, by overseeing actual preventer testing, and by inspecting possible unprotected cross connections.

Additional information concerning potential threats to water distribution systems is provided in a set of articles (<http://www.epa.gov/safewater/tcr/tcr.html#distribution>) prepared for the EPA. The papers only present available information and do not represent EPA policy.

Methods and Materials

The following sections provide information regarding the sample processing and analytical laboratory procedures.

Free Chlorine Residual

The sample will be collected in two small sample containers provided with the Hach® Pocket Colorimeter Kit. One of the sample containers will be designated as the blank and the other will be the actual sample to be analyzed. The blank is filled with 10 ml of water placed into the pocket colorimeter and the “zero” button is depressed. The blank is removed from the pocket colorimeter after the instrument has been zeroed. The actual sample is filled with 10 ml of water and a DPD powder pillow (test reagent) is added to the sample container and gently shaken for 20 seconds, placed in the pocket colorimeter. The “read” button is depressed and the free chlorine residual is analyzed (read directly from the pocket colorimeter display) within one minute.

Independent chlorine sampling will be conducted monthly at either the Y-12 NNSA Complex DOE facility or the Oak Ridge National Laboratory DOE facility. Reasonable attempts will be made to rotate sampling between these two facilities each month. Specific sampling sites and number of samples to be taken will be determined based on water usage patterns, distribution system layouts, and other factors, such as construction activities and line breaks.

Independent chlorine sampling at the ETTP DOE facility will be conducted upon request or in case of line breaks/repairs due to the city of Oak Ridge accepting ownership of the system at ETTP.

As stated previously, if it is determined by evidence that shallow subsurface plume infiltration, cross connections, low chlorine residuals, line breaks/leaks, or other upset conditions have occurred that could cause a possible threat to the quality of the drinking water at Y-12, ORNL, and/or ETTP, then, as-needed independent sampling of organic, inorganic, and radiological constituents will be conducted. The following methods will be used for sampling organic, inorganic, and radiological constituents.

Bacteriological

The U.S. Environmental Protection Agency (EPA)-approved method for coliforms (Colilert® in the pass/fail mode) will be the methodology utilized by Laboratory Services. The lab has expertise in a broad scope of services and analyses available to the division and other TDEC divisions statewide. For bacteriological testing on raw water sources, the counting application of the Colilert kits would be identified and utilized.

Sample collection will be completed by filling an appropriate sample container with 100 ml of water. All chain-of-custody procedures for conducting bacteriological sampling will be followed.

Organic, Inorganic and Radiological

Analytical methods are provided in the Standard Operating Procedures (SOP) manuals for Laboratory Services. The SOPs refer to proper EPA and/or other methods. In order to assess methods used, division staff should communicate with their sampling and analytical counterparts

within the ORR on a basis that facilitates technical exchange and openness. General sampling and analysis methods will follow EPA guidelines as listed in the appropriate section of Title 40 of the Code of Federal Regulations (CFR).

Quality Control/Quality Assurance

If independent sampling activities are conducted, care will be taken to include quality control samples. The level of quality control methodology implemented will be commensurate with the level of independent sampling conducted. Forms of control sampling to be considered will be blanks, duplicate analysis, division-split samples, or even-split samples with site DOE contractor. Information pertaining to the quality control samples will be included in program files and spreadsheets.

Equipment that will be required to accomplish this oversight and sampling project include:

- latex or vinyl exam gloves
- Hach Pocket Colorimeter Kit,
- Hach free chlorine DPD powder pillows
- bound field book
- state vehicle
- *Health, Safety, and Security Plan*
- sample bottles
- sampling cooler
- disinfectant (full strength) spray bottle
- ice
- chain-of-custody forms
- sample labels

Table 1 displays sampling sites, constituents, and anticipated frequency.

Table 1: Anticipated Sampling

SITE	CONSTITUENTS	FREQUENCY	NUMBER OF SAMPLES
Y-12	Free Chlorine	Every other Month	1 per every other Month
	Bacteriological	As Needed	As Needed
	VOCs ¹	As Needed	As Needed
	Radiological ²	As Needed	As Needed
	Mercury	As Needed	As Needed
ORNL	Free Chlorine	Every other Month	1 per every other Month
	Bacteriological	As Needed	As Needed
	VOCs ¹	As Needed	As Needed
	Radiological ²	As Needed	As Needed
	Metals including Mercur	As Needed	As Needed
ETTP	Free Chlorine	As Needed	As Needed
	Bacteriological	As Needed	As Needed
	VOCs ¹	As Needed	As Needed
	Radiological ²	As Needed	As Needed
	Metals including Mercur	As Needed	As Needed

Note¹ = volatile organic compounds
 Note² = gross alpha/beta and gamma will be collected.

References

- Tennessee Department of Environment and Conservation. *Cross Connection Control Manual*. Division of Water Supply. Nashville, Tennessee. 1988.
- Tennessee Department of Environment and Conservation. *Regulations for Public Water Systems and Drinking Water Quality (Chapter 1200-5-1)*, Division of Water Supply. Nashville, Tennessee.
- Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement Between The U.S. Department of Energy and the State of Tennessee*. DOE Oversight Division, Oak Ridge, Tennessee. 2011.
- Tennessee Department of Environment and Conservation. *Tennessee Safe Drinking Water Act*, (T.C.A. 68-13-701), Nashville, Tennessee.
- U.S. Environmental Protection Agency. *Cross Connection Control Manual*. EPA 570/9-89-007. June 1989.
- U.S. Environmental Protection Agency. *Total Coliform Rule*. Office of Drinking Water and Ground Water. <http://www.epa.gov/safewater/tcr/tcr.html#distribution>
- Yard, C.R. *Health, Safety, and Security Plan*, Tennessee Department of Environment and Conservation, DOE Oversight Division, Oak Ridge, Tennessee, 2011.

RadNet Drinking Water on the Oak Ridge Reservation

Introduction

In 2012, the Tennessee Department of Environment and Conservation, DOE Oversight Division (the division), will continue to monitor drinking water quarterly at five area water treatment plants with EPA's RadNet Precipitation Monitoring program. This program is important because it conducts radiological analysis of drinking water processed from waters near the Oak Ridge Reservation (ORR). Since any radiological contaminants released on the ORR can enter local streams and be transported to the Clinch River, the possibility that ORR pollutants could impact area water supplies remains. To date, the monitoring of the river via local water treatment facilities has indicated that concentrations of radioactive contaminants are below regulatory criteria. The program provides a mechanism to evaluate the impact of DOE activities on water systems located in the vicinity of the Oak Ridge Reservation and to verify DOE monitoring in accordance with the *Tennessee Oversight Agreement* (TDEC, 2011).

Methods and Materials

As in the past, EPA will provide radiochemical analysis of finished drinking water samples collected quarterly by division staff at five public water supplies located on and in the vicinity of the ORR. This analysis will be performed at EPA's National Air and Radiation Environmental Laboratory in Montgomery, Alabama. When received, the results will be compared to each other (to identify anomalies) and to drinking water standards (to assess DOE compliance, adequacy of contaminant controls, and any associated hazards). Analytical parameters and the frequencies of RadNet analysis are provided in Table 1. Results from these analyses will be provided to the division and will be available on EPA's RadNet website (<http://www.epa.gov/radnet>) via a link, or directly (http://iaspub.epa.gov/enviro/erams_query_v2.simple_query) via the EPA searchable Envirofacts database.

Table 1: EPA Analysis for RadNet Drinking Water Samples

ANALYSIS	FREQUENCY
Tritium	Quarterly
Gross Alpha	Annually on composite samples
Gross Beta	Annually on composite samples
Gamma Scan	Annually on composite samples
Iodine-131	Annually on one individual sample/sampling site
Strontium-90	Annually on composite samples
Radium-226	Annually on samples with gross alpha >2 pCi/L
Radium-228	On samples with Radium-226 between 3-5 pCi/L
Plutonium-238, Plutonium-239, Plutonium-240	Annually on samples with gross alpha >2 pCi/L
Uranium-234, Uranium-235, Uranium-238	Annually on samples with gross alpha >2 pCi/L

The five Oak Ridge area monitoring locations in the program are the Kingston Water Treatment Plant, the City of Oak Ridge Water Treatment Facility at ETTP, West Knox Utility District, the City of Oak Ridge Water Treatment Facility at Y-12, and the Anderson County Utility District. Figure 1 depicts the approximate locations of raw water intakes associated with these facilities.

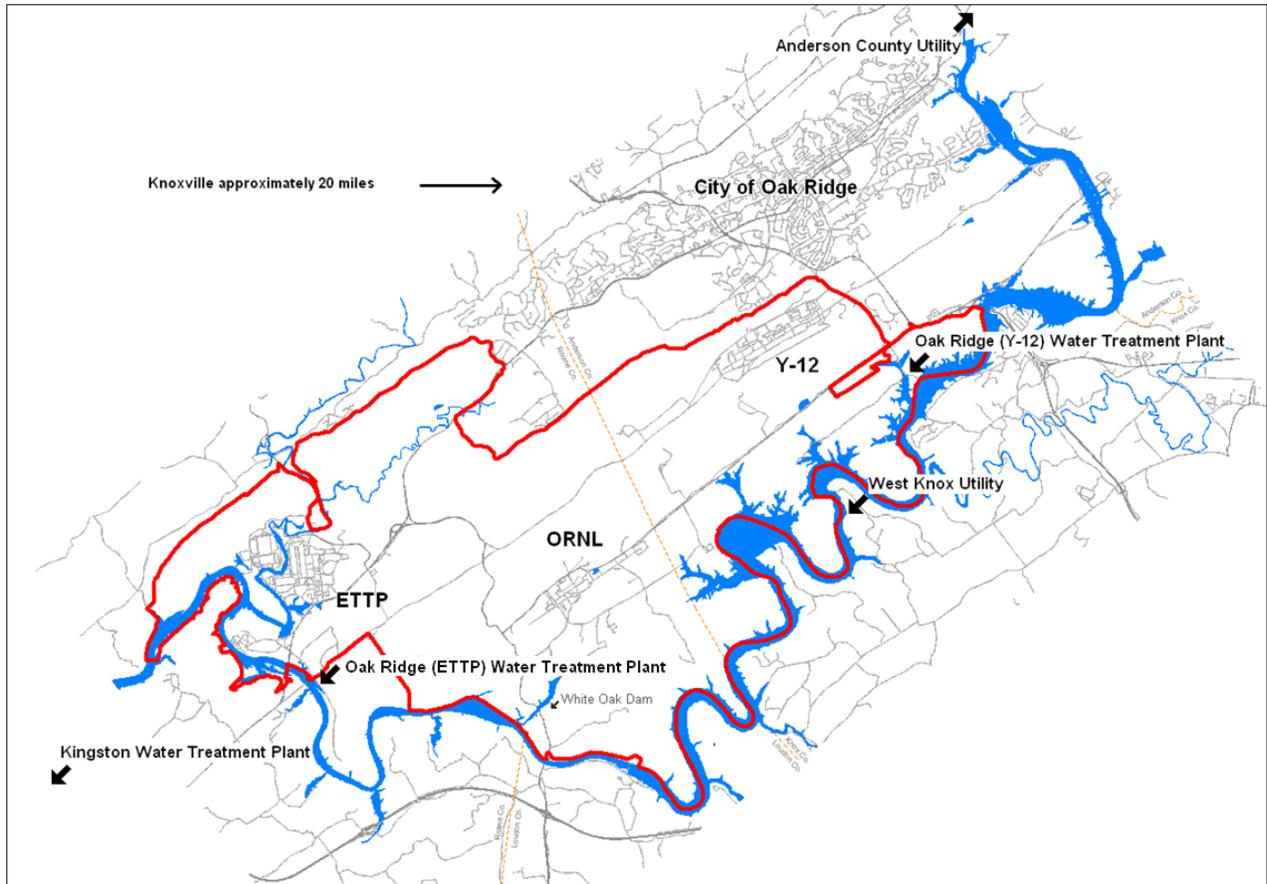


Figure 1: Approximate locations of the intakes for public water systems monitored in association with EPA’s RadNet drinking water program

References

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*. DOE Oversight Division. Oak Ridge, Tennessee. 2011.

United States Environmental Protection Agency. *Environmental Radiation Ambient Monitoring System (ERAMS) Manual*. Doc. EPA 520/5-84-007, 008, 009. May 1988.

United States Environmental Protection Agency. National Air and Radiation Environmental Laboratory. http://iaspub.epa.gov/enviro/erams_query_v2.simple_query (Last updated August 31, 2011).

United States Environmental Protection Agency. National Air and Radiation Environmental Laboratory. <http://www.epa.gov/radnet> (Last updated August 31, 2011).

Yard, C.R., *Health and Safety Plan*, Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

GROUNDWATER MONITORING

Groundwater Monitoring Plan for the Oak Ridge Reservation and its Environs

Introduction

In concordance with the mission of the state's Department of Energy Oversight Division (TDEC/DOE-O), as established under the Tennessee Oversight Agreement (TOA) and the Federal Facilities Agreement (FFA), to protect the people and environment of East Tennessee, in respect to wastes and contaminants generated by Oak Ridge Reservation (ORR) Department of Energy (DOE) operations, both legacy and current, the division conducts monitoring of the groundwaters of the Oak Ridge Reservation (ORR) and its environs.

The primary goal of the DOE-Oversight Division's groundwater sampling program during 2012 is to

- Plan and conduct an offsite groundwater monitoring program for the purpose of protecting the people and environment of East Tennessee, where the potential exists for impact to groundwaters by past and or present activities of the DOE on or off the ORR.
- In support of the above, where feasible, locate and monitor groundwater exit pathways within the peripheral areas of the ORR.
- Sampling efforts for 2012 will focus on the state review of the East Tennessee Technology Park (ETTP) Zone 1 Record of Decision (ROD).

Description

Monitoring by the division's groundwater program will focus on activities that directly support the offsite ground water monitoring effort. These activities will consist of monitoring seeps, springs and wells located on the periphery of DOE properties that are known or suspected of having been impacted by DOE's legacy or current activities. See Figure 1 for a map of the groundwater sampling locations. Groundwater tracing in support of monitoring objectives may be conducted from onsite to offsite, onsite to onsite, offsite to onsite, and/or offsite to offsite locations.

Analytes for samples will be chosen based on known or suspected DOE contamination, and for the acquisition and compilation of supporting hydrogeological and hydrogeochemical data.

Tracing

In carbonate, karst and fractured rocks assumptions about the functioning of wells and the implicit assumption existence of a porous medium are not valid (ASTM, 1995; USEPA, 1997). The only reliable way to base the design of a monitoring system in these settings is by the use of groundwater tracing. This should involve using contaminants as tracers, and/or natural isotopic and geochemical fingerprints.

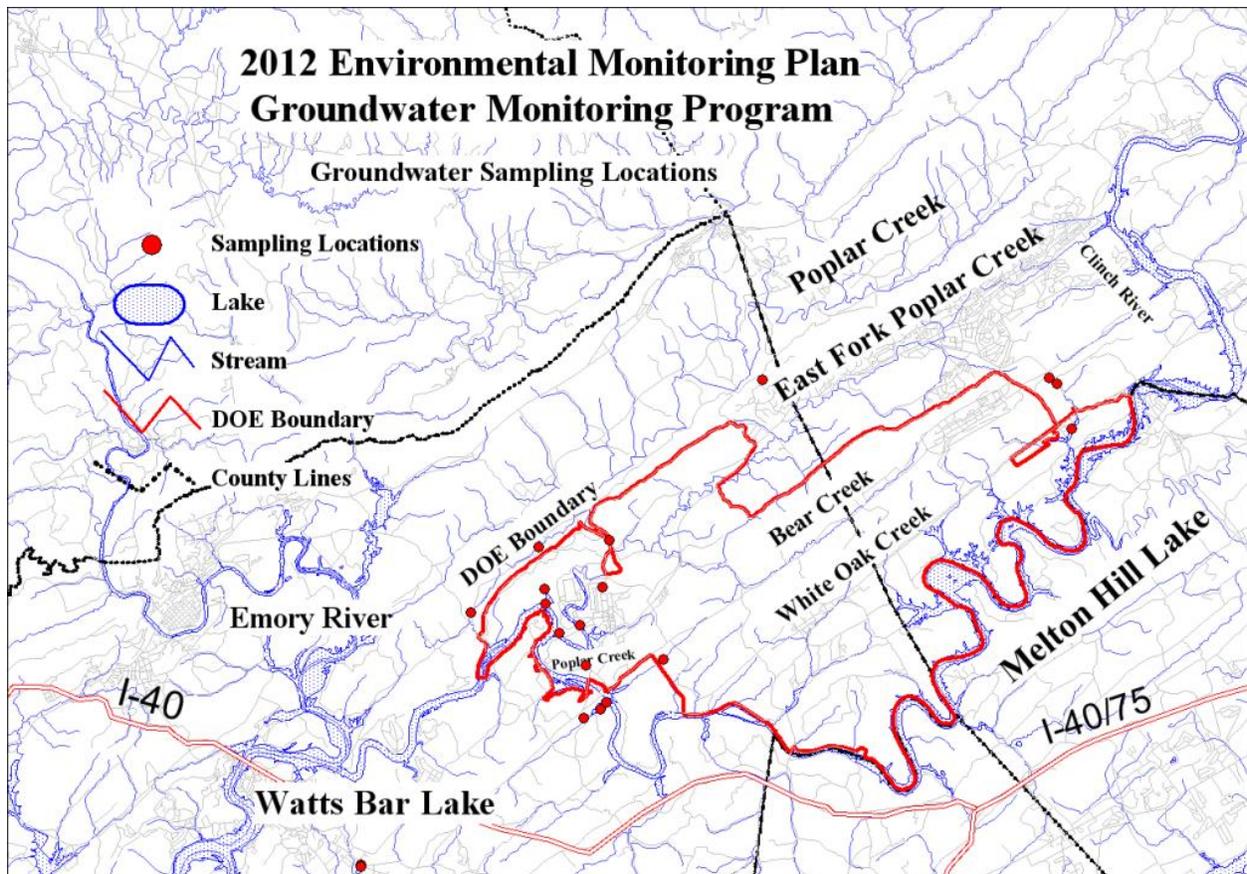


Figure 1: 2011 Groundwater Sampling Locations

However, these tracers do not yield all flow and transport data. For old facilities it is often the case that contaminants have been in the ground for decades and even detection down gradient does not yield data revealing initial migration velocities. The only reliable way to obtain these data is by injected tracing.

Traced velocities in carbonates and other non-carbonate fractured rocks range from 0.001 m/s to 1 m/s with the highest velocities correlated with highest stage conditions (Worthington et al., 2000a, 2000b). The least expensive, most reliable and easily detectable injectable tracers are fluorescent dyes (ASTM 1995). Injected fluorescent tracers can also serve as surrogates for contaminants and those data are the only way to reliably determine the where to sample for contaminants and determine the appropriate sampling frequency to reliably determine the maximum contaminant load at a monitoring point.

When and where feasible the division will conduct tracing in support of monitoring efforts conducted both on and offsite.

Reconnaissance

The groundwater program, will conduct efforts to locate springs, seeps, and wells either offsite or on the periphery of the ORR that are potential discharge locations and/or may have been

impacted by DOE activities. If feasible, detailed geologic maps and/or hydrogeological cross sections may be generated with the cooperation of the Division of Geology.

Dynamic

The groundwater monitoring program should be considered dynamic in that it is intended that monitoring be responsive to findings and demands rather than regimented to a preconceived schedule.

Methods and Materials

Due to geologic controls on groundwater movement and potential contaminant migration, sampling generally will be performed along geologic strike and along cross strike geologic features, from the historically named Y-12, X-10, K-25 and the South Campus facilities.

Water supply wells will be sampled by collecting water as close to the wellhead as possible. This sampling will take place after being purged for at least 20 minutes or after field parameters stabilize. Monitoring wells will be co-sampled along with facility personnel or by division personnel using disposable bailers. Parameters, such as, pH, temperature, dissolved oxygen, oxidation reduction potential, and conductivity will be collected before sampling and recorded in the field notes. Springs will be sampled based on field observation of flow and safety considerations. Where possible, sampling will be conducted at high, low stage, and at moderate stages (dry season, wet season, normal precipitation) for all sampling locations. Trolls, devices that provide continuous monitoring of temperature and conductivity will, when available and feasible, be used to determine optimum frequency and timing of sampling events.

As watercress and algae may bio-accumulate contaminants, occasional samples of aquatic vegetation samples may be collected and analyzed for inorganic and radiologic parameters.

As contaminants may transport in turbulent groundwater on sediment, occasional sediment samples may be collected and analyzed for inorganic and radiologic parameters.

Specific radiochemical analyses will be determined prior to sampling or modified upon consultation with the Radiological Monitoring Oversight Program (RMO). If domestic water supplies show a gross alpha activity greater than 5 picocuries/liter, then radionuclide isotope-specific analysis for alpha emitters will be performed on the laboratory-archived sample.

New sampling locations will include cation/anion parameters to include, at a minimum, calcium, magnesium, sodium, potassium, chloride, sulfate, nitrate, bicarbonate, and carbonate in order to calculate ionic charge balances and to perform groundwater geochemical “fingerprints”. A list of metals that may include the health-based analytes will be considered for analysis at new locations. Volatile organic compounds (VOCs) will be sampled for at all new springs. At sampling points where metals, VOCs, or radionuclide results indicate a need to determine variability, then appropriate follow up samples will be collected and analyzed.

As new contaminants of concern are identified by the regulatory and monitoring community, new parameters may be added to the analysis of ground and surface waters sampled by the program.

The Tennessee Department of Health analytical laboratory in Knoxville, Tennessee will furnish sample containers. Samples will be collected using approved TDEC and EPA sampling procedures. Vinyl exam gloves and decontamination equipment and procedures will be necessary to avoid cross contamination. TDEC DOE-O sample coolers will be used to insure that samples are preserved in route to the laboratory.

Appropriate lab, field and trip blanks (QA/QC) will be utilized.

DOE Coordination/Communication

DOE will be notified by this document, monitoring meetings, and revisions to this document, of division groundwater sampling plans. Should the DOE request the opportunity to observe and/or take split samples, every effort will be made to facilitate DOE participation in the division's groundwater program. Analytical results will be made available to any and all interested parties upon request.

All results and findings will be reported in the DOE-Oversight Division's annual report. It is anticipated there will be two sections in the 2012 Environmental Monitoring Report covering:

- Offsite Sampling Results (private residential and non-community wells, and springs)
- Onsite and/or Exit Pathway Investigations

References

Bailey, Z. C. and Roger W. Lee. *Hydrology and Geochemistry in Bear Creek Valleys Near Oak Ridge, Tennessee*. U. S. Geological Survey. Water-Resources Investigations Report 90-4008. 1991.

Davies, Gareth J. "Water Temperature Variation at Springs in the Knox Group Near Oak Ridge, Tennessee". In *Proceedings of the 3rd Conference on Hydrogeology, Ecology, Monitoring, and Management of Groundwater in Karst Terrains*. Nashville, Tennessee p. 197. 1991.

Hatcher, R. D., P. J. Lemiszki, R. B. Dreier, R. H. Kettle, R. R. Lee, D. A. Lietzke, W. M. McMaster, J. L. Foreman, and S. Y. Lee. *Status Report on the Geology of the Oak Ridge Reservation*. ORNL/TM-12074. Oak Ridge National Laboratory. Oak Ridge, Tennessee. 1992.

King, H. L. and C. Stephen Haase. *Subsurface-Controlled Geological Maps for the Y-12 Plant and Adjacent Areas of Bear Creek Valley*. ORNL/TM-10112. Martin Marietta Energy Systems. Oak Ridge, Tennessee. 1987.

Martin Marietta Energy Systems. *A Study of Groundwater Flow from Chestnut Ridge Security Pits Using a Fluorescent Dye Tracer*. Y/SUB/90-00206C/6. Prepared by Geraghty & Miller, Inc. Oak Ridge, Tennessee. 1990.

Martin Marietta Energy Systems. *Final Report of the Second Dye Tracer Test at the Chestnut Ridge Security Pits, Oak Ridge, Tennessee*. Y/SUB/93-99928c/Y10/1. Prepared by Science Applications International Corporation. Oak Ridge, Tennessee. 1992.

- Rubin, Paul A. and Peter Lemiszki. *Aspects of Oak Ridge Karst Hydrology and Geomorphology. Characterization Plan With Emphasis on the K-25 Bedrock Flow System*. Unpublished report for Martin Marietta Energy Systems/Department of Energy. Oak Ridge, Tennessee. 1992.
- Smart, P. L. and I. M. S., Laidlaw. *An Evaluation of Some Fluorescent Dyes for Water Tracing. Water Resources Research*. Vol. 13. No. 1: 15-33. 1977.
- Standard Guide for the Design of Monitoring Systems in Karst and Fractured Aquifers*. American Society for the Testing and Materials, Philadelphia, PA. 1995.
- Tennessee Department of Environment and Conservation. *Environmental Laboratory Service Guide and Sampling Manual*. Nashville, Tennessee. 1992.
- Tennessee Department of Environment and Conservation. *Spring Monitoring Data*-Unpublished data. DOE Oversight Division. 1994-2001.
- Tennessee Department of Environment and Conservation. *Standard Operating Procedures*. DOE Oversight Division. Oak Ridge, Tennessee. 1996.
- Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*. DOE Oversight Division, Oak Ridge, Tennessee. 2011.
- Tennessee Department of Environment and Conservation. *Work Plan for Dye Trace Study at the Chestnut Ridge East Borrow Area Y-12 Plant Oak Ridge, Tennessee*. DOE Oversight Division Oak Ridge, Tennessee. 1995.
- U.S. Environmental Protection Agency. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM)*. Enforcement and Investigations Branch, Region IV. Athens, Georgia. 1997.
- U.S. Environmental Protection Agency. *Guidelines for Wellhead and Springhead Protection Area Delineation in Carbonate Rock* EPA904-B-97-003, Region 4.
- Yard, C.R. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

RADIOLOGICAL MONITORING

Facility Survey Program and Infrastructure Reduction Work Plan

Introduction

The Tennessee Department of Environment and Conservation's Department of Energy Oversight Division (DOE-O), in cooperation with the U.S. Department of Energy and its contractors, operates a facility survey program (FSP) on the Oak Ridge Reservation (ORR). The DOE-O survey program provides a comprehensive, independent characterization of facilities on the ORR based on their operational history, present mission, physical condition, inventories of radiological and/or hazardous materials, degree of contamination, contaminant release history, and potential for release of contaminants to the environment.

The goal of the program is to fulfill part of the commitments agreed to by the State of Tennessee and the Department of Energy in Section 1.2.3 of the Tennessee Oversight Agreement, which states that "Tennessee will pursue the initiatives in attachments A, C, E, F, and G. The general intent of these action items is to continue Tennessee's: (1) environmental monitoring, oversight and environmental restoration programs; (2) emergency preparedness programs; and (3) delivery of a better understanding to the local governments and the public of past and present operations on the ORR and potential impacts on the human health and/or environment by the Oak Ridge Reservation." As part of this larger endeavor, *the facility survey program is designed to provide a detailed assessment of all potential hazards affecting or in any way associated with facilities on the Oak Ridge Reservation.* To meet this objective, survey team members walk through each facility and gather information that is recorded in a database that allows the team to characterize facilities and evaluate their potential for release of contaminants to the environment (PER). The conditions of facilities are considered within a variety of environmental conditions ranging from catastrophic (i.e. tornado, earthquake) to normal everyday working situations. From an emergency preparedness perspective such information is essential.

In 2002, the Department of Energy instituted a formal, accelerated D&D program aimed at facility reduction through demolition. Facility survey staff responded to this activity by making facility visits and conducting external inspections of each facility prior to and during demolition. This activity will continue in 2012.

Methods and Materials

The criteria used in the selection of facilities to be surveyed include 1) position of facility in S&M/D&D programs; 2) perceived physical condition of facility; 3) perceived levels of contamination; 4) types or quantities of inventories (hazardous or radiological); and 5) special circumstances (incidents, public or other agency request, or other unforeseen situations).

Using standard radiation survey instruments, inventory data, and historical documentation, staff walk through each facility and record information in a questionnaire format. Based on these results and professional judgment, staff then rank the potential for release of contaminants to the environment (PER) for each facility by scoring 0 (least potential) to 5 (greatest potential) for

each of 10 “categories.” Tables 1 and 2 illustrate the scoring guidelines for potential environmental release, and the categories to be scored.

Table 1: Potential for Environmental Release Scoring Guidelines

Score	Score is based on observations in the field and the historic and present-day threat of contaminant release to the environment/building and/or ecological receptors.
0	No potential: no quantities of radiological or hazardous substances present.
1	Low potential: minimal quantities present, possibility of an insignificant release, very small probability of significant release, modern maintained containment.
2	Medium potential: radiological or hazardous substances present, structures stable in the near to long term, structures have integrity but are not state-of-the-art, adequate maintenance.
3	Medium potential: structures unstable, in disrepair, containment failure clearly dependent on time, integrity bad, maintenance lacking, containment exists for the short term only.
4	High potential: radiological or hazardous substances present. Containment for any period of time is questionable; migration to environment has not started.
5	Radiological or hazardous substance containment definitely breached, environmental/interior pollution from structures detected, radiological and/or hazardous substances in inappropriate places like sumps/drains/floors, release in progress, or radiological exposure rates above Nuclear Regulatory Commission (NRC) guidance.
Note: A score of 0 or 1 designates a low Potential Environmental Release rank; a score of 2 or 3 designates a moderate rank; a score of 4 or 5 designates a high rank.	

Table 2: Ten Categories Scored

1.	Sanitary lines, drains, septic systems
2.	Process tanks, lines, and pumps
3.	Liquid Low-level Waste tanks, lines, sumps, and pumps
4.	Floor drains and sumps
5.	Transferable radiological contamination
6.	Transferable hazardous materials contamination or waste
7.	Ventilation ducts and exit pathways to create outdoor air pollution
8.	Ventilation ducts and indoor air/building contamination threat
9.	Elevated radiation exposure rates inside the facility
10.	Elevated radiation exposure rates outside the facility

As facilities are surveyed, scored, and compared with each other, a relative “potential for environmental release” will emerge. The facilities that show a high potential for release of contaminants will be noted in the program’s annual report. Staff will revisit these facilities at their discretion to evaluate changing conditions. Table 3 provides a list of target facilities to be surveyed during the next year.

Table 3: Target Schedule of Facilities to be Surveyed 2012*

ORNL		Y-12		K-25	
Facility	Date	Facility	Date	Facility	Date
7019	Jan. 15	Y-9401-1	Jan. 15		
7042	Mar. 15	Y-9404-16	Mar. 15		
2525	May 15	Y 9720-32	May 15		
3618	July 15	Y9720-33	July 15		
3034	Sept 15	Y9201-3	Sept. 15		
3036	Oct. 1				
2026	Dec. 1				

* Facility numbers and dates are subject to change.

References

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement Between the Department of Energy and the State of Tennessee*. DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Yard, C.R. Emergency Response Procedures Manual. Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2005.

Yard, C.R., *Health and Safety Plan*, Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Haul Road Surveys

Introduction

The Tennessee Department of Environment and Conservation, with the cooperation of the U.S. Department of Energy and its contractors, will continue to perform weekly surveys of the Haul Road in 2012. The Haul Road was constructed for and is dedicated to trucks transporting CERCLA radioactive and hazardous waste from remedial activities on the ORR to the Environmental Management Waste Management Facility in Bear Creek Valley for disposal. To account for wastes that may fall or be blown from the trucks in transit, TDEC personnel perform walk over inspections of the road and associated access roads weekly. Items noted are logged and their description and location submitted to DOE for disposition.

Methods and Materials

For safety and by agreement with DOE and its contractors, staff members performing the weekly inspections will sign a log book at the ETPP (northeast) check-in station, where they will advise site personnel they will be entering onto the road to perform the survey. The DOE contractor responsible for the road will brief staff members on any known conditions that could present a safety hazard. The contractor will also provide a two-way radio to maintain communication should unforeseen conditions arise that could present a safety hazard while on the road. When excessive traffic presents a safety concern, the survey will be postponed to a later date. Alternate entrances may be used to access the road with DOE approval, but the basic requirements remain in effect.

When staff arrive at the location to be surveyed, they will park their vehicle completely off the road (as far away from vehicular traffic as possible). No less than two people will perform the surveys, each walking in a serpentine pattern along opposite sides of the road to be surveyed. Typically, a Ludlum Model 2221 Scaler Ratemeter with Model 44-10 2"X 2" NaI Gamma Scintillator probe held approximately six inches above the ground surface will be used to scan for radioactive contaminants as the walk over proceeds.

Items found during the survey will be marked with contractor's ribbon at the side of the road and a description of the item and its location logged and reported to DOE and its contractors for disposition. Each item will be surveyed for radiological contamination and the findings included in the above report, along with the instrumentation and procedures used in the radiological assessments. Table 1 provides the current inventory of equipment available to staff for such assessments.

When staff members return to the road for the next weekly inspection, they will perform a follow-up inspection of items found in previous weeks. If any items remain, they will be included in subsequent reports, until removed or staff are advised the item(s) have been determined to be free of radioactive and hazardous constituents.

Table 1: Division of DOE Oversight Portable Radiation Detection Equipment

Radiological Detection Instruments	Radiological Detection Probes	Radioactivity Measured
Ludlum Model 2221 Scaler Ratemeter	Ludlum Model 44-10 2x2 inch NaI Gamma Scintillator	Gamma (cpm)
Ludlum Model 3 Survey Meter	Ludlum Model 44-9 Pancake G-M Detector	Alpha, Beta, Gamma (cpm)
Ludlum Model 3 Survey Meter	Ludlum Model 43-65 50 cm ² Alpha Scintillator	Alpha (cpm)
Bicron Micro-Rem	Internal 1x1 inch NaI Gamma Scintillator	Tissue Dose Equivalent, Gamma (µrem/hr)
Ludlum Model 2224 Scaler/Ratemeter	Ludlum Model 43-93 Alpha/Beta Scintillator	Alpha, Beta
Ludlum Model 48-2748	Gas proportional detector with 821 cm ² active.	Alpha, Beta
Identifinder-NGH	Isotopic Identifier and Ratemeter	Gamma Spectroscopy and Dose Rate Meter

References

Tennessee Department of Environment and Conservation. *Environmental Restoration Footprint Reduction Process*, Department of Energy Oversight Division. Oak Ridge, Tennessee.

Tennessee Department of Environment and Conservation. *Federal Facility Agreement*, Department of Energy Oversight Division. January 1992 (with revisions).

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*, DOE Oversight Division, Oak Ridge, Tennessee. 2011.

Yard, C.R., *Health and Safety Plan*. Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Ambient Gamma Radiation Monitoring of the Oak Ridge Reservation Using Environmental Dosimetry

Introduction

Gamma radiation is emitted by various radionuclides that have been produced, stored, and disposed of on the Oak Ridge Reservation (ORR). Associated radionuclides are evident in ORR facilities and the surrounding soils, sediments, and waters. In order to assess the risk posed by these contaminants, the Tennessee Department of Environment and Conservation, Department of Energy (DOE) Oversight Division began monitoring ambient gamma radiation levels on the ORR in 1995. The program is intended to provide:

- conservative estimates of the potential dose/risk to members of the public from exposure to gamma radiation attributable to DOE activities/facilities on the ORR
- baseline values used to assess the need/effectiveness of remedial actions
- information necessary to establish trends in gamma radiation emissions
- information relative to the unplanned release of radioactive contaminants on the ORR

In this effort, environmental dosimetry is used to measure the radiation dose attributable to external radiation at selected monitoring locations on and in the vicinity of ORR.

Methods and Materials

Optically stimulated luminescence dosimeters used in the program will be obtained from Landauer, Inc., Glenwood, Illinois. Each of these dosimeters will use aluminum oxide photon detectors to measure the dose from gamma radiation (minimum reporting value = 1 mrem). At locations where there is a potential for the release of neutron radiation, the dosimeters will also contain an allyl diglycol carbonate-based neutron detector (minimum reporting value = 10 mrem for thermal neutrons and 20 mrem for fast neutrons).

To account for exposures that may be received in transit or while in storage, control dosimeters will be included in each batch of dosimeters received from the Landauer Company. These dosimeters will be stored in a lead container at the division office during the monitoring period and returned to Landauer with the associated field-deployed dosimeters for processing. Any dose reported for the control dosimeters will then be subtracted from the dose reported for the field-deployed dosimeters by Landauer. At the end of the year, the results will be summed for each location and the resultant annual doses compared to background values and the state/DOE primary dose limits for members of the public (100 mrem/year).

Monitoring locations will be chosen to identify sources of external radiation on the ORR, to develop conservative estimates of the dose to the public from DOE operations/facilities, and to collect information relative to the need and/or effectiveness of remediation. For 2012 Environmental Dosimetry will monitor the following areas:

- (1) Oak Ridge National Laboratory
- (2) Y-12
- (3) Spallation Neutron Source Site
- (4) Environmental Management Waste Management Facility
- (5) Off site areas of interest
- (6) Tower Shielding Facility
- (7) East Tennessee Technological Park

References

Tennessee Department of Environment and Conservation. *Federal Facility Agreement*, DOE Oversight Division. January 1992 (with revisions).

Tennessee Department of Environment and Conservation *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*, DOE Oversight Division, Oak Ridge, Tennessee. 2011.

Yard, C.R., *Health and Safety Plan*, Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Real Time Monitoring of Gamma Radiation on the Oak Ridge Reservation

Introduction

The Tennessee Department of Environment and Conservation, DOE Oversight Division, has deployed continuously-recording exposure-rate monitors on the Oak Ridge Reservation since 1996 and will continue the project in 2012. The monitors record gamma radiation levels at predetermined intervals over extended periods of time. The instruments have primarily been used to monitor remedial activities and supplement the integrated dose rates provided by environmental dosimeters. In this regard, the dosimeters provide a cumulative dose over the monitoring interval, but the data do not indicate the specific time and magnitude of fluctuations in the dose rates. Consequently, a series of small releases cannot be distinguished from a single large release using the dosimeters alone. In contrast, the exposure rate monitors provide a profile of gamma emissions that can be correlated with changing environmental and/or anthropogenic conditions, allowing the cause of the release to be tracked and appropriate precautions taken.

Methods and Materials

The continuous exposure rate monitors used in the program incorporate detection equipment, power supply, software, and associated instrumentation in a portable weather resistant case. The units are capable of measuring and recording gamma exposure rates from 1 $\mu\text{rem/hr}$ to 1 rem/hr at preset intervals of one minute to two hours over extended time periods (e.g., a month). The data is downloaded in the field using an infrared transceiver, a lap top computer, and associated software.

Monitoring focuses on the measurement of exposure rates under conditions where gamma emissions are expected to fluctuate substantially over short time periods or where there is a potential for the unplanned release of gamma emitting radionuclides. The primary areas monitored in the program will be associated with remedial or waste management activities at sites where gamma radiation is known to be a concern. The locations of sites currently being monitored in the program are depicted in Figure 1. These sites include:

- the Core Hole 8 remediation at Oak Ridge National Laboratory (ORNL)
- the Spallation Neutron Source stack
- the TRU Waste Processing Facility in Melton Valley
- the background station located at Fort Loudoun Dam in Loudon County

Monitoring stations can be expected to vary as the sites subject to remediation change and findings warrant. Additional candidates for monitoring in 2012 include the demolition of buildings in the 3026 and 2000 complexes at ORNL. These facilities are considered to be some of the highest risk facilities at ORNL, due to the condition of the structures, the presence of loose radioactive contamination, and their proximity to active ORNL facilities.

To evaluate the exposure rates recorded, data collected from the monitoring locations will be compared to background concentrations, the state limits for the maximum dose to an unrestricted area (2 mrem in any one hour period), and the state/DOE dose limits for members of the public.

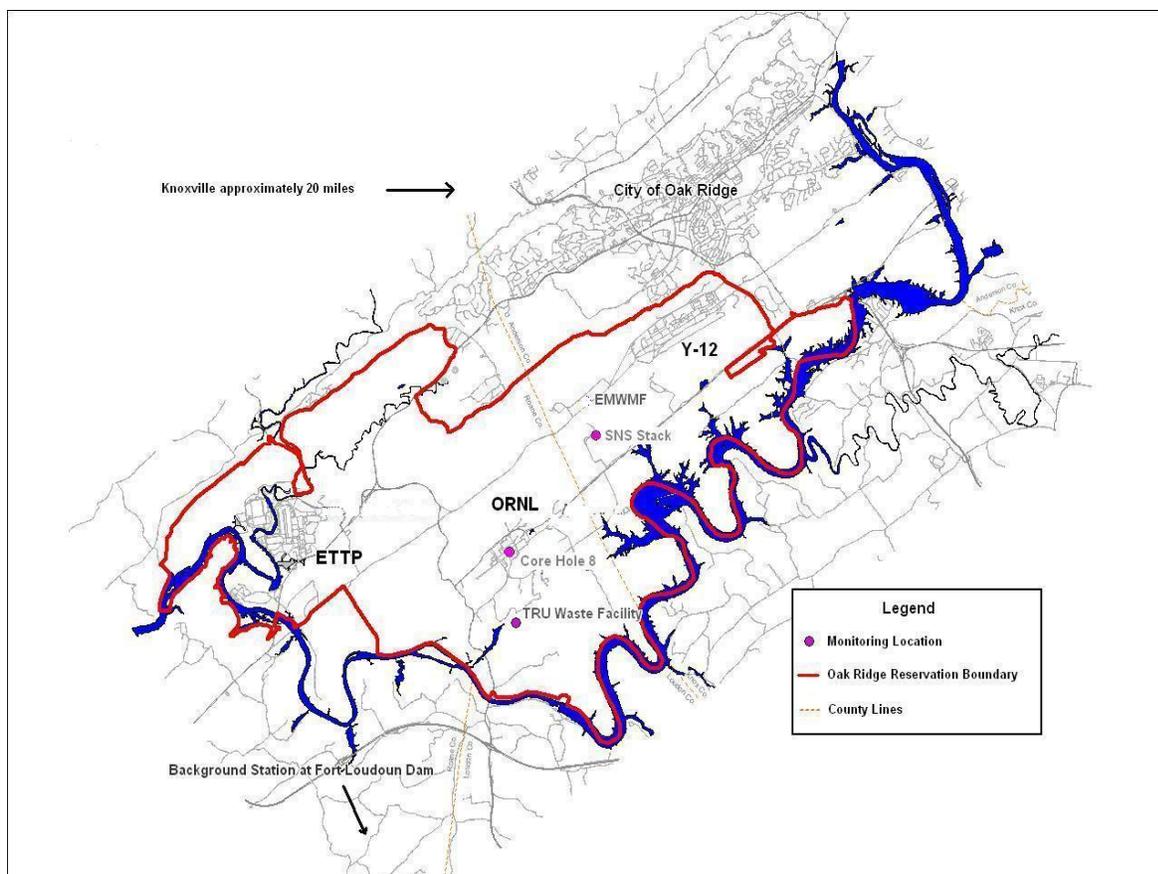


Figure 1: Current Continuous Exposure Rate Monitoring Locations

References

Conley, T.B., Van Hoesen, S.D., Harper, M.A., Dillinger, D., Schneider .K.R., Walsh. T.M., Johnson, M.A., Billingsley K. M. *D&D of the Radioisotope Development Laboratory (3026 Complex) and the Quonset Huts (2000 Complex) at Oak Ridge National Laboratory Funded by the American Recovery and Reinvestment Act – 10255*. WM2010 Conference. March 7-11, Phoenix AZ. 2010. (<http://www.wmsym.org/app/2010cd/wm2010/pdfs/10255.pdf>)

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement. Agreement Between the U.S. Department of Energy and the State of Tennessee*. DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Yard, C.R., *Health Safety Plan*. Tennessee Department of Environment and Conservation. DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Surplus Material Verification

Introduction

Since 2002, the Tennessee Department of Environment and Conservation, Department of Energy Oversight Division (the division), in cooperation with the U.S. Department of Energy and its contractors, has conducted random radiological surveys of surplus materials that are destined for sale to the public on the Oak Ridge Reservation (ORR). Standard radiological survey protocols and instrumentation are used for these surveys. In addition to performing the surveys, the division reviews the procedures used for release of materials under DOE radiological regulations. The overall goal of the program is to ensure that DOE radiation controls are adequately preventing radiological contamination from reaching the public. Pre-auction surveys are performed for every auction where time and adequate staff are available for the survey.

Also reviewed are any occurrence reports that involve surplus materials. Some materials, such as scrap metal, may be sold to the public under annual sales contracts, whereas other materials are staged at various sites around the ORR awaiting public auction or sale. The division, as part of its larger radiological monitoring role on the reservation, conducts these surveys to help ensure that no potentially contaminated materials reach the public.

In the event that radiological activity is detected, the division will immediately report to the responsible supervisory personnel of the surplus sales program. The division will follow their response to the notification, ensuring that appropriate steps (removal of items from sale, resurveys, etc.) are taken to protect the public. The division reviews any occurrence reports, procedural changes and removal of items from sales inventories.

Methods and Materials

Staff members make random surveys of items that are arranged in sales lots by using standard survey instruments and standard survey protocols. Instrumentation used is the Ludlum Model 2221 Scaler/Ratemeter with a Ludlum Model 44-10 NaI/Tl gamma radiation scintillation detector and the Ludlum Model 2224 Scaler/Ratemeter with a Ludlum Model 43-93 Alpha/Beta Scintillator. Potential items range from furniture and computer equipment to vehicles and construction materials. Particular survey attention is paid to smaller equipment and parts. Where radiological release information is attached, radiation clearance information is compared to procedural requirements. If any contamination that exceeds twice the background reading is detected during the on-site survey, the surplus materials manager for the facility will be notified immediately. In addition to radioactivity, any chemical concerns will be immediately brought to the attention of the manager.

References

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Yard, C.R., *Health Safety Plan*. Tennessee Department of Environment and Conservation. DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Monitoring of Waste at the Environmental Management Waste Management Facility Using a Radiation Portal Monitor

Introduction

In 2012, the Tennessee Department of Environment and Conservation, DOE Oversight Division, will use a radiation portal monitor (RPM) to survey waste as it is transported into the disposal area at the Environmental Management Waste Management Facility (EMWMF). The EMWMF is used to dispose of CERCLA hazardous and radioactive waste generated by remedial activities on the Oak Ridge Reservation. Only low level radioactive waste that does not contain concentrations of radionuclides in excess of limits specified in waste acceptance criteria (WAC), agreed to by FFA parties, is approved for disposal in the facility. To help ensure these provisions of the WAC are not violated, the state (with the assistance of DOE and its contractors), erected a radiation portal monitor at the check-in station for trucks delivering waste to the EMWMF disposal area.

The RPM uses two large area gamma-ray scintillators (placed on each side of the road at the check-in station) to measure gamma radiation emission as trucks transporting waste pass through portal, into the disposal area. The RPM stores the measurements and associated information (e.g., date, time), then uploads the data to a secure website, where it is available for the state and DOE to review. If measurements exceed a predetermined level, the RPM software generates an alert notification that is sent by email to TDEC staff members. When such a notification is received or anomalies are noted in daily reviews of the data, EMWMF staff will be notified and the source of the waste passing through the portal at the time of the measurements determined. If a review of available information indicates provisions of the WAC have been violated, FFA parties will be so notified.

Methods and Materials

A Canberra RadSenrty POV-G portal monitor is used in the program. The system is comprised of two large area gamma-ray scintillators, an occupancy sensor, a control box, a computer, and associated software. The gamma-ray scintillators and instrumentation are contained in radiation sensor panels (RSPs) mounted on stands located on each side of the road leading to the check-in station (Figure 1). Measurements are initiated by the occupancy sensor when a truck enters the portal. Data is transmitted from the RSPs to the control box, where it is stored, analyzed, and uploaded to a secure website, along with associated information (date, time, background measurements. etc.),

Data on the website will be reviewed daily by division staff and will be available for remote viewing by DOE personnel and its authorized contractors. The RPM is programmed to send an alert notification by email, if measurements exceed a preset level. When an alert notification is received or anomalies are noted in the daily reviews of the data, EMWMF personnel will be contacted and the source of the waste lot passing through the portal monitor at the time of the measurements determined. If a subsequent investigation indicates that provisions of the WAC may have been violated, FFA parties will be so notified.



Figure 1: TDEC Portal Monitor at the Environmental Management Waste Management Facility

References

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement. Agreement between the U.S. Department of Energy and the State of Tennessee*. DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Yard, C.R., *Health and Safety Plan*. Tennessee Department of Environment and Conservation. DOE Oversight Division. Oak Ridge, Tennessee. 2011.

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SURFACE WATER MONITORING

Environmental Monitoring at the Environmental Management Waste Management Facility

Introduction

The Tennessee Oversight Agreement (TOA) requires the state to perform monitoring to verify Department of Energy (DOE) data and to assess the effectiveness of DOE contaminant control systems on the Oak Ridge Reservation (ORR). During 2012, TDEC's Division of DOE Oversight will monitor effluents, sediments, and biota at DOE's Environmental Management Waste Management Facility (EMWMF), located in eastern Bear Creek Valley. This facility was constructed to dispose of waste generated by remedial activities on the ORR and is operated under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). While the facility holds no permit from any state agency, it is required to comply with substantive portions of relevant and appropriate legislation contained in the CERCLA Record of Decision (DOE, 1999) and with requirements associated with responsibilities delegated to the DOE by the Atomic Energy Act.

While the availability of the EMWMF has expedited remedial activities, the east Tennessee region presents environmental challenges for landfill design, e.g., the height of the groundwater table, the quantity of surface water runoff, and the porosity of local soils. The height of the groundwater table required the installation of a French drain under the facility to lower the water table, which on occasion rose to levels that approached the liner of the facility. The quantity of surface water runoff required pooling effluent (a mixture of rainwater runoff and drainage from wastes) to be pumped to holding ponds, where it is sampled prior to being released to a drainage ditch that flows to a sediment basin. The sediment basin discharges to a local tributary of Bear Creek (NT-5).

It is the intent of the project to verify that the design, operations, and associated contaminant control mechanisms of the facility are consistent with criteria agreed to by the state, EPA, and DOE.

Methods and Materials

To ensure that EMWMF is meeting its design requirements, several parameters and analytes are being monitored. To ensure that the water table is below the geologic buffer, a review of groundwater level measurements will be conducted annually from data received on the wells listed in Table 1. Table 2 lists surface water, groundwater and contact water samples along with sample frequency, list of analytes, and sampling rationale. Table 3 lists sediment sample locations, sampling schedule, list of analytes, and sampling rationale. Any biota samples collected at the facility will be in accordance and in conjunction with the aquatic biota monitoring plan. Monitoring locations are depicted in Figures 1 and 2.



Figure 1: Surface Water / Groundwater / Contact Water Sample Locations at EMWMF DigitalGlobe, GeoEye, US Geological Survey, USDA Farm Service Agency (2010) Google Maps [online]



Figure 2: Sediment Sampling Locations at EMWMF. DigitalGlobe, GeoEye, US Geological Survey, USDA Farm Service Agency (2010) Google Maps [online].

Additionally, water parameters (pH, temperature, conductivity, dissolved oxygen and turbidity) will be monitored periodically and/or on a continuous basis with a water quality data logger at EMWWMF-2 (underdrain) and EMWWMF-3 (sediment basin outfall).

Sampling frequencies will depend on conditions and activities at the site. Samples will be taken as conditions merit with the intent to monitor waste streams in order to characterize and delineate contaminant releases. However, to ensure some consistency in sample duration, groundwater/surface water samples will be collected, at a minimum, quarterly or annually.

References

DigitalGlobe, GeoEye, US Geological Survey, USDA Farm Service Agency (2010) Google Maps [online].

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*. DOE Oversight Division. Oak Ridge, Tennessee. 2011.

United States Department of Energy. *Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste*. DOE/OR/01-1791&D3. Oak Ridge, Tennessee. November 1999.

Yard, C.R., *Health, and Safety Plan*, Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Table 1: Groundwater Wells

Well ID	Zone	Rationale
GW-363	Shallow	Downgradient
GW-639	Deep	Downgradient
GW-916	Shallow	Crossgradient to waste cell 1
GW-917	Shallow	Downgradient to waste cell 1
GW-918	Shallow	Background
GW-920	Shallow	Downgradient
GW-921	Shallow	Downgradient
GW-922	Shallow	Downgradient
GW-923	Shallow	Crossgradient to waste cell 1
GW-924	Shallow	Downgradient
GW-925	Deep	Downgradient
GW-926	Deep	Downgradient and Important to monitor effectiveness of underdrain
GW-927	Deep	Downgradient
GW-946	Piezometer	Upgradient to waste cell 2
GW-947	Piezometer	Upgradient to waste cell 1 and 2
GW-948	Piezometer	Upgradient to waste cell 1
GW-949	Piezometer	Crossgradient to waste cell 1 (has been dry since installation)
GW-950	Piezometer	Upgradient to waste cell 2
GW-951	Piezometer	Downgradient to waste cell 2
GW-952	Piezometer	Downgradient to waste cell 1
GW-961	Shallow	Downgradient near waste cell 6
GW-964	Shallow	Downgradient near waste cell 6
GW-965	Deep	Downgradient near waste cell 6
PP-01	Piezometer/pressure transducer	Under waste cell 3
PP-02	Piezometer/pressure transducer	Under waste cell 4 (has been dry since installation)
PP-03	Piezometer/pressure transducer	Under waste cell 4 (has been dry since installation)
PP-05	Piezometer/pressure transducer	Under waste cell 4
PP-06	Piezometer/pressure transducer	Under waste cell 5
PP-07	Piezometer/pressure transducer	Under waste cell 5
PP-08	Piezometer/pressure transducer	Planned under waste cell 6
PP-09	Piezometer/pressure transducer	Planned under waste cell 6

Table 2: Surface Water / Groundwater / Contact Water Samples

DOE-O Sample Location	Alias	Schedule	List of Analytes	Rationale
EMWMF-1 or GW-918	GW-918	Quarterly	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99, tritium	Upgradient spring/well location (headwaters for NT-5 and background)
EMWMF-2	EMWMF UNDERDRAIN	Quarterly	alpha & beta, gamma, technetium-99, tritium, carbon-14, and Iodine-129,	A French drain that collects groundwater under the waste cells (headwaters for NT-4)
EMWMF-3	EMW-VWEIR	Quarterly	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99, tritium	Sediment Pond Discharge location to NT-5, which leads to Bear Creek (EMWMF Discharge)
EMWMF-4a or EMWMF-4b	Uncontaminated Stormwater Discharge	Quarterly / as needed	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99, tritium	Discharge location from waste cells that are designated as inactive, but contain stored materials (EMWMF discharge after rain events)
EMWMF-5	Discharge from Contact Water Ponds	As needed	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99, tritium	Discharge location for the CWP's (sampled only if CWP's not sampled)
EMWMF-6	NT-4	Annually / as needed	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99, tritium	Downgradient of the underdrain (samples needed once a year or based on elevated underdrain results)
EMWMF-7	NT-5	As needed	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99, tritium	At NT-5 surface water structure (samples are based on elevated EMWMF-3 results)
EMWNT-5	EMWNT-5	Quarterly	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99, tritium	Upgradient from the sediment pond V-weir but downgradient from the western end of the waste cells (Potential Surface Flow)
EMWNT-3	EMWNT-3A	Quarterly	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99, tritium	Downgradient from the eastern end of the waste cells, upgradient from other known sites (Potential Surface Flow)
CWP-1 CWP-2 CWP-3 CWP-4	Contact Water Ponds 1, 2, 3, 4	As needed	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99, tritium	Effluent holding pond (prior to discharge to Sediment Pond or Leachate Tanks)
CWT-A CWT-B CWT-C CWT-D	Contact Water Tanks A, B, C, D	As needed	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99, tritium	Effluent holding pond (prior to discharge to Sediment Pond or Leachate Tanks)

Table 3: Sediment Samples

DOE-O Sample Location	Schedule	List of Analytes	Rationale
EMWMF NT-5 SD1	Annually	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99	Collected upgradient at EMWNT-05 (Background prior to Sediment Pond Discharge)
EMWMF NT-5 SD2	Annually	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99	Collected downgradient from the V-weir
EMWMF NT-5 SD3	Annually	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99	Collected at NT-5 surface water structure (sediments prior to entering Bear Creek)
EMWMF BC SD1	as needed	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99	Upgradient from the confluence of NT-5 and Bear Creek (sample only if EMWNT-5 SD3 results are elevated)
EMWMF BC SD2	as needed	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99	Downgradient from the confluence of NT-5 and Bear Creek (sample only if EMWNT-5 SD3 results are elevated)
EMWMF BC SD3	as needed	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99	Upgradient from the confluence of NT-4 and Bear Creek (sample only if EMWMF BC SD1 or EMWMF BC SD2 are elevated)
EMWMF BC SD4	as needed	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99	Downgradient from the confluence of NT-4 and Bear Creek (sample only if EMWMF BC SD1 or EMWMF BC SD2 are elevated)
EMWMF SP SD1	Annually	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99	Northern end of Sediment Pond (determine sediment loading at the beginning of the pond)
EMWMF SP SD2	Annually	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99	Center of Sediment Pond (determine sediment loading at the center of the pond)
EMWMF SP SD3	Annually	alpha & beta, gamma, isotopic uranium, strontium-90, technetium-99	Southern end of Sediment Pond near discharge location (determine sediment loading near the discharge location)

NT: North Tributary
BC: Bear Creek
SP: Sediment Pond

Ambient Sediment Monitoring Program

Introduction

Sediment samples are collected annually at 15 sites on the Clinch River and some of its tributaries. There are seven sites on the Clinch river, four sites on Poplar Creek and four tributary sites (McCoy Branch, Raccoon Creek, Grassy Creek, and Clear Creek). The sediment samples are analyzed for metals and radiological contamination in order to assess the sediment quality for public health and ecological considerations. The objective of this monitoring program is to assess the degree of sediment pollution of the Clinch River and some of its tributaries.

Sample Locations

Site	Location	Clinch River Mile*
2	Clinch River	52.6
3	Clinch River	35.5
4	Clinch River	17.9
5	Clinch River	10.0
7	Clinch River	41.5
10	McCoy Branch (MCM 0.1)	37.5
18	Raccoon Creek (RCM 0.1)	19.5
20	Grassy Creek (GCM 0.1)	14.55
25	Clear Creek (CCM 1.0)	78.2
29	Clinch River Mouth	0.0
32	Clinch River	19.7
33	Poplar Creek (PCM 1.0)	12.0
36	Poplar Creek (PCM 2.2)	12.0
37	Poplar Creek (PCM 3.5)	12.0
38	Poplar Creek (PCM 5.5)	12.0

*Clinch River Mile Column refers to location of stream mouth for tributaries.

Methods and Materials

Parameters to be analyzed:

Inorganics: aluminum, arsenic, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, selenium (McCoy Branch only) and zinc.

Radiological: gross alpha (total), gross beta (total), $^{89-90}\text{Sr}$ (Raccoon Creek only), gross gamma (total), *gamma radionuclides:* ^{137}Cs , ^{40}K , ^{214}Pb , ^{214}Bi , ^{212}Pb , ^{228}Ac , ^{208}Tl , ^{212}Bi and others as detected.

Toxicity: *Chironomus tentans* 10-day survival & growth test (EPA Method 100.2/ASTM 1706)

Schedule

The ambient sediment monitoring will be conducted in the second quarter of 2012.

Sediment Standard Operating Procedures

Sediment analysis is a key component of environmental quality and impact assessment for rivers, streams, lakes, and impoundments. Samples can be collected for a variety of chemical, physical, toxicological and biological investigations. This procedure is to be used to obtain quality assured sediment sampling. The resulting data may be qualitative or quantitative in nature and is appropriate for use in preliminary surveys and in confirmatory sampling.

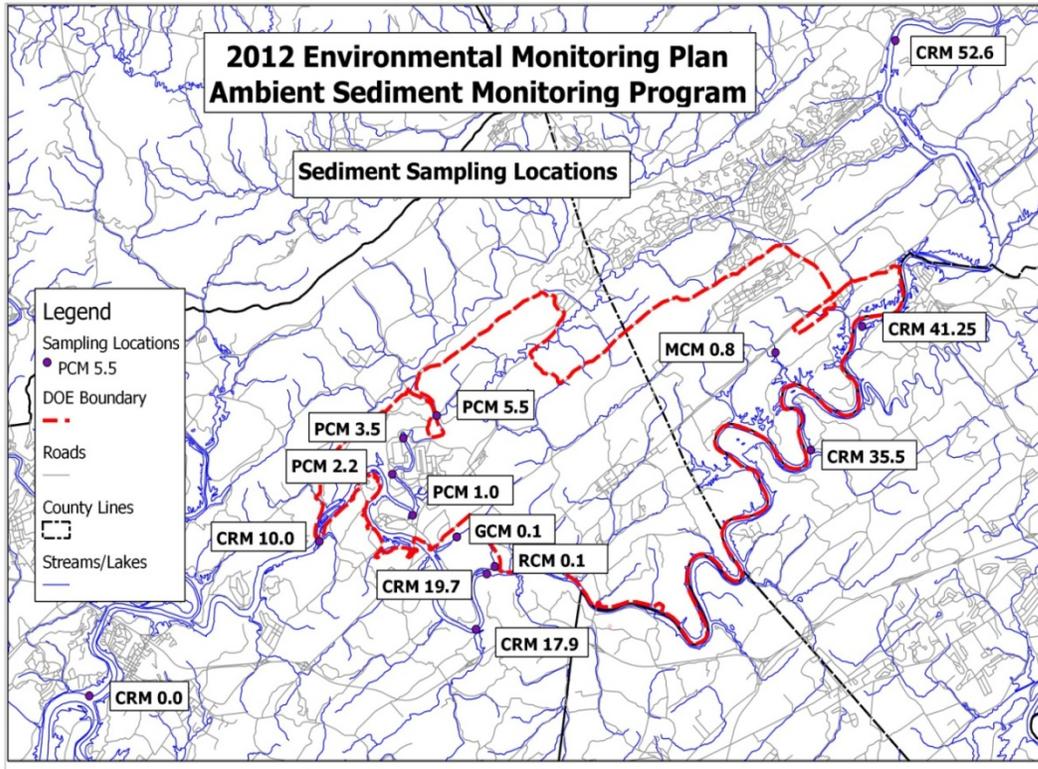


Figure 1: Ambient Sediment sampling locations

Required Equipment

sampling platform/boat	aluminum foil
depth finder	sample jars
stainless steel petite ponar grab sampler	sample labels
stainless steel mixing bowl	cooler/ice packs
stainless steel spoon	scrubber
pressurized water sprayer	lab sheets
deionized water	chain-of-custody forms
rubber gloves	field notebook

Procedure

If the water is wadeable, one can collect a sediment sample by scooping the sediment using a stainless steel spoon or scoop. This can be accomplished by wading into the stream, and while facing upstream, scooping the sample along the stream bottom in the upstream direction. If one

is sampling a deep lake or impoundment, one can use the Petite Ponar dredge to obtain a sample. Step-by-step directions are as follows:

Sediment sampling in wadeable streams and rivers

Locate suitable sampling site. Remember that a site immediately downstream of a riffle area has the greatest amount of deposition since the velocity of the stream slows down. Beware of constrictions in the stream where scouring may be occurring.

1. Don nitrile gloves to avoid self-contamination during sampling.
2. Using a decontaminated stainless steel spoon, obtain sediment sample by scraping the streambed.
3. Place sufficient amount of sediment in a stainless steel bowl and mix thoroughly to obtain a homogeneous sample.
4. Carefully transfer sample into the appropriate containers as directed by the state labs.
5. Record all pertinent information on lab sheets, sample labels, and make necessary entries into field notebook.
6. Place all samples into cooler as soon as possible. Temperature within the cooler should be maintained at 4° C by using ice or freezer packs.
7. Deliver sediment samples to state lab within appropriate holding time frames, and sign chain-of-custody forms.

Sediment sampling in lakes or reservoirs using Petite Ponar dredge

1. Don nitrile gloves to avoid self-contamination during sediment sampling.
2. Place stabilizing pin into arm attachments to lock dredge jaws in open position.
3. Using dredge cable, carefully lower dredge through water column. Slow the descent just prior to contact with sediment to prevent any disturbance to the sediment.
4. As the dredge contacts the sediment, allow the line to go slack, which in turn releases the stabilizing pin.
5. Give a quick tug to the cable; this enables the dredge jaws to close. Carefully pull the dredge through the water column.
6. Repeat steps 2-5 until sufficient sediment has been obtained, placing sediment into a stainless steel bowl.
7. Thoroughly mix the sediment with a stainless steel spoon to obtain a homogeneous composite.
8. Carefully transfer the collected sediment into appropriate sampling jars as directed by the state of Tennessee Labs.
9. Record all pertinent information on lab sheets, samples labels, and make necessary entries into field notebook.
10. Place sediment samples into cooler as soon as possible. Temperature within the cooler should be maintained at 4° C by using ice or freezer packs.
11. Deliver samples to state lab within appropriate time frames. Be sure to sign all chain-of-custody forms.

Laboratory Procedures

The Tennessee Department of Health, Environmental Laboratory and Microbiological Laboratory Organization (the state lab) has expertise in a broad scope of services and analyses

available to the Tennessee Department of Environment and Conservation (TDEC) Department of Energy Oversight (DOE-O) and to other TDEC divisions statewide. General sampling and analysis methods are to follow Environmental Protection Agency (EPA) guidelines as listed in appropriate parts of 40 Code of Federal Regulations (CFR). Laboratory Services may subcontract certain analyses and QC samples out to independent laboratories. Bench level Quality Assurance/Quality Control (QA/QC) records and chain-of-custody records are maintained at the Tennessee Environmental Laboratory, as are QA records on subcontracted samples.

DOE-O will primarily use the Knoxville branch of Laboratory Services. Wet chemistry and metals samples will generally be analyzed in Knoxville while organics samples will be sent on to the state lab in Nashville. Coastal Bioanalysts, Inc. will conduct the toxicity testing. All laboratory analysis will follow appropriate methods as documented in the Laboratory Services Inorganic Chemistry SOP and Organic Chemistry SOP. Specific analytical methods are covered in these manuals. They also direct analysts to the proper EPA or other methodology.

References

Tennessee Department of Environment and Conservation. *Standard Operating Procedures*. DOE Oversight Division. Oak Ridge, Tennessee 1996.

Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement. Agreement Between the U.S. Department of Energy and the State of Tennessee*. DOE Oversight Division. Oak Ridge, Tennessee. 2011.

United States Environmental Protection Agency. *Environmental Compliance Standard Operating Procedures and Quality Assurance Manual*. Region IV, Environmental Services Division. Atlanta, Georgia. 1991.

United States Environmental Protection Agency. *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual*. Doc: EPA 823-B-01-002. Office of Water. Washington: GPO. 2001.

Yard, C.R. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Ambient Surface Water Monitoring

Introduction

Surface water sampling is conducted twice yearly at ten sites located on the Clinch River and its tributaries. The surface water samples are analyzed for radiological activity, metals, nutrients and other parameters in order to assess the water quality for public health and ecological considerations. Sampling sites 1 and 2 are reference data collection sites and are located upstream of the Oak Ridge Reservation (ORR). (See Figure 1.) The other sites were chosen to detect contaminants being transported by surface water coming from the ORR or areas affected by Department of Energy (DOE) related activities.

Sample Locations

Site	Location	Clinch River Mile*
1	Clinch River	78.7
2	Clinch River	52.6
3	Clinch River	35.5
4	Clinch River	17.9
5	Clinch River	10.0
7	Clinch River	41.2
10	McCoy Branch (MCM 0.8)	37.5
18	Raccoon Creek (RCM 0.1)	19.5
20	Grassy Creek (GCM 0.1)	14.5
33	Poplar Creek (PCM 1.0)	12.0

*For tributaries, the Clinch River Mile column refers to the mouth of the tributary.

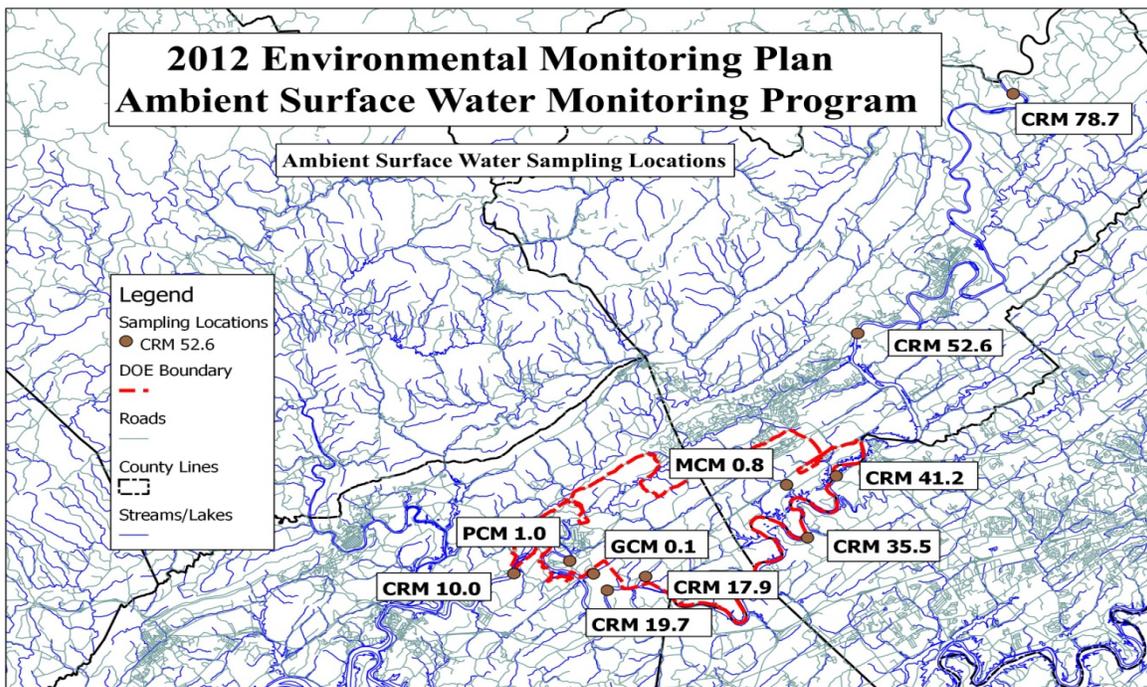


Figure 1: Ambient surface water sampling sites

Methods and Materials

Parameters to be analyzed:

Inorganics: arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, zinc, nitrogen (NO₂ & NO₃, ammonia, total Kjeldahl), selenium (McCoy Branch only), total phosphorus.

Other tests: COD, dissolved residue, suspended residue, total hardness.

Radiological: Gross alpha and beta, gamma radionuclides, Sr-90 & Tc-99 (Raccoon Creek only).

Schedule

The ambient water monitoring will be conducted in the second and fourth quarters of 2012.

Standard Operating Procedures

Special care must be taken when sampling water in which contaminants can be detected in the parts per billion and/or parts per trillion ranges. In order to prevent cross-contamination of these samples, the following precautions shall be taken when trace contaminants are of concern:

- A clean pair of new, non-powdered, disposable nitrile gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling.
- In streams and rivers shallow enough to wade, submerge the sample container directly in the main water column to collect the sample, taking care to not lose the preservative by overfilling the bottles.
- Avoid disturbing the sediment when wading to the sampling location. If sediment is stirred up, sample upstream of the affected water or wait for the cloudy water to flow downstream of the sampling area.
- In rivers or lakes where the water is too deep to wade, fill the sample containers from the bow of the boat when the boat is facing upstream.
- If multiple sample containers are going to be filled at the same station, fill the unpreserved samples first, then the bacteriological, nutrients, and the metal samples last.
- Collect subsequent samples upstream of the previous sample to avoid possible contamination from the substrate or previous preservatives.
- Sample containers for source samples or samples suspected of containing high concentrations of contaminants should be placed in separate plastic bags immediately after collecting, tagging, etc.
- If possible, one member of the field sampling team should take all the notes, fill out tags, etc., while the other members collect the samples.
- When sampling surface waters, the water sample should always be collected before the sediment sample is collected.
- Sample collection activities should proceed progressively from the least suspected contaminated area to the most suspected contaminated area.
- Field blanks, trip blanks and duplicate samples must be collected at a minimum of ten percent of sampling events, defined as every 10th site sampled.
- Take water quality parameter measurements (dissolved oxygen, temperature, conductivity, and pH) at each site. For depths less than 10 feet, lower the probe to mid-depth and measure, after

allowing for equilibration. For depths greater than 10 feet, lower the probe to depth of five feet and take readings.

Sample Handling

After collection, all sample handling should be minimized. Investigators should use extreme care to ensure that samples are not contaminated. If samples are placed in an ice chest, investigators should ensure that melted ice cannot cause the sample containers to become submerged, as this may result in sample cross-contamination. Plastic zip-top bags or similar plastic bags sealed with tape should be used to prevent cross-contamination when small sample containers (e.g., VOC vials or bacterial samples) are placed in ice chests.

Laboratory Procedures

The state lab has expertise in a broad scope of services and analyses available to the division and to other TDEC divisions statewide. General sampling and analysis methods are to follow Environmental Protection Agency (EPA) guidelines as listed in appropriate parts of 40 Code of Federal Regulations (CFR). Laboratory Services may subcontract certain analyses and QC samples out to independent laboratories. Bench level Quality Assurance/Quality Control (QA/QC) records and chain-of-custody records are maintained at the state lab, as are QA records on subcontracted samples.

DOE-O will primarily use the Knoxville branch of Laboratory Services. Wet chemistry and metals samples will generally be analyzed in Knoxville while organics samples will be sent on to the state lab in Nashville. All laboratory analysis will follow appropriate methods as documented in the Laboratory Services Inorganic Chemistry SOP and Organic Chemistry SOP. Specific analytical methods are covered in the state lab manuals and they direct analysts to the proper EPA or other methodology.

References

- American Society for Testing and Materials. *Standard Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing*. E 1391-90. Philadelphia, PA, 1990.
- Tennessee Department of Health Laboratory Services. Standard Operating Procedures. Nashville, Tennessee. 1999.
- Tennessee Department of Environment and Conservation. *Quality System Standard Operating Procedure for Chemical and Bacteriological Sampling of Surface Water*. Division of Water Pollution Control, Nashville, Tennessee. 2011.
- Tennessee Department of Environment and Conservation. *Tennessee Oversight Agreement, Agreement Between the U.S. Department of Energy and the State of Tennessee*. DOE Oversight Division. Oak Ridge, Tennessee. 2011.
- United States Environmental Protection Agency. *Environmental Compliance Standard Operating Procedures and Quality Assurance Manual*. Region IV, Environmental Services Division. Atlanta, GA, 1991.

United States Environmental Protection Agency. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual* Region IV, Athens, GA. 1996.

Yard, C.R. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Surface Water (Physical Parameters) Environmental Monitoring

Introduction

Due to the presence of areas of extensive point and non-point source contamination on the Oak Ridge Reservation (ORR), there exists the potential for contamination to impact surface waters on the ORR. During 2012, to assess the degree of surface water impact relative to this potential contamination displacement, stream monitoring data will be collected monthly to establish a database of physical stream parameters (conductivity, pH, temperature, and dissolved oxygen).

The primary objective of this monitoring project is to provide supplementary water quality data for division programs and organizations outside of TDEC. Furthermore, this monitoring task is directed toward determining long-term water quality trends, assessing attainment of water quality standards and providing additional baseline data for evaluating stream recovery. Table 1 lists the locations that have been selected for monitoring.

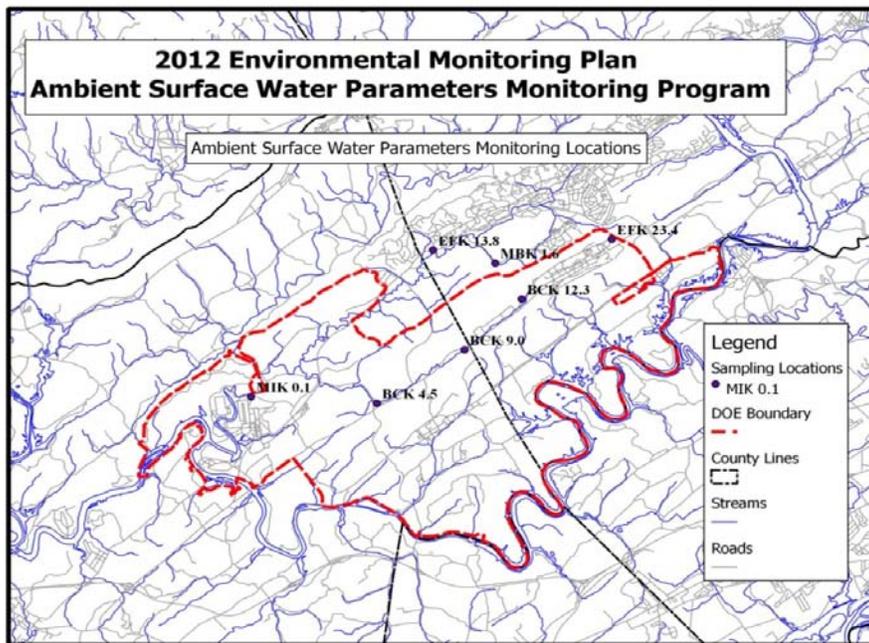


Figure 1: Monitoring Locations

Table 1: Sample Locations in kilometers (mile equivalents)

Site	Location
MIK 0.1 (0.06)	Mitchell Branch (Weir at ETPP)
BCK 4.5 (2.8)	Bear Creek (Weir at Hwy. 95)
BCK 9.0 (6.0)	Bear Creek (near Walk-in Pits)
BCK 12.3 (7.6)	Bear Creek (near Y-12 west guard entrance)
EFK 23.4 (14.5)	East Fork Poplar Creek (Station 17)
MBK 1.6 (1.0)	Mill Branch (Reference)
EFK 13.8 (8.6)	East Fork Poplar Creek (near Big Turtle Park)

Methods and Materials

The surface water physical parameters of temperature, pH, conductivity, and dissolved oxygen will be measured.

Schedule

Once per month, surface water monitoring will be conducted.

References

Tennessee Department of Environment and Conservation. *The Status of Water Quality in Tennessee: Technical Report*. Division of Water Pollution Control, Tennessee Department of Environment and Conservation. Nashville, Tennessee. 1998.

Yard, C.R. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation DOE Oversight Division. Oak Ridge, Tennessee. 2011.

Ambient Trapped Sediment Monitoring

Introduction

Sediment analysis is a key component of environmental quality and impact assessment for rivers, streams, lakes, and impoundments. Samples can be collected for a variety of chemical, physical, toxicological and biological investigations. The objective of this monitoring program is to assess the sediment that is being currently transported and deposited in Poplar Creek and in the Clinch River via White Oak Creek. Sediment samples will be collected with sediment traps at three sites on Poplar Creek (miles 2.2, 3.5, and 5.5) and at the mouth of White Oak Creek (Clinch River Mile 20.8), just outside the coffer dam. The sediment samples will be analyzed for metals and radiological contamination.

Methods and Materials

The following parameters will be analyzed utilizing TDH Laboratory services:

Inorganics: aluminum, arsenic, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, and zinc.

Radionuclides: gross alpha, gross beta, gamma radionuclides, strontium-89, strontium-90, and uranium.

Schedule

Traps were deployed on June 9, 2011 and will be harvested in the spring of 2012.

Sediment Standard Operating Procedures

This procedure is to be used to obtain quality assured sediment sampling. The resulting data may be qualitative or quantitative in nature and is appropriate for use in preliminary surveys and in confirmatory sampling.

Required Equipment

boat	aluminum foil
depth finder	sample jars
sediment traps	sample labels
stainless steel mixing bowl	cooler/ice packs
stainless steel spoon	scrubber
pressurized water sprayer	lab sheets
deionized water	chain-of-custody forms
rubber gloves	field notebook

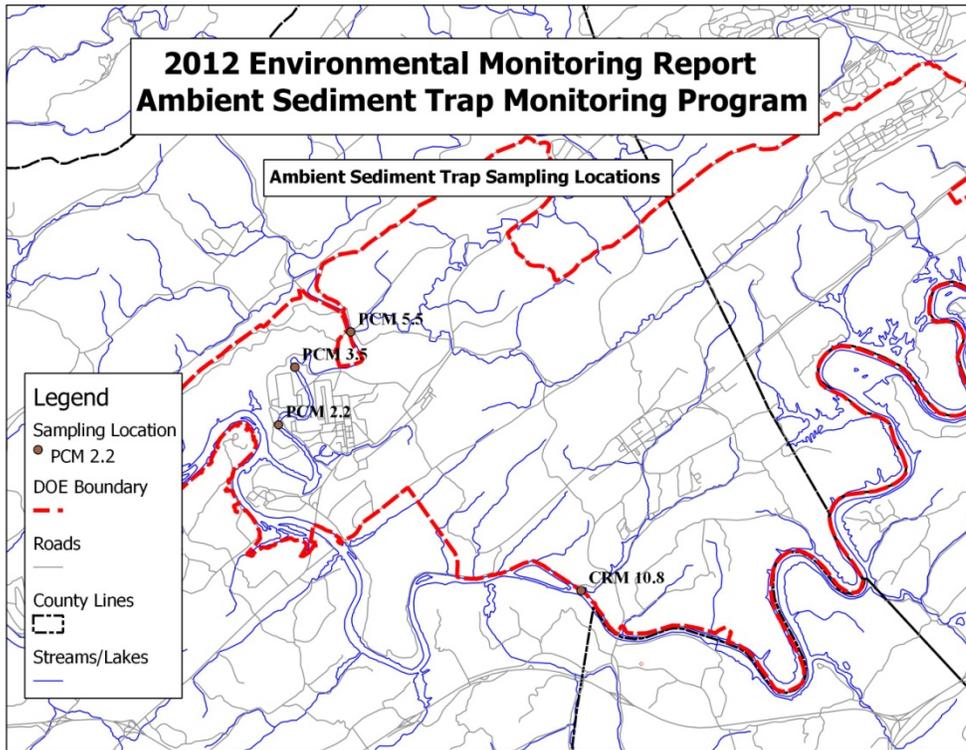


Figure 1: Trapped Sediment Site Locations

Procedure

Clinch River and Poplar Creek sediment traps will be lowered from the boat into a suitable location on the river bottom and secured with a wire cable which will be discretely secured to a tree or tree root on the bank. Step by step directions are as follows:

1. Locate a sampling site that is suitable for sediment deposition (low velocity and water pressure).
2. Don nitrile gloves to avoid self-contamination during sampling.
3. Position the trap on the bottom; secure the trap to the bank with steel cable.
4. Check the trap approximately twelve months after deployment and collect the sediment. Carefully transfer sample into the appropriate containers as directed by the state of Tennessee Labs.
5. Record all pertinent information on lab sheets, sample labels, and make necessary entries into field notebook.
6. Place all samples into cooler as soon as possible. Temperature within the cooler should be maintained at 4° C by using wet ice.
7. Deliver sediment samples to state lab within appropriate holding time frames, and sign chain-of-custody forms.

Laboratory Procedures

Laboratory Services has expertise in a broad scope of services and analyses available to DOE-O and to other TDEC divisions statewide. General sampling and analysis methods are to follow Environmental Protection Agency (EPA) guidelines as listed in appropriate parts of 40 Code of Federal Regulations (CFR). Certain analyses and QC samples may be subcontracted out by Laboratory Services to independent laboratories. Bench level Quality Assurance/Quality Control (QA/QC) records and chain-of-custody records are maintained at the state lab as are QA records on subcontracted samples.

DOE-O will primarily use the Knoxville branch of Laboratory Services. Wet chemistry and metals samples will be analyzed in Knoxville. All laboratory analysis will follow appropriate methods as documented in the Laboratory Services Inorganic Chemistry SOP and Organic Chemistry SOP. Specific analytical methods are covered in these manuals. They also direct analysts to the proper EPA or other methodology.

References

Tennessee Department of Environment and Conservation. *Standard Operating Procedures*. DOE Oversight Division. Oak Ridge, Tennessee. 1996.

Tennessee Department of Health Laboratory Services. *Standard Operating Procedures*. Nashville, Tennessee. 1999.

United States Environmental Protection Agency. *Environmental Compliance Standard Operating Procedures and Quality Assurance Manual*, Region IV, Environmental Services Division. Atlanta, Georgia. 1991.

United States Environmental Protection Agency. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM)*. Region IV. Enforcement and Investigations Branch. Athens, Georgia. 1997.

United States Environmental Protection Agency. *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual*. Doc: EPA 823-B-01-002. Office of Water. Washington: GPO. 2001.

Yard, C.R. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation, DOE Oversight Division. Oak Ridge, Tennessee. 2011.

APPENDIX

DATA QUALITY OBJECTIVES, White-Tailed Deer

Herein, following the format of the US Environmental Protection Agency's (EPA) data quality objectives process (DQO, EPA 2006), we present our 2012 environmental monitoring plan for this pilot project investigating white-tailed deer on the Oak Ridge Reservation.

Nature of the Problem

The Oak Ridge Reservation (ORR) provides a diversity of wildlife habitats imbedded in large areas of unfragmented, mature eastern deciduous forest, wetlands, old fields, river bluffs, cedar barrens, and grasslands (Giffen et al. 2007). Early ORR field biological studies involved pathologic, hematologic, and parasitologic survey of rodents (e.g., white-footed mouse, eastern cotton rat, etc.) to determine techniques for the diagnosis of radiation damage in small mammals found in the White Oak Lake vicinity (Dunaway and Kaye 1961, 1963, Childs and Cosgrove 1966, Taylor and Parr 1978, Kitchings and Levy 1981). Further ORR wildlife monitoring studies have provided radio-tracking of coyote (Whitlock 1987), ecological assessments of birds (Hardy 1991, Mitchell et al. 1996), bobcats (Kitchings and Story 1984), amphibians and reptiles (Johnson 1964, Klein 1989), fish (Ryon and Loar 1988, Southworth et al. 1995), gray fox (Greenberg et al. 1988), white-tailed deer (Mitchell 1989), and other mammals (Kitchings and Mann 1976, Mitchell et al. 1996). Garten and Lomax (1987) reported the uptake of strontium-90 (^{90}Sr) by deer ingesting vegetation and possible contaminants from mineral licks in ORNL waste seepage areas. Studies have documented the environmental fate and transport of mercury (Hg) and cesium-137 (^{137}Cs) discharged from ORR facilities into the environment (i.e., soils and sediment, Turner et al. 1985, Revis et al. 1989). Wildlife researchers have reported that ORR contaminated animals (e.g., Canada geese, white-tailed deer, kingfishers, turtles, fish, wild turkeys) with large home ranges have been collected at locations outside the boundaries of the reservation (Ashwood 1992, Ashwood et al. 1994). Additional comprehensive ecological studies, human risk assessments, and wildlife toxicology studies were conducted on the ORR during the late-1990s (Lewis 1995, Stevens et al. 1997, Moore et al. 1999, Sample and Suter II 1999, Widner et al. 1999).

During the present decade, the ecotoxicology emphasis focused upon fish, plants, insect, soils and herpetology studies conducted in ORR watersheds such as East Fork Poplar Creek and McCoy Branch (Southworth et al. 2000, Sample and Suter II 2002, Loar 2004, Burger and Campbell 2004, Burger et al. 2005, 2007, Campbell et al. 2005, Han et al. 2006, 2007, Peterson-et al. 2009). Very recent ORR studies investigated the effect of hunting on ORR deer-vehicle collisions (Pierce 2010), and the long term effects of heavy metal pollutants in East Fork Poplar Creek (EFPC) floodplain on tree diversity, mycorrhizal fungi presence and abundance and soil composition (Jean-Phillipe 2010), but neither study evaluated the uptake of metals by wildlife. Hence, per our literature review,

heavy metals bioaccumulation by ORR terrestrial wildlife, especially game animals and browse, has seldom been studied or monitored since the late 1990s.

In 1985, the ORR was designated a Wildlife Management Area and the first ORR WMA deer hunts began the fall of that year as a method of population control and to reduce increasing deer/vehicle collisions for the protection of public and employee safety (Parr and Evans 1992, Giffen et al. 2007, Pierce 2010). During ORR WMA deer hunts, the hunters are required to bring their harvested game animal to the TWRA deer checking station on Bethel Valley Road for radiological scanning prior to release. Because deer mainly consume vegetation, forbs, nuts, fruits and grasses, and ingest mineral soils, ORR deer represent a potentially important vector (i.e., sentinel species) for exposures to the public not only from radionuclides, but possibly heavy metal contamination as well. Hence, road-killed and hunter-killed deer provide a unique opportunity to survey the animals not only for uptake of radioactive contamination, but also for bioaccumulation of heavy metals in deer tissues.

Goal of the Study

Because ORR deer mainly consume vegetation and ingest mineral soils, they represent a potentially important vector for exposures to the public not only from radionuclides, but possibly heavy metal contamination as well. However, except for two known ORR deer tissue studies by Tasca (1988) and Travis et al. (1989), little is known about metals concentrations in ORR game animals. Ashwood (1992) reported that very few data are available on non-radioactive contamination in biota around Oak Ridge National Laboratory environmental restoration sites.

Wildlife researchers have reported that ORR contaminated animals (e.g., Canada geese, white-tailed deer, kingfishers, turtles, fish, wild turkeys) with large home ranges have been collected at locations outside the boundaries of the reservation (Kitchings and Story 1979, 1982, 1984, Story and Kitchings 1979, 1982, 1985, Ashwood 1992, Ashwood et al. 1994).

Study question (Objective): What is the home range of white-tailed deer, and their movement and dispersal patterns on the ORR and offsite?

Data and Information Needs

Five GPS collars will be deployed to track the movements and home range of ORR deer. Data required for answering the study questions include: (1) animal tissue metals analyses, and (2) GPS collar tracking data. Tissue sampling and deer trapping protocols are outlined previously.

Boundaries of the Study

The target population is white-tailed deer (*Odocoileus virginianus*) on the Oak Ridge Reservation. Specifically, deer will be trapped in the Melton Valley area of Oak Ridge National Laboratory. We estimate five deer will be trapped to fit with GPS collars and that 15 road-killed animals will be collected for metals analysis of tissues.

Plan for Obtaining Data (Methods and Materials)

The project will entail trapping deer to apply GPS collars. Field sampling activities will follow the guidelines of the TDEC *Health, Safety and Security Plan* (Yard 2011). In the performance of these tasks, all live animals will be handled in accordance with standard operating procedures of the Tennessee Wildlife Resources Agency (TWRA), the American Society of Mammalogists (Gannon et al. 2007, Sikes et al. 2011), and the University of Tennessee Knoxville Institutional Animal Care and Use Committee (UTK-IACUC) protocol for use of live vertebrate animals. Trapping methods described herein have been modified from James and Stickles (2010) and recommendations of the TWRA.