TENNESSEE DEPARTMENT OF

ENVIRONMENT AND CONSERVATION

DOE OVERSIGHT DIVISION

ENVIRONMENTAL MONITORING REPORT

JANUARY THROUGH DECEMBER 2002

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LIST OF COMMON ACRONYMS AND ABREVIATIONS

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)
E. coli	Escherichia coli
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	Ephemeroptera, Plecoptera, Trichoptera (May flies, Stone flies, Caddis flies)
ERAMS	Environmental Radiation Ambient Monitoring System
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)

LIST OF COMMON ACRONYMS AND ABREVIATIONS CONTINUED

K-25	Oak Ridge Gaseous Diffusion Plant (now called ETTP)
KBL	Knoxville Branch Laboratory
KEAC	Knoxville Environmental Assistance Center
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	Microroentgen
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.bechteljacobs.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	$1x10^{-12}$ Curie (Picocurie)
PCM	Poplar Creek Mile (station location)
pH	Proportion of Hydrogen Ions (acid vs. base)
PWSID	Potable Water Identification “number”
ppb	Parts per Billion

LIST OF COMMON ACRONYMS AND ABREVIATIONS CONTINUED

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)

EXECUTIVE SUMMARY

The Tennessee Department of Environment and Conservation, DOE Oversight Division (the division) is providing a report of its independent environmental monitoring for the calendar year 2002. The report is a series of individual reports completed by division personnel. The reports are organized by general areas of interest: Surface Water; Sediment; Drinking Water; Biological/Fish and Wildlife; Groundwater; Air Quality and Radiation. An abstract is provided in each report. All supporting information and data used in the completion of these reports are available for review in the division's files.

Surface Water

General ambient surface water analysis is a key component of environmental quality and impact assessment for rivers, streams, lakes, and impoundments. The DOE Oversight Division conducted sampling at 25 sites in 2002. The samples were analyzed for standard water quality parameters. Based on comparisons with the Tennessee Water Quality Criteria (TWQC) for recreation, none of the sites exceeded these criteria. It should be recognized that sites very close to or within contaminated burial areas were not part of this scope.

Specialized surface water investigations aid in evaluating point and non-point sources. In order to determine the fate and transport of uranium in the waters of Bear Creek Valley, quarterly samples and flow measurements were taken at various locations on Bear Creek and associated springs and tributaries. The flow measurements and the results of radiochemical analysis on the samples were used to calculate the flux of gross alpha moving through Bear Creek Valley. The flux data were then used to determine the movement and fate of uranium dissolved in the waters of the valley. The data indicates that most of the uranium in Bear Creek is delivered along discrete, low volume, high concentration flowpaths, during the wetter parts of the year, suggesting that uranium inputs to the creek can be identified and controlled.

Sediment

Sediment analysis is a key component of environmental quality and impact assessment for aquatic ecosystems. The DOE Oversight Division (DOE-O) conducted sediment sampling at 30 sites in 2002. The sediments were analyzed for inorganics, organics, and radiological parameters. Since there are no federal or state sediment cleanup levels, the data were compared to the Department of Energy's (DOE) Preliminary Remediation Goals (PRGs) for use at the Department of Energy Oak Ridge Operations Office. Based on the designation of the water bodies involved, the values were compared to the recreational PRGs. Under recreational land use, individuals are assumed to be exposed to contaminated media while playing, fishing, hunting, or engaging in other outdoor activities. Exposure could result from ingestion of soil or sediment, inhalation of vapors from soil or sediment, dermal contact with soil or sediment, external exposure to ionizing radiation emitted from contaminants in soil or sediment, and consumption of fish. For the contaminants that were analyzed, the sediments showed no levels of concern for human health. These samples were taken under ambient conditions and not near or within contaminated burial grounds.

Drinking Water

The monitoring activities through oversight and independent sampling of the sanitary water distribution systems on the ORR met the regulatory requirement of 0.2 mg/L for residual chlorine. No elevated levels of bacteria above the regulatory limits were reported. The Environmental Radiation Ambient Monitoring System (ERAMS) which samples from five local drinking water treatment plants indicate that radionuclides are well below regulatory criteria. However, tritium has historically been found in higher concentrations for the Gallaher water treatment plant than the four other systems monitored in the program. The plant is located about seven river miles downstream of White Oak Creek which drains the ORNL watershed.

In January repairs were made to an 8-inch potable water line serving the High Flux Isotope Reactor area at ORNL. Concern over the potential for ground water with high tritium content to come into contact with the broken water line led to the decision to determine the level of tritium, if any, in drinking water in the vicinity of the line break. Drinking water samples collected in proximity to the break showed no tritium contamination.

Biological/Fish and Wildlife

On June 20 and 21, 2002, the Tennessee Department of Environment and Conservation (TDEC), DOE Oversight Division (DOE-O) conducted oversight of the annual Canada Geese (*Branta canadensis*) monitoring project on the Oak Ridge Reservation (ORR). The objective of this study was to determine if geese are becoming contaminated on the ORR. The captured geese were transported to the Tennessee Wildlife Resources Association (TWRA) game check station on Bethel Valley Road and tested for radioactive contamination. Three of the geese captured at Oak Ridge National Laboratory (ORNL) showed elevated gamma counts above the 5pCi/g game release level. In response, the DOE-Oversight Division conducted additional offsite sampling of Canada Geese. None of the offsite geese were found to be contaminated.

Semi-quantitative benthic macroinvertebrate samples were collected from twelve study sites on five streams impacted by Department of Energy (DOE) operations and six reference sites located on or near the Oak Ridge Reservation (ORR). Using the state of Tennessee standard operating procedures for macroinvertebrate surveys, samples were collected, processed, and analyzed using suggested metrics. A score was calculated from the metrics and a stream site “health” rating was assigned. Results indicated that the study streams tended to show signs of biotic improvement with increasing water quality downstream of DOE influences. The number of EPT taxa and the total number of taxa at all study sites remain depressed compared to reference conditions.

Deer hunts and turkey hunts were held on the ORR in 2002. Thirty-eight turkeys were killed and none were retained. Deer hunts resulted in 421 animals killed with three retained because of internal contamination. The Oak Ridge National Laboratory supports the state by testing tissue samples at the check stations while hunters wait. This screening prevents public consumption of contaminated meat from game animals killed on the ORR. Contamination in wildlife is an indicator of the effectiveness of remedial efforts on contaminated streams, springs, and burial areas. The state did no independent sampling of deer or turkey in 2002. The DOE work is mentioned in this summary due to its importance.

Groundwater

Samples were taken at different times of the year from the ORR and water sources off the reservation. Springs and seeps provide exit pathway monitoring points. Some of these points are close to burial grounds and others are some distance away. This program continues to look for new springs and seeps to sample.

The sampling for 2002 provided some insights into the behavior of contaminants in the subsurface via their movement in groundwater. Springs in Bear Creek Valley down gradient from the bear creek burial grounds continue to be impacted by radiochemical, metal as well as volatile organic constituents. Several springs at K-25, Y-12 and X-10 are impacted as well. Volatile organics, nitrates, gross alpha and gross beta activity are the contaminants of greatest concern. The levels of the contaminants with some exceptions near waste sites are very low and the general quality of the groundwater on the ORR is good. Residential wells meet drinking water standards for parameters monitored.

Air Quality

State monitoring verified that the public was not adversely impacted from airborne releases of radionuclides. However, the state did detect increases in airborne radioactive pollutants around the DOE facilities, due to system failure (ORNL), normal operations (Y-12), and from decontamination and decommissioning operations (ETTP).

The EPA sponsored Environmental Radiation Ambient Monitoring System (ERAMS) detected a strontium-90 release from the X-3038 stack at ORNL known to have occurred on June 26 and 27, 2002. The release was investigated by ORNL as being due to errors in system filter maintenance. The perimeter program measured increased airborne radionuclides around the Y-12 plant, presumably from production and waste management operations. The fugitive radiological air emission results at the ETTP Three Buildings Project were higher than background measurements for a period of time but declined back to background levels. All measurements were below Clean Air Act standards.

The Hazardous Air Pollutants (HAPs) for metal monitoring at Y-12, ETTP, and Oak Ridge National Laboratory (ORNL) indicated no apparent elevated concentration of metals of concern. HAPs metals monitored were arsenic, beryllium, cadmium, total chromium, lead, nickel and uranium metal. Analyses for all metals of concern were below guidelines, and/or detection limits of laboratory analysis.

Radiation

The Tennessee Department of Environment and Conservation began monitoring ambient radiation levels on the Oak Ridge Reservation in 1995. This program provides estimates of the dose to members of the public from exposure to gamma/neutron radiation attributable to Department of Energy activities on the reservation and baseline values for measuring the need and effectiveness of remedial activities. In this effort, environmental dosimeters have been placed at selected locations on and near the reservation. Results from the dosimeters are compared to background values and the state primary dose limit for members of the public (100 mrem/yr). Since the dose reported for each site is based on continuous exposure over the course of the year, the results are considered conservative by nature. All the doses reported for 2002 at off-site locations were below the state primary dose limit for members of the public. However, several locations on the reservation that are considered to be potentially accessible to the public exhibited results in excess of this limit. These sites are primarily associated with uranium hexafluoride cylinder storage yards at the East Tennessee Technology Park. DOE's reindustrialization initiative has resulted in an influx of businesses not directly related to DOE operations and a non-DOE workforce (public). As in the past, various sites located in restricted areas of the reservation exhibited annual doses in excess of the dose limit for members of the public. These sites are subject to remediation in accordance with provisions specified in CERCLA and the Federal Facility Agreement for the Oak Ridge Reservation. Decreases in the doses observed at several of these locations in 2002 can be attributed to remedial activities.

Like other Department of Energy research facilities across the nation, the Oak Ridge Reservation released large quantities of chemical and radiological contamination into the surrounding environment during nearly five decades of nuclear weapons research and development. In response to this history, the Tennessee Department of Environment and Conservation's Department of Energy Oversight Division developed a Facility Survey Program to document the history and hazards of facilities on the Reservation. During 2002 the survey team evaluated eight facilities and found that five posed a high potential for environmental release. Two of these facilities were at Y-12 (Y-9616-3, Y-9738), and three were at K-25 (K-1004-E, K-1015, K-633). Since the inception of the program, DOE corrective actions (including demolitions) have removed ten facilities from the division's list of "high" Potential Environmental Release facilities.

Beginning in 2002 the Facility Survey Program also began organized document reviews and visits to facilities that were targeted for demolition at the ORNL and Y-12. This activity was in response to formal, accelerated infrastructure reduction (demolition) programs at each of those sites. During 2002 staff made 90 site visits before and during the demolition of 31 facilities.

In 2001 the Tennessee Department of Environment and Conservation began a pilot study to assess the feasibility of monitoring radon emissions on the Department of Energy's Oak Ridge Reservation. The project was prompted by a concern that the disposal of uranium in reservation burial grounds may have resulted in elevated radon levels (radon is produced by the uranium decay series). The results from the initial study indicated radon levels could be measured and suggest the burial grounds have areas where the radon levels are above background concentrations. However, loss and damage to the detectors resulted in uncertainties that limited the use of the data. It was subsequently decided to continue the study, but deploy the detectors during the winter months in an effort to avoid some of the problems encountered in 2001. Results of the subsequent study will not be available until the summer of 2003.

The Oak Ridge Reservation (ORR) was placed on the National Priorities List (NPL) in 1989. The purpose of Footprint Reduction was to identify portions of the ORR that have not been environmentally impacted by past federal (Department of Energy - DOE) activities. The mission was to determine which land parcels could be conditionally released from Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements. CERCLA 120(h) was used as the guideline by the footprint team for the footprint investigations. The goal was further identified as reducing the size and configuration of the area of the ORR designated as part of the NPL site and determining a No Further Investigation (NFI) status. The land parcels were assigned numerical identifiers ranging from 1 through 20.

Tennessee Department of Environment and Conservation, DOE Oversight Division performed a radiological walkover and reconnaissance survey of each parcel and adjacent land. The investigation focused on identifying potential anthropogenic sources of contamination and exit pathway releases on the ORR which could render the parcel(s) unfit for release. In summation, the division investigated 21,439 acres of ORR land during the footprint project.

In performance of the field investigation work, certain maintenance action items were identified on the various land parcels i.e. "study areas." The division clearly emphasized these concerns to DOE in each footprint study area report released to the public. This current project revisited these sites to determine if action had in fact been taken by DOE to rectify the problems and other division concerns. Commonly DOE had not corrected problems.

A pilot vegetation (watercress) sampling and radiochemical analysis effort was done by division staff in 1995. The project had been idle since that time due to inconclusive results and laboratory budget constraints. A new study was designed to correlate previous TDEC and DOE groundwater radiochemistry data with watercress/vegetation radiochemistry data sampled from the same ORR springs as an aid in determining if aquatic vegetation is bioaccumulating radiological contaminants. In other words, division staff gathered collateral vegetation monitoring data in support of the groundwater monitoring and sampling of springs and surface water impacted by hazardous substances. Sometimes, spring-fed creeks and ponds were sampled if adequate amounts of aquatic vegetation were present. "Vegetation" sampled included watercress (*Nasturtium officinale*), other aquatic macrophytes (i.e., *Salvinia sp*., *Sagittaria latifolia,Typha latifolia,* etc), and green algae. Thirty-seven (37) vegetation samples from reference springs/creeks/ponds (offsite) and onsite springs/creeks/ponds were sampled during 2002 ("Phase 1"). Collection times of samples were random as there was no need in this case to organize a schedule into wet and dry season sampling events. In a few cases, the data show a clear correlation between groundwater impacted by gross beta contamination also detected in corresponding radiological data of vegetation sampled from the same sampling sites. For example, Cattail West Spring, Raccoon Creek Spring, and SS-5 Spring all demonstrate elevated levels of gross beta (although below the MCLs for Drinking Water) in both division and DOE groundwater and vegetation samples. The state also noted that cesium-137 and cobalt-60 were present in vegetation samples collected from the White Oak Weir site.

As part of the Tennessee Consent Order of 1999, the Tennessee Department of Environment and Conservation (TDEC), DOE Oversight Division reviews reports on surveillance and maintenance activities at the ETTP DUF_6 cylinder storage yards. In the event of cylinder breaches, the order specifies requirements for sampling to determine whether the surrounding environment has been impacted. Included in these requirements is the analysis of surface soil in any water runoff path. In October 2000 a cylinder breach was discovered at the K-1066-E cylinder storage yard. The contractor analyzed three surface soil samples at the edge of the pavement in the water runoff path. Results of those samples did not indicate a significant radiological contamination problem (alpha, beta concentrations at approximately 50 pCi/g, the remediation level for the Zone 1 industrial area of ETTP). At the same time, the contractor analyzed a "background" sample that was collected at a location approximately 60 feet east of the runoff samples. The “background” sample yielded results that were almost 10 times the remediation levels. The result of this sample indicates a potential of significant contamination due to events unrelated to the October 2000 breach. In March 2002 TDEC conducted a soil sampling project to determine whether previous events at the K-1066-E cylinder storage yard have resulted in contamination that is migrating away from the edge of the paved yard. There may be some small, localized areas of radiological contamination that will be removed during the remediation of the cylinder yards after all cylinders are removed from the yard.

The Tennessee Department of Environment and Conservation has used continuously recording exposure rate monitors to measure gamma radiation on the U.S. Department of Energy (DOE) Oak Ridge Reservation since 1996. By using these instruments monitoring is directed toward sites where exposure rates are expected to fluctuate significantly over relative short time periods and / or there is a potential for elevated releases of gamma emitting radiouclides. Data derived from the program, along with that generated by environmental dosimetry, are used to identify unplanned releases and assess the need and effectiveness of remedial activities.

In 2002 the gamma monitors were stationed at a background location (Fort Loudoun Dam), the Y-12 Industrial Landfill, Portal 4 at the East Tennessee Technology Park, the check-in station for the Environmental Management Waste Management Facility, the Corehole 8 Plume Reduction Remedial Action (Bethel Valley), and the Surface Impoundments Operable Unit Remedial Action (Bethel Valley). Measurements collected from these sites ranged from 0 μR/hr to 1,740 μR/hr. The highest exposure rates were recorded at the boundary of a radiation area surrounding sediments taken from surface impoundments at the Oak Ridge National Laboratory. Dose rates at this location averaged 1730 μR/hr (1.73 mrem/hr by rule-of-thumb). While not a DOE requirement, these values approach limits specified by state and Nuclear Regulatory Commission regulations requiring their licensees to conduct operations in such a manner that the external dose in any unrestricted area not exceed 2.0 mrem in any one hour.

Conclusion

The 2002 monitoring results showed effort by DOE to improve the overall health of the public and the environment. Although some mistakes were made, such as with the accidental stack release of strontium-90 at ORNL, DOE is moving in the right direction to aggressively decontaminate and/or demolish old facilities, excavate buried wastes, and properly dispose of legacy wastes. Many of the pollutant anomalies measured were a result of remediation activities and resulting fugitive emissions. However, none of these resulted in an unacceptable risk to the public. The state recognizes that some releases are inevitable when environmental clean up is done. The overall benefit of cleanup out weighs the short-term negative impacts. There are still significant source terms of contaminants that could be released through failure of engineering and administrative controls. Additionally, sources of gamma radiation exposure still exist that must be effectively isolated from the public. Sources of contamination in the human food chain still exist as evidenced by the necessary confiscation of three harvested deer in 2002. It is necessary and prudent for the state and DOE to continue monitoring efforts to detect and evaluate as early as possible, potential releases and radiation that could affect the public.

INTRODUCTION

The Tennessee Department of Environment and Conservation (TDEC), DOE Oversight Division in accordance with the Tennessee Oversight Agreement Attachment A.7.2.2, is providing an annual environmental monitoring report of the results of its monitoring and analysis activities during the calendar year of 2002 for public distribution. The division was established in 1991 to administer the Tennessee Oversight Agreement and the CERCLA required Federal Facility Agreement. These agreements are designed to assure the citizens of Tennessee that their health, safety, and environment are being protected through existing programs and substantial new commitments by the Department of Energy (DOE).

This report consists of a series of individual reports that involve independent environmental monitoring by the division. The individual reports are organized by general areas of interest: Surface Water; Drinking Water; Biological/Fish and Wildlife; Groundwater; Air Quality; and Radiation. Abstracts and conclusions are available in each report to provide a quick overview of the content and outcome of each monitoring effort. All supporting information and data used in the completion of these reports are available for review in the division's program files. Overall, the report characterizes and evaluates the chemical and radiological emissions in the air, water, and sediments both on and off the Oak Ridge Reservation.

TDEC has considered the location, environmental setting, history, and on-going DOE operations in its environmental monitoring programs. The information gathered provides a better understanding of the fate and transport of contaminants released from the Oak Ridge Reservation into the environment. This understanding has lead to the development of an ambient monitoring system and increased the probability of detecting releases in the event that institutional controls on the Oak Ridge Reservation fail.

Currently, TDEC's monitoring activities have not detected any imminent threats to public health or the environment outside of the Oak Ridge Reservation. However, unacceptable releases of contaminants from past DOE operational and disposal activities continue to pose risk to the environment and it is imperative to note that if current institutional controls fail or if the present contaminant source controls can no longer be maintained, the public would be at risk of environmental contamination.

Site Description

The DOE Oak Ridge Reservation (ORR), as shown in Figure 1, encompasses approximately 35,000 acres and three major operational DOE facilities: the Oak Ridge National Laboratory (ORNL), the Oak Ridge Y-12 Plant (Y-12), and the East Tennessee Technology Park (ETTP, formerly the K-25 Gaseous Diffusion Plant). The initial objectives of the ORR operations were the production of plutonium and the enrichment of uranium for nuclear weapons components. In the 56 + years since the ORR was established, a variety of production and research activities have generated numerous radioactive, hazardous, and mixed wastes. These wastes, along with wastes from other locations, were disposed of on the ORR. Early waste disposal methods on the ORR were rudimentary compared to today's standards.

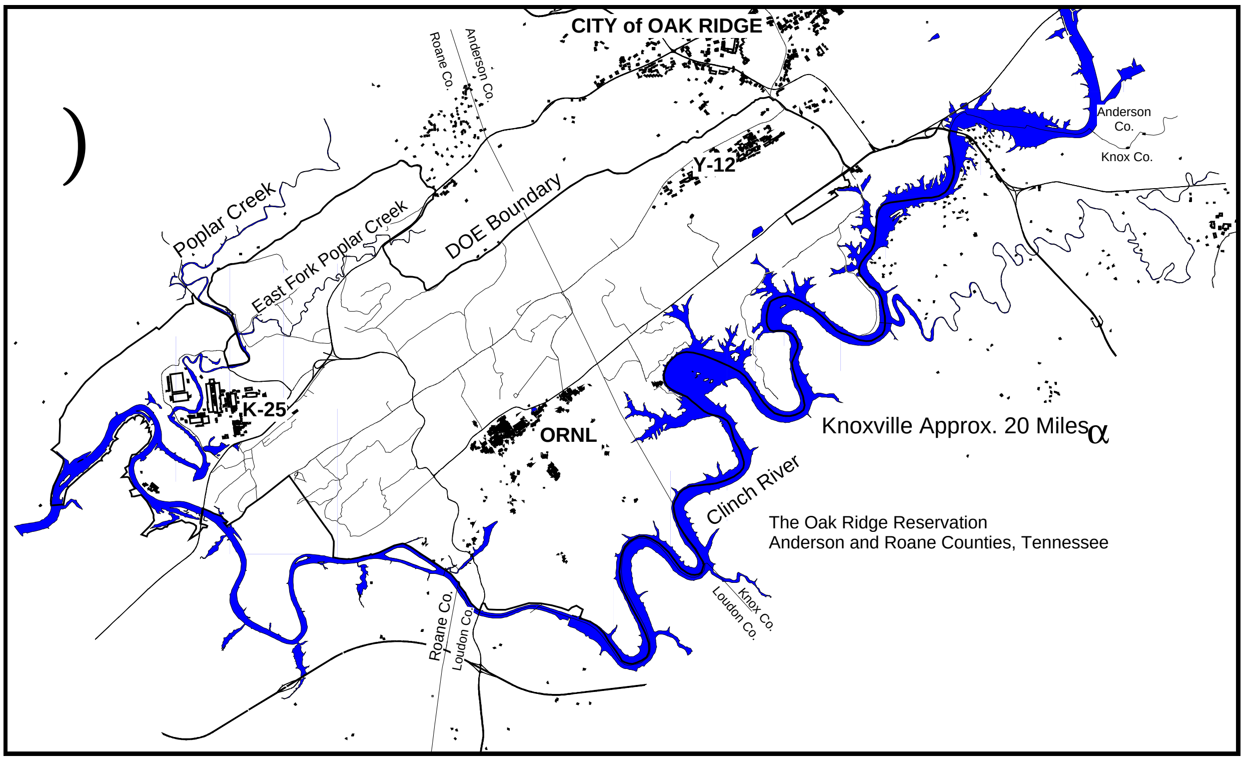


Figure 1: The Oak Ridge Reservation

The ORR is located within the corporate boundaries of the city of Oak Ridge, Tennessee, in the counties of Anderson and Roane. The Reservation is bounded on the north and east by residential areas of the city of Oak Ridge and on the south and west by the Clinch River. Counties adjacent to the Reservation include Knox, Loudon, and Morgan. Meigs and Rhea counties are immediately downstream on the Tennessee River from the ORR. The nearest cities are Oak Ridge, Oliver Springs, Kingston, Lenoir City, Harriman, Farragut, and Clinton. The nearest metropolitan area, Knoxville, lies approximately 20 miles to the east. Figure 2 depicts the general location of the Oak Ridge Reservation and nearby cities.

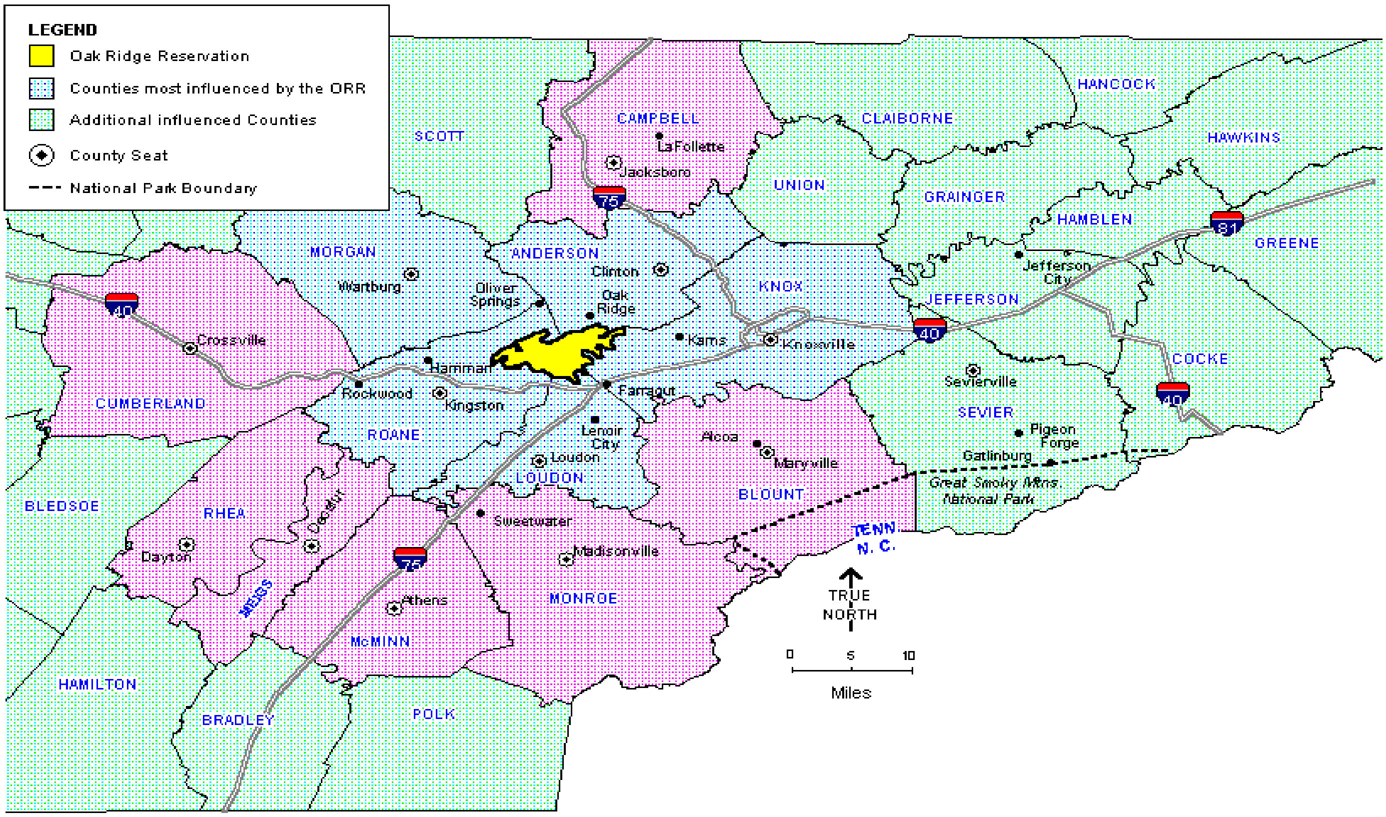


Figure 2: Location of the Oak Ridge Reservation

The ORR lies in the Valley and Ridge Physiographic Province of East Tennessee. The Valley and Ridge Province is a zone of complex geologic structures dominated by a series of thrust faults and characterized by a succession of elongated southwest-northeast trending valleys and ridges. In general, the ridges are underlain by sandstones, limestones, and/or dolomites that are relatively resistant to erosion. The valleys are underlain by weaker shales and more soluble carbonate rock units.

The hydrogeology of the ORR is very complex with a number of variables influencing the direction, quantity, and velocity of groundwater flow that may or may not be evident from surface topography. In many areas of the ORR, groundwater appears primarily to travel along short flow paths in the storm flow zone to nearby streams. In other areas, evidence indicates substantial groundwater flow and, thereby, contaminant transport may occur preferentially in fractures and solution cavities in the bedrock for relatively long distances.

As seen in Figure 3, streams on the ORR drain to the Clinch River. Melton Hill Dam impounded the Clinch River in 1963. Contaminants released on the Oak Ridge Reservation enter area streams (e.g., White Oak Creek, Bear Creek, East Fork Poplar Creek, and Poplar Creek) and are transported into the Clinch River and Watts Bar Reservoir on the Tennessee River.

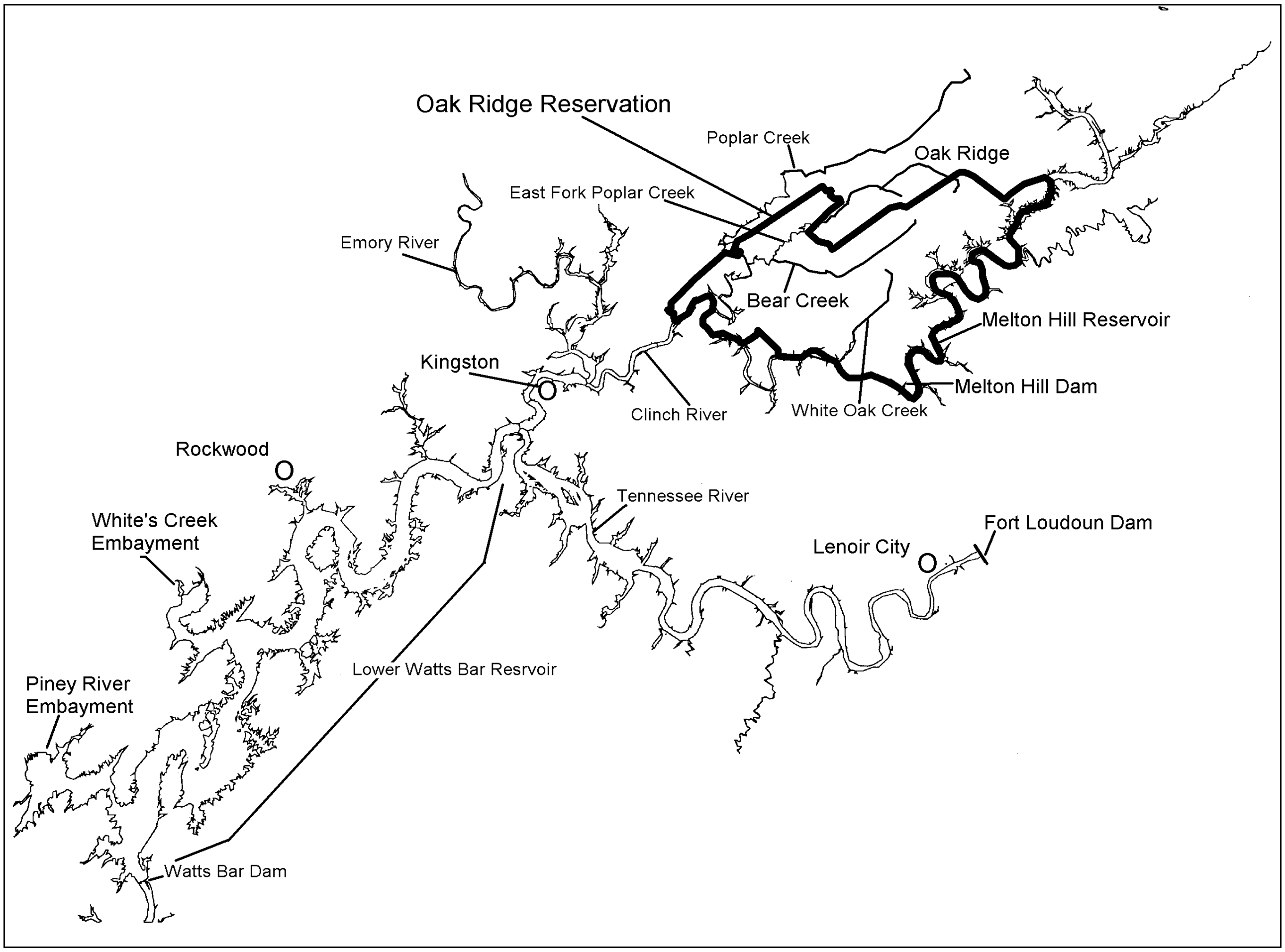


Figure 3: Watts Bar Reservoir

The climate of the region is moderately humid and the annual average precipitation is around 55 inches. Winds on the reservation are controlled, in large part, by the valley and ridge topography with prevailing winds moving up the valleys (northeasterly) during the daytime and down the valleys (southwesterly) at night.

CHAPTER 1 SURFACE WATER MONITORING

Ambient Surface Water Monitoring Program

Principle Author: John Peryam

Abstract

Surface water analysis is a key component of environmental quality and impact assessment for rivers, streams, lakes, and impoundments. The Tennessee Department of Environment and Conservation, DOE Oversight Division (TDEC/DOE-O) conducted sampling at 25 sites in 2002. The samples were analyzed for standard water quality parameters. Based on comparisons with the Tennessee Water Quality Criteria (TWQC) for recreation, none of the sites exceeded these criteria.

Introduction

TDEC/DOEO conducts an ambient surface water sampling program that monitors 25 sites. Seven sites were originally chosen for the purpose of detecting any possible contamination from DOE sites via surface water, stormwater, or groundwater. Sites 1 and 2 were chosen as background data collection sites and are located above the Oak Ridge Reservation before any impact by the three DOE sites. The original seven sampling sites on the Clinch River (sites 1 through 7) were sampled quarterly under this program from 1993 to 1996. In 1997, fifteen sampling sites were added to the program. These newer sites are tributaries of the Clinch River located on or near the Oak Ridge Reservation (ORR). These sites are numbered 8 through 22 and listed in Table 1.1. Three new sites were added in 1999. These three new sites are numbered 23 through 25; two of these are background streams (Clear Creek and White Creek) and the other one (Ernie's Creek) is a tributary of the Clinch River that flows through Oak Ridge.

The Clinch River, being large and subject to dilution, is not expected to have high concentrations of pollutants in surface water grab samples. However, the sampling data do set up a baseline for comparison to previous sampling events. In the case of an unplanned release or an accident, the sampling data may help to reflect the amount and extent of pollution.

The sampling sites were sampled twice during 2002, once in June/July and in October. Samples were analyzed for E. coli, Enterococcus, ammonia, COD, dissolved residue, NO_3 & NO_2 nitrogen, suspended residue, total hardness, total kjeldahl nitrogen, total phosphate, arsenic, cadmium, copper, iron, lead, manganese, mercury, chromium, and zinc. The data is available at the Environmental Protection Agency (EPA) STORET website: http://www.epa.gov/storet/.

Table 1.1 Sample Locations:

Site	Location	Clinch River Mile	Map
1	Downstream of Norris Dam	78.7	Figure 1.5
2	Anderson County Water Treatment Plant		Figure 1.4
3	Melton Hill Park	35.5	Figure 1.3
4	Grubb Islands	17.9	Figure 1.2
5	Brashear Island	10.1	Figure 1.1
6	Bull Run Steam Plant	48.7	Figure 1.4
7	Oak Ridge City Water Treatment Plant		Figure 1.3
8	Scarboro Creek	41.2	Figure 1.3
9	Kerr Hollow Branch	41.2	Figure 1.3
10	McCoy Branch	37.5	Figure 1.3
11	Western Branch	37.5	Figure 1.3
12	East Fork of Walker Branch	33.2	Figure 1.3
13	Bearden Creek	31.8	Figure 1.3
14	Unnamed Stream	27.0	Figure 1.3
15	Unnamed Stream	26.6	Figure 1.3
16	Unnamed Stream	23.0	Figure 1.2
17	Unnamed Stream	20.0	Figure 1.2
18	Raccoon Creek	19.5	Figure 1.2
19	Ish Creek	19.1	Figure 1.2
20	Grassy Creek	14.55	Figure 1.2
21	Unnamed Stream	14.55	Figure 1.2
22	Unnamed Stream	14.45	Figure 1.2
23	Ernie's Creek	51.1	Figure 1.4
24	White Creek	102.4	Figure 1.6
25	Clear Creek	77.7	Figure 1.5

Sampling Sites

Site 1 – Downstream of Norris Dam: Samples are taken at Clinch River Mile (CRM) 78.7. The coordinates are approximately 36º 13' 11" N latitude and 84º 05' 20" W longitude. See Figure 1.5.

Site 2 - Anderson County Water Treatment Plant: Samples are taken at CRM 52.6. See Figure 1.4.

Site 3 - Melton Hill Park: Samples are taken at CRM 35.5. See Figure 1.3.

Site 4 - Grubb Islands: Samples are taken at CRM 17.9. The coordinates are approximately 35º 53' 52" N latitude and 84º 22' 24" W longitude. See Figure 1.2.

Site 5 - Brashear Island: Samples are taken at CRM 10.1. The coordinates are approximately 35º 55' 13" N latitude and 84º 26' 02" W longitude. See Figure 1.1.

Site 6 - Bull Run Steam Plant: Samples are taken at CRM 48.7. The coordinates are approximately 36º 01' 28" N latitude and 84º 10' 02" W longitude. See Figure 1.4.

Site 7 – Oak Ridge City Water Treatment Plant: See Figure 1.3.

Site 8 - Scarboro Creek: Samples are taken about 500 feet upstream of Melton Hill Lake. The coordinates are approximately 35º 58' 59" N latitude and 84º 13' 00" W longitude. See Figure 1.3.
Site 9 - Kerr Hollow Branch: Samples are taken about 200 feet upstream of Melton Hill Lake. The coordinates are approximately 35º 58' 45" N latitude and 84º 13' 37" W longitude. See Figure 1.3.

Site 10 - McCoy Branch: Samples are taken underneath the power lines just upstream from Melton Hill Lake. The coordinates are approximately 35º 57' 57" N latitude and 84º 14' 54" W longitude. See Figure 1.3.

Site 11 - Western Branch: Samples are taken about 500 feet upstream of Melton Hill Lake. The coordinates are approximately 35º 58' 00" N latitude and 84º 15' 05" W longitude. See Figure 1.3.

Site 12 - East Fork of Walker Branch: Samples are taken about 300 feet upstream of Melton Hill Lake. The coordinates are approximately 35º 57' 22" N latitude and 84º 15' 58" W longitude. See Figure 1.3.

Site 13 - Bearden Creek: Samples are taken about 300 feet upstream of Melton Hill Lake. The coordinates are approximately 35º 56' 05" N latitude and 84º 17' 01" W longitude. See Figure 1.3.

Site 14 – Unnamed Stream: Samples are taken about 100 feet upstream of the Clinch River. The coordinates are approximately 35º 54' 25" N latitude and 84º 16' 39" W longitude. See Figure 1.3.

Site 15 – Unnamed Stream: Samples are taken about 75 feet upstream of the Clinch River. The coordinates are approximately 35º 54' 21" N latitude and 84º 17' 06" W longitude. See Figure 1.3.

Site 16 – Unnamed Stream: Samples are taken about 100 feet upstream of the Clinch River. The coordinates are approximately 35º 53' 22" N latitude and 84º 18' 04" W longitude. See Figure 1.2.

Site 17 – Unnamed Stream: Samples are taken about 2000 feet upstream of the Clinch River. The coordinates are approximately 35º 54' 14" N latitude and 84º 20' 12" W longitude. See Figure 1.2.

Site 18 - Raccoon Creek: Samples are taken about 1500 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 12" N latitude and 84º 21' 05" W longitude. See Figure 1.2.

Site 19 - Ish Creek: Samples are taken about 1500 feet upstream of the Clinch River. The coordinates are approximately 35º 54' 11" N latitude and 84º 21' 33" W longitude. See Figure 1.2.

Site 20 - Grassy Creek: Samples are taken about 200 feet from the confluence with the Clinch River/Grassy Creek Embayment. The coordinates are approximately 35º 54' 36" N latitude and 84º 22' 55" W longitude. See Figure 1.2.

Site 21 – Unnamed Stream: Samples are taken about 75 feet from the confluence with the Clinch River/Grassy Creek Embayment. The coordinates are approximately 35º 54' 36" N latitude and 84º 22' 57" W longitude. See Figure 1.2.

Site 22 – Unnamed Stream: Samples are taken approximately 100 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 29" N latitude and 84º 23' 25" W longitude. See Figure 1.2.

Site 23 – Ernie's Creek: This stream is located behind Warehouse Road in Oak Ridge. Samples are taken a short distance upstream of the Clinch River embayment at Clinch River Mile 51.1. The approximate coordinates are 36º 02' 19" N latitude and 84º 12' 47" W longitude. See Figure 1.4.

Site 24 – White Creek: This stream is located in the Chuck Swann Wildlife Management Area in Union County. Samples are taken about one mile upstream of Norris Lake/Clinch River. The approximate coordinates are 36º 20' 47" N latitude and 83º 53' 42" W longitude. See Figure 1.6.

Site 25 – Clear Creek: This stream is located near Norris Dam near Clinch River Mile 77.7 Samples are taken near a water storage facility about one mile upstream of the river. The approximate coordinates are 36º 12' 49" N latitude and 84º 03' 33" W longitude. This is a background site. See Figure 1.5.

Figure 1.1. Ambient Surface Water Monitoring Sites for 2002 (See Table 1.1)

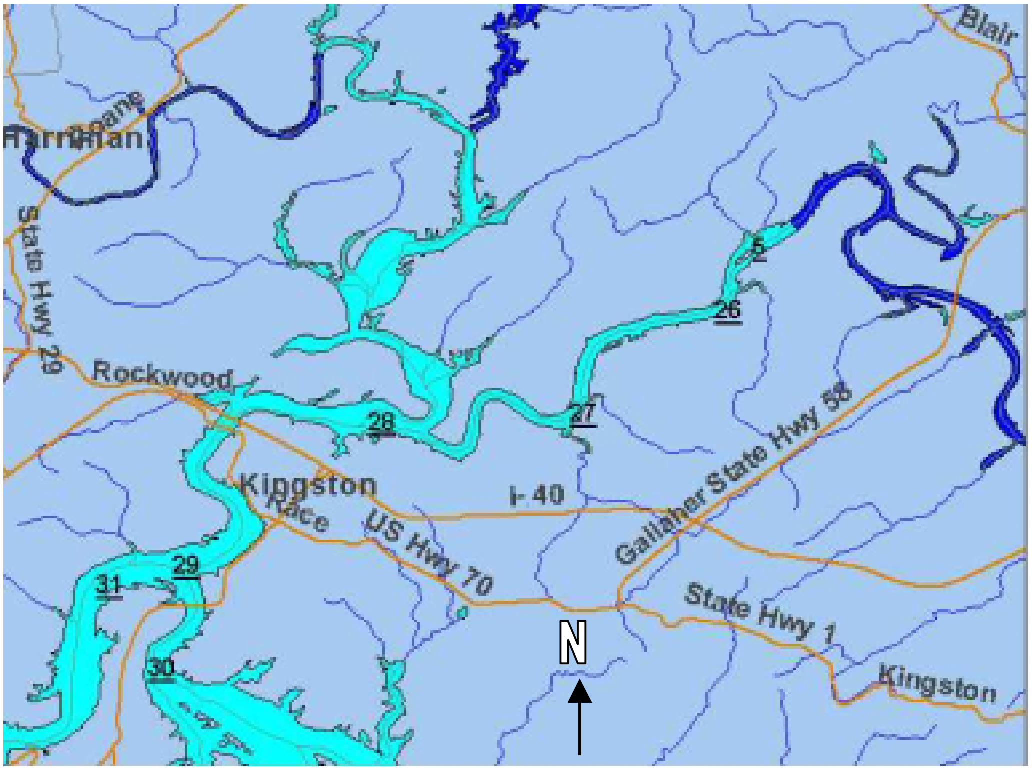


Figure 1.2. Ambient Surface Water Monitoring Sites for 2002 (See Table 1.1)

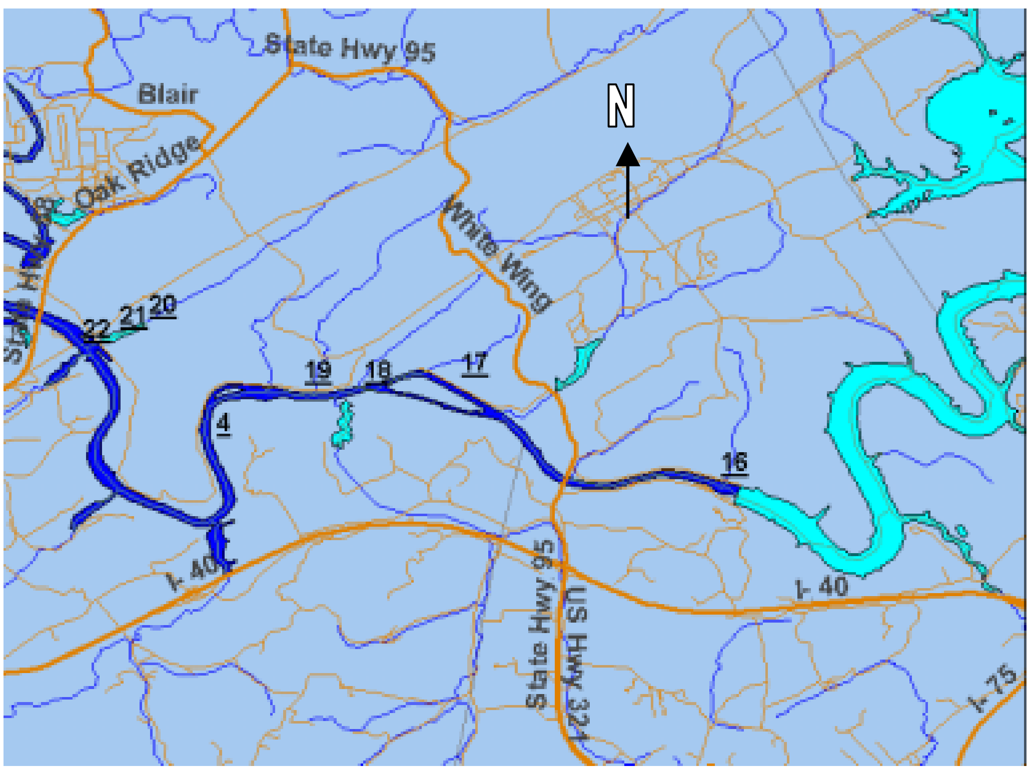


Figure 1.3. Ambient Surface Water Monitoring Sites for 2002 (See Table 1.1)

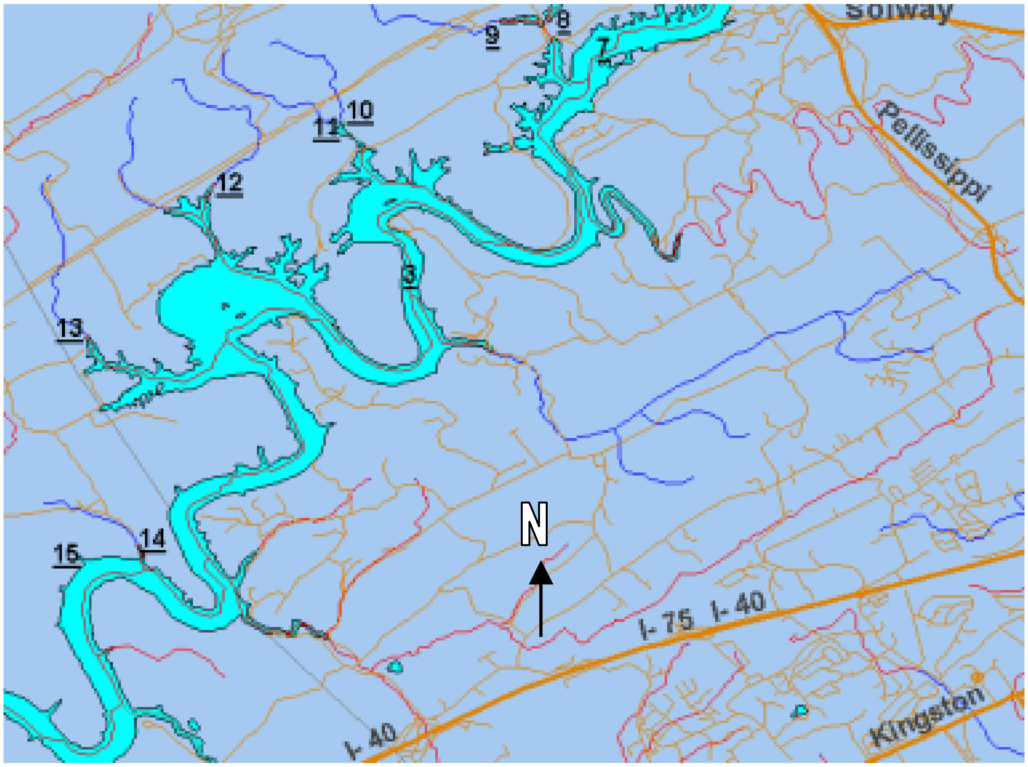


Figure 1.4. Ambient Surface Water Monitoring Sites for 2002 (See Table 1.1)

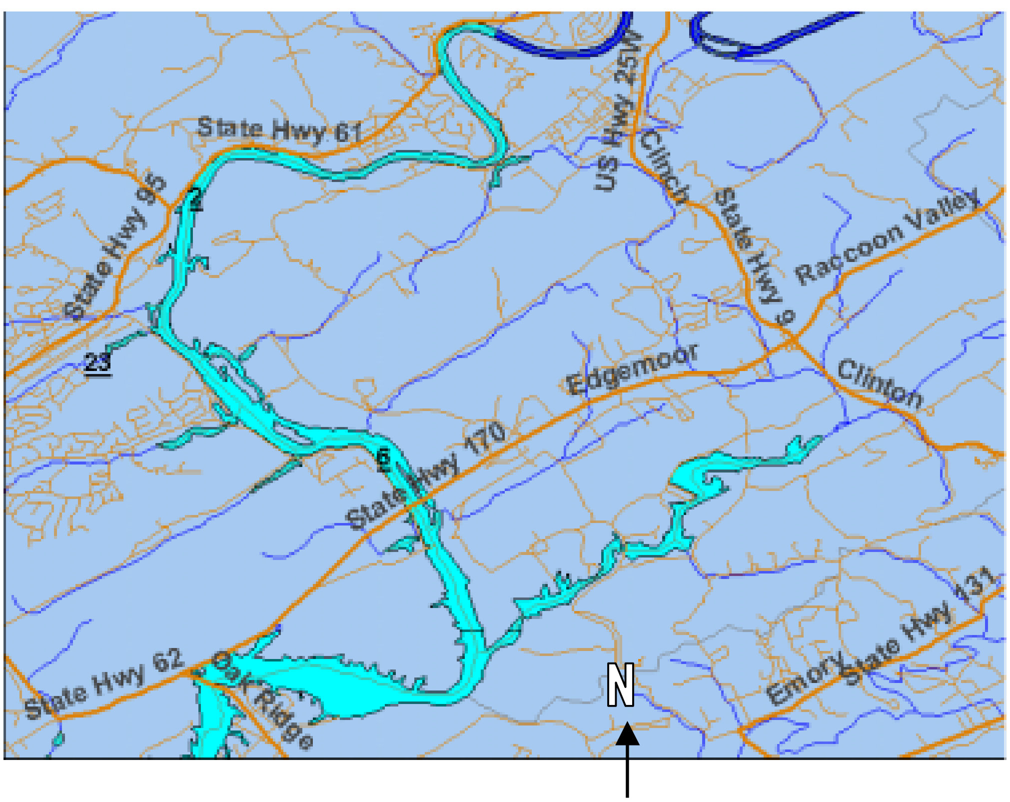


Figure 1.5. Ambient Surface Water Monitoring Sites for 2002 (See Table 1.1)

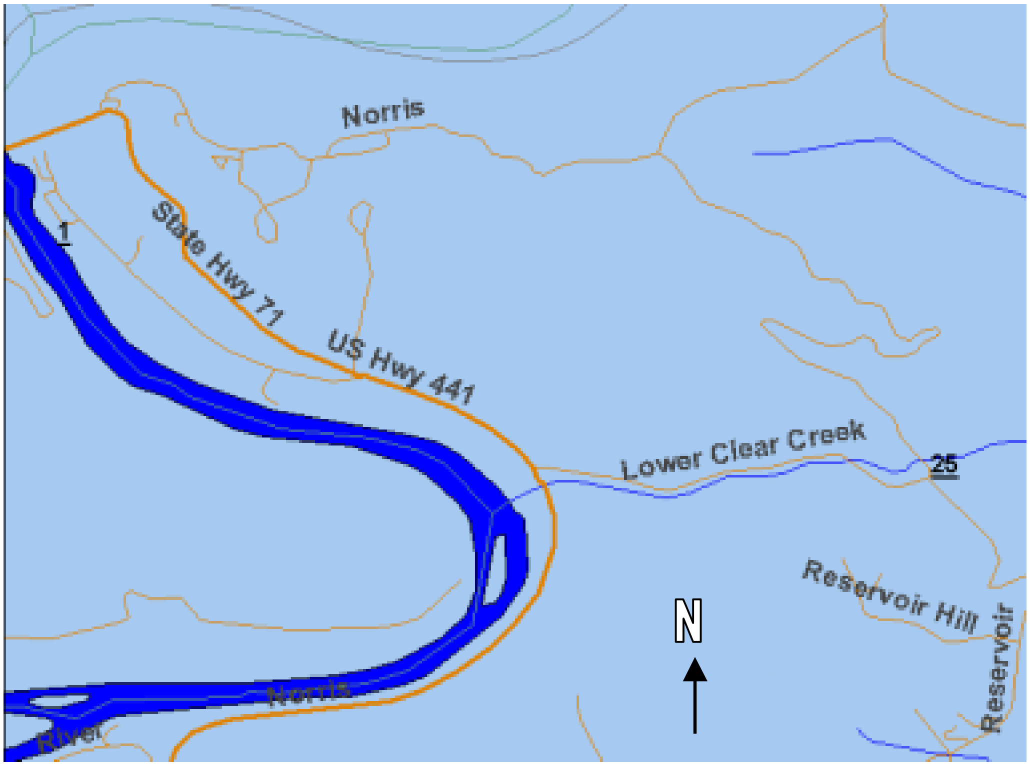
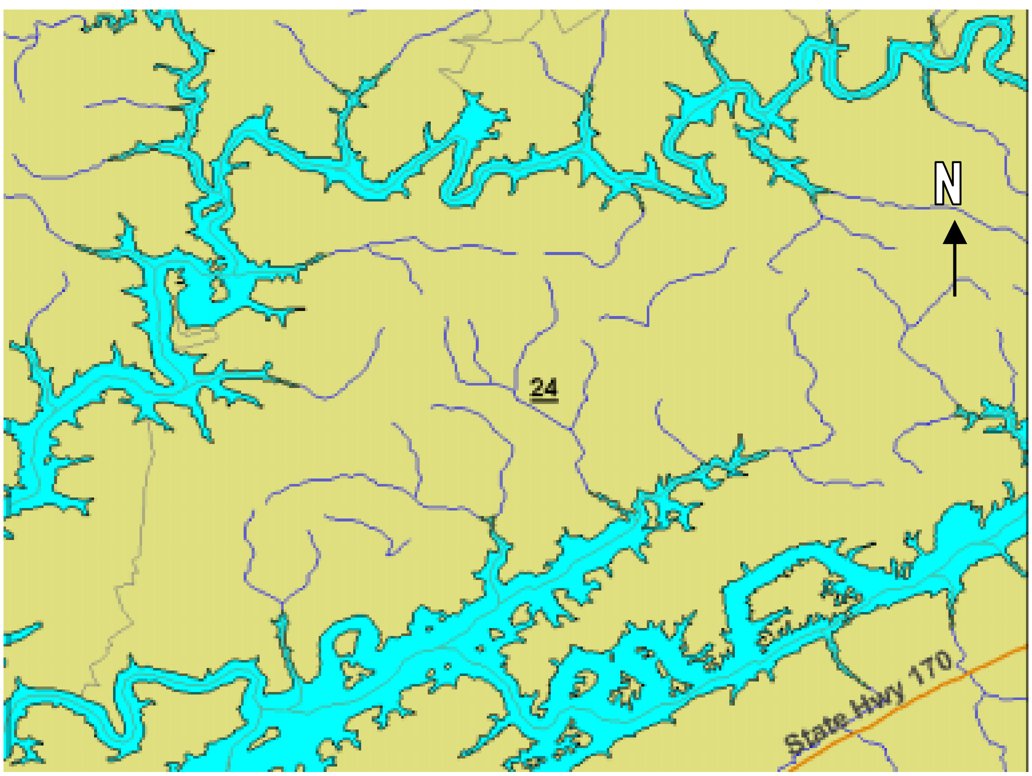


Figure 1.6. Ambient Surface Water Monitoring Sites for 2002 (See Table 1.1)



Methods and Materials

Surface water samples were taken during June/July and October using the methods described in the 2002 Ambient Surface Water Sampling Plan. The Tennessee Department of Health (TDH) Laboratories processed the samples, according to EPA approved methods.

Results and Discussion

Surface water quality in the Clinch River and tributaries sampled is good. None of the parameters sampled for exceeded Tennessee Water Quality Criteria.

Conclusions

The water quality of the Clinch River and the tributaries sampled is good. Lab results indicate that there is no threat to human health or wildlife.

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CHAPTER 1 SURFACE WATER MONITORING

Bear Creek Uranium Study (RMO)

Principle Author: John Edward Sebastian RRPT, PG

Abstract
In order to determine the fate and transport of uranium in the waters of Bear Creek Valley, quarterly samples and flow measurements were taken at various locations on Bear Creek and associated springs and tributaries. The flow measurements and the results of radiochemical analysis on the samples were used to calculate the flux of gross alpha moving through Bear Creek Valley. The flux data were then used to determine the movement and fate of uranium dissolved in the waters of valley. The data indicates most of the uranium in Bear Creek is delivered along discrete, low volume, high concentration flowpaths, during the wetter parts of the year, suggesting that uranium inputs to the creek can be identified and controlled.

Data in 2002 continued to indicate that the movement of uranium in Bear Creek waters parallels the gaining and losing seasonal behavior of the stream. As uranium is transported by the waters of the creek, it is carried into the karst aquifer beneath, only to reemerge at the surface further downstream. In 2001 spring SS-6 tended to be the primary point where the uranium reemerged from the aquifer. In 2002 the reemergence tended to be less consistent, occurring intermittently at springs SS-4, SS-5, and/or SS-7, depending on ambient conditions. Uranium below Bear Creek Kilometer 7.0 continued to show the expected process of dilution (from clean water entering the stream) and the unexpected one of diminished flux. However, there was greater variability in the areas that provided input of dissolved uranium back into the surface waters after the uranium loaded waters descended into the subsurface below Bear Creek Kilometer 11. A phenomenon believed to be caused by the more extreme variations in rainfall during 2002.

Introduction
Uranium dissolved in the waters of Bear Creek on DOE's Oak Ridge Reservation (ORR) originates in the western portion of the Y-12 Plant and numerous disposal sites located in Bear Creek Valley. In 2001 and 2002, the Tennessee Department of Environment and Conservation DOE Oversight Division collected radiological samples and flow measurements along Bear Creek, its tributaries, and associated springs in an attempt to determine the source, transport, and fate of this uranium. As uranium is an emitter of alpha radiation, the project used gross alpha measurements as indicators of the uranium concentrations in the waters sampled. Using these measurements and the estimated flow of each stream at the time of sampling, the flux of alpha moving past the sampling point was calculated. These fluxes were then used to estimate the sources, transport, and fate of uranium in Bear Creek and its associated groundwaters.

Location: Bear Creek Valley is located within East Tennessee's Valley and Ridge Physiographic Province. The valley lies between Pine Ridge (to the map north) and Chestnut Ridge (to the map south) and trends in a general northeasterly and southwesterly direction that is common to the long narrow valleys of this physiographic province. Bear Creek, along with its complex karst and fracture flow groundwater systems, drains the western portion of the Y-12 complex and a number of sites used to dispose of depleted uranium and other wastes from historic DOE processes.

Geology: Fractured clastic and carbonate Cambrian aged sedimentary rocks of the Conasauga Group underlie Bear Creek Valley. Sedimentary beds strike in a general northeastern manner and dip approximately 30 to 45 degrees toward the southeast. Within the regional structure of imbricate thrust blocks, deformation can become too complex for description. Bear Creek Valley and its bordering ridges form part of one such block. The valley is segregated into a number of fractured clastic formations that underlie the majority of the valley's surface and one well developed karst unit, the Maynardville Limestone, which runs parallel to the base of Chestnut Ridge and in some areas forms the lower slopes of Chestnut Ridge. Adjacent to the Maynardville Limestone are the dolomites of the Cambrian and Ordovician aged Knox Group formations. The Knox Group aquifer is also a developed karst system dominated by conduit flow groundwaters.

Hydrogeology: Groundwater and surface water movement in the valley is dominated by the well-developed karst of the Maynardville Formation. With the exception of occasional deeper fracture systems, much of the precipitation that falls on the clastic units is carried by surface or near surface runoff into Bear Creek and its underlying karst aquifer. The creek itself is a surface expression of well developed karst drainage and is composed of a series of gaining and losing stretches. In at least one location, the creek as a whole can be observed seasonally cascading into a swallet formed in the limestone of the creek bed. In this regard, the upper reaches of the creek only flow continuously when the underlying karst has been filled to capacity. A series of springs, which most likely represent a seasonally variable mixture of waters from the Maynardville karst aquifer and the adjacent Knox Group aquifer, exists along the base of Chestnut Ridge and contributes considerable flow to the Bear Creek System.

Methods and Materials

The sampling points in the project (Figure 1) can be divided into three groups: springs, tributaries of Bear Creek, and Bear Creek itself. Each of the sampling points in the three groups is related to the others in such a way that a cross section of the watershed could be sampled essentially simultaneously. Quarterly gross alpha concentrations (pCi/L) and flow measurements (L/s) were used to calculate the flux (total mass/energy) of alpha moving through system (i.e., pCi/L*L/s = pCi/s). The locations and timing of the sampling was chosen to provide a determination of both the source and fate of the contaminant mass.

For the purposes of the study, gross alpha concentrations were assumed to be representative of dissolved phase uranium (an alpha particle emitter) in the waters of Bear Creek Valley. To verify the accuracy of this assumption, alpha spectography was performed on a series of samples and the results compared to gross alpha concentrations measured for the same sample. This comparison indicated the gross alpha measurements could provide a reasonable estimate of the uranium moving through the hydrological system.

Flow measurements at each location were derived by the best available means. Where weirs had been emplaced, they were used to calculate the flow. At other locations, the flow had to be estimated. While these estimates have a high degree uncertainty, even very large margins of error (50% or greater) would not be expected to alter associated conclusions significantly. In this regard, a review of flow measurements taken by the U.S. Geologic Survey along Bear Creek indicate that there are no measurements in this study that are unusual or unlikely for Bear Creek or its environs. Further, the data gathered is logical from one sampling point to another and consistent with other studies performed in the same area. Nevertheless, the uncertainty associated with the flow measurements is considered problematic, along with the lack of a more accurate method to gauge the movement of sediments.

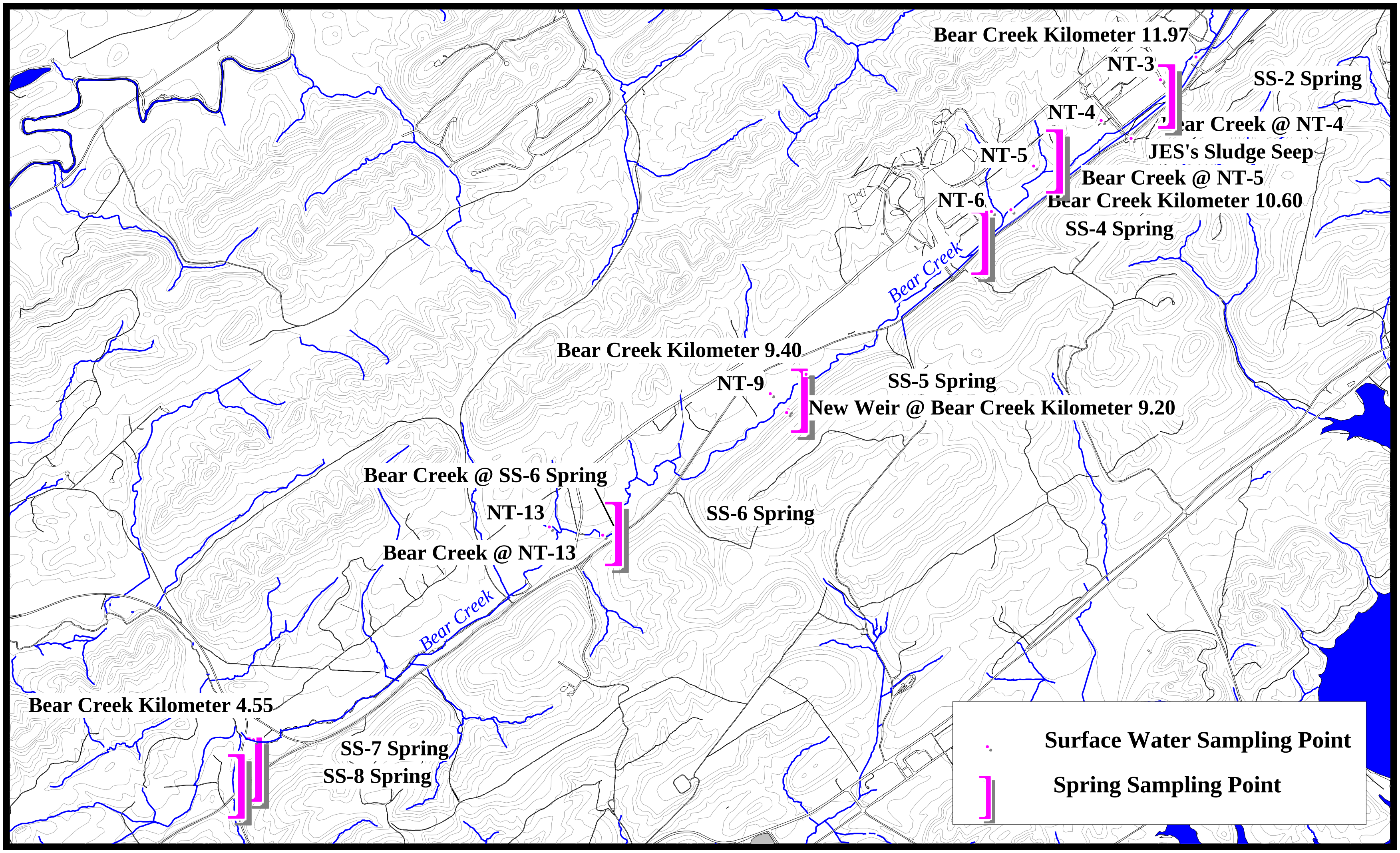

Figure 1: Uranium and Gross Alpha Sampling Points in Bear Creek Valley during 2002

Results and Discussion

Bear Creek: With one exception, results for Bear Creek showed an expected decrease in the gross alpha concentrations at downstream sampling locations (due to dilution provided by clean water discharging to the creek) and an unexpected decrease in the flux of gross alpha in the creek (indicating a lose of contaminant mass). The exception was Bear Creek Kilometer (BCK) 4.55, where an increase in the flux was observed for the last quarter of 2002. Figures 2, 3, and 4 provide the calculated fluxes for gross alpha at pertinent locations on Bear Creek. The figures are arranged sequentially from the upstream portions of the study area to the downstream stations. Each figure represents the results obtained at three points along creek. Seasonal variations in the fluxes can be attributed to gaining and losing sections of the creek and a general decrease in the contaminant loads, attributable to chemical precipitation and the possible loss of water/contaminants to subsurface drainage. The increase in the flux at BCK 4.55 is of indeterminate origin, but could be due to increased runoff of contaminated sediment associated with heavy precipitation in the last quarter of 2002.

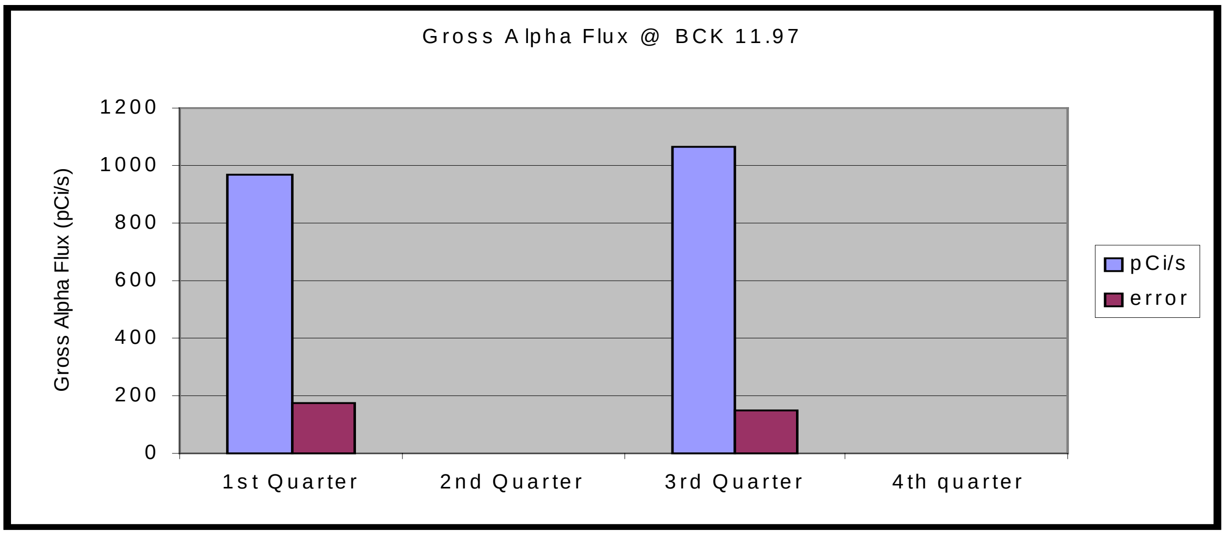

Figure 2: Gross Alpha Flux at Bear Creek Kilometer (BCK) 11.97

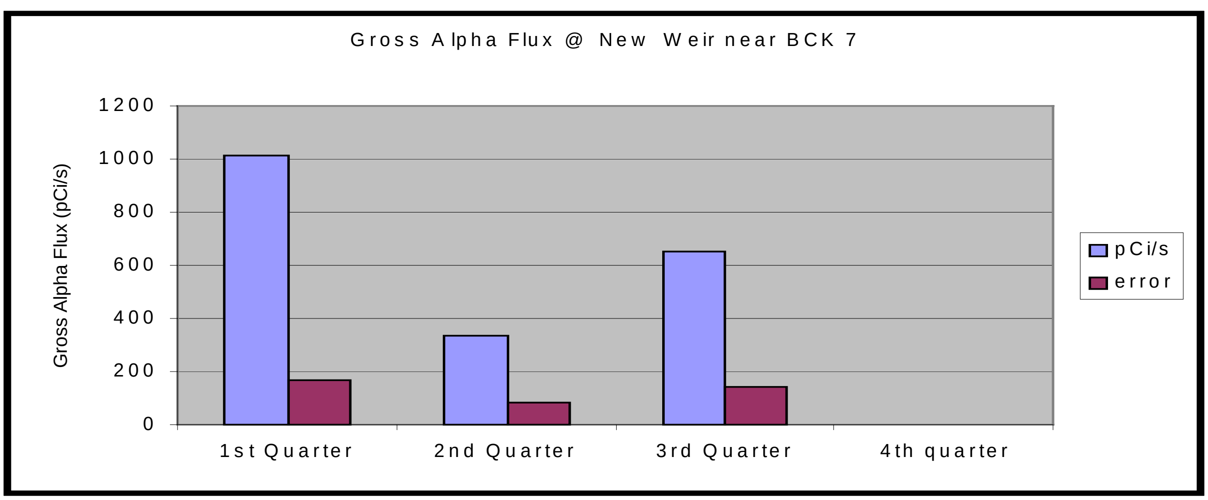

Figure 3: Gross Alpha Flux at the New Weir near Bear Creek Kilometer (BCK) 7.0

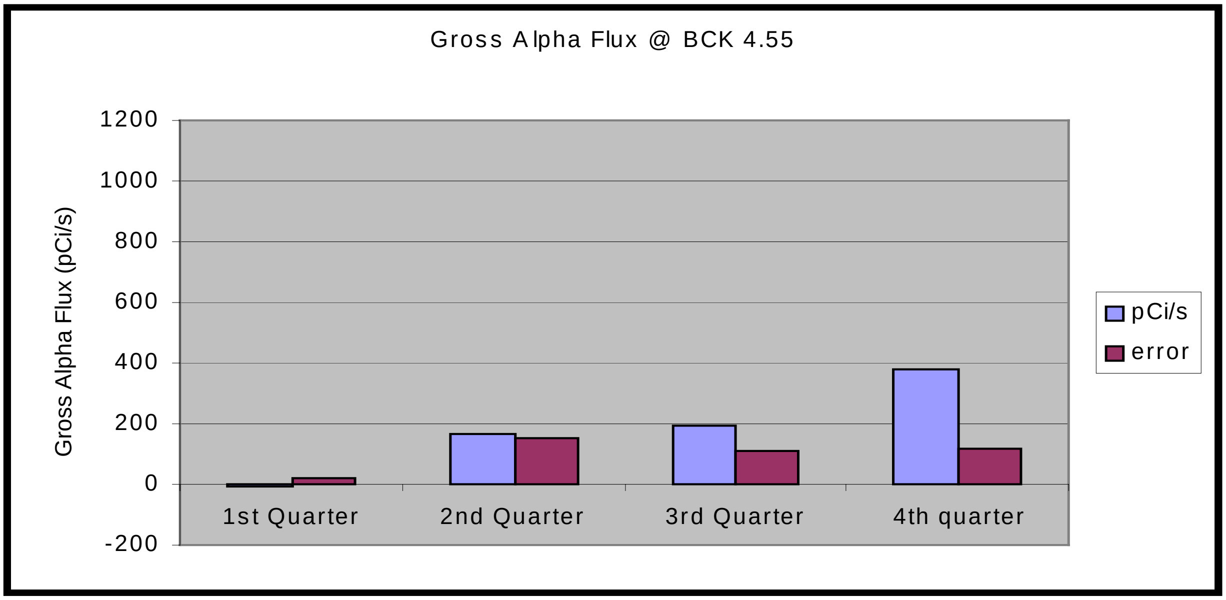

Figure 4: Gross Alpha Flux at Bear Creek Kilometer (BCK) 4.55.

Tributaries: The tributaries were the only mode of transport in which significant differences in 2001 and 2002 data were observed. This can be attributed to the various remediation efforts that were begun in 2002: in particular, the excavation of the Boneyard-Burnyard and associated erosion control on NT-3. It is apparent from the sampling results that NT-3 began 2002 behaving as it had in 2001, but experienced a significant drop in the uranium burden being delivered to the creek in the later part of the year (Figure 5).

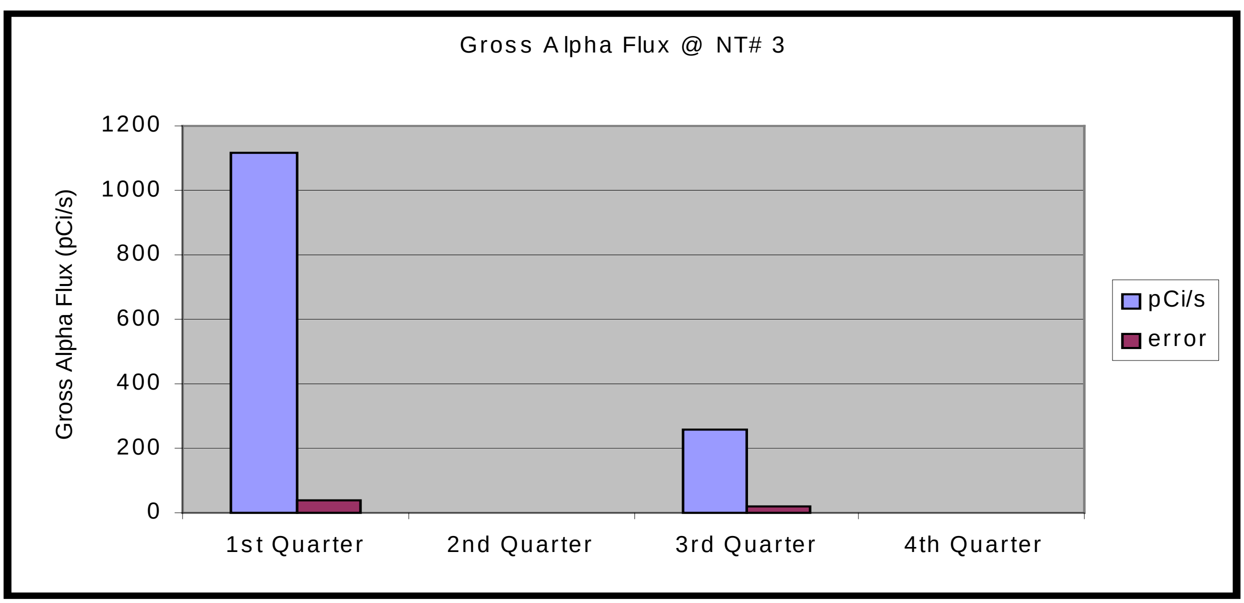

Figure 5: Gross Alpha Flux in Beer Creek Tributary NT-3

Springs: Figures 6, 7, and 8 provide the fluxes for selected springs proceeding from the top of the study area to the lowest portion. Other springs were sampled, but the results tend to closely follow those of the springs shown. As can be seen in the figures, the flux of gross alpha contributed by the springs was considerably less than the portion born by Bear Creek. This is interpreted to indicate that uranium contamination in the springs is, in general, sourced from losing reaches of Bear Creek. The balance of the spring waters being sourced by uncontaminated water from the Knox Aquifer underlying Chestnut Ridge. Gross alpha fluxes and concentrations can be traced from the losing reaches of Bear Creek around BCK 11.97 to the springs down gradient, particularly, spring SS-4. Of interest is the close mimicking of the behavior of the contaminant flux from the springs with that of Bear Creek, demonstrating the strongly coupled nature of the surface and groundwater systems above and within the conduit dominated flow regimes of the karst aquifer.

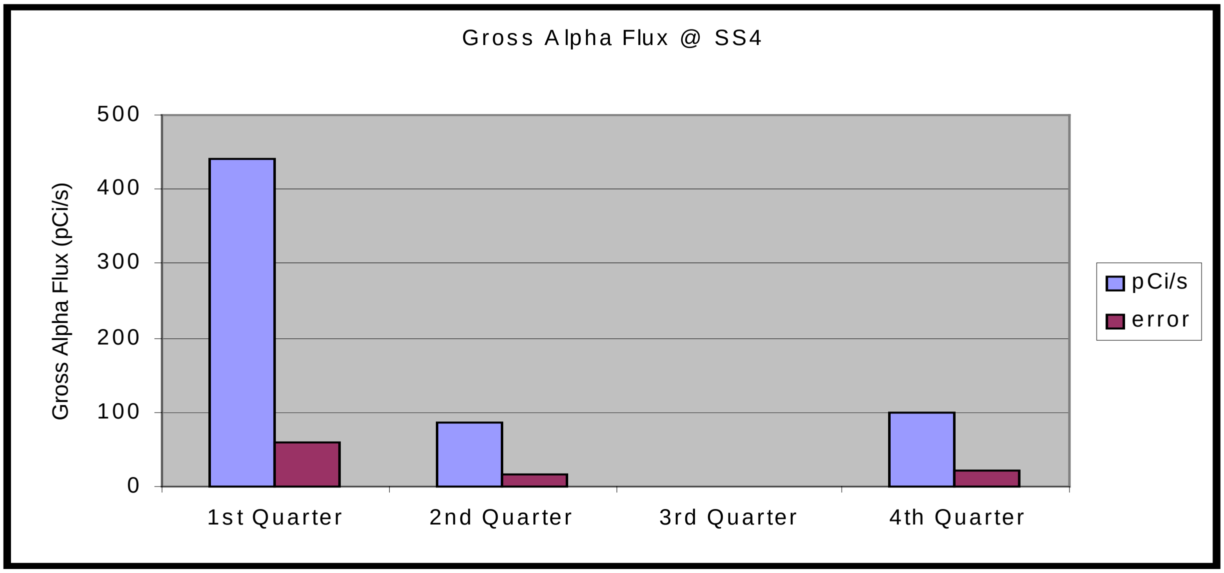

Figure 6: Gross Alpha Flux at Spring SS-4 on Bear Creek

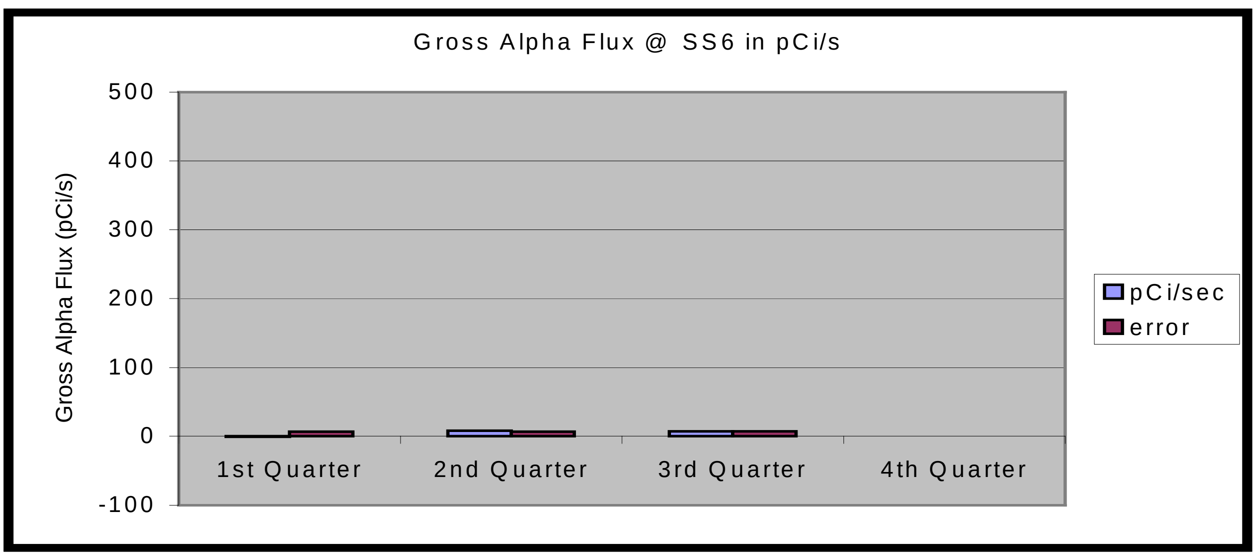

Figure 7: Gross Alpha Flux at Spring SS-6 on Bear Creek

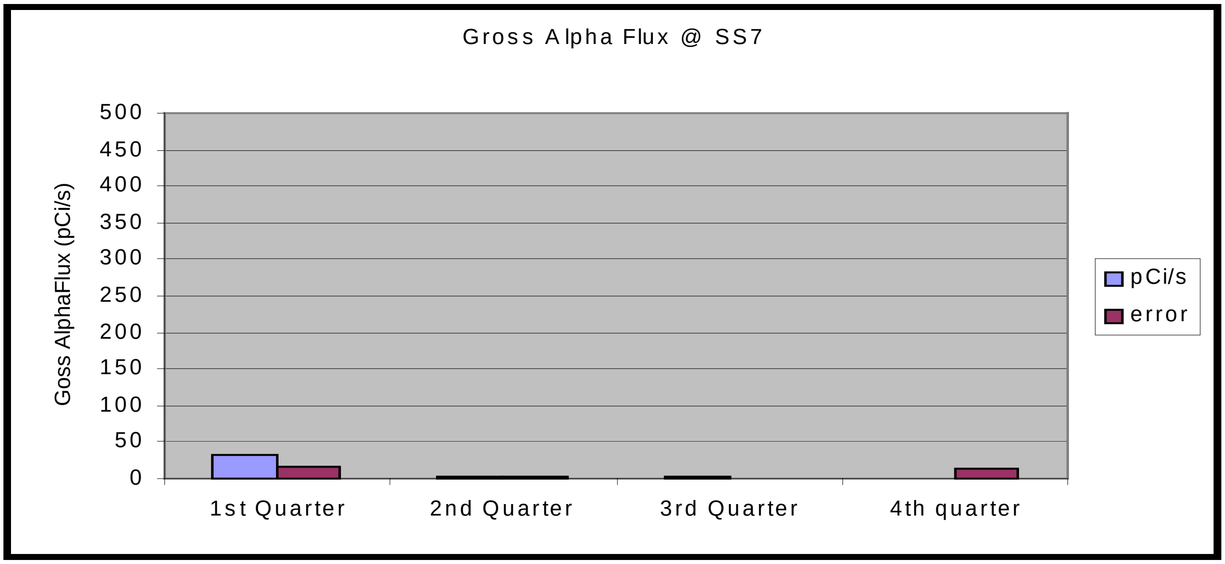

Figure 8: Gross Alpha Flux at Spring SS-7 on Bear Creek

JES's Sludge Seep exemplifies contaminant pathways characteristic of Bear Creek Valley. This seep is located on Bear Creek just upstream of NT-5. It was discovered by TDEC staff in 2001 and sampled by TDEC's spring monitoring project the same year. Results from the sample included elevated levels of cis-1,2-dichloroethene at 114 ppb, vinyl chloride at 4.2 ppb, gross alpha at 167 pCi/L, and uranium at 335 ug/L. This contaminant signature does not match known plumes and the source of the contamination is currently unknown. Similar results were reported for samples taken in 2002 (see associated report, *Oak Ridge Reservation and Vicinity Spring and Seep Monitoring Project Report*).

Gross Alpha Flux in the Bear Creek Hydrological System: Study results suggest that much of the gross alpha contamination in the waters of Bear Creek Valley are transported from uranium waste disposal areas along individual discrete pathways to local surface drainages (e.g., NT-3 & NT-6) or through shallow subsurface fractures such as those that supply JES's Sludge Seep. The surface streams transport the bulk of the contaminant mass to Bear Creek (particularly NT-3).

The gross alpha/uranium is then transported through the valley by Bear Creek and the closely associated karst aquifer beneath the streambed. Much of the contaminant that is "lost" from Bear Creek into the aquifer beneath at losing reaches of the stream, reemerges in the series of springs along the base of the northern slope of Chestnut Ridge and presumably in gaining reaches of creek itself. In 2001 this process was generally completed in the vicinity of SS-6. In 2002 most of the gross alpha reentered the surface component of Bear Creek at SS-4 and SS-5, which may be due to the large amount of rainfall during the year. Some of the contaminant mass is probably lost to the deeper Maynardville Aquifer, where contaminants have been detected from time to time in deep wells located in this formation.

Bear Creek from spring SS-6 (BCK 7.0) to Hwy 95 (BCK 4.6) exhibits a considerable decrease in the gross alpha flux. This is presumably due precipitation of uranium in solution and the loss of contaminant bearing waters to the deeper portions of the Maynardville Aquifer.

Conclusions

Most of the uranium in Bear Creek is delivered along discrete, low-volume, high-concentration flows during the wetter parts of the year. Uranium also enters the creek through discrete fractures such as JES's Seep. This suggests that uranium inputs to the creek can be identified and controlled.

Once in the creek, uranium transport mimics the karst conduit mixed surface and subsurface drainage of the Maynardville Limestone, reemerging in springs along Chestnut Ridge (after being diluted with water from the Knox Aquifer) and in springs that are intregal to the bed of Bear Creek itself. This process of reemergence is substantially completed around spring SS-6 with greatly diminished gross alpha fluxes at SS-7 and SS-8, except during the dryer parts of the year when a lower flow regime dominates the karst system. It should also be considered that in the dryer parts of the year inputs from the karst aquifer underlying Chestnut Ridge are diminished and the entire system loses water to evapotranspiration.

Between the point where SS-6 drains into BCK 7.0 and BCK 4.6 (at Highway 95) the flux of uranium decreases, presumably due to neutralization of the dissolved phase and loss contaminant mass (via precipitation) to the deeper aquifer. The chief difference from 2001 was the greater variability in the spring contributing the greater flux of gross alpha to the system. This most probably reflects the greater variability seen in rainfall for 2002 compared to 2001.

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CHAPTER 1 SURFACE WATER MONITORING

Ambient Sediment Monitoring Program

Principle Author: John Peryam

Abstract
Sediment analysis is a key component of environmental quality and impact assessment for aquatic ecosystems. The Department of Energy -Oversight Division (DOE-O) conducted sediment sampling at 30 sites in 2002. The sediments were analyzed for inorganics, organics, and radiological parameters. Since there are no federal or state sediment cleanup levels, the data were compared to the Department of Energy's (DOE) Preliminary Remediation Goals (PRGs) for use at the Department of Energy Oak Ridge Operations Office. Based on the designation of the water bodies involved, the values were compared to the recreational PRGs. Under recreational land use, individuals are assumed to be exposed to contaminated media while playing, fishing, hunting, or engaging in other outdoor activities. Exposure could result from ingestion of soil or sediment, inhalation of vapors from soil or sediment, dermal contact with soil or sediment, external exposure to ionizing radiation emitted from contaminants in soil or sediment, and consumption of fish. Based on this comparison, the sediments showed no levels of concern for human health for the contaminants that were analyzed for.

Introduction
Many organisms depend upon sediments as their primary habitat. Man-made chemicals and waste materials introduced into aquatic systems are often accumulated in sediments. Sediment analysis is an important aspect of environmental quality and impact assessment for rivers, streams, and lakes. The DOE-O conducts an ambient sediment monitoring program that includes 30 sampling sites, numbered 2 through 31. Sites 2 through 7 are located on the Clinch River and have been sampled since 1994. In 1997, fifteen tributaries of the Clinch River were added (sites 8-22). Three new stations (23-25) were added in 1999. Sites 24 and 25 are background streams and site 23 is a tributary of the Clinch River that flows through parts of Oak Ridge. In 2000, two sites on the Clinch River were added downstream of Brashear's Island. These new sites were 26 at Clinch River Mile (CRM) 9.0 and 27 at CRM 7.0. In 2001, two more sites at Clinch River Miles 4.0 and 0.0 were added to the program. The 2002 monitoring plan added two sites on the Tennessee River: site 30 at Tennessee River Mile (TRM) 569 and site 31 at TRM 567. These sites are one mile upstream and downstream of the Clinch River's mouth, respectively.

Sampling was conducted once during 2002 during the months of June and July. Samples were analyzed for inorganic, organic and radiological parameters. Since there are no federal or state sediment cleanup levels, the data were compared to the Department of Energy's (DOE) Preliminary Remediation Goals (PRGs) for use at the Department of Energy Oak Ridge Operations Office. The PRGs are human health risk assessment figures that are dynamic in nature, changing as new information becomes available. Data are available on request.

Analytical Parameters

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

Organics (extractables): butyl benzyl phthalate, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, di-n-octyl phthalate, diethyl phthalate, dimethyl phthalate, n-nitrosodimethylamine, n-nitrosodiphenylamine, n-nitroso-di-n-propylamine, isophorone, nitrobenzene, 2,4-dinitrotoluene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, fluoranthene,fluorene, indeno(1,2,3-cd)pyrene, napthalene, phenanthrene, pyrene, chrysene, bis(2-chloroethyl) ether, bis(2-chloroethoxy)methane, bis(2-chloroisopropyl) ether, 4-bromophenylphenyl ether, 4-chlorophenylphenyl ether, hexachlorocyclopentadiene, hexachlorobutadiene, hexachlorobenzene, hexachoroethane, 1,2,4-trichlorobenzene, 2-chloronapthalene, 4-chloro-3-methylphenol, 2-chlorophenol, 2,4-dichlorophenol, 2,4-dimethylphenol, 2,4-dinitrophenol, 2-methyl-4,6-dinitrophenol, 2-nitrophenol, 4-nitrophenol, pentachlorophenol, phenol, 2,4,6-trichlorophenol, 2,4,5-trichlorophenol, pyridine, o-cresol, m & p cresol, 2-methylnaphthalene, 4-chloroaniline, dibenzofuran, 3,3-dichlorobenzidine, 2-nitroaniline, 3-nitroaniline, 4-nitroaniline, aldrin, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC (lindane), alpha-chlordane, gamma-chlordane, technical chlordane, p,p-DDD, p,p-DDE, p,p-DDT, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin aldehyde, endrin ketone, heptachlor, heptachlor epoxide, toxaphene, methoxychlor, PCB 1016/1242, PCB 1221, PCB 1232, PCB 1248, PCB 1254, PCB 1260, PCB 1262, carbazole, acetophenone, benzaldehyde, 1,1'-biphenyl, and caprolactam.

Radiological: gross alpha, gross beta, and gamma radionuclides.

Sampling Stations

Site 2 - Anderson County Water Treatment Plant: Samples are taken in an area approximately 20 to 40 feet from the west bank of the river, just offshore from the water treatment plant. This site is upstream of any possible DOE impacts and is a reference site in this respect. It may, however, show effects of any agricultural, industrial and residential activities upstream. See Figure 1.4.

Site 3 - Melton Hill Park: Samples are taken in an area approximately 40 feet from the west bank of the river near the Knoxville Utility Board's pumping station. See Figure 1.3.

Site 4 - Grubb Islands: Samples are taken in an area approximately 20 to 40 feet from the west bank of the island (downstream side) on the inside of the bend in the river. The coordinates are approximately 35º 53' 52" N latitude and 84º 22' 24" W longitude. See Figure 1.2.

Site 5 - Brashear Island: Samples are taken in an area approximately 20 to 40 feet south of the last sandbar (going downstream) of the river approximately 300 to 400 feet upstream of Brashear Island. The coordinates are approximately 35º 55' 13" N latitude and 84º 26' 02" W longitude. See Figure 1.1.

Site 6 - Bull Run Steam Plant: Samples are taken at the upstream end of the skimmer wall. The coordinates are approximately 36º 01' 28" N latitude and 84º 10' 02" W longitude. See Figure 1.4.

Site 7 – Oak Ridge City Water Treatment Plant: Samples are taken in shallows on the inside of the bend in the river across from the water treatment plant intake. See Figure 1.3.

Site 8 - Scarboro Creek: Samples are taken about 500 feet upstream of Melton Hill Lake. The coordinates are approximately 35º 58' 59" N latitude and 84º 13' 00" W longitude. See Figure 1.3.

Site 9 - Kerr Hollow Branch: Samples are taken about 200 feet upstream of Melton Hill Lake. The coordinates are approximately 35º 58' 45" N latitude and 84º 13' 37" W longitude. See Figure 1.3.

Site 10 - McCoy Branch: Samples are taken underneath the power lines just upstream from Melton Hill Lake. The coordinates are approximately 35º 57' 57" N latitude and 84º 14' 54" W longitude. See Figure 1.3.

Site 11 - Western Branch: Samples are taken about 500 feet upstream of Melton Hill Lake. The coordinates are approximately 35º 58' 00" N latitude and 84º 15' 05" W longitude. See Figure 1.3.

Site 12 - East Fork of Walker Branch: Samples are taken about 300 feet upstream of Melton Hill Lake. The coordinates are approximately 35º 57' 22" N latitude and 84º 15' 58" W longitude. See Figure 1.3.

Site 13 - Bearden Creek: Samples are taken about 300 feet upstream of Melton Hill Lake. The coordinates are approximately 35º 56' 05" N latitude and 84º 17' 01" W longitude. See Figure 1.3.

Site 14 – Unnamed Stream: Samples are taken about 100 feet upstream of the Clinch River. The coordinates are approximately 35º 54' 25" N latitude and 84º 16' 39" W longitude. See Figure 1.3.

Site 15 – Unnamed Stream: Samples are taken about 75 feet upstream of the Clinch River. The coordinates are approximately 35º 54' 21" N latitude and 84º 17' 06" W longitude. See Figure 1.3.

Site 16 – Unnamed Stream: Samples are taken about 100 feet upstream of the Clinch River. The coordinates are approximately 35º 53' 22" N latitude and 84º 18' 04" W longitude. See Figure 1.2.

Site 17 – Unnamed Stream: Samples are taken about 2000 feet upstream of the Clinch River. The coordinates are approximately 35º 54' 14" N latitude and 84º 20' 12" W longitude. See Figure 1.2.

Site 18 - Raccoon Creek: Samples are taken about 1500 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 12" N latitude and 84º 21' 05" W longitude. See Figure 1.2.

Site 19 - Ish Creek: Samples are taken about 1500 feet upstream of the Clinch River. The coordinates are approximately 35º 54' 11" N latitude and 84º 21' 33" W longitude. See Figure 1.2.

Site 20 - Grassy Creek: Samples are taken about 200 feet from the confluence with the Clinch River/Grassy Creek Embayment. The coordinates are approximately 35º 54' 36" N latitude and 84º 22' 55" W longitude. See Figure 1.2.

Site 21 – Unnamed Stream: Samples are taken about 75 feet from the confluence with the Clinch River/Grassy Creek Embayment. The coordinates are approximately 35º 54' 36" N latitude and 84º 22' 57" W longitude. See Figure 1.2.

Site 22 – Unnamed Stream: Samples are taken approximately 100 feet from the confluence with the Clinch River. The coordinates are approximately 35º 54' 29" N latitude and 84º 23' 25" W longitude. See Figure 1.2.

Site 23 – Ernie's Creek: This stream is located behind Warehouse Road in Oak Ridge. Samples are taken a short distance upstream of the Clinch River embayment at Clinch River Mile 51.1. The approximate coordinates are 36º 02' 19" N latitude and 84º 12' 47" W longitude. See Figure 1.4.

Site 24 – White Creek: This stream is located in the Chuck Swann Wildlife Management Area in Union County. Samples are taken about one mile upstream of Norris Lake/Clinch River. The approximate coordinates are 36º 20' 47" N latitude and 83º 53' 42" W longitude. See Figure 1.6.

Site 25 – Clear Creek: This stream is located near Norris Dam near Clinch River Mile 77.7 Samples are taken near a water storage facility about one mile upstream of the river. The approximate coordinates are 36º 12' 49" N latitude and 84º 03' 33" W longitude. This is a background site. See Figure 1.5.

Site 26 – Clinch River Mile 9.0: Samples are taken just upstream of rock cliffs and downstream of where a creek empties into the river, on the inside of the bend in the river. The coordinates are approximately 35º 54' 36" N latitude and 84º 26' 15" W longitude. See Figure 1.1.

Site 27 – Clinch River Mile 7.0: Samples are taken just upstream of where a creek empties into the river, on the inside of the bend in the river. The coordinates are approximately 35º 53' 37" N latitude and 84º 27' 46" W longitude. See Figure 1.1.

Site 28 – Clinch River Mile 4.0: Samples are taken near a small island (heron rookery) just downstream of the mouth of the Emory River. The coordinates are approximately 35º 53' 29" N latitude and 84º 29' 55" W longitude. See Figure 1.1.

Site 29 – Clinch River Mile 0 .0: Samples are taken near the pole with the green beacon in about 10 feet of water. The coordinates are approximately 35º 51' 52" N latitude and 84º 32' 01" W longitude. See Figure 1.1.

Site 30 – Tennessee River Mile 569 (one mile upstream of Clinch River mouth): The coordinates are approximately 35º 50' 43" N latitude and 84º 32' 23" W longitude. See Figure 1.1.

Site 31 – Tennessee River Mile 567 (one mile downstream of Clinch River mouth): The coordinates are approximately 35º 51' 38" N latitude and 84º 32' 38" W longitude. See Figure 1.1.

Methods and Materials

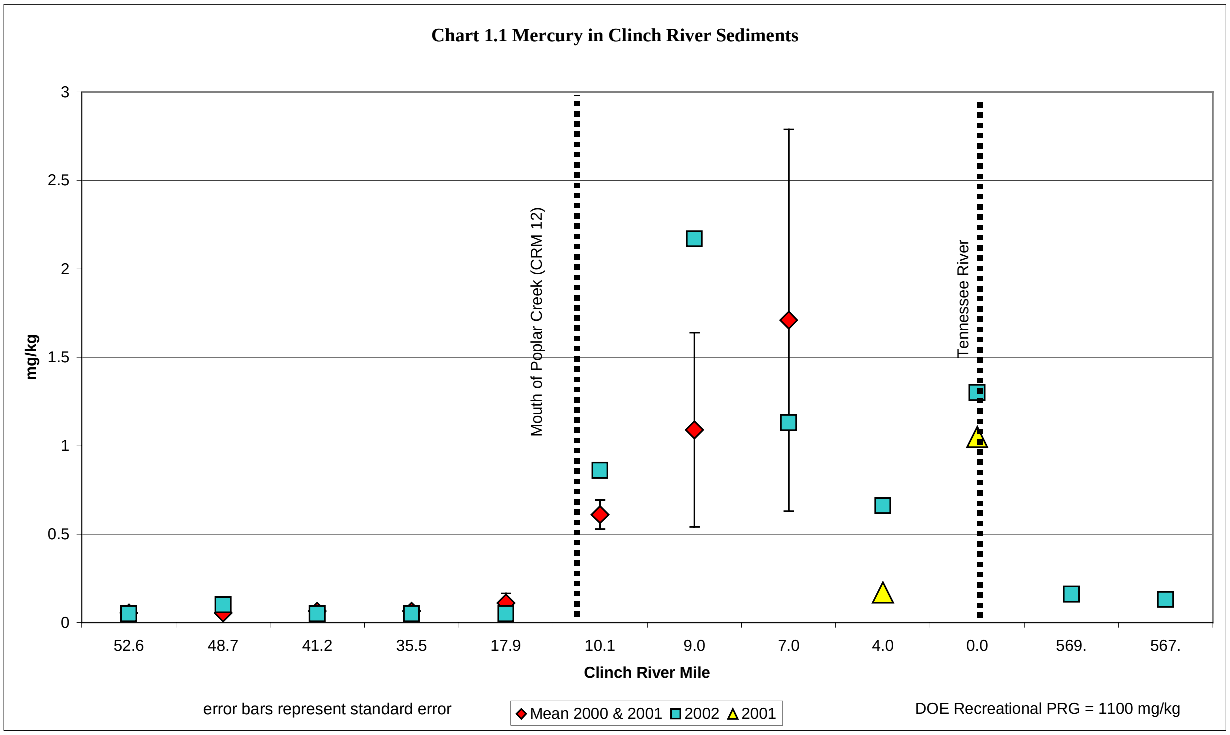
Sediment samples were taken during June and July using the methods described in the 2002 Ambient Sediment Monitoring Plan. Samples were collected at locations with fine sediments; rocky or sandy areas were not used. River sediment samples were taken with a petite ponar dredge; stream samples were taken with stainless steel spoons. The Tennessee State Laboratories processed the samples, according to EPA approved methods.

Results and Discussion

Inorganics Analyses

Inorganic analyses of sediment samples taken in 2002 showed no levels of concern based on comparisons with DOE's Preliminary Remediation Goals (PRGs) for recreation use of soils and sediments. PRGs are used for comparison because there are no state or federal sediment criteria.

Mercury levels in the samples taken in the Clinch River below the confluence of Poplar Creek (sites 5, 26, 27, 28, and 29: river miles 10.1, 9.0, 7.0, 4.0, and 0.0, respectively) increase as one goes downstream. Although the levels of mercury are well below the recreational PRG (1100 mg/kg), they are higher than all of the other sediment sampling sites (see Chart 1.1). Mercury is virtually undetectable at the sites upstream of the mouth of Poplar Creek; this is why the data points for the means are obscured by the 2002 data points at Clinch River Miles (CRM) 52.6, 48.7, 41.2, 35.5 and 17.9. There is not a mean for CRM 4.0 and CRM 0.0 because these sites have only been monitored for two years, 2001 and 2002. The sites at Tennessee River Miles (TRM) 569 and 567 were added to the program in 2002, so they only have one datum each with no mean.



Organics Analyses

Some of the polycyclic aromatic hydrocarbon (PAHs) compounds are elevated in sediment samples taken from Ernie's Creek (site 23, mouth at Clinch River Mile 51.1) and Scarboro Creek (site 8, mouth at Clinch River Mile 41.2). The contaminants are: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno[1,2,3-cd]pyrene, phenanthrene, and pyrene. Both sites have noticeably higher concentrations of these chemicals as compared to all of the other sampling sites. Charts demonstrate this in the case of two of the chemicals listed: Chart 1.2 (benzo(a)anthracene) and Chart 1.3 (pyrene). Concentrations of these chemicals are virtually undetectable at all of the other sites and this is why the mean points are obscured by the 2002 data points. The concentrations are well below the DOE Preliminary Remediation Goals (PRGs) and pose no threat to human health. Ernie's Creek runs through the eastern part of Oak Ridge and behind Warehouse Road. PAHs are indicative of hydrocarbons such as petroleum and coal. At this point the exact source of the elevated levels has not been determined. Scarboro Creek may be receiving some flow from the old Oak Ridge landfill in the vicinity of the driving range, but this is not confirmed. As for Ernie's Creek, this flows right through Oak Ridge and may be getting impacted by petroleum waste runoff from surface streets and businesses.

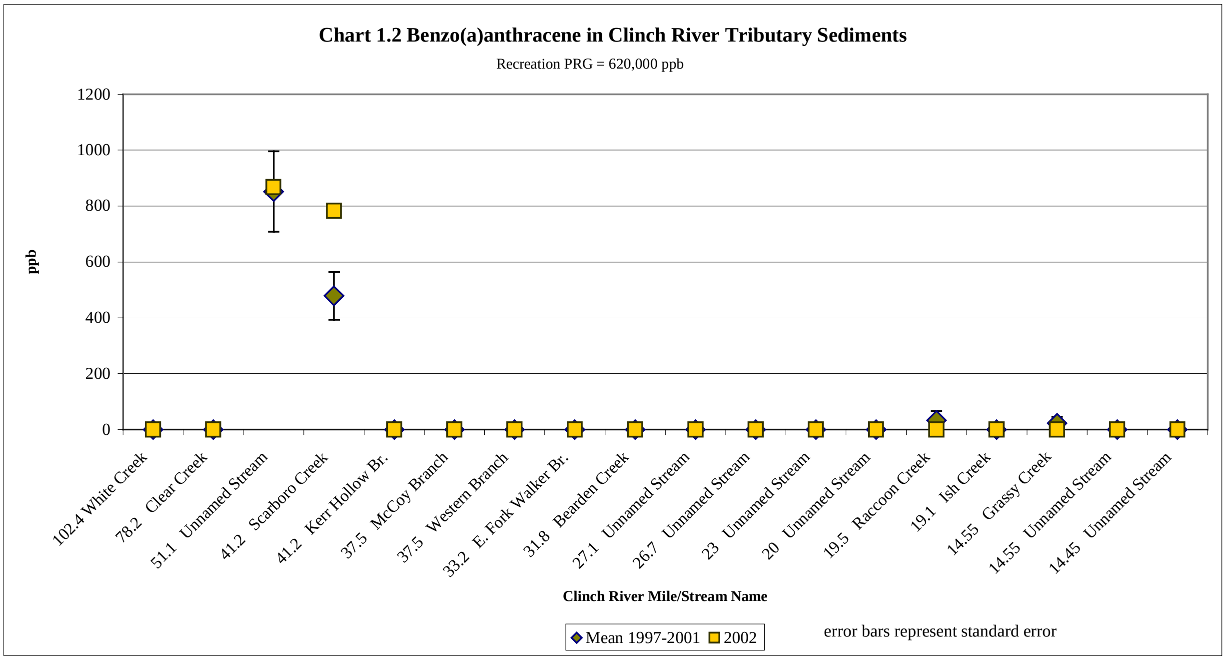


Chart 1.2 Benzo(a)anthracene in Clinch River Tributary Sediments
Recreation PRG = 620,000 ppb
ppb
1200
1000
800
600
400
200
0
102.4 White Creek
78.2 Clear Creek
51.1 Unnamed Stream
41.2 Scarboro Creek
41.2 Kerr Hollow Br.
37.5 McCoy Branch
37.5 Western Branch
33.2 E. Fork Walker Br.
31.8 Bearden Creek
27.1 Unnamed Stream
26.7 Unnamed Stream
23 Unnamed Stream
20 Unnamed Stream
19.5 Raccoon Creek
19.1 Ish Creek
14.55 Grassy Creek
14.55 Unnamed Stream
14.45 Unnamed Stream
Clinch River Mile/Stream Name
Mean 1997-2001
2002
error bars represent standard error

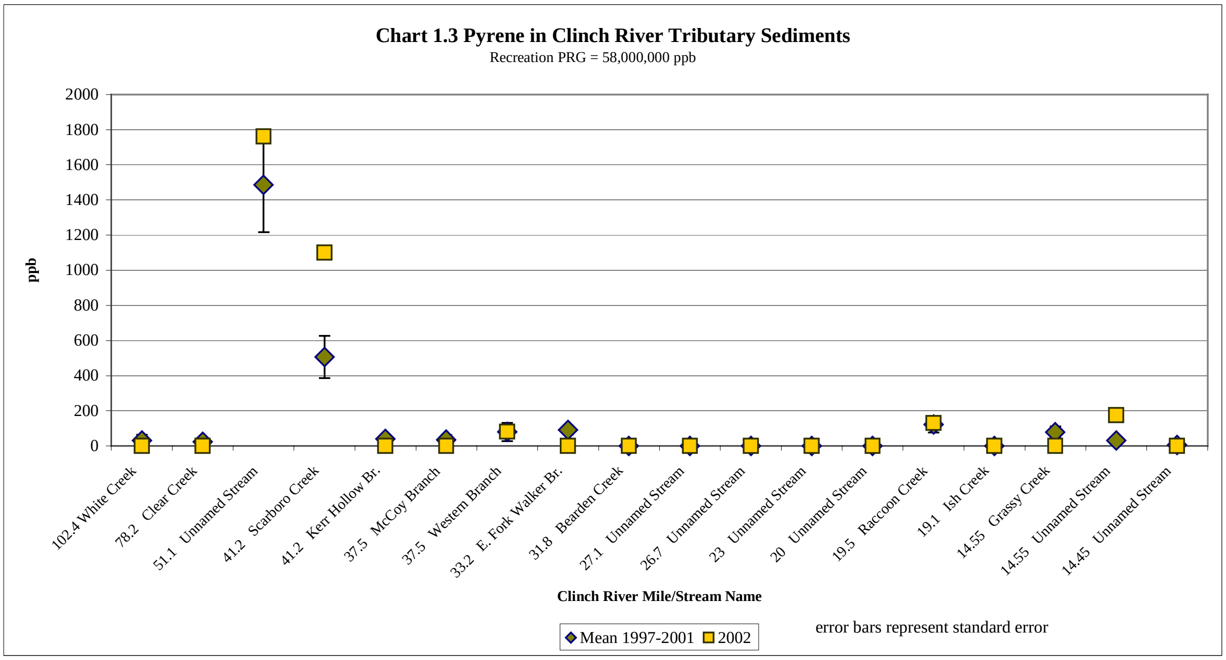
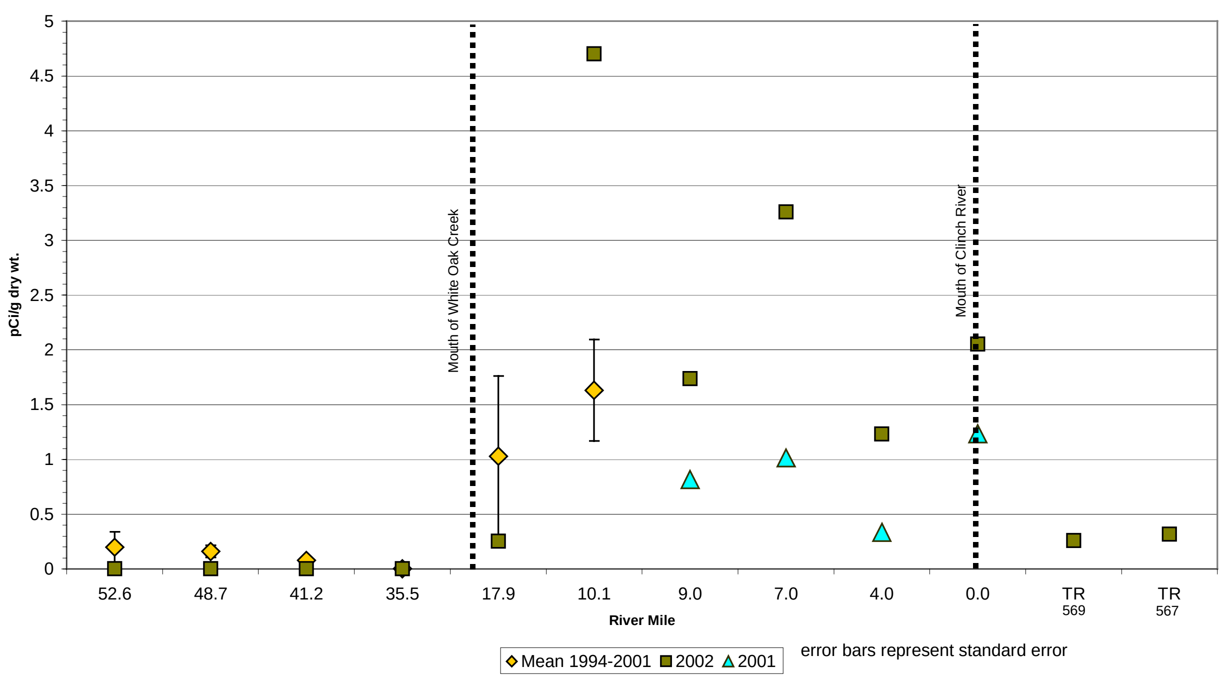


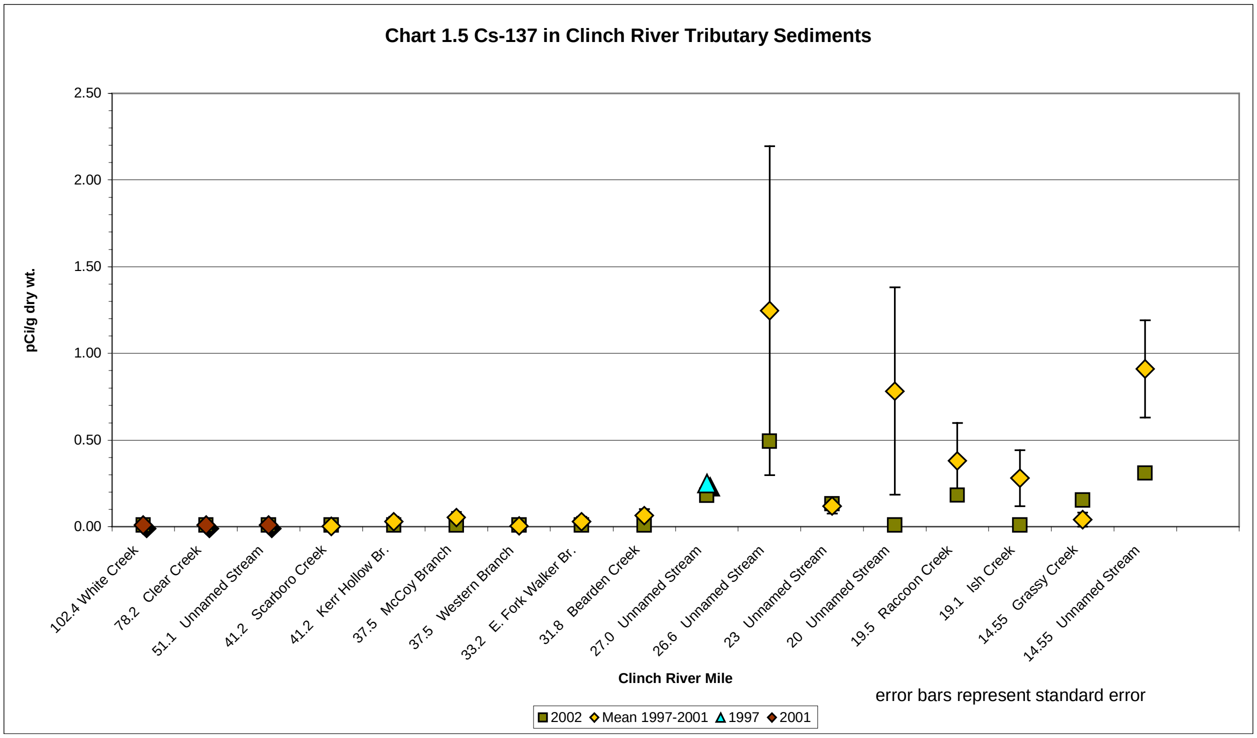
Chart 1.3 Pyrene in Clinch River Tributary Sediments
Recreation PRG = 58,000,000 ppb
ppb
2000
1800
1600
1400
1200
1000
800
600
400
200
0
102.4 White Creek
78.2 Clear Creek
51.1 Unnamed Stream
41.2 Scarboro Creek
41.2 Kerr Hollow Br.
37.5 McCoy Branch
37.5 Western Branch
33.2 E. Fork Walker Br.
31.8 Bearden Creek
27.1 Unnamed Stream
26.7 Unnamed Stream
23 Unnamed Stream
20 Unnamed Stream
19.5 Raccoon Creek
19.1 Ish Creek
14.55 Grassy Creek
14.55 Unnamed Stream
14.45 Unnamed Stream
Clinch River Mile/Stream Name
Mean 1997-2001
2002
error bars represent standard error

Radiological Analyses

The radiological sediment data show no reason for concern; all parameters are well below DOE PRGs. In the Clinch River, Cs-137 levels are typically higher in samples taken downstream of the mouth of White Oak Creek than those taken upstream (see Chart 1.4). Cs-137 is virtually undetectable at all of the sites upstream of the mouth of White Oak Creek; this is why the means are obscured by the 2002 data points at CRM 41.2 and 35.5. Tributary samples taken near ORNL (CRM 27.0) and downstream appear to have higher levels of Cs-137 than samples taken upstream of CRM 27.9 (See Chart 1.5). In both cases, the amounts are very low and do not pose a threat to human health. The recreational PRG for Cs-137 is 190,000 pCi/g. Site 22 (CRM 14.45) has shown significantly higher levels of Cs-137 than all of the other sites. It is not shown in Chart 1.5 because it distorts the perspective for the other sampling sites. The mean for Cs-137 at site 22 (based on 3 samples taken between 1997 and 2001) is 18.75 pCi/g (standard error 5.13). Samples were taken in 2002 in July and October; data were 9.03 ± 0.24 pCi/g and 10.43 ± 0.20 pCi/g, respectively. This stream runs through the K-1515C lagoon that was once used to receive backwash material from filters at the ETTP Water Treatment Plant. It is believed that these water filters concentrated the Cs-137 from suspended river sediments. The K-1515C lagoon is no longer used for the purpose of catching filter backwash material.

Chart 1.4 Cs-137 in Clinch River Sediments





Conclusions

Sediment data from 2002 samplings show no levels of contamination that exceed DOE Preliminary Remediation Goals (PRGs) for recreation and based on these criteria do not pose a threat to human health. If in the future, these sediments are to be used for agricultural and/or other purposes, analysis may be performed to determine the suitability for these new purposes. Mercury levels in the samples taken in the Clinch River below the confluence of Poplar Creek increase as one goes downstream. Although the levels of mercury are well below the recreational PRG, they are higher than all of the other sediment sampling sites. Ernie's Creek (site 23) and Scarboro Creek show elevated levels of some polycyclic aromatic hydrocarbons (PAHs) that are well below the recreational PRG but substantially higher than all of the other sampling sites. Radiological data show a slight elevation in Cs-137 in samples taken near or downstream of ORNL as compared to upstream sampling sites. Site 22 (CRM 14.45) has shown considerably higher levels of Cs-137 than all of the other sites. This is believed to be due to the effect of concentrating suspended Cs-137-contaminated sediment particles in river water by filters at the ETTP Water Treatment Plant and disposing of the filter backwash material in the K-1515C lagoon. This lagoon is no longer used for this purpose.

Table 1.1 Sample Locations for Sediment in 2002:

Site	Location	Clinch River Mile
2	Anderson County Water Treatment Plant	
3	Melton Hill Park	35.5
4	Grubb Islands	17.9
5	Brashear’s Island	10.1
6	Bull Run Steam Plant	48.7
7	Oak Ridge City Water Treatment Plant	
8	Scarboro Creek	41.2
9	Kerr Hollow Branch	41.2
10	McCoy Branch	37.5
11	Western Branch	37.5
12	East Fork Walker Branch	33.2
13	Bearden Creek	31.8
14	Unnamed Stream	27.0
15	Unnamed Stream	26.6
16	Unnamed Stream	23.0
17	Unnamed Stream	20.0
18	Raccoon Creek	19.5
19	Ish Creek	19.1
20	Grassy Creek	14.55
21	Unnamed Stream	14.55
22	Unnamed Stream	14.45
23	Ernie’s Creek	51.1
24	White Creek	102.4
25	Clear Creek	77.7
26	Clinch River Mile 9.0	9.0
27	Clinch River Mile 7.0	7.0
28	Clinch River Mile 4.0	4.0
29	Clinch River Mouth	0.0
30	Tennessee River Mile 569	n.a.
31	Tennessee River Mile 567	n.a.

Figure 1.1. Ambient Sediment Monitoring Sites for 2002 (See Table 1.1)

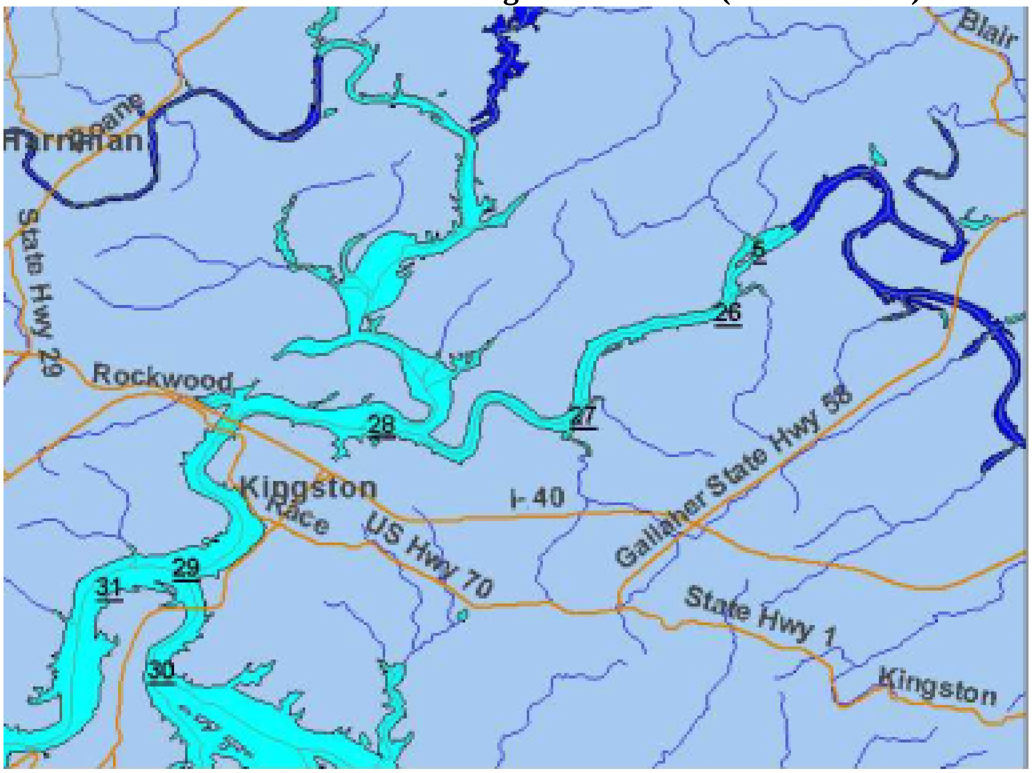


Figure 1.2. Ambient Sediment Monitoring Sites for 2002 (See Table 1.1)

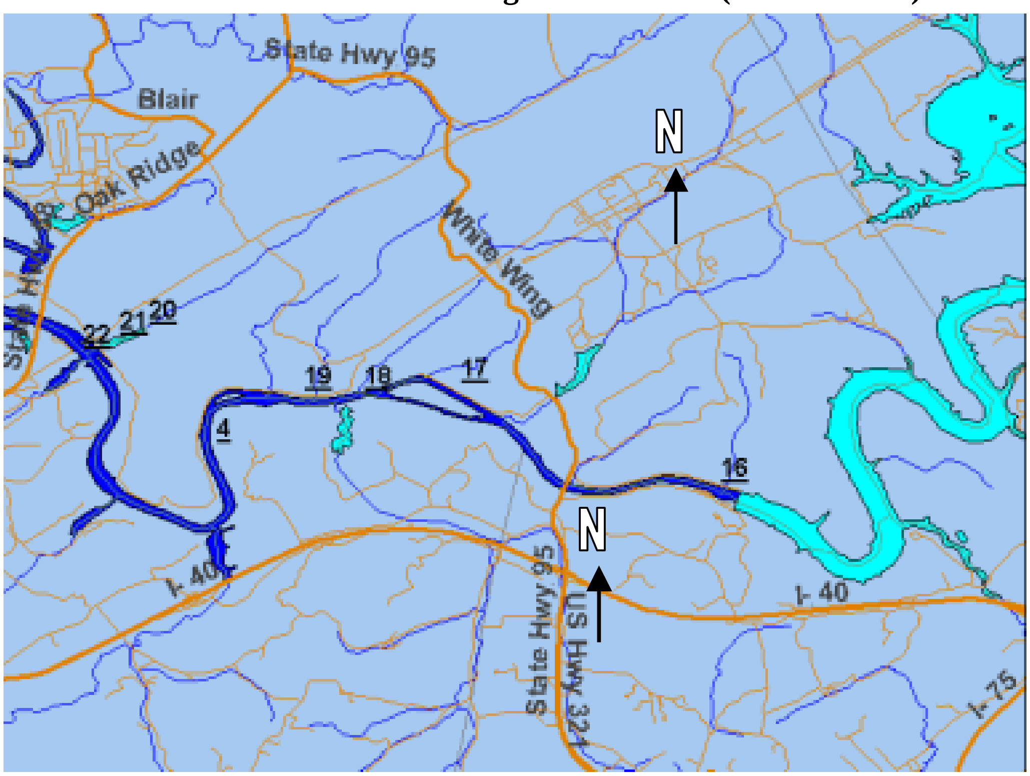


Figure 1.3. Ambient Sediment Monitoring Sites for 2002 (See Table 1.1)

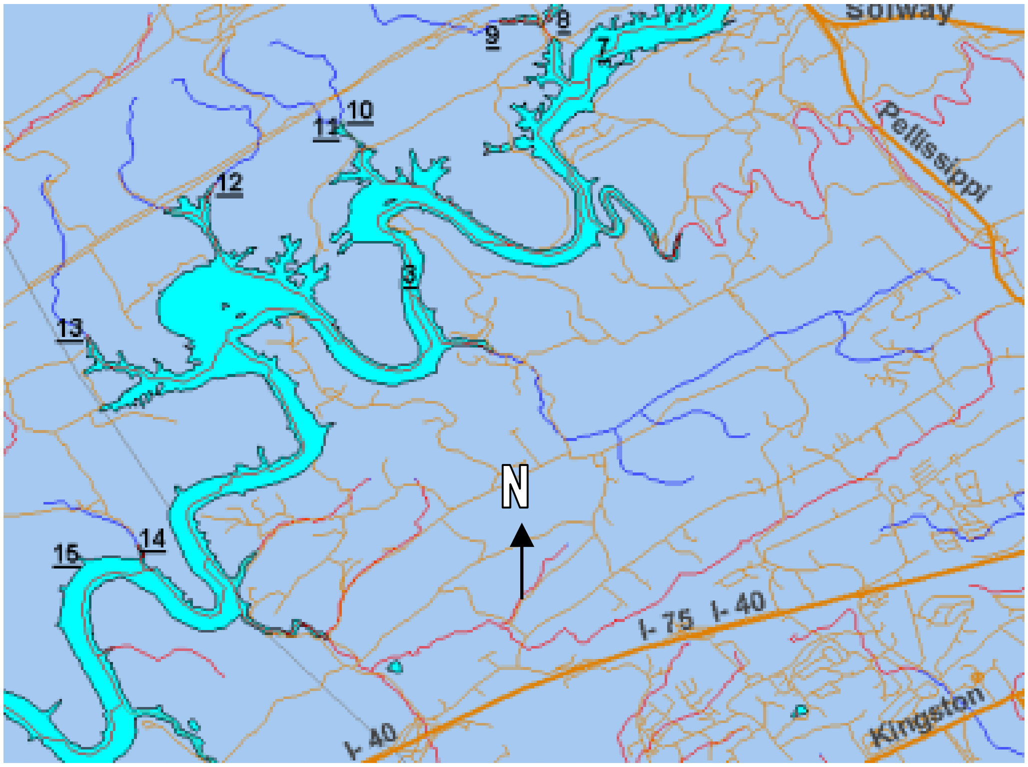


Figure 1.4. Ambient Sediment Monitoring Sites for 2002 (See Table 1.1)

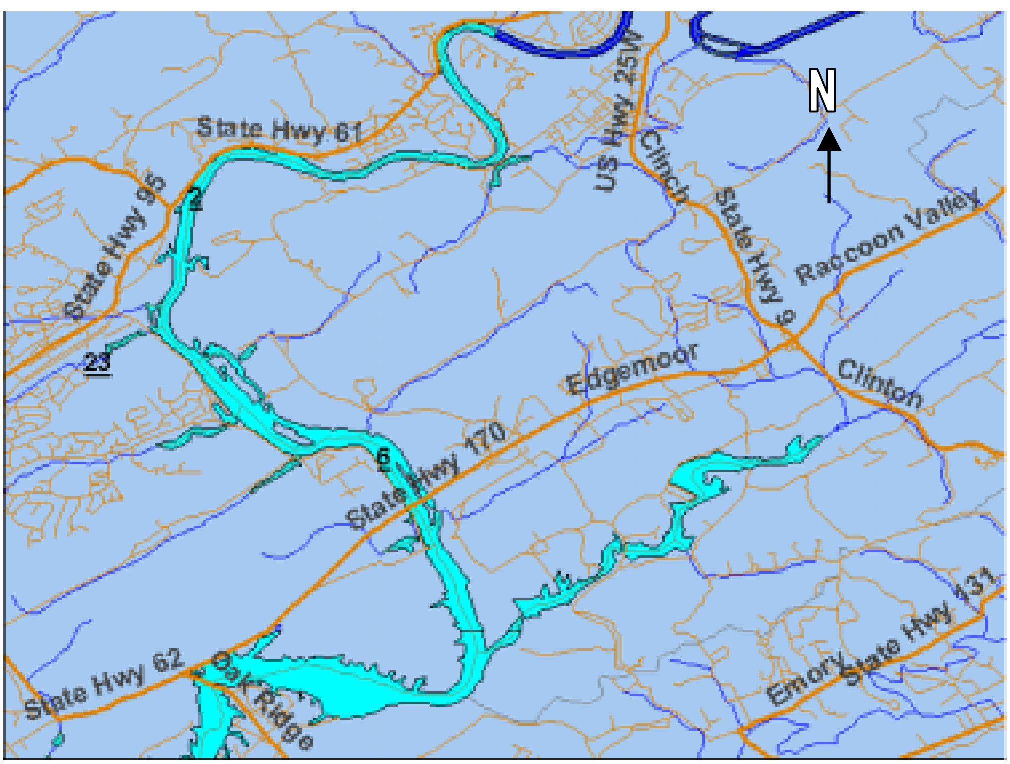


Figure 1.5. Ambient Sediment Monitoring Sites for 2002 (See Table 1.1)

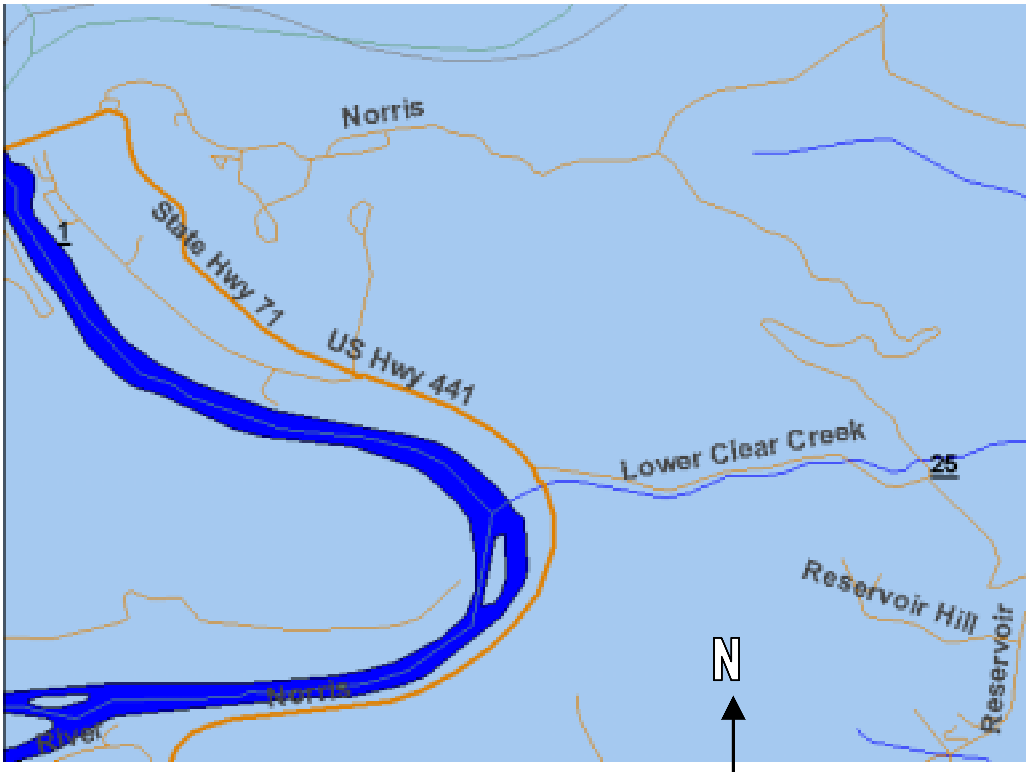
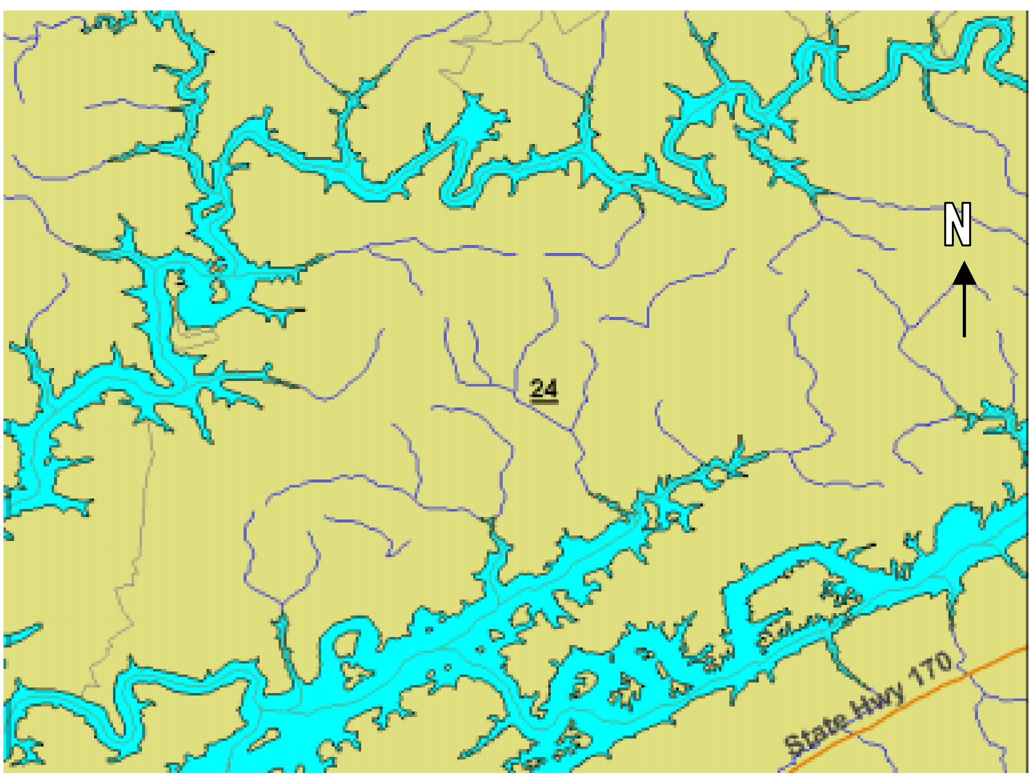


Figure 1.6. Ambient Sediment Monitoring Sites for 2002 (See Table 1.1)



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CHAPTER 2 DRINKING WATER

Oversight of Free Residual Chlorine and Bacteriological Sampling of Oak Ridge Reservation Sanitary Water Distribution Systems

Principal Author: Kathleen Kitzmiller

Abstract

As the three Department of Energy (DOE) Oak Ridge Reservation (ORR) plants become more accessible to the public, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) has expanded its oversight of the DOE facilities' safe drinking water programs. The scope of TDEC DOE-O's independent sampling includes oversight of potable water quality on or impacted by the ORR. TDEC conducted oversight of total coliform bacteria and free residual chlorine sampling at various buildings on the DOE ORR. Oversight of routine, monthly sampling activities allowed TDEC personnel to become familiar with site potable water contacts in each plant's utility organization or subcontractor. In conjunction with these oversight activities, TDEC took independent samples of free chlorine residuals during site visits to monitor monthly sampling activities.

Introduction

Public consumption of the water on the Oak Ridge Reservation (ORR) continues to increase. In order to facilitate technology transfer, work for non-governmental sectors, and utilization of surplus buildings by private companies, security has been relaxed or reprioritized in recent years at some portions of the sites, most notably at East Tennessee Technology Park (ETTP). In turn the composition of the workforce at the ORR has changed substantially. Oak Ridge National Laboratory (ORNL) has always hosted foreign dignitaries and accommodated visiting scientists in an openly cooperative manner. The other two sites, ETTP and Y-12, until recent years allowed only limited public visitation. Current facility use involves a substantial public presence at ETTP and ORNL, and to a lesser extent at Y-12.

During May 2000 Department of Energy (DOE) transferred the Y-12 water treatment plant to the city of Oak Ridge. Both the ETTP and the former Y-12 water treatment plants withdraw surface water from the Clinch River, add coagulants to precipitate suspended sediment, use chlorine disinfectant, and filter water prior to distribution. As prescribed by *Tennessee Regulations for Public Water Systems and Drinking Water Quality - Chapter 1200-5-1*, most sampling focuses upon finished water at the treatment plant prior to distribution. State regulations require relatively little sampling at locations within distribution systems. The ORR potable water systems have been classified as non-community, non-transient systems. *Rule 1200-5-1-.07(1)(d)(3)* states that non-community water systems using surface water must monitor for total coliforms with the frequency required of like-sized community water systems. *Rule 1200-5-1-.31(5)(c)(3)* directs that residual disinfectant concentration be measured at the same times and locations that monthly microbiological contaminant samples are collected. Requirements set forth by *Rule 1200-5-1-.17(4)* mandate that not more than five percent of samples taken each month for two consecutive months contain less than 0.2 mg/L free chlorine residual. Shown below (Table 1) is the minimum number of bacteriological samples required for each of the DOE distribution systems set forth by the sanitary surveys in effect at the close of calendar year 2002.

Table 1. ORR Plant Populations and Required Samples

Facility	Estimated Population	Minimum Samples
ETTP	2,500	2
ORNL	5,000	6
Y-12	7,500	8

Methods and Materials

Although TDEC will conduct independent sampling when situations indicate that the quality of drinking water in an ORR distribution system may be compromised or that the general integrity of the system is in doubt, the objective of this task was to conduct oversight of routine regulatory bacteriological and free residual chlorine monitoring at ETTP, ORNL, and Y-12. Coliform bacteria serve to indicate the presence of pathogenic organisms. A positive microbiological sample signals that pathogens may have entered the water supply due to inadequate initial treatment, poor sanitation, faulty line repair work, or cross connections to potable water distribution lines.

ORNL submitted a positive bacteriological sample in August. Y-12 submitted a positive sample in October. In each case, a repeat bacteriological sample from the original collection site and additional samples from upstream and downstream sites, tested negative for coliform bacteria. TDEC did not observe conditions in ORR distribution systems that warranted additional collection of independent bacteriological samples, and instead focused upon sampling for free residual chlorine only. TDEC used a Hach pocket colorimeter to measure free residual chlorine levels at all three facilities. Monitoring followed Method 4500-Cl G, DPD Colorimetric Method, outlined in the *Standards Methods for the Examination of Water and Wastewater, 20th Edition.* One of two small sample containers is reserved for a sample blank. A reagent, DPD powder, is added to the remaining container. The powder reacts with free chlorine present in the drinking water sample. A slight free chlorine residual results in a pale pink hue, whereas a high chlorine residual produces a deep cranberry color. The colorimeter then measures the concentration of free chlorine in the sample.

Bound logbooks, databases, and trip reports serve collectively to document TDEC's potable water oversight activities.

Results and Discussion

Thirty-one visits were made to oversee monthly bacteriological and free chlorine residual sampling. TDEC sampling for free residual chlorine was done using TDEC's colorimeter. Table 2 summarizes the sampling results.

Table 2. Oversight Visits - Observation of Monthly Sampling

Date of Visit	ORR Facility	Number of Bacteriological Samples Contractor	Lowest Free Chlorine Residual Contractor/TDEC (mg/L)
01/07/02	ORNL	3	0.64/0.90
01/14/02	ORNL	3	1.12/1.02
01/15/02	Y-12	7	0.5/1.08
0/2/04/02	ORNL	3	0.87/0.79
02/11/02	ORNL	3	1.20/1.09
02/13/02	ETTP	3	1.1/0.99
03/04/02	ORNL	3	0.63/0.88
03/05/02	ETTP	3	1.0/0.72
03/05/02	Y-12	7	0.7/1.25
04/01/02	ORNL	3	0.9/0.91
04/02/02	ETTP	3	1.1/0.90
04/08/02	ORNL	3	1.11/1.09
04/09/02	Y-12	5	0.6/1.01
05/06/02	ORNL	3	0.79/0.67
05/13/02	ORNL	3	1.27/0.87
05/13/02	Y-12	7	0.6/1.22
06/03/02	ORNL	3	0.67/0.63
06/04/02	Y-12	5	0.2/0.29
06/10/02	ORNL	3	1.13/1.19
07/01/02	ORNL	3	0.80/0.84
07/08/02	ORNL	3	1.35/1.24
08/12/02	ORNL	3	1.45/1.26
09/03/02	ORNL	3	0.74/0.67
09/09/02	ORNL	3	1.60/1.58
09/10/02	Y-12	7	0.3/0.49
11/04/02	ORNL	3	1.07/1.00
11/04/02	Y-12	5	0.2/0.77
12/02/02	ORNL	3	0.76/0.74
12/09/02	ORNL	3	1.25/1.20
12/10/02	Y-12	5	0.5/0.21
12/17/02	Y-12	4	0.30.85

Conclusion

As can be seen in Table 2 no samples collected by the contractor or TDEC indicated chlorine levels to be below the regulatory limit of 0.2 mg/L. Also, there were no samples reported to have elevated levels of bacteria above the regulatory limits. TDEC will continue to monitor the sample collection activities and if conditions warrant will collect free chlorine and/or bacteriological samples for comparisons.

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CHAPTER 2 DRINKING WATE R

Special Projects

Principal Author: Kathleen Kitzmiller

Abstract
Pursuant to the 2002 Environmental Monitoring Plan "Oversight and Independent Sampling of Oak Ridge Potable Water Distribution Systems for Bacteriological, Free Chlorine Residual, Radiological, or Organic Content," drinking water collected near the High Flux Isotope Reactor (HFIR) at the Oak Ridge National Laboratory (ORNL) was analyzed for tritium content. In addition, during the calendar year 2002 projects arose that were not covered under existing monitoring plans. These special projects allow for increased opportunities to monitor and evaluate Department of Energy (DOE) water system operations. They included three issues related to ORR and area water systems.

Introduction
Special projects provide opportunities for the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) to further evaluate the operation and condition of water systems on the Oak Ridge Reservation (ORR) and to aid in regulatory compliance efforts. During the previous year, TDEC focused upon three issues pertaining to ORR and area water systems.

- ORNL Tritium Sampling
- city of Oak Ridge Waterborne Disease Emergency Plan
- Phase 2 Water Study of ETTP

Discussion
ORNL Tritium Sampling. In January, repairs were made to an 8-inch potable water line serving the HFIR area. Concern over the potential for ground water with high tritium content to come into contact with the broken water line led to the decision to determine the level of tritium, if any, in drinking water in the vicinity of the line break. The level of tritium in finished drinking water at the Oak Ridge Water Treatment Plant, which supplies potable water to ORNL, provided a basis of comparison.

DOE-O staff collected a one-gallon sample of drinking water from a drinking fountain in a trailer immediately to the south and downstream of the line repair location. ORNL Industrial Hygiene technicians collected a 250 mL sample from the fountain for independent analysis. Both groups next drove to the Oak Ridge water treatment plant and collected corresponding samples of finished water from the clear well. Later that afternoon, DOE-O staff delivered the one-gallon water samples to the Knoxville Branch Laboratory. From there the samples were sent to Nashville for analysis of tritium content. The analyses indicate that effectively no tritium was present in either sample. As can be seen in the table below, the levels reported fell well below the EPA regulatory detection limit of 1,000 pCi/L.

Drinking Water Sampling Location	Result pCi/L	Error (+ / -) pCi/L
ORNL / X-7964-A	-56	94
Oak Ridge WTP	-14	94

city of Oak Ridge Waterborne Disease Emergency Plan. Members of the Waterborne Disease Emergency Response Group met in October. In addition to reviewing the waterborne disease emergency plan, members discussed issues pertaining to infrastructure security.

Phase 2 Water Study of ETTP. Phase 2 of the ETTP Water Quality Project focused upon the history of the ETTP drinking water system and the likelihood of worker health effects due to consumption of water at the plant in the past. DOE/ORO requested that DOE-O participate in an oversight group, the Community Input Team (CIT), similar in composition to that formed for the Phase I Water Study. DOE hired Parallax, Inc., to facilitate the Phase 2 Water Study. The JSI Center for Environmental Health Studies, TerraGraphics Environmental Engineering, and Malcolm Pirnie, Inc., comprised the project team.

In November, DOE released its final report on a controversial years- long effort slated to determine whether the sanitary water at ETTP was contaminated, and if so, whether workers were exposed through drinking, showering or in the preparation of food. The study began in July 2000, after employees voiced concern that cross-connections in water lines for sanitary, fire-fighting and cooling waters, steam and storm drains could have resulted in exposure to hazardous materials at the plant. The report concluded that water at the site is safe to drink.

However, the review of historical operations did identify temporary situations in which outlets intended for sanitary use may have been mis-connected to non-sanitary sources in certain areas of the federal plant, in three instances to fire-fighting water lines and in one to cooling water. The independent investigation team, headed by Parallax Inc., suggested that adverse health impacts were unlikely.

One confirmed cross-connection did exist between sanitary water and fire-fighting water at the Steam Plant, but the report noted “there is no evidence of sanitary water contamination caused by this cross-connection.” Backflow prevention devices were installed in the mid-1970s. Two possible cross-connections were located, one at the K-1004 laboratory complex, and one at the clear well of the K-802 Pump House. In both instances, again according to the report, there was “no evidence” of contamination of sanitary water at these points.

- Task 1 – Identify contaminants and routes of exposure, and the timeframes of operational eras.
- Task 2 – Determine whether quantitative or qualitative exposure assessments can be done, and develop estimates of contaminant concentrations in the water systems.
- Task 3 – Estimate worker exposures and assess potential health impacts.
- Task 4 – Review stakeholder comments, incorporate appropriate revisions, and publish a final report.

During the site visit, project team members began the process of identification and review of plant records and documents. They met with individuals knowledgeable about past operations. Project team members, along with several CIT representatives including DOE-O personnel, also toured sites related to systems for re-circulating cooling water, firewater, sanitary water treatment and distribution, sanitary sewers and sewage treatment, storm water, and steam production and distribution.

Conclusion

The special projects described above, ORNL tritium sampling, participation both in Waterborne Disease Emergency Response Group and the Phase 2 Water Study of ETTP, allowed for increased opportunities to monitor and evaluate DOE water system operations.

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CHAPTER 2 DRINKING WATE R

Implementation of EPA's Environmental Radiation Ambient Monitoring System (ERAMS) Drinking Water Program (RMO)

Principal Author: John Sebastian

Abstract

The Environmental Radiation Ambient Monitoring System was developed by the U.S. Environmental Protection Agency (EPA) to monitor potential pathways for significant population exposures from routine and/or accidental releases of radioactivity from major sources in the United States (U.S. EPA, 1988). This program provides for radiochemical analysis of finished water at five public water supplies located near and on the Oak Ridge Reservation. In this effort, quarterly samples are taken by personnel from the Tennessee Department of Environment and Conservation to be analyzed at the EPA's National Air and Radiation Environmental Laboratory in Montgomery, Alabama. While data from the program indicate tritium results have been consistently higher for the Gallaher Water Treatment Plant than the four other systems monitored in the program, all the results received from EPA, to date, have been well below regulatory criteria.

Introduction

Radioactive contaminants released on the Oak Ridge Reservation (ORR) enter local streams and are transported to the Clinch River. While monitoring of these streams, the river, and local water treatment facilities has indicated that concentrations of radioactive pollutants are below regulatory standards, there has remained a concern that area public water supplies could be impacted by ORR pollutants. In 1996, the Tennessee Department of Environment and Conservation (TDEC) Department of Energy Oversight Division began participation in the Environmental Protection Agency's (EPA) Environmental Radiation Ambient Monitoring Systems (ERAMS). This program provides radiological monitoring of finished water at public water supplies near nuclear facilities throughout the United States. The ERAMS program is designed to:

1. Monitor pathways for significant population exposure from routine and/or accidental releases of radioactivity;
2. Provide data indicating additional sampling needs or other actions required to ensure public health and environmental quality;
3. Serve as a reference for data comparison (U.S. EPA, 1988)

The ERAMS program also provides a mechanism to evaluate the impact (if any) of DOE activities on area water systems and validate DOE monitoring in accord with the *Tennessee Oversight Agreement* (TDEC, 1996).

Methods and Materials

In the Oak Ridge ERAMS Program, EPA provides radiochemical analysis of finished drinking water samples taken quarterly by TDEC staff at five public water supplies located on and in the vicinity of the ORR. The samples are collected using procedures and supplies prescribed in *Environmental Radiation Ambient Monitoring System (ERAMS) Manual* (U.S. EPA, 1988). Analytical frequencies and parameters are provided in Table 1.

Table 1: ERAMS Analysis for Drinking Water

ANALYSIS	FREQUENCY
Tritium	Quarterly
Gamma Scan	Annually on composite samples
Gross Alpha	Annually on composite samples
Gross Beta	Annually on composite samples
Iodine-131	Annually on one individual sample/sampling site
Radium-226	Annually on samples with gross alpha >2 pCi/L
Radium-228	On samples with Radium-226 between 3-5 pCi/L
Strontium-90	Annually on composite samples
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 are: Kingston Water Treatment Plant, Gallaher (K-25) Water Treatment Plant, West Knox Utility, City of Oak Ridge Water Treatment Facility (formerly DOE Water Treatment Plant at Y-12), and Anderson County Utility District. Figure 1 depicts the approximate locations of raw water intakes associated with these facilities.

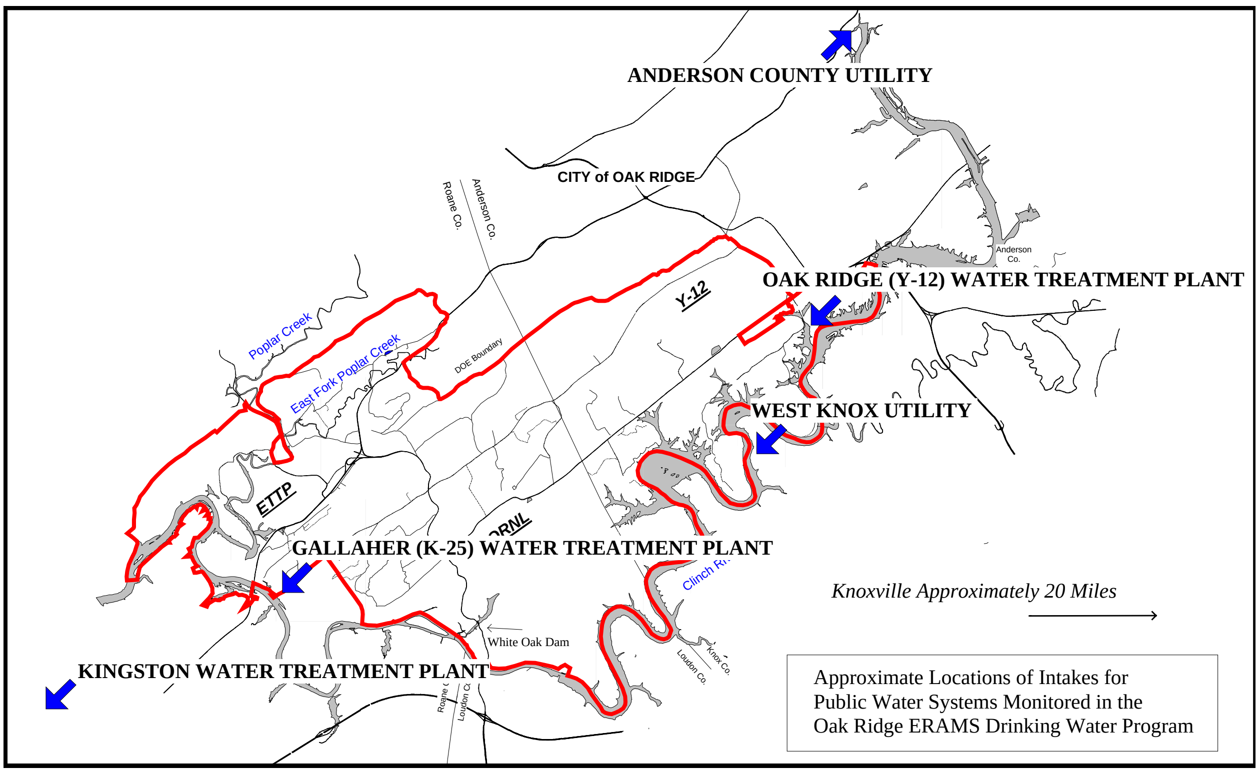

Figure 1: Approximate Locations of the Intakes for Public Water Systems Monitored in Association with EPA's Environmental Radiation Ambient Monitoring System (ERAMS) Drinking Water Program

Results and Discussion

A large proportion of the radioactive contaminants that are transported off the ORR in surface water enter the Clinch River by way of White Oak Creek, which drains the Oak Ridge National Laboratory complex and associated waste disposal areas. When contaminants carried by White Oak Creek and other ORR streams enter the Clinch, their concentrations are significantly lowered by the dilution provided by the waters of the river. With exceptions, contaminant levels are further reduced in finished drinking water by conventional water treatment practices used by area utilities. Consequently, the levels of radioactive contaminants measured in the Clinch and at area water supplies are far below the concentrations measured in White Oak Creek and some of the other streams on the ORR.

Since the Gallaher Water Treatment Plant is the closest water supply downstream of White Oak Creek (approximately 6.5 River Miles), this facility would be expected to exhibit the highest concentrations of radioactive contaminants of the five utilities monitored in the program. Conversely, the Anderson County Facility (located upstream of the reservation) would be expected to be the least vulnerable of the facilities to ORR pollutants.

While all analysis of ERAMS samples for 2002 have yet to be completed, the results received for tritium and iodine-131 were below applicable drinking water standards (Tables 2 and 3). As in the past, results reported for tritium (a radionuclide not removed by conventional treatment processes) are higher for the Gallaher facility. While consistently higher than the concentrations measured at the other facilities, the results for tritium reported for the Gallaher plant were all well below the standard prescribed by the Safe Drinking Water Act. In this regard, the Safe Drinking Water Act specifies that the annual average concentration of tritium in community drinking water systems not exceed 20,000 pCi/L. The average concentration of tritium measured at the Gallaher facility for 2002 was 484 pCi/L (Figure 2), which is higher than the average of 252 pCi/L reported in 2001. At least in part, this increase may be due to the excessive rainfall in 2002 (high levels of precipitation tends to mobilize tritium located in the burial grounds).

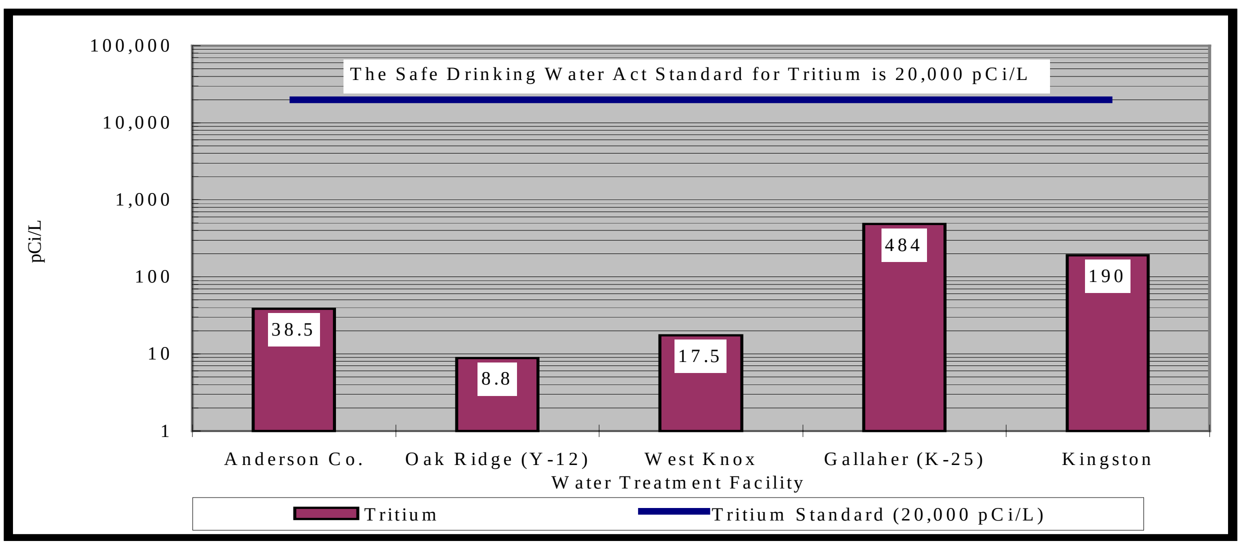

Figure 2: Average Tritium Results for 2002 for Samples of Finished Drinking Water taken at Oak Ridge Area Water Treatment Facilities in association with EPA's ERAMS Program

Table 2: 2002 ERAMS Tritium Results for Drinking Water in the Oak Ridge Area

Water Treatment Facility	Collection Date	Activity (pCi/L)	Error (+/- 2 σ) (pCi/L)	MDC[a] (pCi/L)	Standard[b] (pCi/L)
Anderson Co.	02/21/02	44	80	134	20,000
Anderson Co.	05/24/02	5	78	134	20,000
Anderson Co.	08/12/02	59	73	121	20,000
Anderson Co.	12/02/02	46	77	129	20,000
Gallaher (K-25)	03/04/02	1000	120	135	20,000
Gallaher (K-25)	06/04/02	485	98	134	20,000
Gallaher (K-25)	09/24/02	195	86	133	20,000
Gallaher (K-25) Dup[c]	09/24/02	208	86	134	20,000
Gallaher (K-25)	12/09/02	255	84	125	20,000
Kingston	02/26/02	31	79	134	20,000
Kingston	05/30/02	79	82	134	20,000
Kingston	08/23/02	630	98	121	20,000
Kingston	12/06/02	19	75	126	20,000
West Knox	02/21/02	-17	78	135	20,000
West Knox Dup.[c]	02/21/02	9	79	135	20,000
West Knox	05/24/02	-15	78	135	20,000
West Knox	08/12/02	121	77	122	20,000
West Knox	12/02/02	-19	74	129	20,000
Oak Ridge (Y-12)	03/01/02	-9	74	129	20,000
Oak Ridge (Y-12)	05/24/02	11	78	133	20,000
Oak Ridge (Y-12) Dup [c]	05/24/02	-13	76	132	20,000
Oak Ridge (Y-12)	08/27/02	26	797	134	20,000
Oak Ridge (Y-12)	12/09/02	7.0	73	124	20,000

[a]Minimum Detectable Concentration
[b]40 CFR Part 141—National Primary Drinking Water Regulations.
[c]Duplicate analysis

Table 3: 2002 ERAMS Iodine-131 Results for Drinking Water in the Oak Ridge Area

Water Treatment Facility	Collection Date	Activity (pCi/L)	Error (+/- 2 σ) (pCi/L)	MDC[a] (pCi/L)	Standard[b] (pCi/L)
Anderson Co.	08/23/02	-0.16	0.18	0.30	3.0
Gallaher (K-25)	06/04/02	0.05	0.15	0.25	3.0
Kingston	08/23/02	-0.05	0.17	0.28	3.0
Oak Ridge (Y-12) [c]					3.0
West Knox	08/12/02	0.05	0.17	0.29	3.0

[a] Minimum Detectable Concentration
[b] The Safe Drinking Water Act prescribes beta and photon emitters in drinking water not exceed an annual dose equivalent of 4 mrem/year. The values referenced represent annual average concentrations yielding 4 millirem per year for a two liter daily intake from Appendix III in *Radioactivity in Drinking Water* (EPA, 1991).
[c]The iodine-131 result for the Oak Ridge (Y-12) Facilities was not reported in the ERAMS data received to date

Conclusion

Radioactive contaminants migrate from the ORR to the Clinch River, which serves as a raw water source for area public drinking water supplies. The impact of these contaminants is diminished by dilution provided by waters of the Clinch. Contaminant concentrations are further reduced in finished drinking water by conventional water treatment practices employed by area utilities. In 2002, ERAMS results reported for iodine-131 and tritium were all well below drinking water criteria. While below drinking water standards, tritium was reported at higher levels in samples taken from the Gallaher Water Treatment Facility than the other facilities monitored in the program. In this respect, the Gallaher plant is the closest facility downstream of White Oak Creek, the major pathway for radiological pollutants entering the Clinch from the ORR. Although gross alpha, gross beta, and gamma spectroscopy results were unavailable at the time of publication, it is expected that these results will be similar to those of previous years (i.e., well below drinking water standards).

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CHAPTER 3 BIOLOGICAL/FISH AND WILDLIFE

Canada Geese Monitoring

Principal Author: Roger Petrie

Abstract

On June 20 and 21, 2002, the Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) conducted oversight of the annual Canada Geese (*Branta canadensis*) monitoring project on the Oak Ridge Reservation (ORR). The objective of this study was to determine if geese are becoming contaminated on the ORR. The captured geese were transported to the Tennessee Wildlife Resources Association (TWRA) game check station on Bethel Valley Road and tested for radioactive contamination. Three of the geese captured at Oak Ridge National Laboratory (ORNL) showed elevated gamma counts above the 5pCi/g game release level. In response, the DOE-Oversight Division conducted additional offsite sampling of Canada Geese.

Introduction

A large population of Canada geese, both resident and transient, frequents the Oak Ridge Reservation (ORR) (Crabtree 1998). The thriving goose population in this area makes this animal an easily accessible food for area residents. Geese with elevated levels of Cs137 in muscle tissue have been found on the ORR (MMES 1987 and Loar 1994). Studies in the 1980s demonstrated that geese associated with the contaminated ponds/lakes on the ORR can accumulate radioactive contaminants quickly and that contaminated geese frequent off site locations (Loar 1990, Waters 1990, MMES 1987).

Every year the Department of Energy (DOE) and Tennessee Wildlife Resource Agency (TWRA) capture geese on the ORR during the annual “Goose Roundup” and perform whole body counts on them to determine if the birds are radioactively contaminated. During the 1998 “Goose Roundup,” 38 geese at ORNL contained Cesium 137 concentrations that exceeded the game release limit of 5 pCi/g (ORNL 1998). A subsequent study in September 1998 found elevated levels of Cs137 in grass and sediment at two reaches of White Oak Creek south of 3513 Pond and in grass around the 3524 pond (ORNL 1998).

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) has a sampling plan that is implemented when geese with elevated gamma readings are detected during the regular “Goose Roundup.” If any geese with elevated gamma readings are detected, then arrangements are made to sample geese that are found in the vicinity of the ORR on non-DOE property. This is to determine if contaminated geese are leaving the reservation and are presenting a risk to area hunters.

Results and Discussion

During the 2002 sampling, a total of 182 birds were captured. All of these geese were banded and released. All birds were given total body counts for five minutes with a sodium iodide detector at the TWRA game checking facility on Bethel Valley Road. Three of the birds analyzed had levels of gamma above the 5pCi/g game release level. These were juvenile birds that had been captured at ORNL. Table 1 shows results of the 2002 DOE Goose Roundup. Table 2 shows results for the three contaminated birds.

Table 1. 2002 DOE Goose Round-up Results

Site	Date	# Captured	Adults	Juveniles	# > 5pCi/g
ETTP (K-1007 Area)	6/20	43	43	0	0
ETTP (CNF Area)	6/20	26	11	15	0
ORNL (STP Area)	6/20	29	14	15	3
Solway Park	6/20	13	3	10	0
OR Marina	6/21	46	46	0	0
ORNL (1505 Area)	6/21	18	6	12	0
Y-12 (Union Valley)	6/21	7	2	5	0
Totals		182	120	62	3

Table 2. Contaminated geese from ORNL

Weight (kg)	Cs- 137 Levels (pCi/g)	Error
3.57	7.5	0.19
3.60	5.1	0.16
3.59	5.5	0.16

Since three of the birds analyzed showed signs of contamination, additional offsite sampling was conducted. On June 27, 2002, the TDEC DOE-Oversight Division conducted additional offsite sampling at the Solway Park and the Oak Ridge Marina. Locations closer to ORNL would have been preferred, but due to absence of any significant population closer, these sites were selected. Seven geese were collected at Solway Park and fourteen geese were collected at the Oak Ridge Marina. None of these geese had levels of gamma above the 5pCi/g game release level.

Conclusion

The presence of three contaminated birds indicates that this species is still susceptible to contamination from sources on the ORR. Since the contaminated birds were juveniles and no adults were contaminated there is still apparently only a small likelihood that contaminated individuals are travelling off the ORR. Although this does not preclude the possibility of contaminated geese being present off the ORR, it does indicate that there is a reduced likelihood of this situation existing.

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CHAPTER 3 BIOLOGICAL/FISH AND WILDLIFE

Rapid Bioassessment III: Benthic Macroinvertebrate Biomonitoring in Streams on the Oak Ridge Reservation

Principal Author: Randall P. Hoffmeister

Abstract
Semi-quantitative benthic macroinvertebrate samples were collected from twelve study sites on five streams impacted by Department of Energy (DOE) operations, and six reference sites located on or near the Oak Ridge Reservation (ORR). Using the state of Tennessee standard operating procedures for macroinvertebrate surveys, samples were collected, processed, and analyzed using suggested metrics. A score was calculated from the metrics and a stream site "health" rating was assigned. Results indicated that the study streams tended to show signs of biotic improvement with increasing water quality downstream of DOE influences. The number of EPT taxa and the total number of taxa at all study sites remained depressed compared to reference conditions.

Introduction
Benthic macroinvertebrates are organisms that inhabit the bottom substrates of aquatic systems. Examples include insects, crustaceans, annelids, and mollusks. Because of their relatively long life spans and sedentary nature, benthic macroinvertebrate community structure can be useful in assessing the condition or "health" of an aquatic system. A continuous biomonitoring program is a proven method of assessing and documenting any changes that may occur within the impacted system.

Benthic macroinvertebrate samples were collected from locations on five streams originating on the ORR that have been impacted by past and present DOE operations. Two of these streams, East Fork Poplar Creek and Bear Creek, have been impacted by the Y-12 Plant. One stream, Mitchell Branch, has been impacted by the East Tennessee Technology Park (ETTP) and two streams, White Oak Creek and Melton Branch, have been impacted by operations at the Oak Ridge National Laboratory (ORNL).

Dual objectives of this study were (1) to conduct an independent assessment of the condition of streams on the ORR, and (2) to identify potential impacts from DOE activities on the aquatic environment.

Method and Materials
Semi-quantitative sampling of benthic macroinvertebrate communities was conducted during the period of April 22, 2002, to May 22, 2002, using the RBP III method described in the state of Tennessee Department of Environment and Conservation Division of Water Pollution Control *Quality System Standard Operating Procedure* (SOP) *for Macroinvertebrate Stream Surveys.* Depending on stream size, either a one square meter kick net (larger streams) or a D-frame stationary net (smaller streams) was used to collect benthic macroinvertebrates. In larger streams, two separate riffle kicks were performed by a two-person crew. One individual held the double handle kick net perpendicular to the current with the net's weighted bottom resting firmly on the streambed. Another person disrupted the substrate with a kicking and sweeping motion in a one square meter stretch just upstream of the net. Benthic organisms were dislodged and drifted into

the waiting net. After allowing suitable time for all the debris to flow into the net, the person performing the kick lifted the bottom of the net at each end in a smooth, continuous motion while the person holding the net at the top was careful not to let the top edge dip below the water's surface. After a second riffle was sampled in an identical fashion, the collected organisms were picked from the net and transferred into a container as a composite sample.

At smaller stream sites (e.g., Bear Creek BCK 12.3), where riffles were less than one meter wide, four separate riffle kicks were performed using the one-man, D-frame net. A crewmember held the single handle net perpendicular to the current with the net's bottom pressed firmly to the streambed. The same person disrupted the upstream substrate for an 18-inch distance and the width of the net, dislodging any benthic organisms. After allowing suitable time for all debris to drift into the net, the net was lifted from the water and three additional riffles were sampled in the same fashion. The debris from all four kicks was composited.

Benthic macroinvertebrate samples were preserved in 80% ethanol with internal and external site specific labels. Labeling information included site name, sampling date, and sampler's initials. If more than one sample container was needed at a site, the debris was split evenly with internal and external labels completed for each container.

Sample collection methods were modified in the White Oak Creek watershed due to the presence of radioactive contamination in the stream sediments. The two, 1-meter kick samples were combined in a 5-gallon bucket, creek water was added and the sample swirled to suspend the lighter material (including invertebrates) with the elutriate then being poured through a sieve. This process was repeated 5 times, to ensure the thorough collection of organisms. Any material not needed was returned to the creek. Samples from radioactively contaminated sites were processed in laboratory space designated by ORNL Health Physics personnel.

Following the state SOP for laboratory sample processing, a subsample was randomly chosen and the first 200 benthic organisms were removed. If the minimum number of organisms were not collected after the first subsample, a second subsample was randomly chosen and examined. This process was repeated until the target number was achieved. Using a dissecting scope and taxonomic references, organisms were identified to the genus level, with the exception of Chironomids (midges) and Oligochaetes (aquatic worms), and enumerated. Suggested metrics in the state SOP were used for data analyses. The metrics included Comparative Taxa Richness, Indicator Assemblage Index, Dominants in Common, EPT Index, and the Index of Biotic Integrity using the North Carolina Biotic Index. A metric value was calculated at each test site using the appropriate reference site(s) for comparison. Once values were obtained for each of the five metrics, a score of 0 to 6 was given to each metric and the five scores were summed and divided by the maximum possible score (30). The resulting percentage score was then used to rate the biological condition of each study site. A complete description of each metric, the scoring criteria, and associated biological conditions and attributes can be obtained by referencing the state SOP.

Results and Discussion

East Fork Poplar Creek

The scores from each of the five metrics analyzed and the overall rating for each test site are presented in Appendix A. EFK 24.4, EFK 23.4, and EFK 6.3 each rated moderately impaired when compared to the two reference sites at Hinds Creek and Brushy Fork Creek. EFK 13.8 was rated slightly to moderately impaired compared to reference conditions. Figure 1 shows that over the past three years, the numbers of the most pollution intolerant taxa (Ephemeroptera, Plecoptera, and Trichoptera, or EPT) remained at levels lower than those found at the reference sites. The total number of taxa found at the East Fork Poplar Creek sites were also lower than those at the reference sites (Figure 2). Both EPT and the total taxa richness showed a gradual increase in numbers with distance from the Y-12 Plant.

Bear Creek

BCK 12.3 rated severely impaired compared to the Gum Hollow reference site and moderately to severely impaired when examined with the Mill Branch reference site. BCK 10.3 rated moderately impaired compared to both reference locations. Figure 1 and Figure 2 show trends of increasing numbers in EPT richness and the total taxa richness with distance from the Y-12 Plant over the past three years. The observed numbers, however, were well below those found at the two reference sites indicating that although stream conditions appear to improve somewhat downstream, Bear Creek remains impacted.

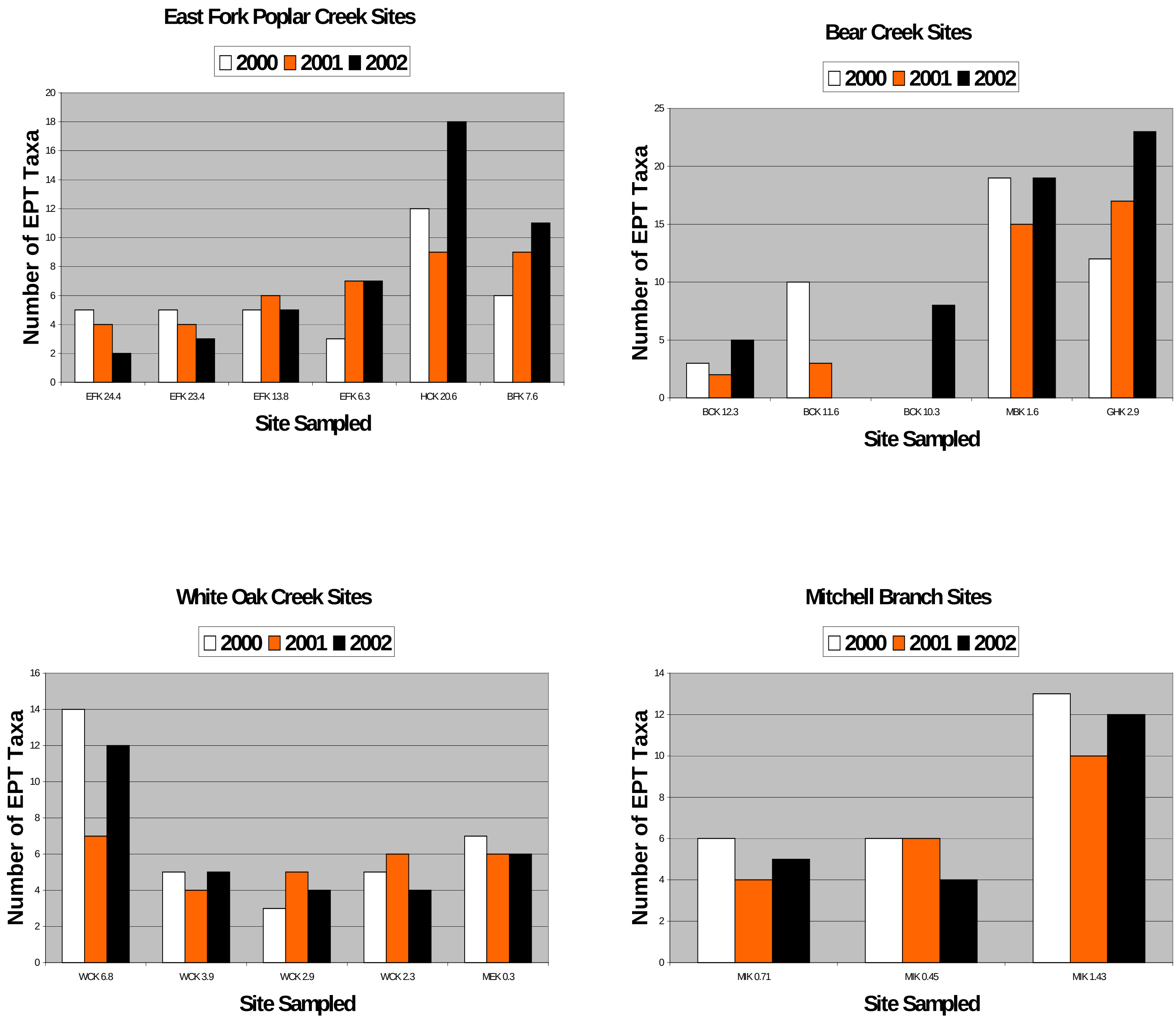
White Oak Creek and Melton Branch

Site ratings in the White Oak Creek watershed ranged from moderately to severely impaired compared to the upstream reference site, WCK 6.8. The uppermost test site, WCK 3.9, was determined to be moderately impaired as was the Melton Branch site, MEK 0.3. WCK 2.9 and WCK 2.3 rated as severely impaired compared to WCK 6.8. The rating for WCK 3.9 has remained the same over the past three years while the lower sites had ratings decrease in 2002. The number of EPT taxa and the total taxa richness at all sites continued to be depressed compared to the reference site (Figure 1 and Figure 2).

Mitchell Branch

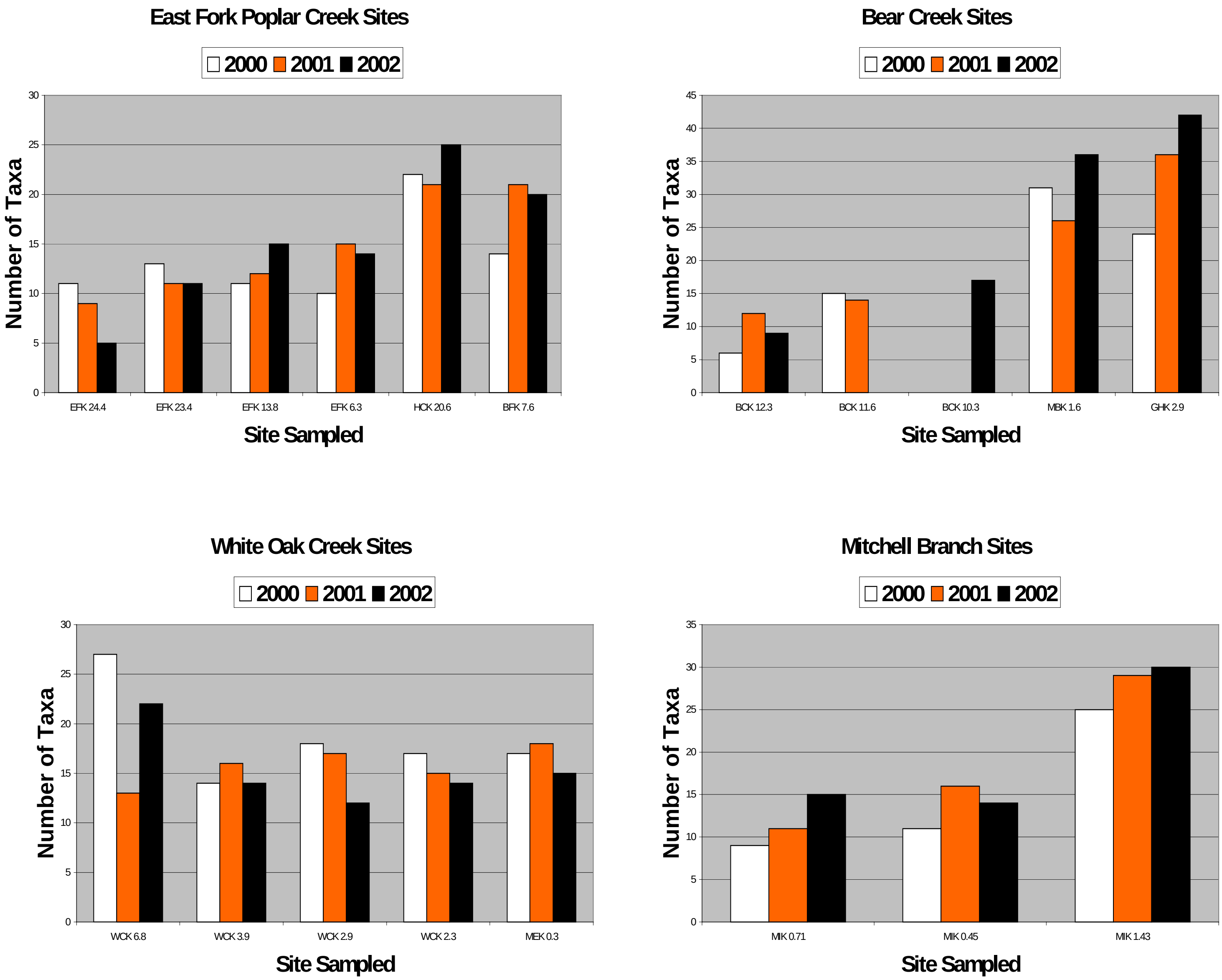
The ETTP sampling location at MIK 0.71 is located within the remediated portion of Mitchell Branch, necessitating a modified small stream sampling technique. A stiff bristled brush was used to loosen organisms clinging to and in between the interlocking concrete tiles that line the streambed. The debris was allowed to drift into the receiving D-frame net. Four riffles were sampled and composited following the procedure used for smaller streams. The scraping technique was a more effective method of dislodging benthic organisms from the surface of the tiles and, especially, from between the tiles than would have been the standard kicking and sweeping method.

MIK 0.71 was rated as being moderately impaired and MIK 0.45 was rated as being slightly impaired compared to reference conditions at the upstream reference site, MIK 1.43 (Appendix A). These ratings have remained relatively unchanged over the past three years. The diversity of the benthic macroinvertebrate communities in the sampled reaches of Mitchell Branch remained depressed compared to those conditions at the reference site (Figure 1 and Figure 2).



Reference Site locations: East Fork Poplar Creek: HCK 20.6 and BFK 7.6; Bear Creek: MBK 1.6 and GHK 2.9; White Oak Creek: WCK 6.8; Mitchell Brach: MIK 1.43

Figure 1. Comparison of the numbers of pollution intolerant benthic macroinvertebrate EPT taxa found in select Oak Ridge Reservation stream sites, Spring 2000 to Spring 2002.



Reference Site locations: East Fork Poplar Creek: HCK 20.6 and BFK 7.6; Bear Creek: MBK 1.6 and GHK 2.9; White Oak Creek: WCK 6.8; Mitchell Brach: MIK 1.43

Figure 2. Comparison of the total numbers of benthic macroinvertebrate taxa found in select Oak Ridge Reservation stream sites, Spring 2000 to Spring 2002.

Conclusions

Only one study site, MIK 0.45, rated as high as slightly impaired compared to its reference site, MIK 1.43. The remaining eleven sites rated between moderately impaired to severely impaired with respect to their reference locations. The uppermost Bear Creek site, BCK 12.3, along with two White Oak Creek sites, WCK 2.9 and WCK 2.3 showed signs of severe impairment.

The benthic communities in East Fork Poplar Creek showed downstream improvement as pollution sensitive EPT taxa and the total number of taxa increased with distance from the Y-12 Plant. However, environmental degradation continues to be persistent relative to the two reference sites. Mercury detected in surface water samples in upper East Fork Poplar Creek continues to be the largest contributor to adverse conditions. Decreases in the mean mercury levels were observed with distance from the Y-12 Plant.

The benthic macroinvertebrate conditions in Bear Creek continued to show signs of slight improvement with distance from the Y-12 Plant. The stream continues to be plagued by elevated NO_3 and NO_2 nitrogen concentrations, nutrients, metals, and high levels of gross alpha and gross beta activity. It is important to note that the natural habitat available for macroinvertebrates at BCK 12.3 continues to be less than optimal, and may have an impact on this site's score. Continued sampling in Bear Creek may capture any effects associated with the construction and operation of the Environmental Management Waste Management Facility near BCK 11.6.

The gamma radionuclide Cesium-137 along with high gross alpha and gross beta radioactivity were detected in White Oak Creek water samples. Conditions at the upstream reference site, WCK 6.8, appeared to have improved from 2001 based on EPT and total number of taxa. The number of EPT taxa increased to 12 genera in 2002 from a low of seven in 2001. Total taxa improved to 22 genera in 2002 compared to thirteen in 2001. Although the EPT and total number of taxa increased from the previous year, they remained lower than those observed in 2000.

An increase in the number of EPT taxa and total taxa at MIK 0.71 suggests that environmental conditions continue to improve within this remediated portion of Mitchell Branch. Depressed numbers at MIK 0.45 compared to 2001 indicate that storm water outfalls located upstream of MIK 0.45 continue to be the primary sources impacting the aquatic environment.

Future benthic macroinvertebrate biomonitoring and surface water sampling in East Fork Polar Creek, Bear Creek, the White Oak Creek watershed, and Mitchell Branch will continue to build on the existing database of information. Assessments of stream "health" can be made and monitored over time as conditions change. Continuous field sampling events will also aid in more closely defining the sources of any impacts from past, current, and future DOE related activities.

References

State of Tennessee Department of Environment and Conservation Division of Water Pollution Control. March 2002. *Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys.*

Yard, C. R. 2001. *Health, Safety, and Security Plan*. Tennessee Department of Environment and Conservation Department of Energy Oversight Division. Oak Ridge, Tennessee.

Appendix A.

Scores for Each of Five Metrics Analyzed

(1) Comparative Taxa Richness (CTR)

$$CTR = \frac{\text{Species richness at study site}}{\text{Species richness at reference site}} \times 100$$

( ) – duplicate value

East Fork Poplar Creek

Site Sampled	Scored with HCK 20.6	Scored with BFK 7.6
EFK 24.4	0 (0)	0 (0)
EFK 23.4	2 (2)	2 (2)
EFK 13.8	4	4
EFK 6.3	2	4

Bear Creek

Site Sampled	Scored with MBK 1.6	Scored with GHK 2.9
BCK 12.3	0	0
BCK 10.3	2	2

White Oak Creek and Melton Branch

Site Sampled	Scored with WCK 6.8
WCK 3.9	4
WCK 2.9	2
WCK 2.3	4
MEK 0.3	4

Mitchell Branch

Site Sampled	Scored with MIK 1.43
MIK 0.71	2
MIK 0.45	2

(2) Indicator Assemblage Index (IAI)

$IAI = CA_r/CA_s$

where: CA_r = Total relative abundance of chironomids and annelids at reference site
CA_s = Total relative abundance of chironomids and annelids at study site

( ) – duplicate value

East Fork Poplar Creek

Site Sampled	Scored with HCK 20.6	Scored with BFK 7.6
EFK 24.4	2 (2)	0 (0)
EFK 23.4	2 (2)	0 (0)
EFK 13.8	6	2
EFK 6.3	4	0

Bear Creek

Site Sampled	Scored with MBK 1.6	Scored with GHK 2.9
BCK 12.3	0	0
BCK 10.3	4	0

White Oak Creek and Melton Branch

Site Sampled	Scored with WCK 6.8
WCK 3.9	2
WCK 2.9	0
WCK 2.3	0
MEK 0.3	6

Mitchell Branch

Site Sampled	Scored with MIK 1.4
MIK 0.71	4
MIK 0.45	6

(3) Dominants in Common (DIC)

where: DIC = five most abundant taxa common to study and reference site
( ) – duplicate value

East Fork Poplar Creek

Site Sampled	Scored with HCK 20.6	Scored with BFK 7.6
EFK 24.4	2 (2)	4 (4)
EFK 23.4	2 (2)	4 (4)
EFK 13.8	2	4
EFK 6.3	2	4

Bear Creek

Site Sampled	Scored with MBK 1.6	Scored with GHK 2.9
BCK 12.3	2	2
BCK 10.3	2	4

White Oak Creek and Melton Branch

Site Sampled	Scored with WCK 6.8
WCK 3.9	2
WCK 2.9	0
WCK 2.3	0
MEK 0.3	0

Mitchell Branch

Site Sampled	Scored with MIK 1.4
MIK 0.71	2
MIK 0.45	2

(4) EPT Index

$$\text{EPT Index} = \frac{\text{Number of distinct EPT taxa at study site}}{\text{Number of distinct EPT taxa at reference site}} \times 100$$

( ) – duplicate value

East Fork Poplar Creek

Site Sampled	Scored with HCK 20.6	Scored with BFK 7.6
EFK 24.4	0 (0)	0 (0)
EFK 23.4	0 (0)	0 (0)
EFK 13.8	0	0
EFK 6.3	0	0

Bear Creek

Site Sampled	Scored with MBK 1.6	Scored with GHK 2.9
BCK 12.3	0	0
BCK 10.3	0	0

White Oak Creek and Melton Branch

Site Sampled	Scored with WCK 6.8
WCK 3.9	0
WCK 2.9	0
WCK 2.3	0
MEK 0.3	0

Mitchell Branch

Site Sampled	Scored with MIK 1.4
MIK 0.71	0
MIK 0.45	0

(5) Index of Biotic Integrity (IBI)

$$NCBI = \Sigma \frac{x_i t_i}{n}$$

$$IBI = \frac{\text{NCBI of reference site}}{\text{NCBI of study site}} \quad X\ 100$$

Where: NCBI = North Carolina Biotic Index
and: x_i = number of individuals within a taxa
t_i = tolerance value of a taxa
n = total number of organisms in the sample
( ) – duplicate value

East Fork Poplar Creek

Site Sampled	Scored with HCK 20.6	Scored with BFK 7.6
EFK 24.4	4 (4)	4 (4)
EFK 23.4	4 (4)	4 (4)
EFK 13.8	4	4
EFK 6.3	6	4

Bear Creek

Site Sampled	Scored with MBK 1.6	Scored with GHK 2.9
BCK 12.3	4	2
BCK 10.3	2	2

White Oak Creek and Melton Branch

Site Sampled	Scored with WCK 6.8
WCK 3.9	0
WCK 2.9	0
WCK 2.3	0
MEK 0.3	0

Mitchell Branch

Site Sampled	Scored with MIK 1.4
MIK 0.71	6
MIK 0.45	6

Combined scores for each study site

SITE	SCORE (out of a possible of 30)	RATING
EFK 24.4	8 (8)vs. Hinds,8 (8) vs. Brushy Fork	Moderately impaired
EFK 23.4	10(10)vs.Hinds,10(10)vs.Brushy Fork	Moderately impaired
EFK 13.8	16 vs. Hinds, 14 vs. Brushy Fork	Slightly to moderately impaired
EFK 6.3	14 vs. Hinds, 12 vs. Brushy Fork	Moderately impaired
BCK 12.3	6 vs. Mill Br., 4 vs. Gum Hollow	Moderately to severely impaired
BCK 10.3	10 vs. Mill Br., 8 vs. Gum Hollow	Moderately impaired
WCK 3.9	8 vs. WCK 6.8	Moderately impaired
WCK 2.9	2 vs. WCK 6.8	Severely impaired
WCK 2.3	4 vs. WCK 6.8	Severely impaired
MEK 0.3	10 vs. WCK 6.8	Moderately impaired
MIK 0.71	14 vs. MIK 1.43	Moderately impaired
MIK 0.45	16 vs. MIK 1.43	Slightly impaired

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CHAPTER 4 GROUNDWATER MONITORING

Oak Ridge Reservation and Vicinity Springs and Wells Monitoring Project Report

Principal Authors: Donald F. Gilmore, Robert C. Benfield and Jack D. Wheat

Abstract
The Tennessee Department of Environment and Conservation, Department of Energy Oversight Division (TDEC/DOE-O) conducts independent sampling of springs, wells and seeps on the Oak Ridge Reservation (ORR) as part of the Tennessee Oversight Agreement (TOA). This sampling has been ongoing since 1992. This report provides a status review of the sampling performed during calendar year 2002. Samples were taken at different times of the year from the Oak Ridge reservation and water sources off the reservation. Springs and seeps provide exit pathway monitoring points. Some of these points are close to burial grounds and others are some distance away. This program continues to look for new springs and seeps to sample.

The sampling for 2002 provided some insights into the behavior of contaminants in the subsurface via their movement in groundwater. Springs in Bear Creek Valley down gradient from the bear creek burial grounds continue to be impacted by radiochemical, metal as well as volatile organic constituents. Several springs at K-25, Y-12 and X-10 are impacted as well. Volatile organics, nitrates, gross alpha and gross beta activity are the contaminants of greatest concern. The levels of the contaminants with some exceptions near waste sites are very low and the general quality of the groundwater on the ORR is good. Residential wells meet drinking water standards for parameters monitored for.

Introduction
The Tennessee Department of Environment and Conservation, Department of Energy Oversight Division (TDEC/DOE-O) conducts independent sampling of springs and seeps on the Oak Ridge Reservation (ORR) as part of the Tennessee Oversight Agreement (TOA). The state laboratory tests the samples for radionuclides, volatile organic compounds, selected metals, nutrients, and inorganic analytes. During 2002 DOE-O sampled 45 springs, seeps or wells on the ORR (Figure 1). Several of these have been found to contain contaminants, which indicate high probability of a connection with DOE's activities on the ORR.

Methods and Materials
DOE-O's spring/seep sampling activities typically include the following:

1. Locating. Springs/seeps are normally found along the lower edge of slopes near streams, often emerging in streambeds. Reviewing a topographic map of the area of concern will allow the investigator to narrow the search area areas and to mark the map location with considerable accuracy. During 2002 DOE-O used a GPS instrument to determine latitude and longitude of most of the springs.

2. Analysis A list of analytes was selected consisting of parameters that would be consistent with constituents of groundwater found on the ORR. These parameters included radionuclides, volatile organic compounds (VOCs), and inorganic constituents, nutrients and metals.

3. Field sampling A sampling team normally consisting of two DOE-O personnel, locates the spring, and collects the prescribed number of samples. The personnel wear disposable vinyl gloves

while collecting samples. Sample labels (tags) and analysis request/chain of custody forms are completed. Samples are transported in coolers to the DOE-O offices for temporary storage, or may be taken directly to the Knoxville Branch Laboratory (KBL).

Duplicate samples, trip blanks, and field blanks are taken as directed by the sampling plan.

4. Data Storage Analytical results are stored in regular files in the DOE-O office, and the results are entered in a computer database. Eventually this data will be placed onto DOE's OREIS database. Copies of the lab analyses are periodically provided to DOE.

Results and Discussion

Groundwater sampling results in the calendar year 2002 are summarized in the tables and figures in this section. A total of 45 separate locations include springs, monitoring well, and residential wells. No drinking water limits were found to be exceeded in the residential wells for the test performed. The most remarkable spring sampled this year is the JES Sludge Seep. JES Sludge Seep is intermittent spring on Bear Creek near North Tributary (NT-5). This spring was the only location sampled to have positively tested vinyl chloride. The other locations tested for volatile organic compounds yield results similar to past testing where maximum contaminant concentrations are not exceeded, except near sources of contamination. In residential well RWS-71 benzene was found at 1.6 parts per billion but is not thought to be associated with the DOE releases.

Listed in Table 1 below are the particular volatile organic compounds that had values above detection.

Results of sampling for select metals at select locations are summarized in Tables 2-6. All results for metals are below limits established for general use groundwater. Results are consistent with past results and expected levels for each location. JES Sludge Seep contained Arsenic at measurable levels as well as other metal like mercury. Mercury is seldom found in groundwater at the ORR. JES Sludge Seep is the very impacted and levels of constituents are very much above all other sampling location in this sampling program.

The radiological results are illustrated in the Figures 2-12. Bear Creek springs continue to show elevated levels of Gross alpha that is consistent with past sampling for Y-12. Results for radiological parameters show higher values near sources of contamination and then drop off to background at most other sample locations. Tritium values (about 397 pCi/L) at Crooked Tree Spring are similar to past sampling at this location near X-10. JES Sludge Seep has higher tritium and the highest Gross alpha most likely due to uranium from historic Y-12 waste disposal.

Conclusions

Certain ORR springs/seeps monitored during 2002 show traces of contaminants, which indicate an impact from past activities on the ORR. The location of the impacted springs relative to waste burial grounds suggests that the preferential direction of groundwater movement is generally along geologic strike (northeast/southwest). DOE-O plans to continue monitoring many of these springs/seeps. The new spring JES Sludge Seep will be sampled when flowing.

References

Rubin, P. and Peter Lemiszki, 1992 (unpublished report for MMES/DOE) *"Aspects of Oak Ridge Karst Hydrology and Geomorphology."*

ORNL/TM-12074 *"Status Report on the Geology of the Oak Ridge Reservation."*

King, H. and Steven Haase, ORNL/TM-10112 *Subsurface-Controlled Geological Maps for the Y-12 Plant and Adjacent Areas of Bear Creek Valley.*

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

Region IV EPA, May 1996, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*.

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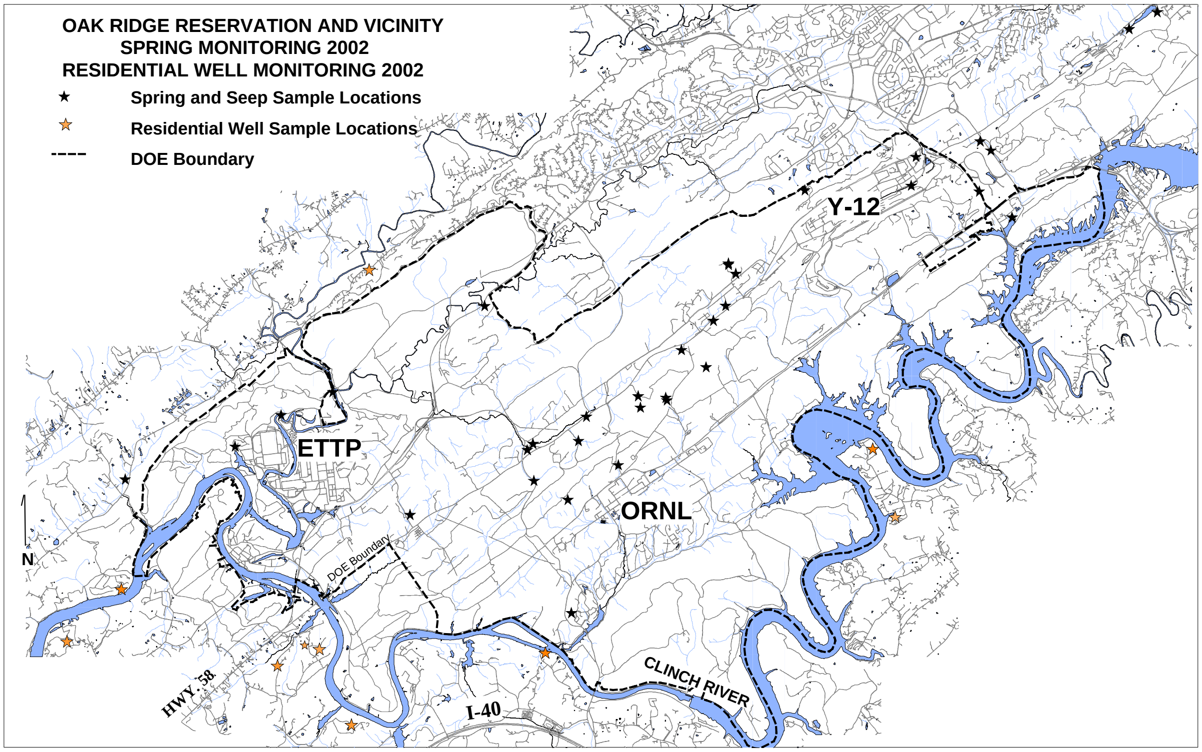
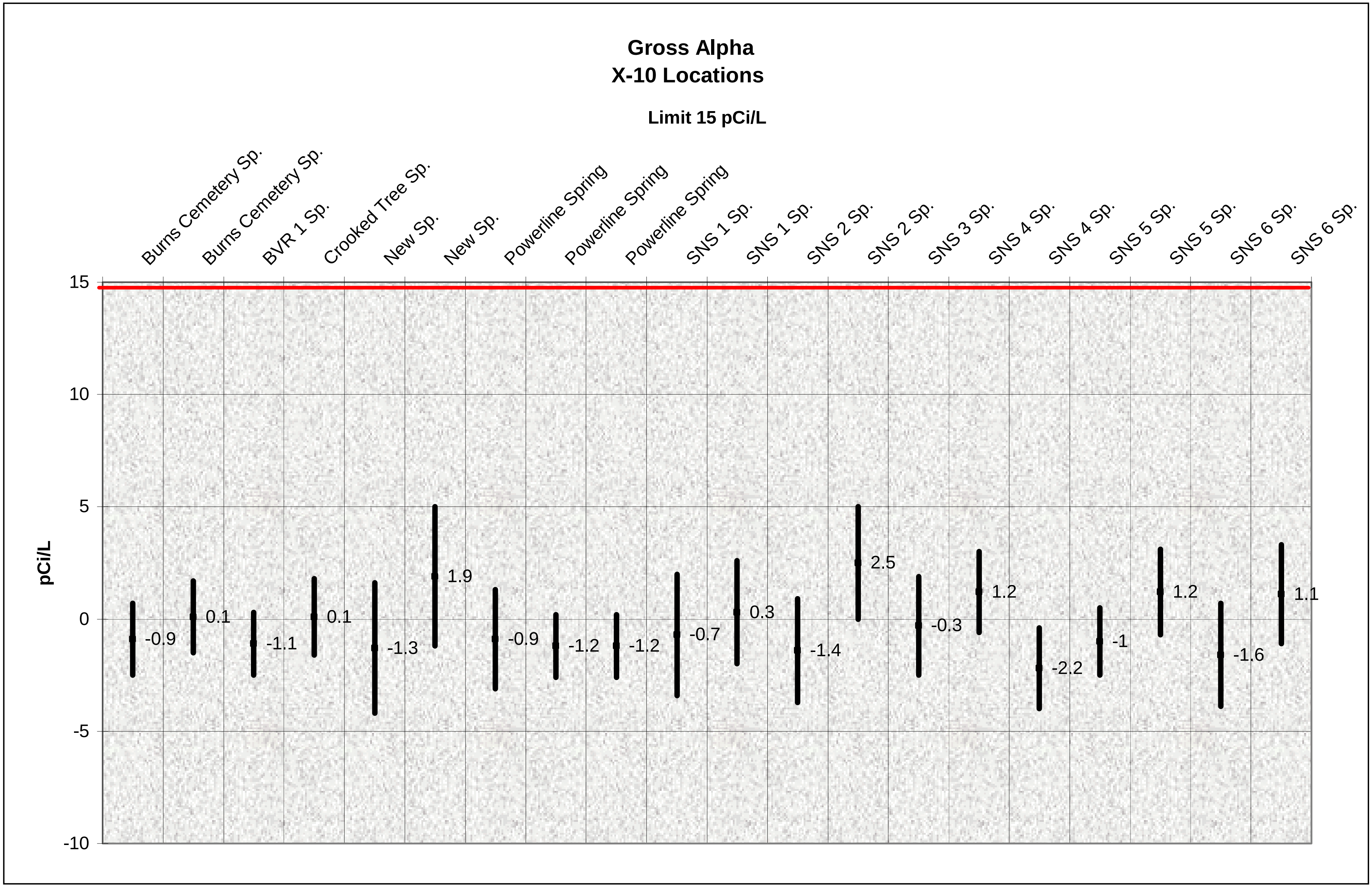


Figure 1 Calendar Year 2002 Sampling Locations for Spring and Wells Monitoring Projects

Table 1 Volatile Organic Compounds and the Maximum Contaminant Limit (MCL) based on Drinking Water Standards.

PARAMETER	Location Name	Date	Part per Billion
1,1-Dichloroethane	JES Sludge Seep	3/21/02	0.0017
		10/22/02	0.0028
1,1-Dichloroethene	21002 Sp.	6/11/02	0.0013
		8/8/02	0.0021
MCL 0.007	JES Sludge Seep	3/21/02	0.0047
		10/22/02	0.0092
Benzene MCL 0.005	RWS 71	4/29/02	0.0016
Carbon Tetrachloride	21002 Sp.	6/11/02	0.0037
		8/8/02	0.003
MCL 0.005		9/9/02	0.0026
	Cattail Sp.	1/28/02	0.0013
Chlorobenzene MCL 0.1	JES Sludge Seep	10/22/02	0.0012
Chloroethane	Crooked Tree Sp.	3/21/02	0.0012
	JES Sludge Seep	3/21/02	0.0012
Cis-1,2-Dichloroethene	21002 Sp.	9/9/02	0.0019
	Bootlegger Sp.	10/7/02	0.0021
MCL 0.07	JES Sludge Seep	3/21/02	0.042
		10/22/02	0.085
	SS-4 Sp.	3/11/02	0.0036
		10/22/02	0.0073
	SS-5 Sp.	3/11/02	0.0018
Tetrachloroethene MCL 0.005	SS-4 Sp.	10/22/02	0.0011
Trichloroethene	21002 Sp.	3/25/02	0.002
		6/11/02	0.022
		8/8/02	0.022
MCL 0.005		9/9/02	0.021
		11/13/02	0.0058
	Cattail Sp.	1/28/02	0.0024
		10/7/02	0.0011
	JES Sludge Seep	10/22/02	0.0021
	SS 5.95KM Sp.	10/24/02	0.0015
	SS-4 Sp.	3/11/02	0.0085
		10/22/02	0.012
	SS-5 Sp.	3/11/02	0.001
	USGS 10-895 Sp.	3/25/02	0.0015
		10/16/02	0.0064
Vinyl Chloride	JES Sludge Seep	3/21/02	0.0022
MCL 0.002		10/22/02	0.0025
Vinyl Acetate	Burns Cemetery Sp.	10/24/02	0.0012

Figure 2



Gross Alpha
X-10 Locations
Limit 15 pCi/L
Burns Cemetery Sp.
Burns Cemetery Sp.
BVR 1 Sp.
Crooked Tree Sp.
New Sp.
New Sp.
Powerline Spring
Powerline Spring
Powerline Spring
SNS 1 Sp.
SNS 1 Sp.
SNS 2 Sp.
SNS 2 Sp.
SNS 3 Sp.
SNS 4 Sp.
SNS 4 Sp.
SNS 5 Sp.
SNS 5 Sp.
SNS 6 Sp.
SNS 6 Sp.
pCi/L
15
10
5
0
-5
-10
-0.9
0.1
-1.1
0.1
-1.3
1.9
-0.9
-1.2
-1.2
-0.7
0.3
-1.4
2.5
-0.3
1.2
-2.2
-1
1.2
-1.6
1.1

Figure 3

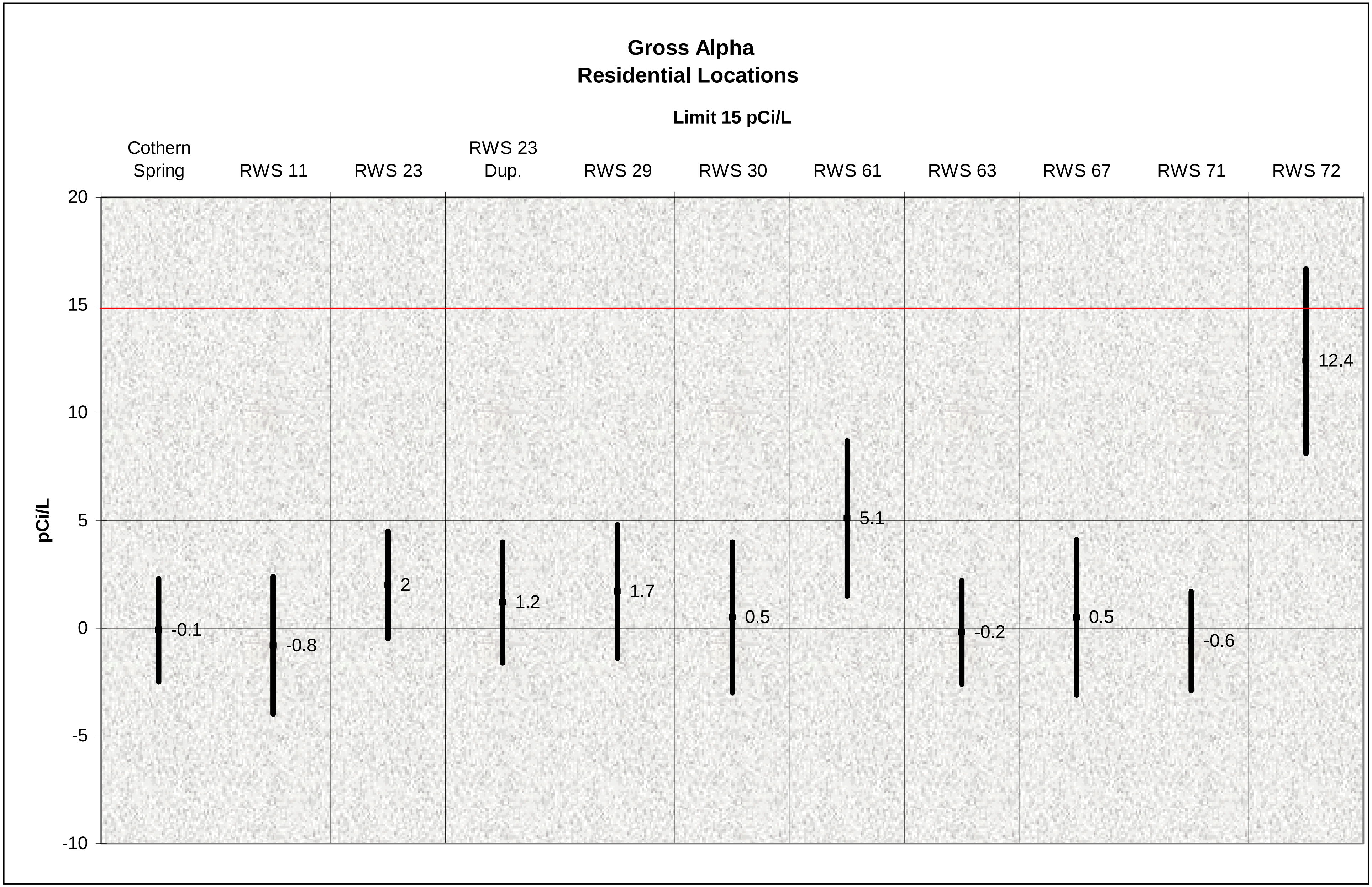

Gross Alpha
Residential Locations
Limit 15 pCi/L
Cothern Spring
RWS 11
RWS 23
RWS 23 Dup.
RWS 29
RWS 30
RWS 61
RWS 63
RWS 67
RWS 71
RWS 72
pCi/L
20
15
10
5
0
-5
-10
-0.1
-0.8
2
1.2
1.7
0.5
5.1
-0.2
0.5
-0.6
12.4

Figure 4

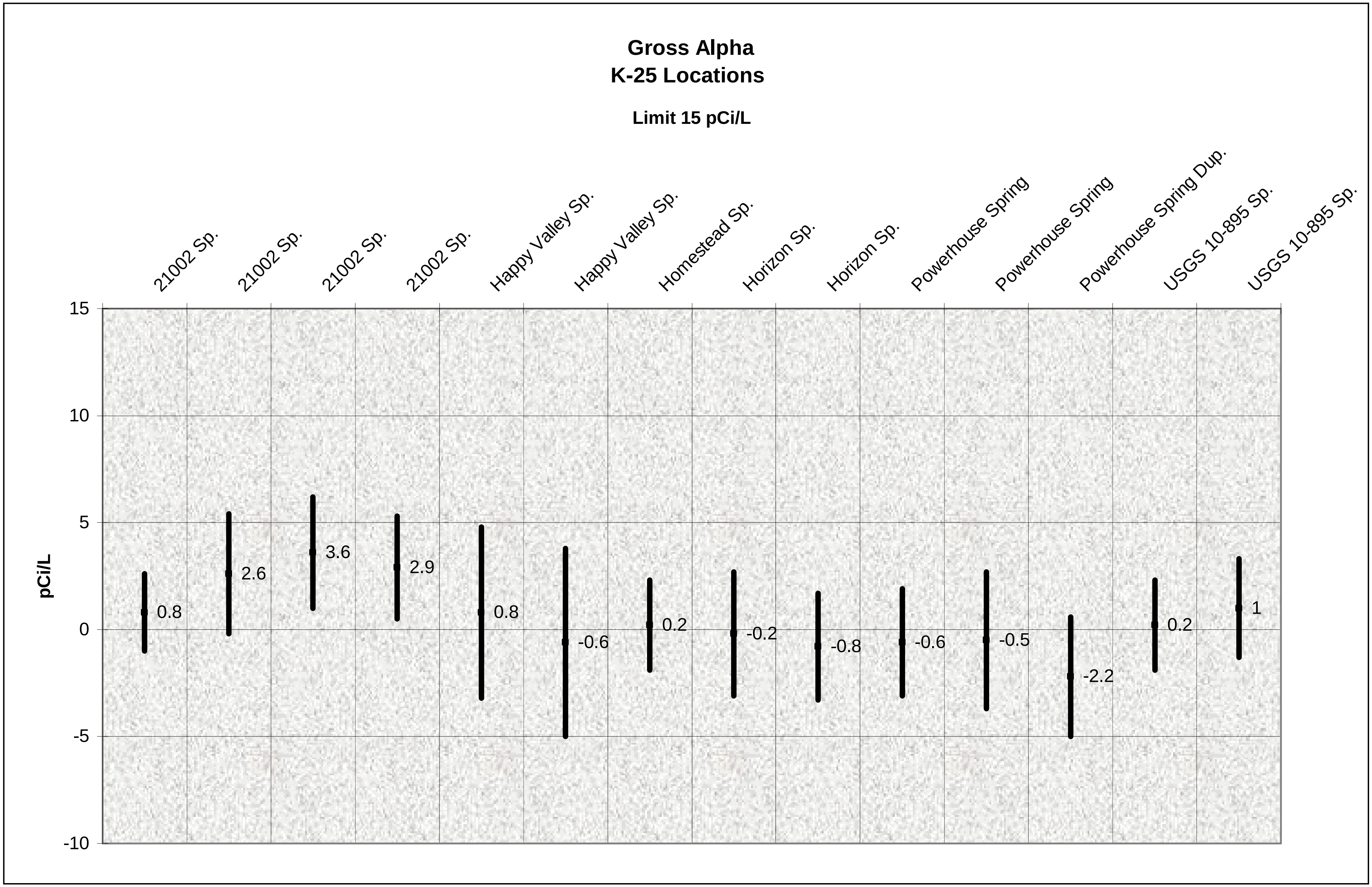
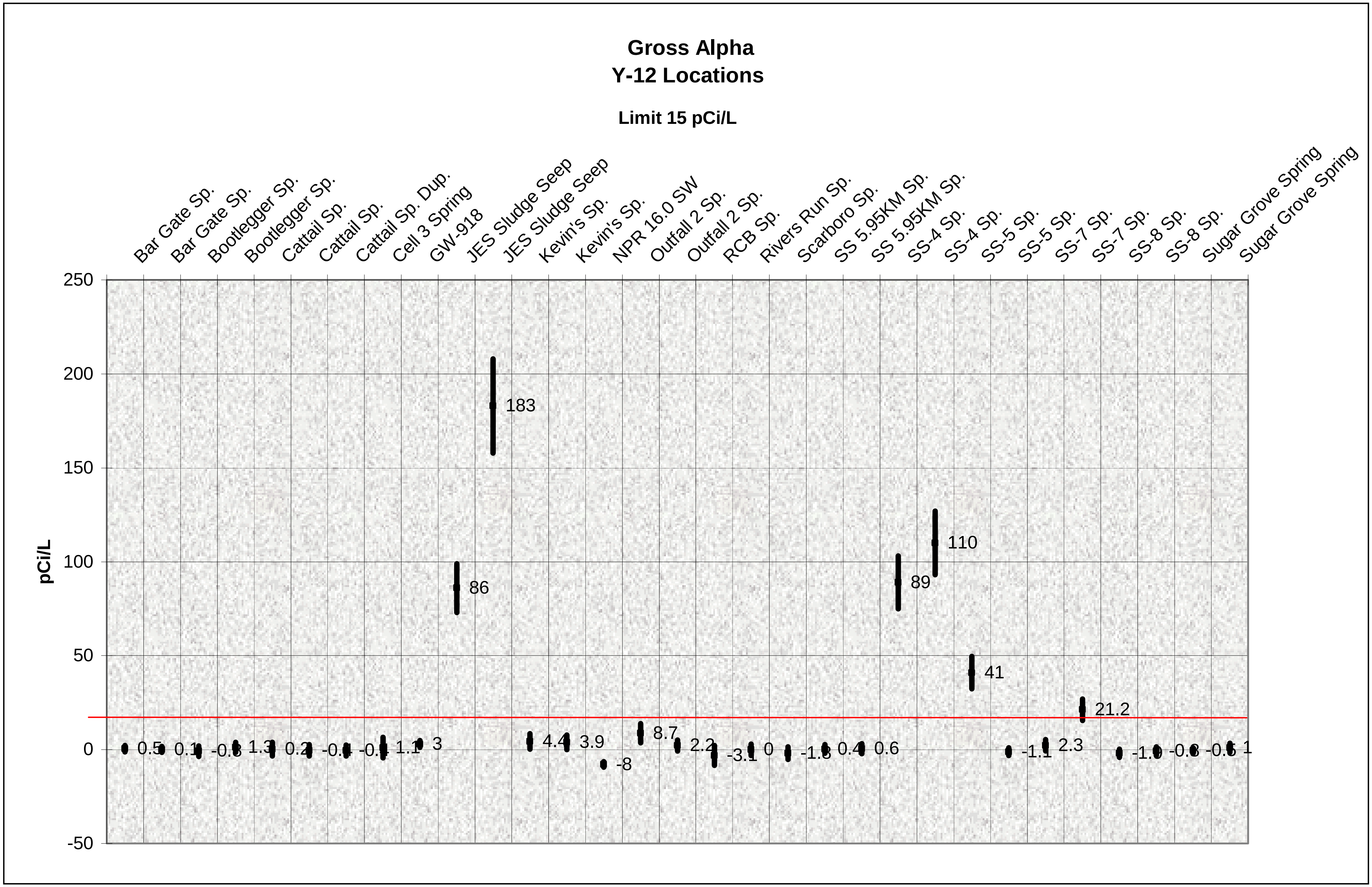
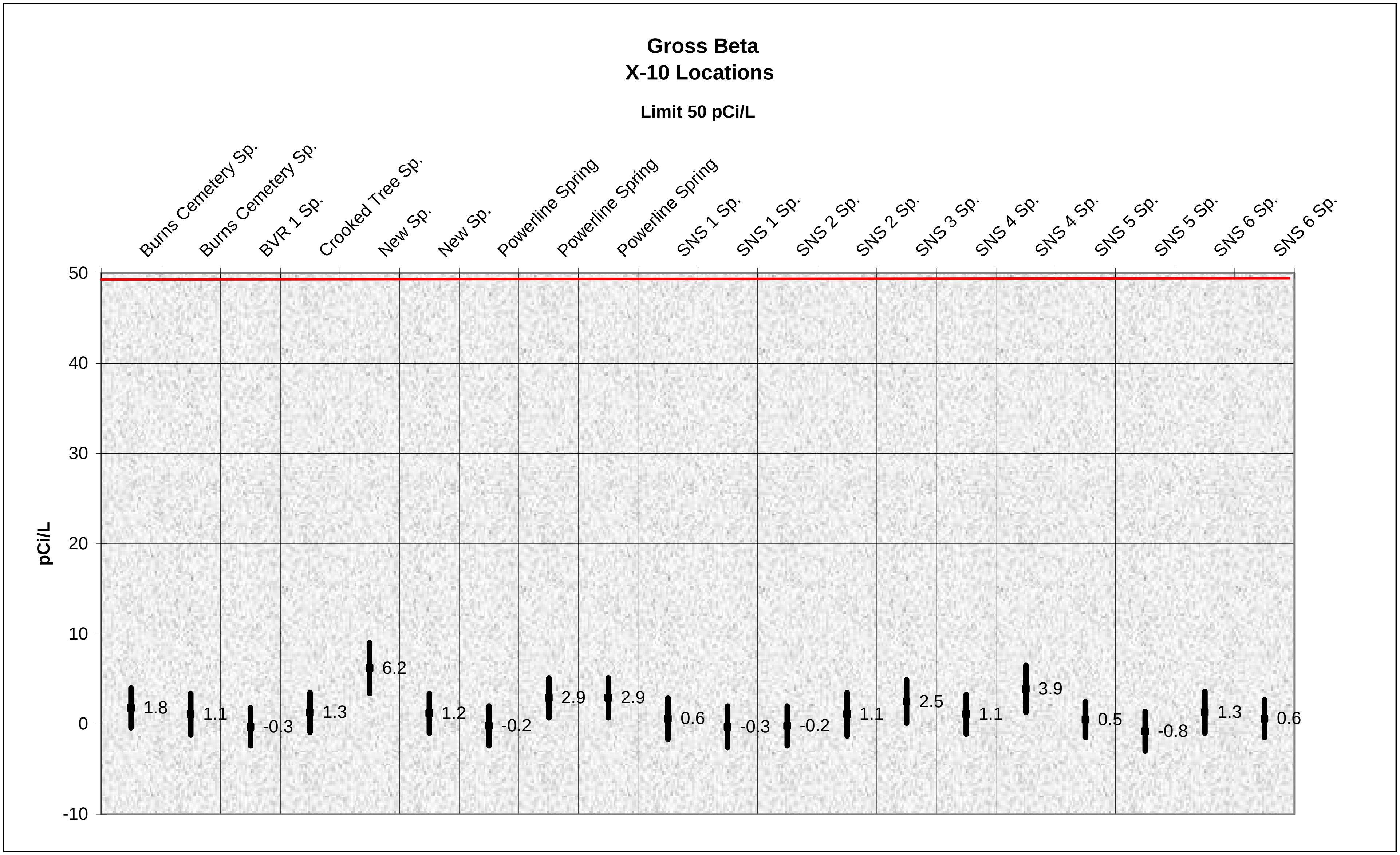

Gross Alpha
K-25 Locations
Limit 15 pCi/L
21002 Sp.
21002 Sp.
21002 Sp.
21002 Sp.
Happy Valley Sp.
Happy Valley Sp.
Homestead Sp.
Horizon Sp.
Horizon Sp.
Powerhouse Spring
Powerhouse Spring
Powerhouse Spring Dup.
USGS 10-895 Sp.
USGS 10-895 Sp.
pCi/L
15
10
5
0
-5
-10
0.8
2.6
3.6
2.9
0.8
-0.6
0.2
-0.2
-0.8
-0.6
-0.5
-2.2
0.2
1

Figure 5



Gross Alpha
Y-12 Locations
Limit 15 pCi/L
Bar Gate Sp.
Bar Gate Sp.
Bootlegger Sp.
Bootlegger Sp.
Cattail Sp.
Cattail Sp.
Cattail Sp. Dup.
Cell 3 Spring
GW-918
JES Sludge Seep
JES Sludge Seep
Kevin's Sp.
Kevin's Sp.
NPR 16.0 SW
Outfall 2 Sp.
Outfall 2 Sp.
RCB Sp.
Rivers Run Sp.
Scarboro Sp.
SS 5.95KM Sp.
SS 5.95KM Sp.
SS-4 Sp.
SS-4 Sp.
SS-5 Sp.
SS-5 Sp.
SS-7 Sp.
SS-7 Sp.
SS-8 Sp.
SS-8 Sp.
Sugar Grove Spring
Sugar Grove Spring
pCi/L
250
200
150
100
50
0
-50
0.5
0.1
-0.8
1.3
0.2
-0.4
-0.1
1.1
3
86
183
4.4
3.9
-8
8.7
2.2
-3.1
0
-1.8
0.4
0.6
89
110
41
-1.1
2.3
21.2
-1.0
-0.8
-0.5
1

Figure 6



Gross Beta
X-10 Locations
Limit 50 pCi/L
Burns Cemetery Sp.
Burns Cemetery Sp.
BVR 1 Sp.
Crooked Tree Sp.
New Sp.
New Sp.
Powerline Spring
Powerline Spring
Powerline Spring
SNS 1 Sp.
SNS 1 Sp.
SNS 2 Sp.
SNS 2 Sp.
SNS 3 Sp.
SNS 4 Sp.
SNS 4 Sp.
SNS 5 Sp.
SNS 5 Sp.
SNS 6 Sp.
SNS 6 Sp.
pCi/L
50
40
30
20
10
0
-10
1.8
1.1
-0.3
1.3
6.2
1.2
-0.2
2.9
2.9
0.6
-0.3
-0.2
1.1
2.5
1.1
3.9
0.5
-0.8
1.3
0.6

Figure 7

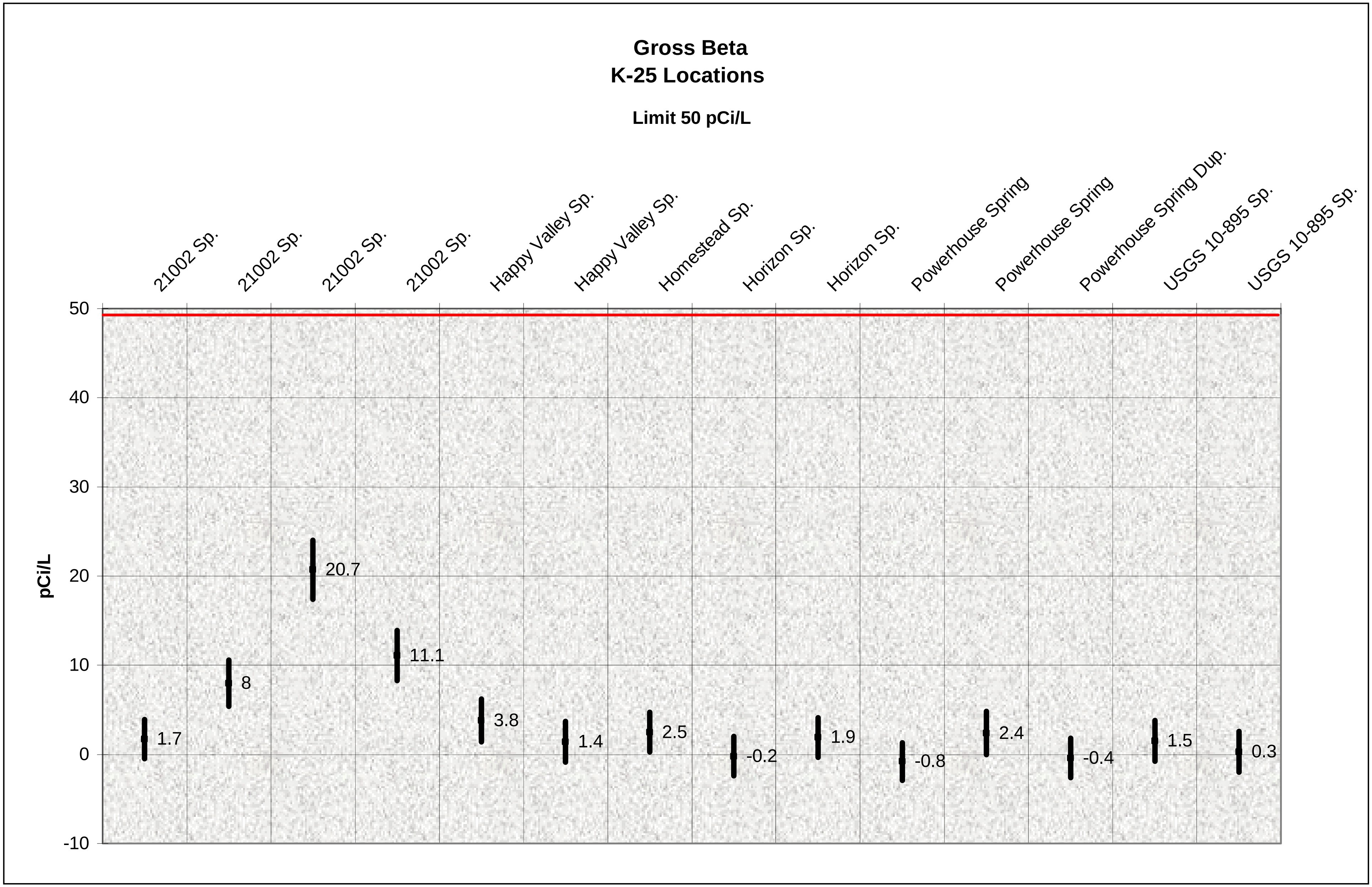

Gross Beta
K-25 Locations
Limit 50 pCi/L
pCi/L
50
40
30
20
10
0
-10
21002 Sp.
21002 Sp.
21002 Sp.
21002 Sp.
Happy Valley Sp.
Happy Valley Sp.
Homestead Sp.
Horizon Sp.
Horizon Sp.
Powerhouse Spring
Powerhouse Spring
Powerhouse Spring Dup.
USGS 10-895 Sp.
USGS 10-895 Sp.
1.7
8
20.7
11.1
3.8
1.4
2.5
-0.2
1.9
-0.8
2.4
-0.4
1.5
0.3

Figure 8

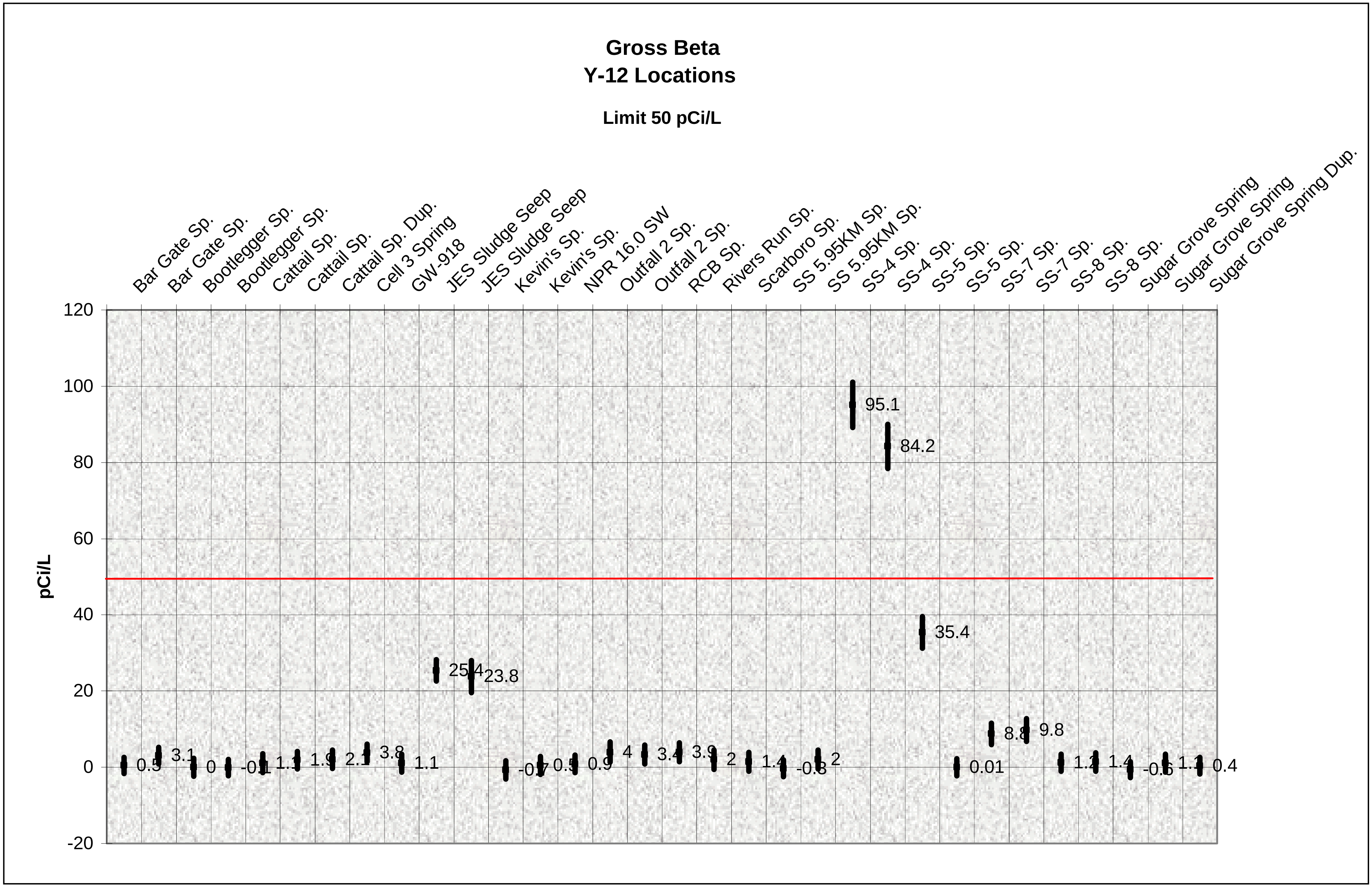

Gross Beta
Y-12 Locations
Limit 50 pCi/L
pCi/L
Bar Gate Sp.
Bar Gate Sp.
Bootlegger Sp.
Bootlegger Sp.
Cattail Sp.
Cattail Sp.
Cattail Sp. Dup.
Cell 3 Spring
GW-918
JES Sludge Seep
JES Sludge Seep
Kevin's Sp.
Kevin's Sp.
NPR 16.0 SW
Outfall 2 Sp.
Outfall 2 Sp.
RCB Sp.
Rivers Run Sp.
Scarboro Sp.
SS 5.95KM Sp.
SS 5.95KM Sp.
SS-4 Sp.
SS-4 Sp.
SS-5 Sp.
SS-5 Sp.
SS-7 Sp.
SS-7 Sp.
SS-8 Sp.
SS-8 Sp.
Sugar Grove Spring
Sugar Grove Spring
Sugar Grove Spring Dup.
120
100
80
60
40
20
0
-20
95.1
84.2
35.4
25.4
23.8
8.8
9.8
0.01

Figure 9

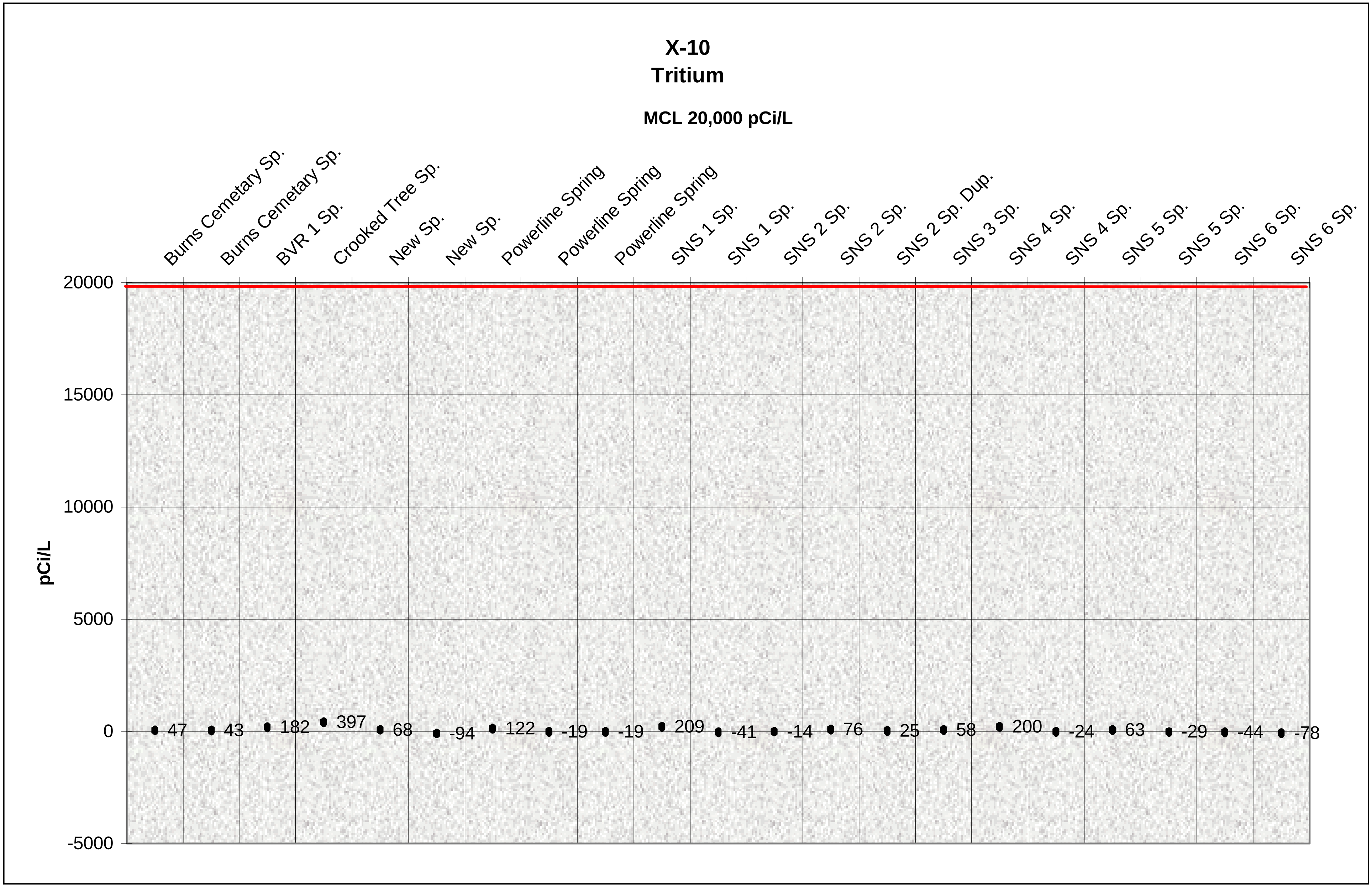
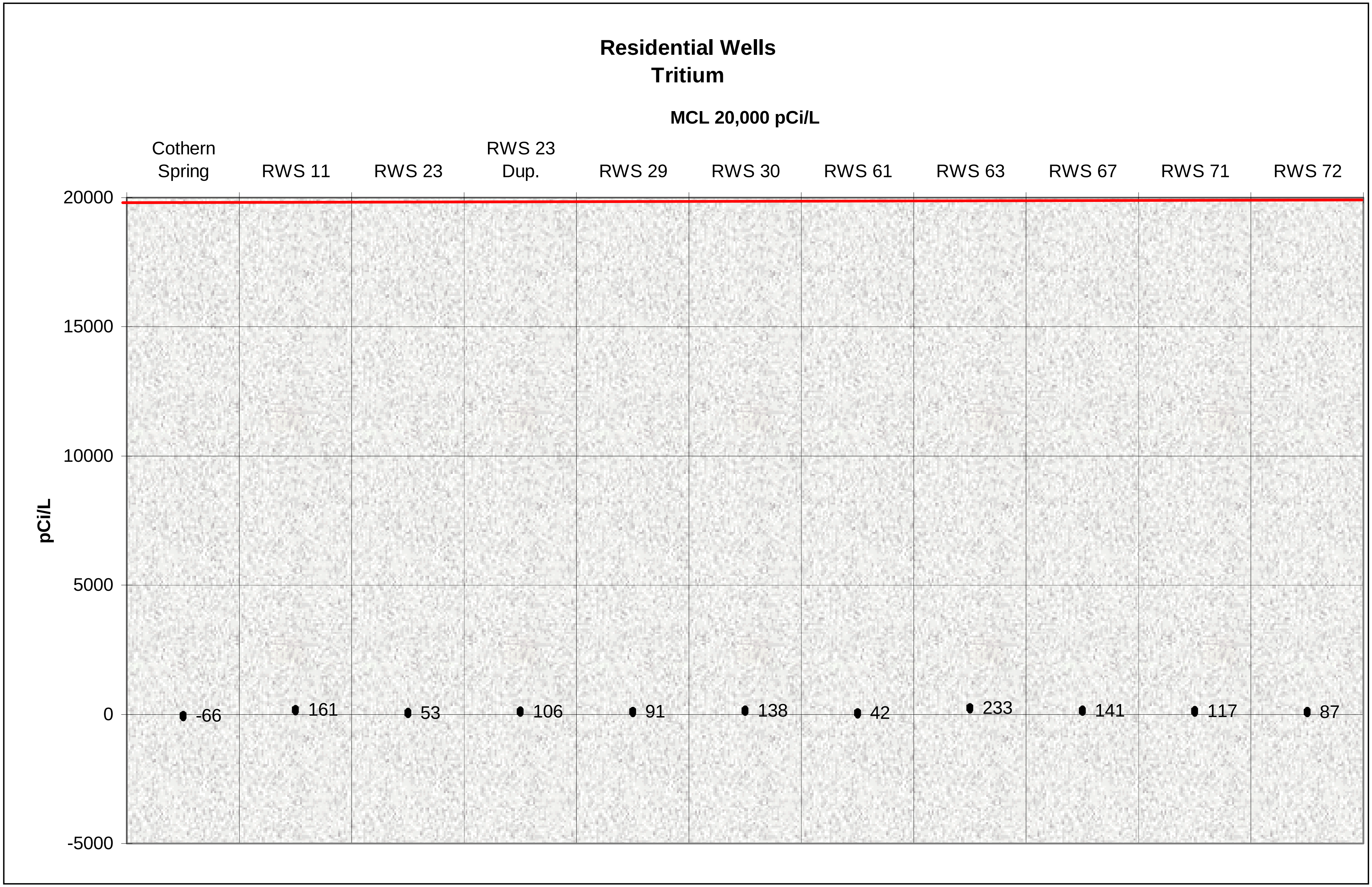
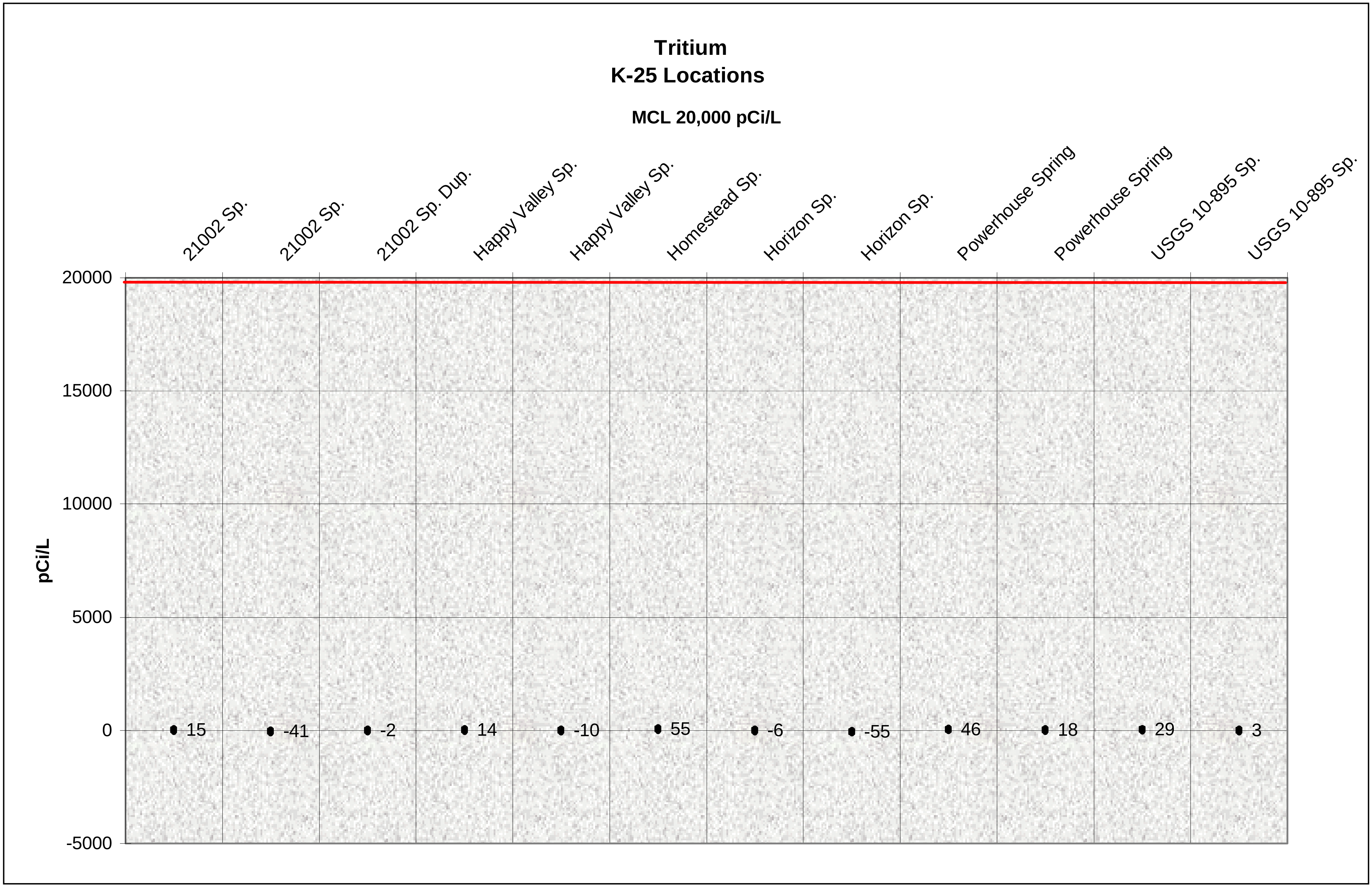

X-10
Tritium
MCL 20,000 pCi/L
Burns Cemetary Sp.
Burns Cemetary Sp.
BVR 1 Sp.
Crooked Tree Sp.
New Sp.
New Sp.
Powerline Spring
Powerline Spring
Powerline Spring
SNS 1 Sp.
SNS 1 Sp.
SNS 2 Sp.
SNS 2 Sp.
SNS 2 Sp. Dup.
SNS 3 Sp.
SNS 4 Sp.
SNS 4 Sp.
SNS 5 Sp.
SNS 5 Sp.
SNS 6 Sp.
SNS 6 Sp.
pCi/L
20000
15000
10000
5000
0
-5000
47
43
182
397
68
-94
122
-19
-19
209
-41
-14
76
25
58
200
-24
63
-29
-44
-78

Figure 10



Residential Wells
Tritium
MCL 20,000 pCi/L
Cothern Spring
RWS 11
RWS 23
RWS 23 Dup.
RWS 29
RWS 30
RWS 61
RWS 63
RWS 67
RWS 71
RWS 72
20000
15000
10000
5000
0
-5000
pCi/L
-66
161
53
106
91
138
42
233
141
117
87

Figure 11



Tritium
K-25 Locations
MCL 20,000 pCi/L
21002 Sp.
21002 Sp.
21002 Sp. Dup.
Happy Valley Sp.
Happy Valley Sp.
Homestead Sp.
Horizon Sp.
Horizon Sp.
Powerhouse Spring
Powerhouse Spring
USGS 10-895 Sp.
USGS 10-895 Sp.
20000
15000
10000
5000
0
-5000
pCi/L
15
-41
-2
14
-10
55
-6
-55
46
18
29
3

Figure 12

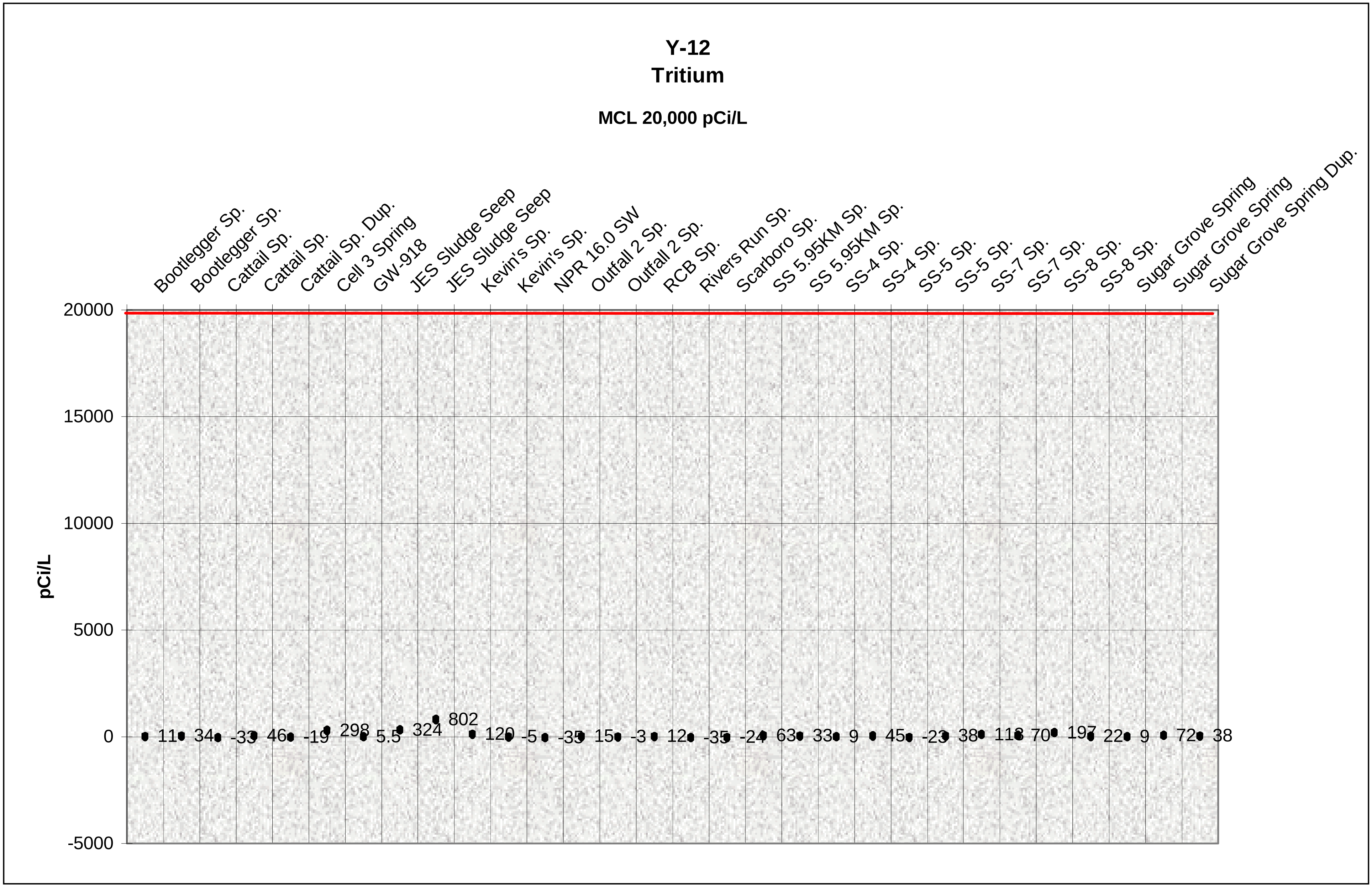

Y-12
Tritium
MCL 20,000 pCi/L
pCi/L
20000
15000
10000
5000
0
-5000
Bootlegger Sp.
Bootlegger Sp.
Cattail Sp.
Cattail Sp.
Cattail Sp. Dup.
Cell 3 Spring
GW-918
JES Sludge Seep
JES Sludge Seep
Kevin's Sp.
Kevin's Sp.
NPR 16.0 SW
Outfall 2 Sp.
Outfall 2 Sp.
RCB Sp.
Rivers Run Sp.
Scarboro Sp.
SS 5.95KM Sp.
SS 5.95KM Sp.
SS-4 Sp.
SS-4 Sp.
SS-5 Sp.
SS-5 Sp.
SS-7 Sp.
SS-7 Sp.
SS-8 Sp.
SS-8 Sp.
Sugar Grove Spring
Sugar Grove Spring
Sugar Grove Spring Dup.
11
34
-33
46
-19
298
5.5
324
802
120
-5
-35
15
-3
12
-35
-24
63
33
9
45
-23
38
118
70
197
22
9
72
38

Table 2 Metals in groundwater for locations near X-10

X-10 Locations	*Drinking Water MCL*	*Arsenic 0.05 ppm*	*Cadmium 0.005 ppm*	*Lead 0.05 ppm*	*Mercury 0.002 ppm*	*Nickel*	*Selenium 0.05 ppm*	*Thallium*	*Chromium 0.1 ppm Total*	*Uranium*
Location Name	Date	Arsenic	Cadmium	Lead	Mercury	Selenium	Thallium	Total Chromium	Uranium	Zinc
Burns Cemetery Sp.	3/27/02	0	0	0	0	0	0	0	0	0.005
BVR 1 Sp.	3/25/02	0	0	0	0	0	0	0	0	0.006
Crooked Tree Sp.	3/21/02	0.001	0	0.004	0	0	0	0.007	0	0.013
New Sp.	1/30/02	0	0	0	0	0	0	0	0	0.006
	11/7/02	0	0	0	0	0	0	0	0	0
Powerline Spring	3/13/02	0	0	0	0	0	0	0	0	0.004
	11/7/02	0	0	0	0	0	0	0	0	0.008
SNS 1 Sp.	3/5/02	0	0	0	0	0	0	0	0	0.004
	11/4/02	0	0	0	0	0	0	0	0	0.006
SNS 2 Sp.	3/5/02	0	0	0	0	0	0	0.002	0	0.006
	11/4/02	0	0	0.001	0	0	0	0	0	0.014
SNS 3 Sp.	3/7/02	0	0	0	0	0	0	0	0	0.011
SNS 4 Sp.	3/11/02	0	0	0.001	0	0	0	0	0	0.005
SNS 5 Sp.	3/13/02	0	0	0	0	0	0	0.001	0	0.005
	10/30/02	0.001	0	0.001	0	0	0	0	0	0.024
SNS 6 Sp.	3/7/02	0	0	0	0	0	0	0	0	0.08
	11/7/02	0	0	0	0	0	0	0	0	0.235

Table 3 Metals in groundwater for locations that are offsite at private water sources

Residential Locations	***Drinking Water MCL***	***Arsenic 0.05 ppm***	***Cadmium 0.005 ppm***	***Lead 0.05 ppm***	***Mercury 0.002 ppm***	***Nickel***	***Selenium 0.05 ppm***	***Thallium***	***Chromium 0.1 ppm Total***	***Uranium***
Location Name	Date	Arsenic	Cadmium	Lead	Mercury	Selenium	Thallium	Total Chromium	Uranium	Zinc
Cothern Spring	4/30/02	0	0	0	0	0	0	0	0	0.008
RWS 11	4/23/02	0	0	0.002	0	0	0	0	0	0.007
RWS 23	4/23/02	0	0	0	0	0	0	0.001	0	0.036
RWS 29	4/16/02	0	0	0	0	0	0	0	0	0.009
RWS 30	4/23/02	0	0	0	0	0	0	0.001	0	0.005
RWS 61	4/23/02	0.001	0	0.002	0	0	0	0	0	0.037
RWS 63	5/28/02	0	0	0	0	0	0	0	0	0.016
RWS 67	4/29/02	0	0	0	0	0	0	0	0	0.004
RWS 71	4/29/02	0	0	0	0	0	0	0	0	0.014

Table 4 Metals in groundwater for locations near K-25

K-25 Locations	*Drinking Water MCL*	*Arsenic 0.05 ppm*	*Cadmium 0.005 ppm*	*Lead 0.05 ppm*	*Mercury 0.002 ppm*	*Nickel*	*Selenium 0.05 ppm*	*Thallium*	*Chromium 0.1 ppm Total*	*Uranium*
Location Name	Date	Arsenic	Cadmium	Lead	Mercury	Selenium	Thallium	Total Chromium	Uranium	Zinc
21002 Sp.	3/25/02	0	0	0	0	0	0	0	0	0.008
	8/8/02	0	0	0	0	0	0	0	0	0
	11/13/02	0	0	0	0	0	0	0	0	0
Happy Valley Sp.	3/25/02	0	0	0	0	0	0	0.001	0	0.005
	10/16/02	0	0	0	0	0	0	0	0	0
Homestead Sp.	4/11/02	0	0	0	0	0	0	0	0	0.006
Horizon Sp.	3/27/02	0	0	0	0	0	0	0	0	0.015
	11/13/02	0	0	0.001	0	0	0	0	0	0.007
Powerhouse Spring	3/27/02	0	0	0	0	0	0	0	0	0.009
	10/16/02	0	0	0	0	0	0	0	0	0.007
USGS 10-895 Sp.	10/16/02	0	0	0	0	0	0	0	0	0.007

Table 5 Metals in groundwater for locations near Y-12

Y-12 Locations	*Drinking Water MCL*	*Arsenic 0.05 ppm*	*Cadmium 0.005 ppm*	*Lead 0.05 ppm*	*Mercury 0.002 ppm*	*Nickel*	*Selenium 0.05 ppm*	*Thallium*	*Chromium 0.1 ppm Total*	*Uranium*	*Zinc 5.0 ppm*
Location Name	Date	Arsenic	Cadmium	Lead	Mercury	Nickel	Selenium	Thallium	Total Chromium	Uranium	Zinc
Bar Gate Sp.	3/21/02	0	0	0	0		0	0	0	0	0.004
	11/13/02	0	0	0	0		0	0	0	0	0
Bootlegger Sp.	10/7/02	0	0	0	0		0	0	0	0	0.001
Cattail Sp.	1/28/02	0	0.001	0	0		0	0	0.001	0	0.009
	10/7/02	0	0	0	0		0	0	0	0	0.004
JES Sludge Seep	3/21/02	0.002	0	0	.00032	0	0	0	0	0	0.003
Kevin's Sp.	1/29/02	0	0	0	0	0.012	0	0	0	0	0.006
	10/31/02	0	0	0	0		0	0	0	0	0.01
NPR 16.0 SW	10/31/02	0	0	0	0		0	0	0	0	0.005
Outfall 2 Sp.	1/29/02	0	0	0	0	0	0	0	0	0	0.015
	10/7/02	0	0	0	0		0	0	0	0	0.012
RCB Sp.	1/30/02	0	0	0	0		0	0	0	0	0.005
Rivers Run Sp.	1/30/02	0	0	0.002	0		0	0	0.001	0	0.006
Scarboro Sp.	1/30/02	0	0	0	0		0	0	0.001	0	0.052
SS 5.95KM Sp.	3/27/02	0	0	0	0		0	0	0	0	0.007
	10/24/02	0	0	0.001	0		0	0	0	0	0.011
SS-4 Sp.	3/11/02	0	0	0	0		0	0	0	0	0.004
	10/22/02	0	0	0	0		0	0	0	0	0.007
SS-5 Sp.	3/11/02	0	0	0	0		0	0	0	0	0.004
	10/21/02	0	0	0	0		0	0	0	0	0.007
SS-7 Sp.	3/6/02	0	0	0	0		0	0	0	0	0.002
	10/21/02	0	0	0	0		0	0	0	0	0.008
SS-8 Sp.	3/6/02	0	0	0	0		0	0	0	0	0.002
	10/21/02	0	0	0	0		0	0	0	0	0.006
Sugar Grove Spring	3/27/02	0	0	0	0		0	0	0	0	0.01
	10/16/02	0	0	0	0		0	0	0	0	0.007

CHAPTER 5 AIR QUALITY MONITORING

Hazardous Air Pollutants Metals Monitoring on East Tennessee Technology Park

Principal Authors: Kristof Czartoryski, Ashwin Brahmbhatt, and Len Berry

Abstract

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division's (DOE-O) Hazardous Air Pollutant (HAPs) Monitoring Program was developed to provide continued independent monitoring at the East Tennessee Technology Park (ETTP) and to verify the Department of Energy's (DOE) reported monitoring results. Monitoring was conducted for arsenic, beryllium, cadmium, total chromium, lead, nickel, and uranium as a metal.

The results of the 2002 monitoring campaign conducted by TDEC at the ETTP sites indicate no apparent elevated levels of for hazardous air pollutants (HAPs) metals of concern. Analyses for all metals of concern were below guidelines, and/or detection limits of laboratory analysis. It should also be noted that other incinerator facilities are in the vicinity of the Oak Ridge Reservation (ORR). The possibility exists that these operations, along with the TVA Bull Run Steam Plant facility on Edgemoor Road and the Kingston Steam Plant, could have an impact on the ambient air around the ORR. Operations at the TSCA Incinerator cannot be singled out as the sole contributor of levels seen in the analytical results from the ETTP or the ORR in general.

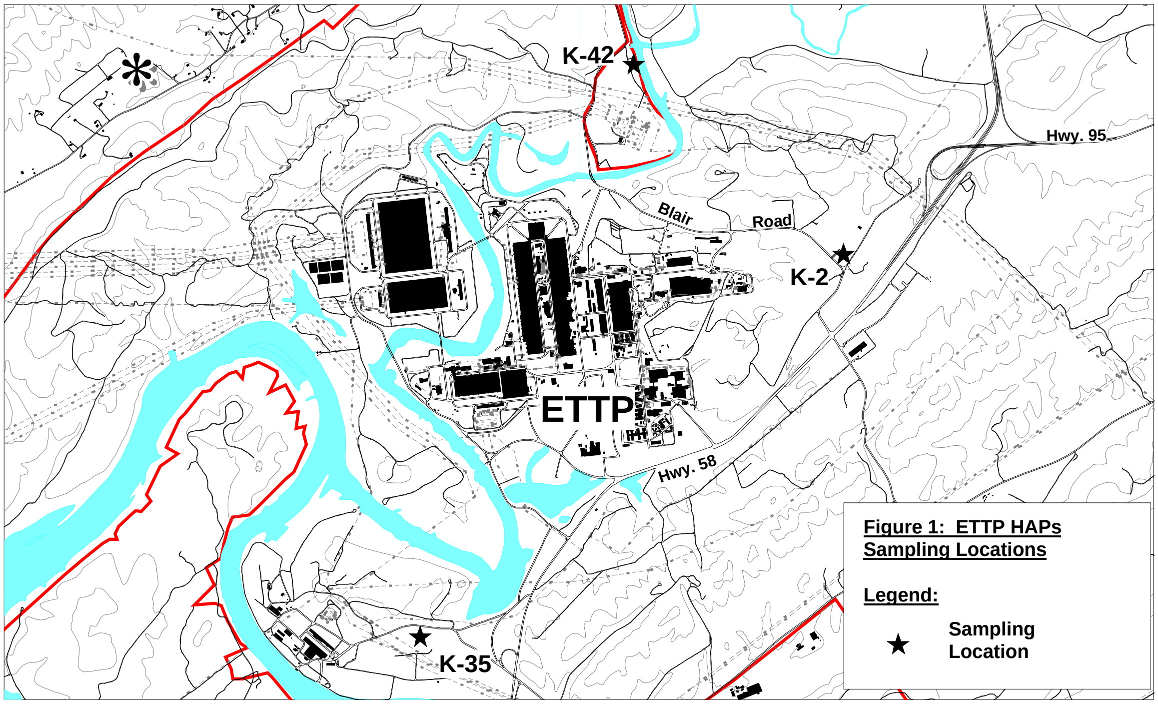
Future D&D activities that could possibly generate emissions of HAPs will continue to be evaluated and monitored as required by TDEC.

This project will continue to monitor for potential effects on the ORR at ETTP in order to provide independent monitoring to assure protection of human health and the environment.

Introduction

Title III of the Clean Air Act Amendments (CAAAs) has identified 189 toxic chemicals. These chemicals, called HAPs, are known or suspected carcinogens, and have high usage and emissions in a wide variety of industries, including printing, metal fabrication, autobody repair, automotive repair, wood finishing, dry cleaning and others. Major stationary sources of HAPs are subject to the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) found in Title III of the CAAAs of 1990. Rather than NESHAPs for each pollutant, the 1990 CAAAs direct EPA to set technology-based standards using maximum achievable control technologies (MACT) for 175 source categories which will require sharp reductions of routine emissions of toxic air pollutants.

In 1997 concerns were raised by members of the public regarding potential health effects due to possible concentrations of HAPs in the ambient air on and around ORR. In response to these concerns, TDEC/DOE-O's Waste Management (WM) program developed an ambient air monitoring program for the ORR in order to determine what effects, if any, DOE operations were having on the ambient air on and around the reservation with regard to HAPs. This program was designed to provide an independent verification of monitoring results as reported by the DOE. Background data was collected at a site located near Norris Lake. These data were used in a comparative manner as a baseline for the area surrounding the ORR. Nickel and uranium as metals were added in 1999 to the list of metals of concern. Future Decontamination and Decommissioning (D&D) activities that could possibly generate emissions of HAPs will continue to be evaluated and monitored as required by TDEC.



ETTP

Methods and Materials

The ambient air sampling for this project was conducted at stations K-2 (Blair Rd opposite the TSCA Incinerator), station K-42 co-located with DOE Perimeter Air Monitor (PAM) 42 (next to Poplar Creek) and station K-35 co-located with DOE Perimeter Air Monitor (PAM) 35 (Gallaher Rd Bridge area). The locations of these monitoring stations are shown in Fig. 1. The same sites were also utilized for the previous TDEC monitoring campaigns.

The monitoring sites selected were chosen based upon windroses data that indicated the sites were in the prevailing wind flow patterns for the region surrounding the ORR. The windflow during the day is a southwest to northeast pattern while during the night; the flow pattern is reversed. The placement then of TDEC's monitors allowed for sampling that would be representative of a 24-hour windflow pattern at the ORR. Additional factor in selecting these locations was an availability of power source.

The project was conducted as closely as possible to the currently established 2002 sampling project schedule. This schedule was modified as needed to accommodate numerous power outages caused by construction near the K-42 site, and other events that effected movement of the samplers. Filter samples were collected on a weekly basis and mailed to the state laboratory in Nashville for analysis.

The principal parameters monitored during 2002 were arsenic, beryllium, cadmium, total chromium, lead, nickel, and uranium. Uranium was analyzed as a metal (by inorganic method). The ambient air sampling schedule is re listed in Table 1.

Results and Discussion

Table 1. HAPs metals ambient air sampling schedule, 2002

Monitoring period[1]	Sampling Locations	Sampling period	Collection frequency	Analysis frequency
1/01/02 – 1/16/02	K-42	Continuous	Weekly	Weekly
1/16/02 – 4/19/02	K-2	Continuous	Weekly	Weekly
4/19/02 – 7/11/02	K-35	Continuous	Weekly	Weekly
7/11/02 –9/10/02	K-2	Continuous	Weekly	Weekly
9/10/02 – 11/22/02	K-35	Continuous	Weekly	Weekly
11/22/02 – 12/31/02	K-42	Continuous	Weekly	Weekly

[1]Sampler rotated between K-2, K-42, and K-35 monitoring locations.

Quarterly lead results were determined from analyses of continuous weekly samples from stations K-2, K-35, and K-42. Lead analytical results are summarized in Table 2 and are compared with the Tennessee and national quarterly ambient air quality standard of 1.5 μg/m^3. The results obtained indicate that this value was only 0.29% of the quarterly standard.

At the time of this report, the ORR Annual Site Environmental Report (ASER) for 2002 was not available. However, analytical results from the 2000, 2001 and 2002 HAPs monitoring program were compared with the 2001 ASER, indicating comparable levels of HAPs in the ambient air in and around the ORR.

Table 2. Lead concentration in ambient air at the ETTP, 2002

Station	**Quarterly averages of weekly samples (μg/m^3)**				**Max quarterly result (μg/m^3)**	**Max weekly result (μg/m^3)**	**Max percent of quarterly standard (μg/m^3)[a]**
	1	**2**	**3**	**4**			
K-2	0.002600	0.002667	0.002375	*b*	0.002667	0.003	0.18
K-35	*b*	0.003500	0.002800	0.004286	0.004286	0.008	0.29
K-42	0.004000	*b*	*b*	0.003250	0.004000	0.004	0.27
Quarterly avg.	0.003300	0.003084	0.002588	0.003768	0.003651	N/A	0.24
Quarterly max	0.004000	0.003500	0.002800	0.004286	0.004286	N/A	0.29
Tennessee and national quarterly ambient air quality standard of 1.5 μg/m^3							
Annual average for all stations = 0.003170 μg/m^3							

[a] Tennessee and national air quality standard for lead is 1.5 μg/m^3 quarterly arithmetic average.
[b] This station was not monitored this quarter.

Analyses of hazardous air pollutant carcinogenic metals (arsenic, beryllium, cadmium, chromium, and nickel) were performed on all collected continuous weekly samples from stations K-2, K-35, and K-42. These analytical results are summarized in Table 3. There are no Tennessee or national ambient air quality standards for these hazardous air pollutants. The annual average concentrations were compared to risk specific doses and reference air concentrations as listed in 40 CFR 266.

There were no detected concentrations of arsenic, beryllium, cadmium, chromium or uranium. The annual average result for nickel was 0.000128 $\mu g/m^3$, well below the risk-specific dose of 0.042 $\mu g/m^3$.

At the time of this report, the ORR Annual Site Environmental Report (ASER) for 2002 was not available. However, analytical results from the 2000, 2001 and 2002 HAPs monitoring program were compared with the 2001 ASER. The 2001 ASER indicated detection of hazardous air pollutant carcinogenic metals with all of them below the risk-specific doses. The maximum monthly concentrations of cadmium reported in 2001 ASER were in the vicinity of the ETTP steam plant and arsenic, beryllium and chromium at the K-770 scrap yard, locations that were not monitored by this DOE Oversight division's independent environmental project. Nickel was not included as a monitoring parameter in 2001 ASER. The maximum concentration of uranium was reported, by DOE in the 2001 ASER, as less than 1% of Derived Concentration Guide of 0.15$\mu g/m^3$.

Table 3. Hazardous air pollutant carcinogenic metals concentration in ambient air at the ETTP, 2002

HAPs	Ambient air concentration ($\mu g/m^3$)			Annual concentration guideline ($\mu g/m^3$)	Percentage of standard (guideline)
	Annual avg.	Weekly max	Max location		
Arsenic	U	U		0.0023[a]	0
Beryllium	U	U		0.004[a]	0
Cadmium	U	U		0.0056[a]	0
Chromium	U	U		0.00083[a] Cr-VI 1000.0[a] Cr-III	0
Nickel	0.000128	0.004	K-2	0.042[a]	0.3
Uranium	U	U		0.15[b]	0

U – Analyte not detected in laboratory analysis

[a] Risk-specific doses for As, Be, Cd, Cr-VI, and Ni and the reference air concentration for Cr-III as listed in 40 CFR 266.

[b] DOE Order 5400.5 Derived Concentration Guide (DCG) for naturally occurring uranium is an annual concentration of 1E-01 pCi/m^3, which is equivalent to 100 mrem annual inhalation dose. This is equivalent to 0.15 ug/m^3 assuming mass-to-curie concentration conversion for natural uranium assay of 0.717% ^{235}U.

Conclusion

The results of the 2002 monitoring campaign conducted by TDEC at the ETTP sites indicate no apparent elevated levels of for hazardous air pollutants (HAPs) metals of concern. Analyses for all metals of concern were below guidelines, and/or detection limits of laboratory analysis.

It should also be noted that other incinerator facilities are in the vicinity of the ORR. The possibility exists that these operations, along with the TVA Bull Run Steam Plant facility on Edgemoor Road and the Kingston Steam Plant could have an impact on the ambient air around the ORR. Operations at the TSCA Incinerator cannot be singled out as the sole contributor of levels seen in the analytical results from the ETTP or the ORR in general.

This project has been re-authorized to continue into 2003. Sampling sites will remain as they have for the year 2002. Future D&D activities that could possibly generate emissions of HAPs will continue to be evaluated and monitored as required by TDEC.

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Operations Manual for GMW Model2000H Total Suspended Particulate Sampling System, 1998 Graseby GMW Variable Resistance Calibration Kit # G2835.

TDEC/DOE-O Procedure number: SOP-ES&H-004 Air Monitoring/Air Sampling

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CHAPTER 5 AIR QUALITY MONITORING

Hazardous Air Pollutants Metals Monitoring on Y-12 and ORNL (X-10)

Principal Authors: Kristof Czartoryski, Ashwin Brahmbhatt, Len Berry

Abstract

The Tennessee Department of Environment and Conservation, Department of Energy Oversight Division's (TDEC/DOE-O) Hazardous Air Pollutant (HAPs) Monitoring Program was developed to provide continued independent monitoring at the Oak Ridge National Lab (ORNL) and Y-12 National Security Complex (Y-12) to verify the Department of Energy's (DOE) reported monitoring results. Monitoring was conducted for arsenic, beryllium, cadmium, total chromium, lead, nickel, and uranium as a metal.

The results of the 2002 monitoring campaign conducted by TDEC at the Y-12 and ORNL sites indicate no apparent elevated levels of for hazardous air pollutants (HAPs) metals of concern. Analyses for all metals of concern were below guidelines, and/or detection limits of laboratory analysis.

It should also be noted that other incinerator facilities are in the vicinity of the Oak Ridge Reservation. The possibility exists that these operations, along with the TVA Bull Run Steam Plant facility on Edgemoor Road and the Kingston Steam Plant could have an impact on the ambient air around the ORR. Operations at the TSCA Incinerator cannot be singled out as the sole contributor of levels seen in the analytical results on the ORR in general.

Future D&D activities that could possibly generate emissions of HAPs will continue to be evaluated and monitored as required by TDEC.

This project will continue to monitor for potential effects on the ORR at Y-12 and ORNL in order to provide independent monitoring to assure protection of human health and the environment.

Introduction

Title III of the Clean Air Act Amendments (CAAAs) has identified 189 toxic chemicals. These chemicals, called HAPs, are known or suspected carcinogens, and have high usage and emissions in a wide variety of industries, including printing, metal fabrication, autobody repair, automotive repair, wood finishing, dry cleaning and others. Major stationary sources of HAPs are subject to the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) found in Title III of the CAAAs of 1990. Rather than NESHAPs for each pollutant, the 1990 CAAAs direct EPA to set technology-based standards using maximum achievable control technologies (MACT) for 175 source categories which will require sharp reductions of routine emissions of toxic air pollutants.

In 1997 concerns were raised by members of the public regarding potential health effects due to possible concentrations of HAPs in the ambient air on and around ORR. In response to these concerns, TDEC/DOE-O's Waste Management (WM) program developed an ambient air monitoring program for the ORR in order to determine what effects, if any, DOE operations were having on the ambient air on and around the reservation with regard to HAPs. This program was designed to provide an independent verification of monitoring results as reported by the DOE. Background data was collected at a site located near Norris Lake. These data were used in a comparative manner as a baseline for the area surrounding the ORR. Nickel and uranium as metals were added in 1999 to the list of metals of concern. Future Decontamination and Decommissioning (D&D) activities that could possibly generate emissions of HAPs will continue to be evaluated and monitored as required by TDEC.

ORNL

Monitoring at ORNL was conducted at stations located at both the east and west ends of this facility. The western site is co-located at the Perimeter Air Monitor (PAM) 3 off Bethel Valley Road. The monitor at the east-end of ORNL is co-located with Meteorological Tower 3. See Figure 1.

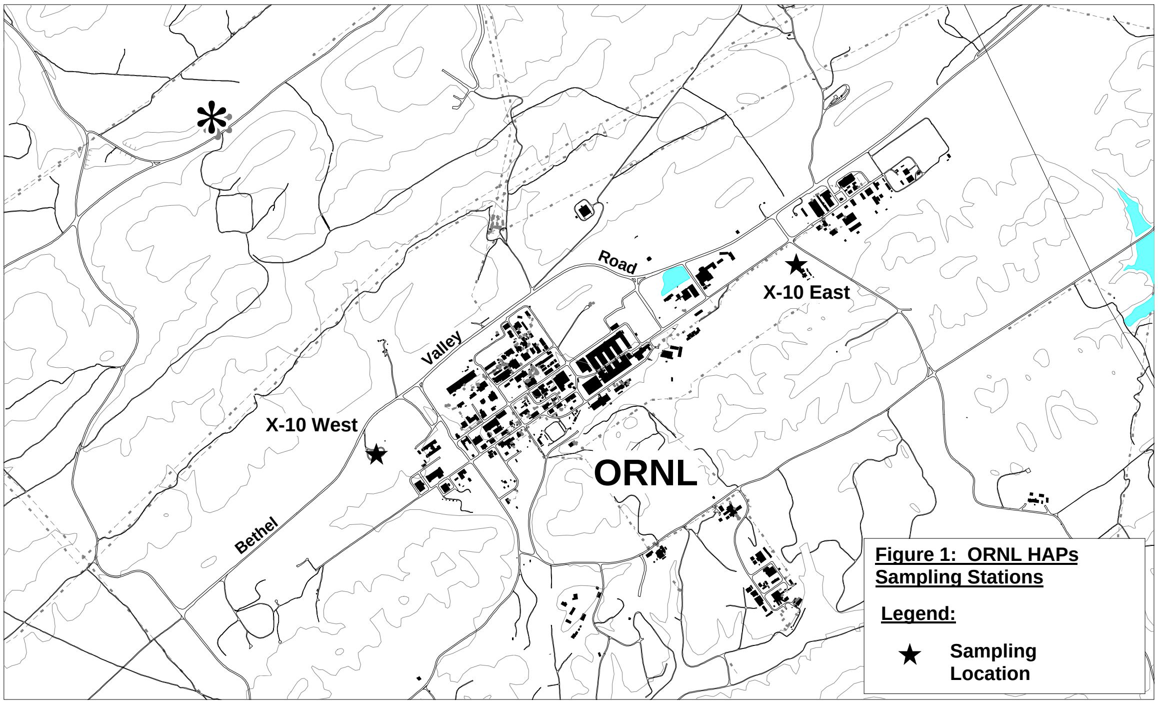

Figure 1: ORNL HAPs Sampling Stations

Y12

Monitoring at Y-12 was conducted at stations located at both the east and west ends of this facility. The site at the west-end of Y-12 is co-located with Meteorological Tower 6 on Bear Creek Valley Road. The monitoring site at the east-end of Y-12 is co-located with Meteorological Tower 5. See Figure 2.

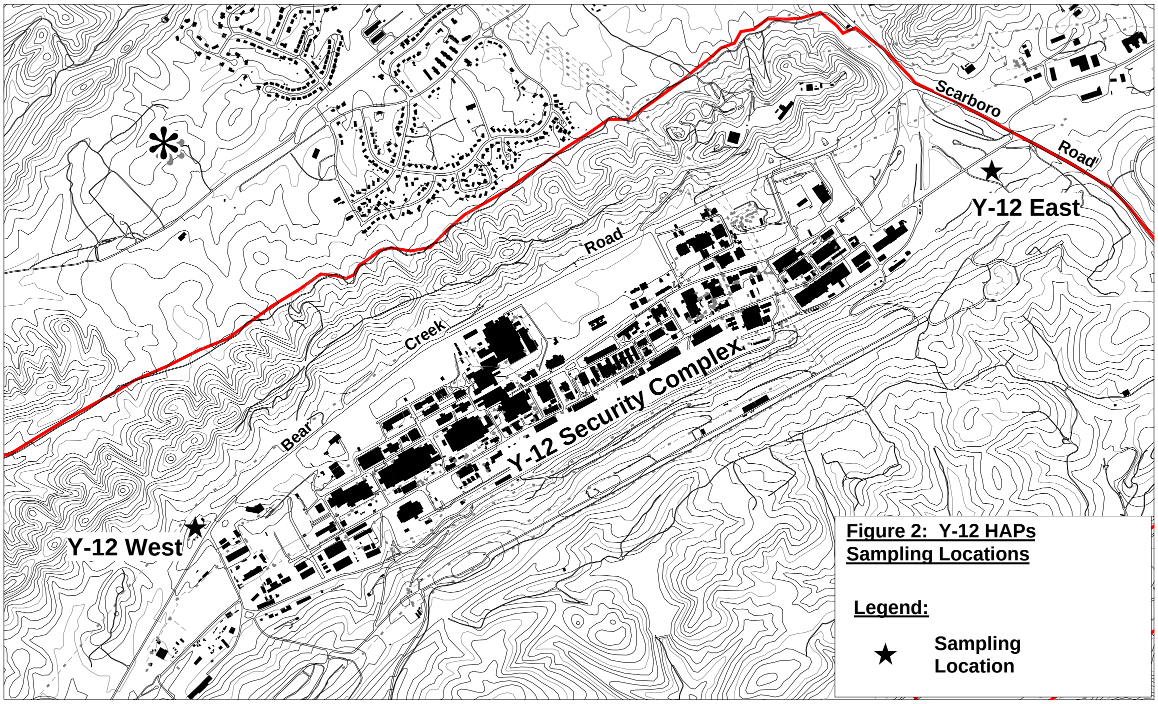

Figure 2: Y-12 HAPs Sampling Locations

Methods and Materials

The monitoring sites selected were chosen based upon windroses data that indicated the sites were in the prevailing wind flow patterns for the region surrounding the ORR. The windflow during the day is a southwest to northeast pattern while during the night; the flow pattern is reversed. The placement then of TDEC's monitors allowed for sampling that would be representative of a 24-hour windflow pattern at the ORR. Additional factor in selecting these locations was an availability of power source.

The project was conducted as closely as possible to the currently established 2002 sampling project schedule. Filter samples were collected on a weekly basis and mailed to the state laboratory in Nashville for analysis.

The principal parameters monitored during 2002 were arsenic, beryllium, cadmium, total chromium, lead, nickel, and uranium. Uranium was analyzed as a metal (by inorganic method). The ambient air sampling schedules for ORNL and Y-12 are listed in Table 1 and Table 2, respectively.

Results and Discussion

Table 1. HAPs metals ambient air sampling schedule, 2002 at ORNL

Monitoring period[1]	Sampling Locations	Sampling period	Collection frequency	Analysis frequency
1/1/02 – 5/2/02	X-10 W	Continuous	Weekly	Weekly
5/2/02 – 7/11/02	X-10 E	Continuous	Weekly	Weekly
7/11/02 – 9/10/02	X-10 W	Continuous	Weekly	Weekly
9/10/02 – 12/6/02	X-10 E	Continuous	Weekly	Weekly
12/6/02 – 12/31/02	X-10 W	Continuous	Weekly	Weekly

[1]Sampler rotated between X-10 E and X-10 W monitoring locations.

Table 2. HAPs metals ambient air sampling schedule, 2002 at Y-12

Monitoring period[1]	Sampling Locations	Sampling period	Collection frequency	Analysis frequency
1/1/02 – 2/5/02	Y-12 W	Continuous	Weekly	Weekly
2/5/02 – 7/11/02	Y-12 E	Continuous	Weekly	Weekly
7/11/02 – 9/10/02	Y-12 W	Continuous	Weekly	Weekly
9/10/02 – 12/17/02	Y-12 E	Continuous	Weekly	Weekly
12/17/02 – 12/31/02	Y-12 W	Continuous	Weekly	Weekly

[1]Sampler rotated between Y-12 E and Y-12 W monitoring locations.

Quarterly lead results were determined from analyses of continuous weekly samples from stations X-10 E and X-10 W at ORNL and from stations Y-12 E and Y-12 W at the Y-12 site. Lead analytical results are summarized in Table 3 and Table 4 and are compared with the Tennessee and national quarterly ambient air quality standard of 1.5 $\mu g/m^3$. At ORNL the results obtained indicate that this value was only 0.35% of the quarterly standard. At Y-12 the results obtained indicate that this value was only 0.21% of the quarterly standard.

At the time of this report, the ORR Annual Site Environmental Report (ASER) for 2002 was not available. However, analytical results from the 2000, 2001 and 2002 HAPs monitoring program were compared with the 2001 ASER, indicating comparable levels of HAPs in the ambient air in and around the ORR.

Table 3. Lead concentration in ambient air at ORNL, 2002

Station	Quarterly averages of weekly samples (μg/m³)				Max quarterly result (μg/m³)	Max weekly result (μg/m³)	Max percent of quarterly standard (μg/m³)[a]
	1	2	3	4			
X-10 E	*b*	0.0032	0.0033	0.0029	0.0032	0.0060	0.21
X-10 W	0.0029	0.0035	0.0052	0.0025	0.0052	0.0070	0.35
Quarterly avg.	0.0029	0.0034	0.0043	0.0027	0.0043	N/A	0.29
Quarterly max	0.0029	0.0035	0.0052	0.0029	0.0052	N/A	0.29
Tennessee and national quarterly ambient air quality standard of 1.5 μg/m³							
Annual average for all stations = 0.003170 μg/m³							

[a] Tennessee and national air quality standard for lead is 1.5 μg/m³ quarterly arithmetic average.
[b] This station was not monitored this quarter.

Table 4. Lead concentration in ambient air at Y-12, 2002

Station	Quarterly averages of weekly samples (μg/m³)				Max quarterly result (μg/m³)	Max weekly result (μg/m³)	Max percent of quarterly standard (μg/m³)[a]
	1	2	3	4			
Y-12 E	0.0032	0.0030	0.0030	0.0026	0.0032	0.0050	0.21
Y-12 W	0.0028	*b*	0.0028	0.0020	0.0028	0.0040	0.19
Quarterly avg.	0.0030	0.0030	0.0029	0.0023	0.0030	N/A	0.20
Quarterly max	0.0032	0.0030	0.0030	0.0026	0.0032	N/A	0.21
Tennessee and national quarterly ambient air quality standard of 1.5 μg/m³							
Annual average for all stations = 0.003170 μg/m³							

[a] Tennessee and national air quality standard for lead is 1.5 μg/m³ quarterly arithmetic average.
[b] This station was not monitored this quarter.

Analyses of hazardous air pollutant carcinogenic metals (arsenic, beryllium, cadmium, chromium, and nickel) were performed on all collected continuous weekly samples from stations X-10 E and X-10 W at ORNL and from stations Y-12 E and Y-12 W at the Y-12 site. These analytical results are summarized in Table 5 and Table 6. There are no Tennessee or national ambient air quality standards for these hazardous air pollutants. The annual average concentrations were compared to risk specific doses and reference air concentrations as listed in 40 CFR 266.

There were no detected concentrations of arsenic, beryllium, cadmium, and uranium. The annual average result for nickel at both X-10 and Y-12 was 0.0001 μg/m³, well below the risk-specific dose of 0.042 μg/m³. The annual average result for chromium at both X-10 and Y-12 was 0.0001 μg/m³, well below the risk specific dose of 0.00083 for Cr VI and 1000.0 for Cr III.

At the time of this report, the ORR Annual Site Environmental Report (ASER) for 2002 was not available. However, analytical results from the 2000, 2001 and 2002 HAPs monitoring program were compared with the 2001 ASER. The 2001 ASER indicated detection of hazardous air pollutant carcinogenic metals with all of them below the risk-specific doses. Nickel was not included as a monitoring parameter in 2001 ASER. The maximum concentration of uranium was reported, by DOE in the 2001 ASER, as less than 1% of Derived Concentration Guide of 0.15μg/m^3.

Table 5. Hazardous air pollutant carcinogenic metals concentration in ambient air at ORNL, 2002

HAPs	Ambient air concentration (μg/m^3)			Annual concentration guideline (μg/m^3)	Percentage of standard (guideline)
	Annual avg.	Weekly max	Max location		
Arsenic	U	U		0.0023[a]	0
Beryllium	U	U		0.004[a]	0
Cadmium	U	U		0.0056[a]	0
Chromium	0.0001	0.005	X-10 W	0.00083[a] Cr-VI 1000.0[a] Cr-III	13.7 for Cr VI 0 for Cr III
Nickel	0.0001	0.003	X-10 E	0.042[a]	0.27
Uranium	U	U		0.15[b]	0

U – Analyte not detected in laboratory analysis

[a] Risk-specific doses for As, Be, Cd, Cr-VI, and Ni and the reference air concentration for Cr-III as listed in 40 CFR 266.

[b] DOE Order 5400.5 Derived Concentration Guide (DCG) for naturally occurring uranium is an annual concentration of 1E-01 pCi/m^3, which is equivalent to 100 mrem annual inhalation dose. This is equivalent to 0.15 ug/m^3 assuming mass-to-curie concentration conversion for natural uranium assay of 0.717% ^{235}U.

Table 6. Hazardous air pollutant carcinogenic metals concentration in ambient air at Y-12, 2002

HAPs	Ambient air concentration (μg/m^3)			Annual concentration guideline (μg/m^3)	Percentage of standard (guideline)
	Annual avg.	Weekly max	Max location		
Arsenic	U	U		0.0023[a]	0
Beryllium	U	U		0.004[a]	0
Cadmium	U	U		0.0056[a]	0
Chromium	0.0001	0.004	Y-12 E	0.00083[a] Cr-VI 1000.0[a] Cr-III	14.6 for Cr VI 0 for Cr III
Nickel	0.0001	0.003	Y-12 E	0.042[a]	0.22
Uranium	U	U		0.15[b]	0

U – Analyte not detected in laboratory analysis

[a] Risk-specific doses for As, Be, Cd, Cr-VI, and Ni and the reference air concentration for Cr-III as listed in 40 CFR 266.

[b] DOE Order 5400.5 Derived Concentration Guide (DCG) for naturally occurring uranium is an annual concentration of 1E-01 pCi/m^3, which is equivalent to 100 mrem annual inhalation dose. This is equivalent to 0.15 ug/m^3 assuming mass-to-curie concentration conversion for natural uranium assay of 0.717% ^{235}U.

Conclusion

The results of the 2002 monitoring campaign conducted by TDEC at ORNL and Y-12 sites indicate no apparent elevated levels of for hazardous air pollutants (HAPs) metals of concern. Analyses for all metals of concern were below guidelines, and/or detection limits of laboratory analysis.

It should also be noted that other incinerator facilities are in the vicinity of the ORR. The possibility exists that these operations, along with the TVA Bull Run Steam Plant facility on Edgemoor Road and the Kingston Steam Plant could have an impact on the ambient air around the ORR. Operations at the TSCA Incinerator cannot be singled out as the sole contributor of levels seen in the analytical results from the ETTP or the ORR in general.

This project has been re-authorized to continue into 2003. Sampling sites will remain as they have for the year 2002. Future D&D activities that could possibly generate emissions of HAPs will continue to be evaluated and monitored as required by TDEC.

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CHAPTER 5 AIR QUALITY MONITORING

Environmental Radiation Ambient Monitoring System (ERAMS) Air Program (RMO)

Principal Author: James L. Dunlap

Abstract

The Environmental Protection Agency's Environmental Radiation Ambient Monitoring System (ERAMS) is designed to monitor potential pathways for significant population exposures from routine and/or accidental releases of radioactivity from major sources in the United States (EPA, 1988). This program provides radiochemical analysis of air samples taken from five air monitoring stations located on the Oak Ridge Reservation. In this effort, samples are collected twice weekly at each station by personnel from the Tennessee Department of Environment and Conservation (TDEC) to be analyzed at the EPA's National Air and Radiation Environmental Laboratory in Montgomery, Alabama. The results are provided to TDEC and published in a quarterly EPA report, *Environmental Radiation Data* (available on the Internet). In 2002 the results were similar for each ERAMS monitoring station with one exception: an elevated measurement taken at the Bethel Valley monitoring station. The elevated result has been attributed to strontium-90 releases from the 3038 stack at the Oak Ridge National Laboratory on June 26 and 27. Aside from this measurement, the ERAMS results exhibited trends and concentrations similar to those observed in TDEC's Perimeter and Fugitive Air Monitoring Programs.

Introduction

In the past, air emissions from Department of Energy (DOE) activities on the Oak Ridge Reservation (ORR) have been believed to be a potential cause of illnesses affecting area residents. While these emissions have substantially decreased over the, concerns have remained that air pollutants from current activities (e.g., incineration of radioactive wastes, production of radioisotopes, and remedial activities) could pose a threat to public health and / or the surrounding environment. As a consequence, the Tennessee Department of Environment and Conservation (TDEC) has implemented three air monitoring programs to assess the impact of ORR air emissions on the surrounding environment and the effectiveness of DOE controls and monitoring systems. TDEC's Perimeter and Fugitive Air Monitoring Programs (described in associated reports) focus on monitoring exit pathways, non-point sources of emissions, and sites of special interest. TDEC's participation in the Environmental Protection Agency's (EPA) Environmental Radiation Ambient Monitoring System (ERAMS) supplements the other programs and provides verification of State and DOE monitoring, via independent third party analysis.

EPA's ERAMS program is comprised of a national network of monitoring stations that regularly collect samples of air, water, and milk for radiochemical analysis. Historically, this network has been used to track environmental releases of radioactivity from nuclear weapons tests and nuclear accidents. In response to TDEC requests and an initiative to incorporate site specific monitoring into the program, EPA agreed to locate five air-monitoring stations on the ORR in December of 1994. These stations began operation in 1996.

Methods and Materials

In the Oak Ridge ERAMS effort, EPA provides radiochemical analysis of air samples collected by TDEC staff at the five monitoring stations depicted in Figure 1.

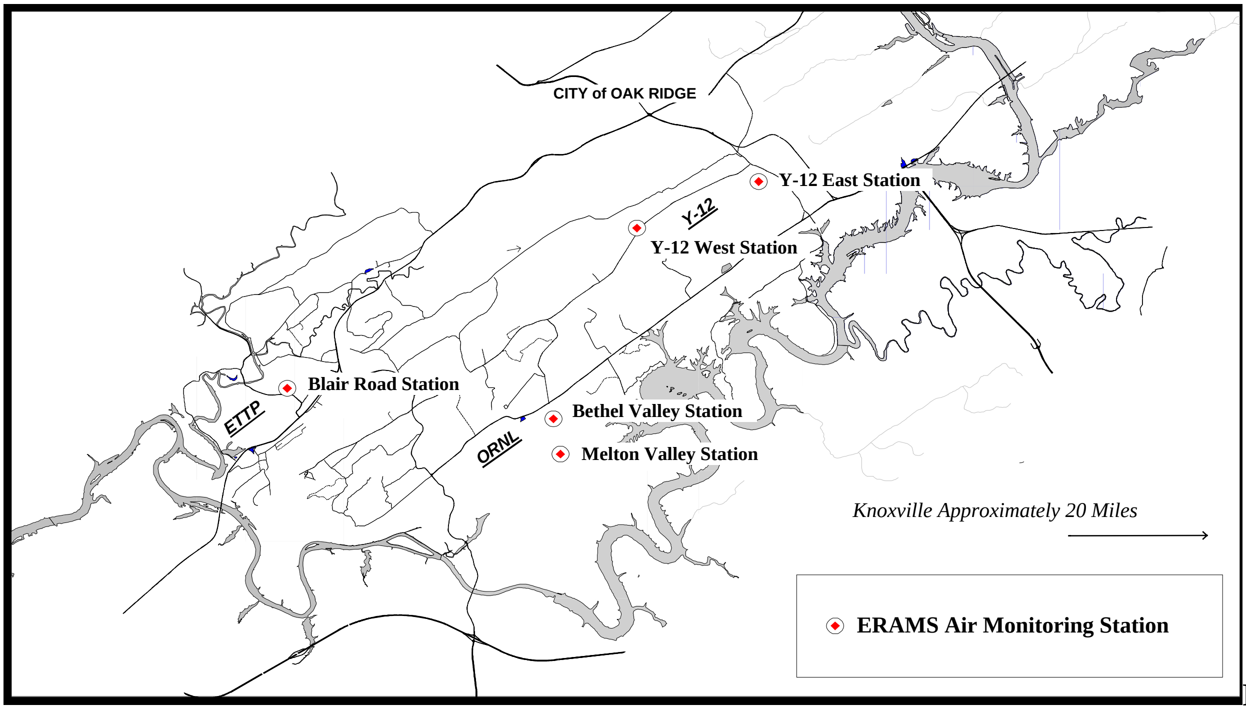


Figure 1: Approximate Locations of Air Stations Monitored in Association with EPA's Environmental Radiation Ambient Monitoring System on the Oak Ridge Reservation

The ERAMS air samplers are operated continuously. As air is moved through the samplers, airborne particulates are collected on synthetic fiber filters. TDEC staff change these filters twice weekly and record the airflow through the units before and after the filter changes. The quantity of radioactivity on each filter is then estimated by using the air flow measurements and a Geiger-Mueller radiation detector, prior to sending the filters to EPA for radiochemical analysis.

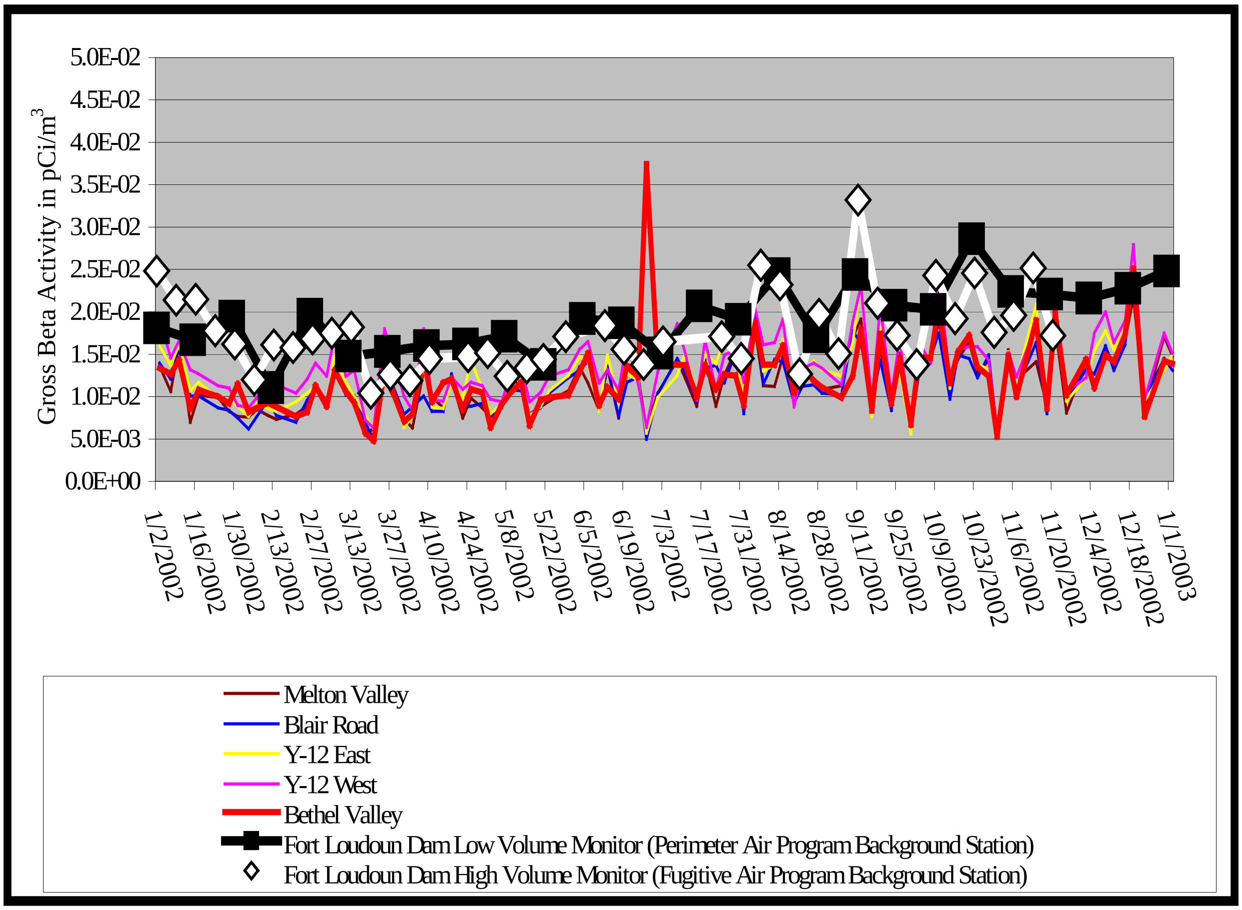
Radiochemical analysis is performed on the filters at EPA's National Air and Radiation Environmental Laboratory (NAREL) in Montgomery, Alabama. Analytical parameters are listed Table 1. Results of the analysis are provided to TDEC and published by EPA in a quarterly report titled *Environmental Radiation Data*. This publication is currently available on the internet at http://www.epa.gov/narel/erams.html.

Table 1: EPA Analysis of Air Samples Taken in Association with the Environmental Radiation Ambient Monitoring System

ANALYSIS	FREQUENCY
Gross Beta	Each of twice weekly samples
Gamma Scan	Samples showing greater than 1 pCi/m^3 of gross beta
Plutonium-238, Plutonium-239, Plutonium-240, Uranium-234, Uranium-235, Uranium-238	Semiannually on composite air particulate filters

Results and Discussion

The gross beta results for each ERAMS monitoring station followed the same general trends noted in the TDEC's Perimeter and Fugitive Air Monitoring Programs. Figure 2 illustrates the similarity in trends noted in the ERAMS results for 2002 and those observed in background samples taken at Fort Loudoun Dam by both the low and high volume air samplers used in the Perimeter and Fugitive Air Monitoring Programs. To a large degree, these trends are due to natural phenomena (e.g., wind and rain) that influence the amount of particulates suspended in the air and have similar effects on both the background location and the ERAMS monitoring locations. With one exception, it can also be noted in Figure 2 that the concentrations reported for the ERAMS stations are slightly lower than those reported for the perimeter and fugitive air monitoring background stations. This slight bias is consistent with past measurements and is believed to be an artifact of the different equipment and frequency of sampling used in the programs.



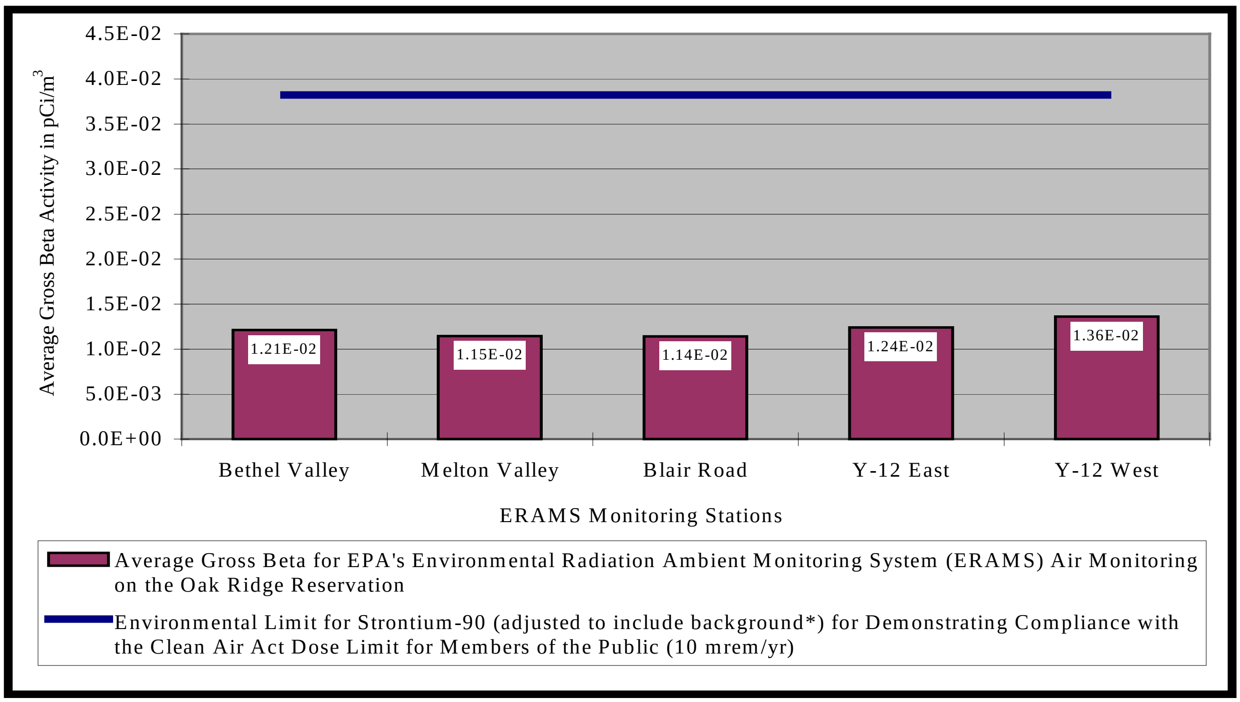
Note: Typical background values for gross beta range from 0.005 - 0.1 pCi/m^3 (ORISE, 1993)

Figure 2: Comparison of Trends in Year 2002 Gross Beta Results from Air Samples taken on the Oak Ridge Reservation in Association with EPA's Environmental Radiation Ambient Monitoring System and Background Data collected in TDEC's Perimeter and Fugitive Air Monitoring Program*

* This chart is intended to illustrate the similarity in trends noted in the gross beta activity for samples associated with the ERAMS program and the division's Perimeter Air Monitoring Program (not convey specific results).

The exception previously noted is represented by the prominent peak near the center of the chart in Figure 2. This measurement was taken from a sample collected at the Bethel Valley ERAMS Station, which is located on the east side of the Oak Ridge National Laboratory (ORNL). The elevated result is believed to be due to accidental releases of strontium-90 from the 3039 stack at ORNL. These releases apparently occurred during the replacement of a high-efficiency particulate air filter at the 3039 stack on June 26 and 27. Associated information can be found in *Investigation Report of the Strontium Contamination Event at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (Bechtel Jacobs Co. LLC, 2002).

Despite the elevated result at the Bethel Valley Monitoring Station, the 2002 average gross beta results for the stations in the ERAMS program were all relatively close (0.0115 to 0.0136 pCi/m^3). Figure 3 provides the 2002 average results for each station in the ORR Program. The environmental level for strontium-90 used to demonstrate compliance with the Clean Air Act radiation dose limit for members of the public (10 mrem/yr) is provided for comparison. This level applies to the dose above background; therefore, the standard provided in the figure has been adjusted to include the average gross beta background measurement for TDEC's Perimeter Air Monitoring Program.



*The standards provided by the Clean Air Act apply to the dose above background; therefore, the standard provided for reference in this figure has been adjusted to include the background measurements taken from the division's Perimeter Monitoring Program during the same period

Figure 3: Year 2002 Average Results for Gross Beta Analysis of Air Samples taken on the Oak Ridge Reservation in Association with EPA's Environmental Radiation Ambient Monitoring System

None of the gross beta results reported by NAREL exceeded the screening level of 1 pCi/m^3 that would have required analysis by gamma spectrometry under ERAMS protocol. The results of isotopic analysis performed semiannually by NAREL on composite samples had not been completed at the time of this report.

Conclusion

In general, the gross beta results for each of the five ERAMS air monitoring stations exhibited similar trends and concentrations observed in TDEC's Perimeter and Fugitive Air Monitoring Programs. An exception to the above was noted for a sample collected in June from the Bethel Valley ERAMS air monitor. This elevated measurement has been attributed to releases of strontium-90 from the 3039 stack at ORNL during the period the sample was being collected. Despite the elevated result, the annual average concentration for all the ORR ERAMS stations were below standards for demonstrating compliance with the Clean Air Act.

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CHAPTER 5 AIR QUALITY MONITORING

Fugitive Radiological Air Emissions Monitoring (RMO)

Principal Author: Gary Riner

Abstract
The Tennessee Department of Environment and Conservation (TDEC) uses a portable high volume air sampler to monitor fugitive radiological air emissions at sites of interest on the Oak Ridge Reservation. A second high volume monitor has been placed at Fort Loudoun Dam in Loudon County to provide background data for comparison. Since August 1999, the portable unit has been stationed between the K-31 and K-33 Process Buildings at the East Tennessee Technology Park. These facilities are contaminated with uranium isotopes, technetium-99, and transuranic radionuclides. They are currently undergoing cleanup activities in association with the Department of Energy's reindustrialization effort on the reservation. In the spring of 2002, an upward trend (when compared to background data) was noted in results from the site. After facility representatives were notified the results began to decline and are currently being reported near background levels. Despite the previous elevated results, the annual average concentration remained well within the standards provided by the Clean Air Act.

Introduction
The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division (DOE-O) conducts monitoring for fugitive radiological air emissions on and in the vicinity of the Oak Ridge Reservation (ORR). This program uses a portable high volume air monitor to supplement air sampling performed at fixed locations. In addition to its mobility, the high volume monitor provides greater measurement sensitivity and resolution than can be achieved with the low volume monitors used in the division's Perimeter Air Monitoring Program. From August 1999 through 2002, the portable sampler was used to monitor emissions from the K-31 and K-33 Process Buildings at the East Tennessee Technology Park (ETTP). Together, these facilities cover more than 47 acres of land and contain greater than 150 acres of floor area. During operations, the facilities were an integral part of the uranium enrichment process and are known to be contaminated with uranium isotopes, technetium-99, and transuranic radionuclides. The facilities are currently being cleaned up in association with DOE's Reindustrialization Initiative.

Methods and Materials
Two high volume air samplers are used in this program. One of these units is mobile, allowing it to be moved to different locations of interest. The second unit has been stationed at Fort Loudoun Dam in Loudon County to collect background information. Both samplers use 8x10 glass fiber filters to collect suspended particulate matter as air is pulled through the units. The filters are collected weekly by staff and shipped by certified mail to the state's radiochemical laboratory in Nashville, Tennessee for analysis. Analysis includes gross alpha, gross beta, and gamma spectrometry on each of the weekly samples. Additional analysis is performed where merited.

Monitoring in this program is directed toward locations where there is a potential for the release of fugitive/diffuse air emissions as a consequence of remedial or waste management activities. Results from the portable samplers are compared to background data collected by the high volume monitor placed at Fort Loudoun Dam and environmental standards provided in the Clean Air Act (CAA).

Since August 1999, the portable monitor has been stationed between the K-31 and K-33 Process Buildings at ETTP. These facilities were contaminated during process operations and are currently being cleaned-up in association with DOE's reindustrialization effort.

Results and Discussion

To a large degree, data from samples taken at the K-31 and K-33 Process Facilities have been relatively consistent with measurements and trends observed at the background station. In 2001 gross alpha measurements taken at the site were slightly above background results, but consistently followed the short-term trends recorded at the background station. In the spring of 2002, staff noted a consistent increase in the ETTP results (when compared to the background values) as can be seen in Figures 1 and 2. These results also diverged from the short-term trends observed at the background station (i.e., the ETTP values increased, where background data decreased), suggesting an increase of emissions from the ETTP Process Facilities or an additional contribution to the levels measured from a new and unknown source.

In discussions of the anomalous data, it was noted the elevated results appeared to correlate with DOE permission to resume work associated with dismantling the K-31 facility that had been suspended earlier in the year. As a consequence, the DOE contractor responsible for the clean up of the K-31 and K-33 facilities advised they would have their radiological control personnel investigate. While the exact cause of the increasing levels remains unclear to division staff, the concentrations reported substantially decreased in August and are currently being measured at levels consistent with background data.

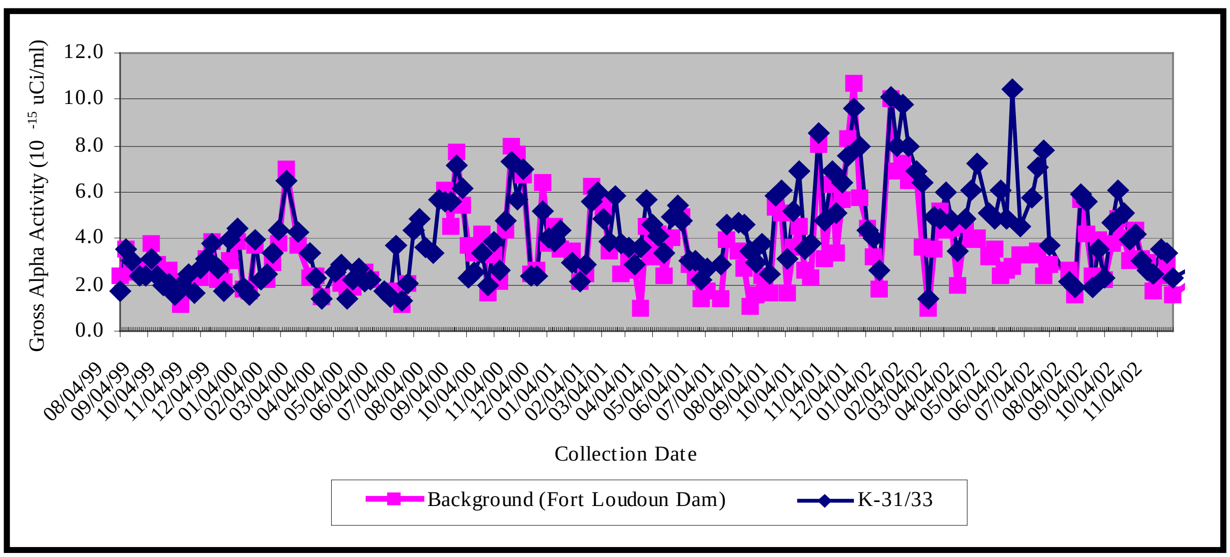


Figure 1: Gross Alpha Activities reported for Year 2002 Monitoring performed at the K-31 and K-33 Process Buildings and the Background Station at Fort Loudoun Dam

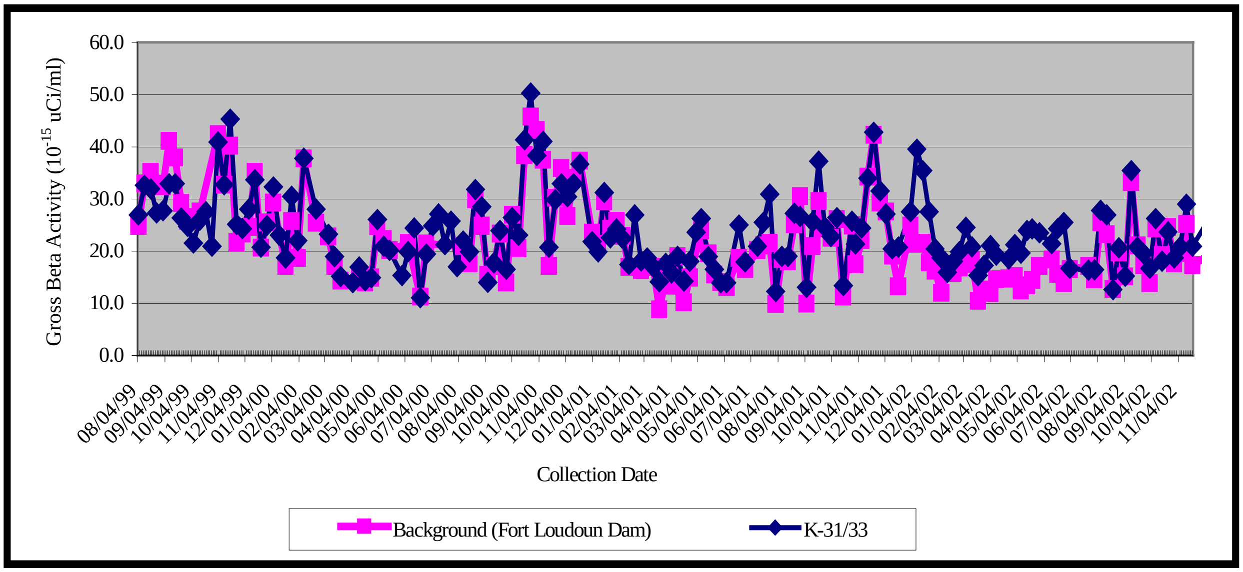
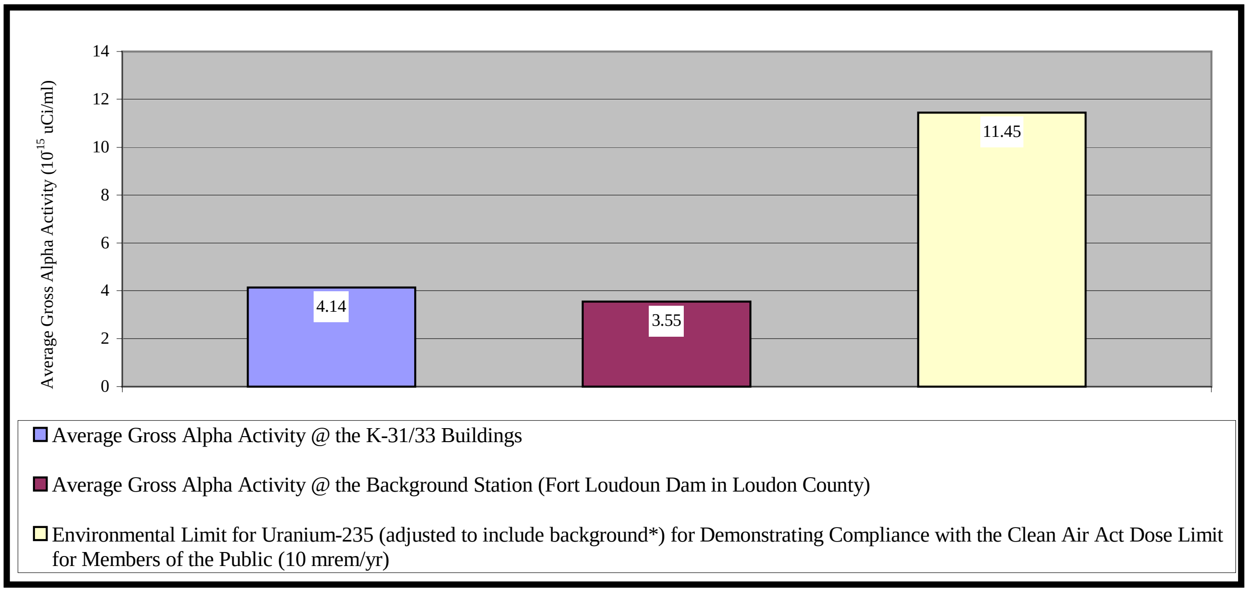


Figure 2: Gross Beta Activities reported for Year 2002 Monitoring performed at the K-31 and K-33 Process Buildings and the Background Station at Fort Loudoun Dam

The CAA specifies that exposures to the public from radioactive materials released to the air from DOE facilities shall not cause members of the public to receive an effective dose equivalent greater than 10 mrem in a year. Compliance with this standard is generally determined for point source emissions that employ air dispersion models to predict the dose at off-site locations. However, the CAA also provides environmental concentrations for radionuclides that can be used to demonstrate compliance with the 10 mrem/yr limit. TDEC staff use these standards to evaluate the predictions derived from air dispersion models and to assess fugitive emissions. Because the hazards associated with the various radionuclides differ significantly, the CAA requires specific analysis for each isotope determined to be of concern. Consequently, the standards provided by the CAA do not include limits for gross alpha and beta activities. Nevertheless, the more economical gross measurements, when treated as surrogates for the more hazardous isotopes, can provide an effective screening mechanism to determine if further evaluation is warranted. To this end, staff compare the gross measurements obtained in TDEC's air sampling programs to some of the more restrictive standards provided by the CAA.

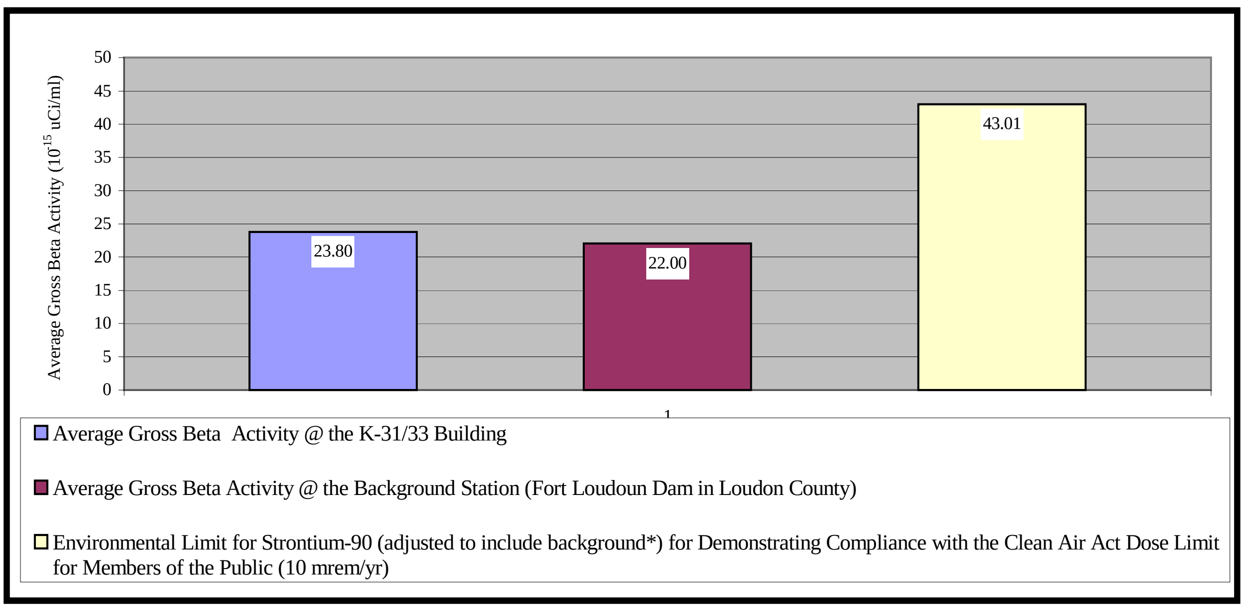
The average gross alpha and beta activities for TDEC's fugitive air monitoring at the K-31 and K-33 Process Building and the Fort Loudoun background station are provided in Figures 3 and 4. The CAA standards provided for reference are those of uranium-235 (primarily an alpha emitter) and strontium-90 (a beta emitter). It is very unlikely that the total gross measurements would be attributable to these radionuclides alone, so the comparison should be viewed as very conservative.

Since the environmental standards provided by the CAA apply to the dose above background, the standards provided for reference in the Figures 3 and 4 have been adjusted to include the average background measurement for the year.



*The standards provided by the Clean Air Act apply to the dose above background; therefore, the standards provided for reference in this figure have been adjusted to include the background measurements taken from the division's perimeter monitoring program during the same period.

Figure 3: Average Gross Alpha measured at the K-31 and K-33 Process Buildings during 2002 compared to Background Measurements and the Concentration Level for Uranium-235 to Demonstrate Compliance with the Clean Air Act Dose Limit for Members of the Public



*The standards provided by the Clean Air Act apply to the dose above background; therefore, the standards provided for reference in this figure have been adjusted to include the background measurements taken from the Division's perimeter monitoring program during the same period.

Figure 4: Average Gross Beta Measured at the K-31 and K-33 Process Buildings during 2002 compared to Background Measurements and the Concentration Level for Strontium-90 to Demonstrate Compliance with the Clean Air Act Dose Limit for Members of the Public

Conclusion

During 2002 measurements of fugitive emissions taken near the K-31 and K-33 Process Buildings at ETTP by TDEC were not indicative of airborne radionuclides (attributable to DOE activities) at levels above CAA standards.

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CHAPTER 5 AIR QUALITY MONITORING

Oak Ridge Reservation Perimeter Ambient Air Monitoring Program (RMO)

Principal Author: James L. Dunlap

Abstract

The Tennessee Department of Environment and Conservation (TDEC) conducts a perimeter air monitoring program on the Oak Ridge Reservation using low volume air samplers. This program, in conjunction with associated air monitoring programs, provides information used to assess the impact of Department of Energy activities on the local environment and public health. In the program, samples are collected biweekly from twelve air monitors stationed near the boundaries of the reservation and at a background location (i.e., Fort Loudoun Dam). Each of the samples is analyzed for gross alpha and gross beta radiation at the state radiochemistry laboratory. A composite sample from each location is analyzed annually for gamma emitters. Results from the perimeter monitoring stations are compared to the background measurements and environmental standards provided in the Clean Air Act. While several short-term excursions were noted at stations near the Y-12 facility during the year, data from the program did not indicate a significant impact on local air quality from activities on the reservation.

Introduction

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division provides radiochemical analysis of air samples taken from twelve low volume air monitors located on and in the vicinity of the Oak Ridge Reservation (ORR). The monitors used to collect the samples are owned by DOE and maintained by DOE contractors. Data derived from this program, along with information generated by the other air monitoring programs on the reservation, is used to (1) assess the impact of DOE activities on the public health and environment, (2) identify and characterize unplanned releases, (3) establish trends in air quality, and (4) verify data generated by DOE and its contractors.

Methods and Materials

The twelve air monitors used in the program are owned by 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. The remaining three monitors were previously used by the Y-12 facility in their perimeter air monitoring program. One of these monitors, station 5 was inaccessible during most of 2002, due to increased security after the attack on the World Trade Center.

All 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 use a pump and rotormeter, which indicates an average flow rate of approximately two cubic feet per minute.

Air filters are collected from the monitors biweekly and sent by certified mail to the state's radiochemical laboratory in Nashville, Tennessee, for analysis. Analysis includes gross alpha and gross beta on the biweekly samples. Gamma spectrometry is performed on any samples that exhibit elevated gross results and annually on composite samples.

The twelve air monitoring stations used in the program are listed in Table 1. Eleven of these stations are located around the perimeter of the ORR and Y-12 facility. The twelfth site is a background station located at Fort Loudoun Dam in Loudon County. (Figure 1)

Table 1: Perimeter Air Monitoring Stations

Station	Location	County
4	Y-12 Perimeter near portal 2	Anderson
5	Y-12 Perimeter near Building 9212	Anderson
8	Y-12 Perimeter west end near portal 17	Anderson
35	East Tennessee Technology Park	Roane
37	Bear Creek at Y-12 / Pine Ridge	Roane
38	Westwood Community	Roane
39	Cesium Fields at Oak Ridge National Laboratory	Roane
40	Y-12 East	Anderson
42	East Tennessee Technology Park off Blair Road	Roane
46	Scarboro Community	Anderson
48	Deer Check Station on Bethel Valley Road	Anderson
52	Fort Loudoun Dam (Background Station)	Loudon

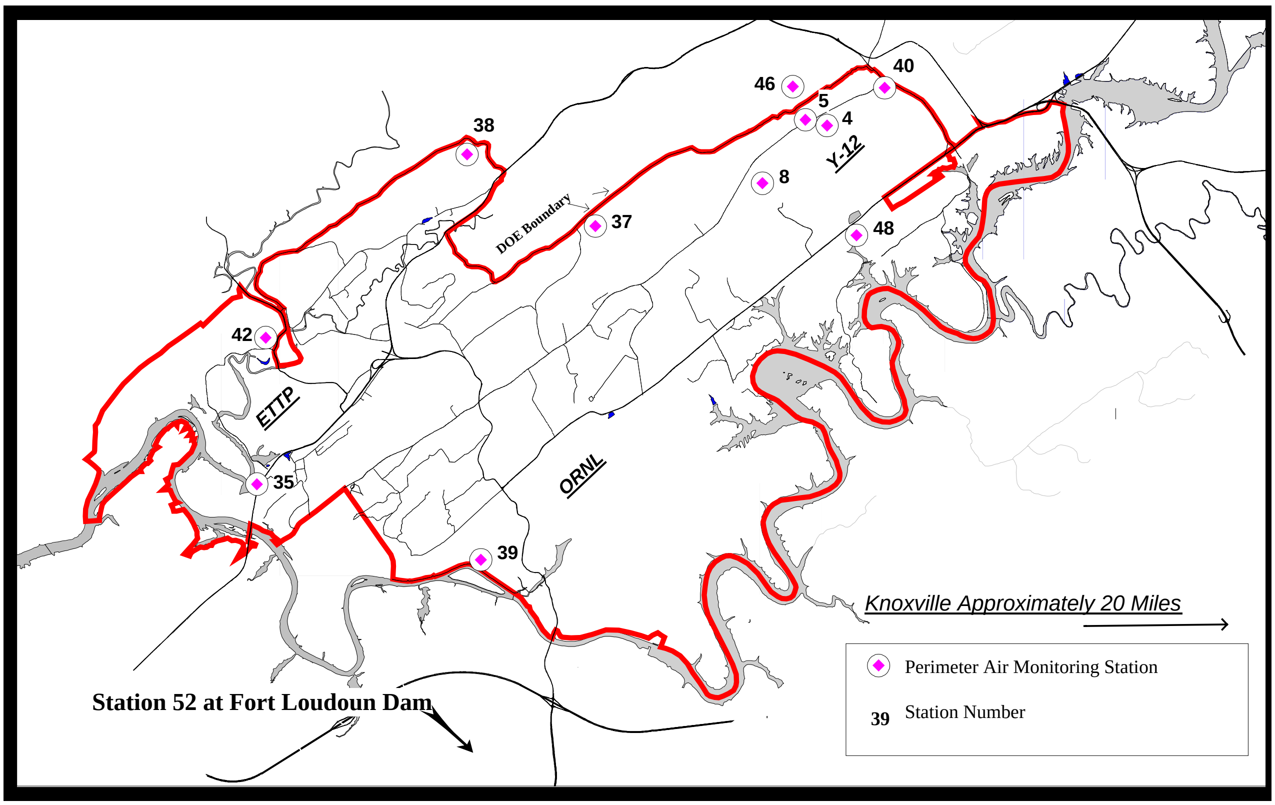


Figure 1: Approximate Location of Perimeter Air Monitoring Stations

Results and Discussion

In general, results reported in 2002 for the perimeter air monitoring stations were near those reported for the background station. Similar trends in the activities for gross alpha and gross beta were observed for each monitoring station. Figures 2 and 3 illustrate the correlation between fluctuations in the gross alpha and beta results at the perimeter stations and the background location. These fluctuations, to a large degree, can be attributed to natural phenomena or changing environmental conditions, which increase or decrease the amount of particulate deposited on the sampling filters. For example, concentrations of potassium-40 and radionuclides in the uranium and thorium decay series may increase, because soils in which they naturally occur have been dispersed in the air as a consequence of dry conditions, heavy winds, and/or local activities (e.g., construction). Conversely, rain and snow can remove materials suspended in the air reducing the concentration of contaminants deposited on the air filters. Concentrations of cosmogenic radionuclides (e.g., beryllium-7) are also highly variable, fluctuating in response to sunspot activity and the degree of mixing between the stratosphere, where they are produced, and the troposphere, where TDEC samples. (ORISE, 1993)

Short-term excursions above background levels can be noted in Figures 2 and 3 during January, March, and December for stations 4, 5, 8, and 46, which are located at/near the Y-12 facility. The exact cause of these elevated results is unknown, but the Y-12 facility is currently undergoing a program to modernize operational facilities and remove unneeded buildings. Either component of the program could have caused the slightly elevated results. As discussed below, these short-term excursions do not constitute a violation of applicable standards.

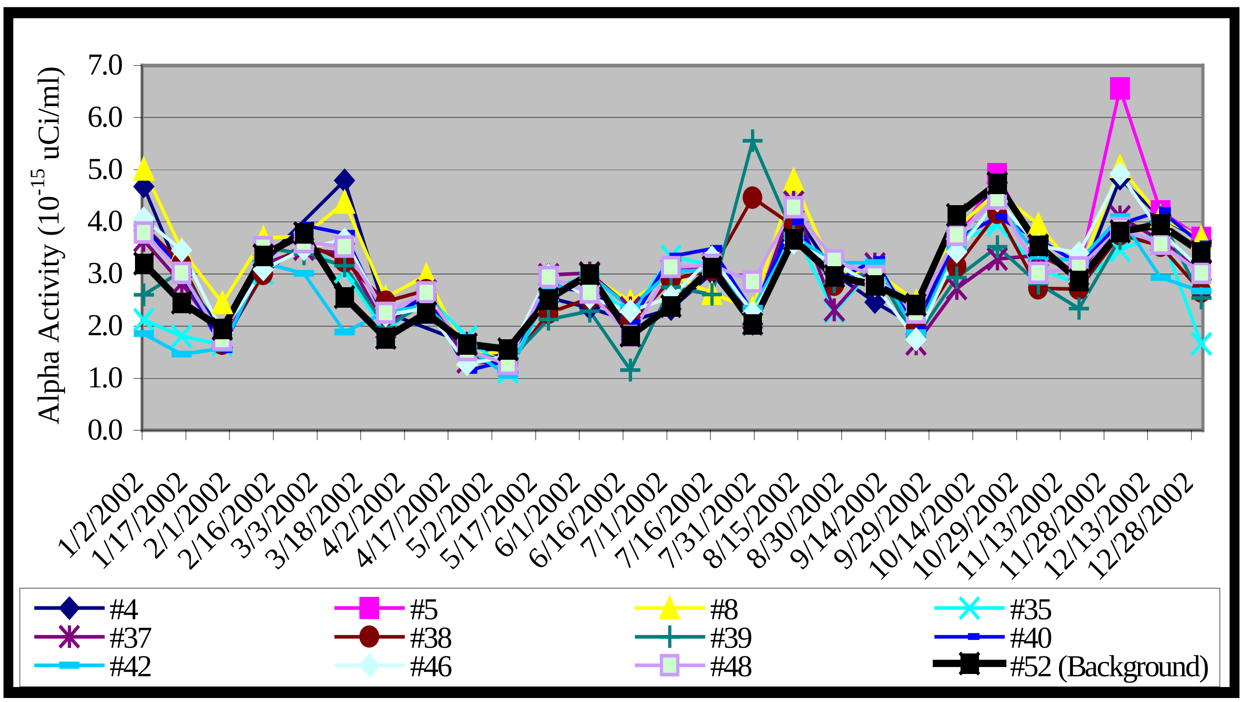


Figure 2: Gross Alpha Results for TDEC Perimeter Air Monitoring Stations for the Year 2002

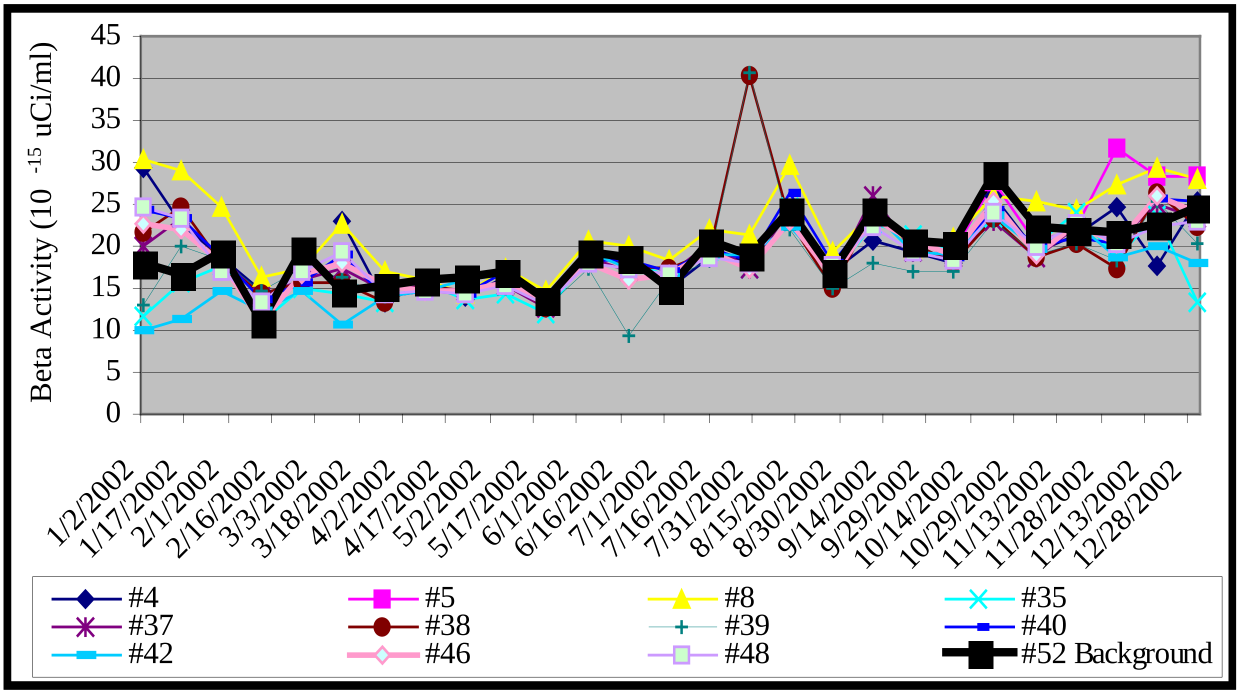
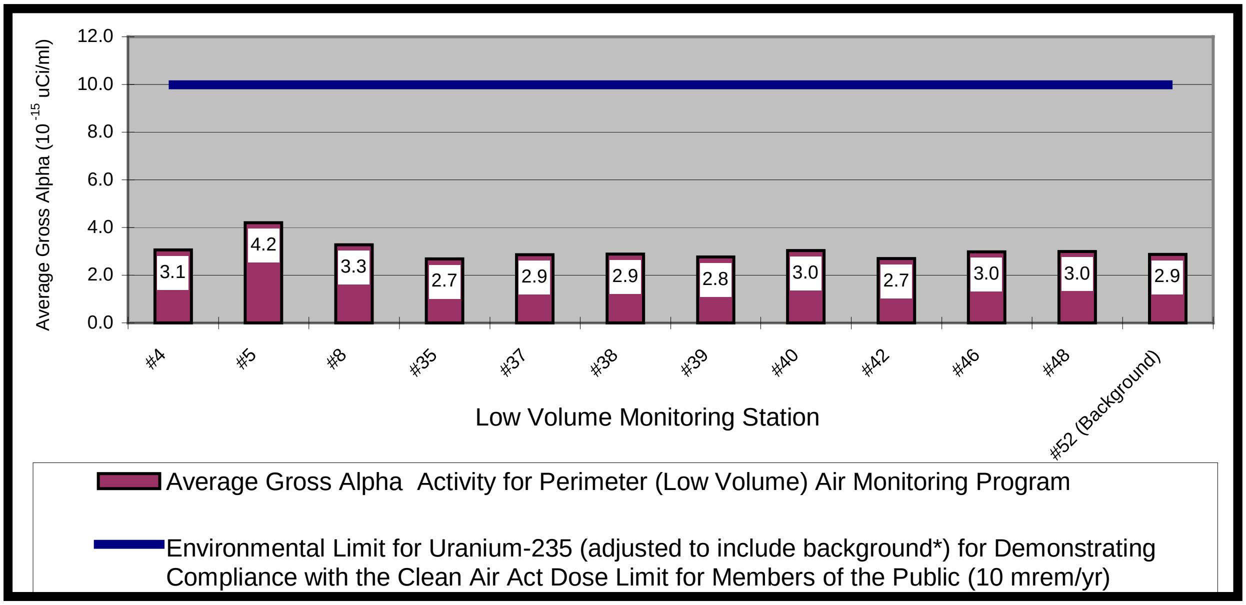


Figure 3: Gross Beta Results for TDEC Perimeter Air Monitoring Stations for the Year 2002

The simplest method of assessing the impact of ORR air emissions on the local environment is to compare results from the perimeter monitoring stations to those of the background station located at Fort Loudoun Dam (Station 52). As can be seen in Figures 2 through 5, the activities reported for the perimeter air stations for gross alpha and gross beta were relatively consistent with the background values, with the exceptions noted above.

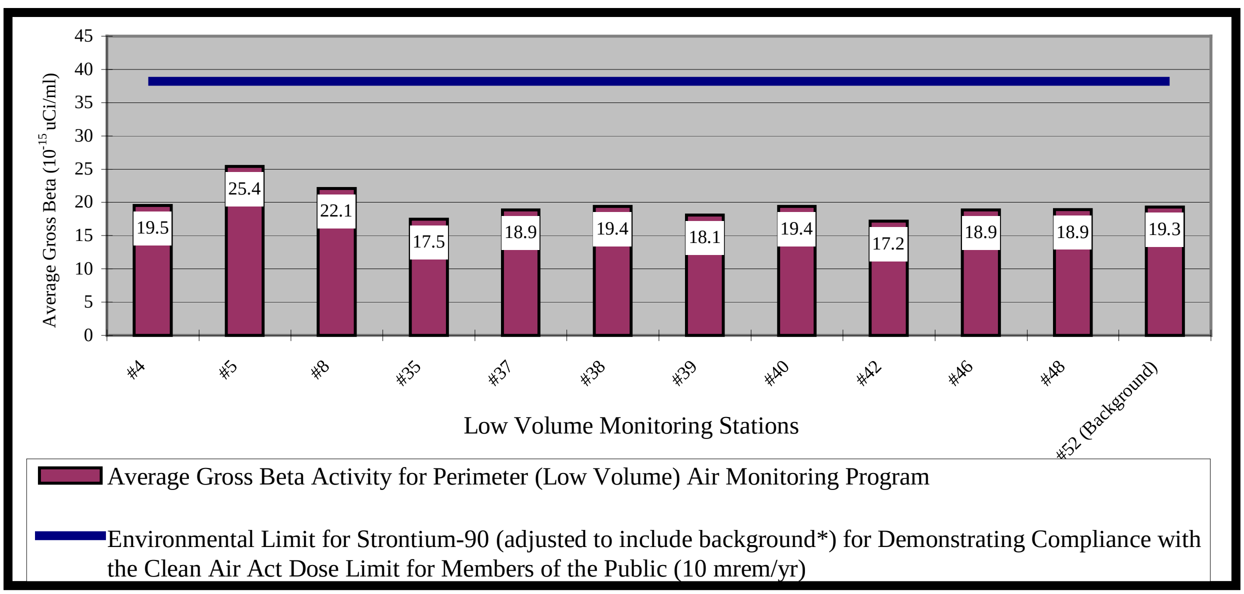
The Clean Air Act (CAA) specifies that exposures to the public from radioactive materials released to the atmosphere from DOE facilities shall not cause members of the public to receive, in a year, an effective dose equivalent greater than 10 mrem above background measurements. Data from TDEC's air monitoring is compared to ambient air concentrations provided in the CAA for demonstrating compliance with the 10 mrem/yr limit. While the CAA environmental standards do not include limits for gross alpha and beta, these measurements provide an effective tool to assess if further investigation merited.

Figures 4 and 5 show the average activity for gross alpha and beta measured during the year 2002 at the perimeter air stations. Station 5 was inaccessible until late September, so the average depicted is only for three months. The CAA environmental standards (adjusted to include background radiation) for uranium-235 (primarily an alpha emitter) and strontium-90 (a beta emitter) are provided for comparison. These isotopes have some of the more restrictive standards prescribed by the CAA. It should be understood that it is very unlikely that these isotopes would be responsible for a major proportion of the gross activity reported for the samples.



*The standards provided by the Clean Air Act apply to the dose above background: therefore, the standard provided for reference in the figure has been adjusted to include the background measurements.
**Station 5 was inaccessible until late September due to increased security after the attack on the World Trade Center. Consequently, the average is based on three months of data.

Figure 4: Average Gross Alpha Results for Perimeter Air Monitoring for the Year 2002



*The standards provided by the Clean Air Act apply to the dose above background: therefore, the standard provided for reference in the figure has been adjusted to include the background measurement.
**Station 5 was inaccessible until late September due to increased security after the attack on the World Trade Center. Consequently, the average is based on three months of data.

Figure 5: Average Gross Beta Results for Perimeter Air Monitoring for the Year 2002

The annual gamma analysis performed on composite samples from each station has not been completed; consequently, these results were not available for this report. In the past, the gamma results have been considered consistent with background measurements.

Conclusion

Environmental concentrations of radionuclides in the atmosphere tend to vary from location to location and seasonally in response to natural and anthropogenic influences. In this regard, results of radiochemical analysis of samples taken at ORR perimeter air monitoring stations appear to follow similar trends as the background station located near Fort Loudoun Dam. In general, concentrations of radionuclides reported for the perimeter air monitoring stations were consistent with data reported for the background stations. Short-term excursions above background measurements were observed in data for air monitors in the vicinity of the Y-12 facility. While the exact cause of these excursions is unknown, the data did not indicate exceedances of standards provided in the CAA.

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CHAPTER 6 RADIOLOGICAL MONITORING

Ambient Radiation Monitoring on the Oak Ridge Reservation Using Environmental Dosimetry (RMO)

Principal Author: Gary Riner

Abstract

The Tennessee Department of Environment and Conservation began monitoring ambient radiation levels on the Oak Ridge Reservation in 1995. This program provides estimates of the dose to members of the public from exposure to gamma/neutron radiation attributable to Department of Energy activities on the reservation and baseline values for measuring the need and effectiveness of remedial activities. In this effort, environmental dosimeters have been placed at selected locations on and near the reservation. Results from the dosimeters are compared to background values and the state primary dose limit for members of the public (100 mrem/yr). Since the dose reported for each site is based on continuous exposure over the course of the year, the results are considered conservative by nature. All the doses reported for 2002 at off-site locations were below the state primary dose limit for members of the public. However, several locations on the reservation that are considered to be potentially accessible to the public exhibited results in excess of this limit. These sites are primarily associated with uranium hexafluoride cylinder storage yards at the East Tennessee Technology Park; where DOE's reindustrialization initiative has resulted in an influx of businesses not directly related to DOE operations. As in the past, various sites located in restricted areas of the reservation exhibited annual doses in excess of the dose limit for members of the public. These sites are subject to remediation in accordance with provisions specified in CERCLA and the Federal Facility Agreement for the Oak Ridge Reservation. Decreases in the doses observed at several of these locations in 2002 can be attributed to remedial activities.

Introduction

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

- conservative estimates of the potential dose 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 and/or 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 dosimeters were used to measure the radiation dose attributable to external radiation at selected monitoring stations. Associated data was compared to background values and the state's primary dose limit for members of the public.

Methods and Materials

The dosimeters used in the program were obtained from Landauer, Inc., Glenwood, Illinois. Each of the dosimeters used an aluminum oxide photon detector to measure the dose from gamma radiation over the period monitored (minimum reporting value = 1 mrem). At locations where there was a potential for the release of neutron radiation, the dosimeters also contained an allyl diglycol carbonate based neutron detector (minimum reporting value = 10 mrem). Dosimeters that contained photon detectors alone were collected quarterly and sent to Landauer for processing. Dosimeters that contained both photon and neutron detectors were collected and processed semiannually (to allow more precise neutron measurements). To account for exposures that could have been received in transit or storage, control dosimeters of both types were provided with each shipment from the Landauer Company. The control dosimeters were stored at the division's office and returned to Landauer with the associated field deployed dosimeters for processing. Any exposure received by the control dosimeters was subtracted from the dose reported for the field-deployed dosimeters.

As the quarterly results were received, staff prepared a report of the data, which was provided to interested parties. At the end of the year, the quarterly results were summed for each location and the resultant annual doses compared to background values and the state primary dose limit for members of the public (100 mrem/year). Associated data is presented in Table 1. Monitoring stations in the program included operating facilities; locations on the ORR that are potentially accessible to the public; local communities; and sites subject to or undergoing remediation. These locations are depicted in Figures 1 through 3, along with the annual dose for each site.

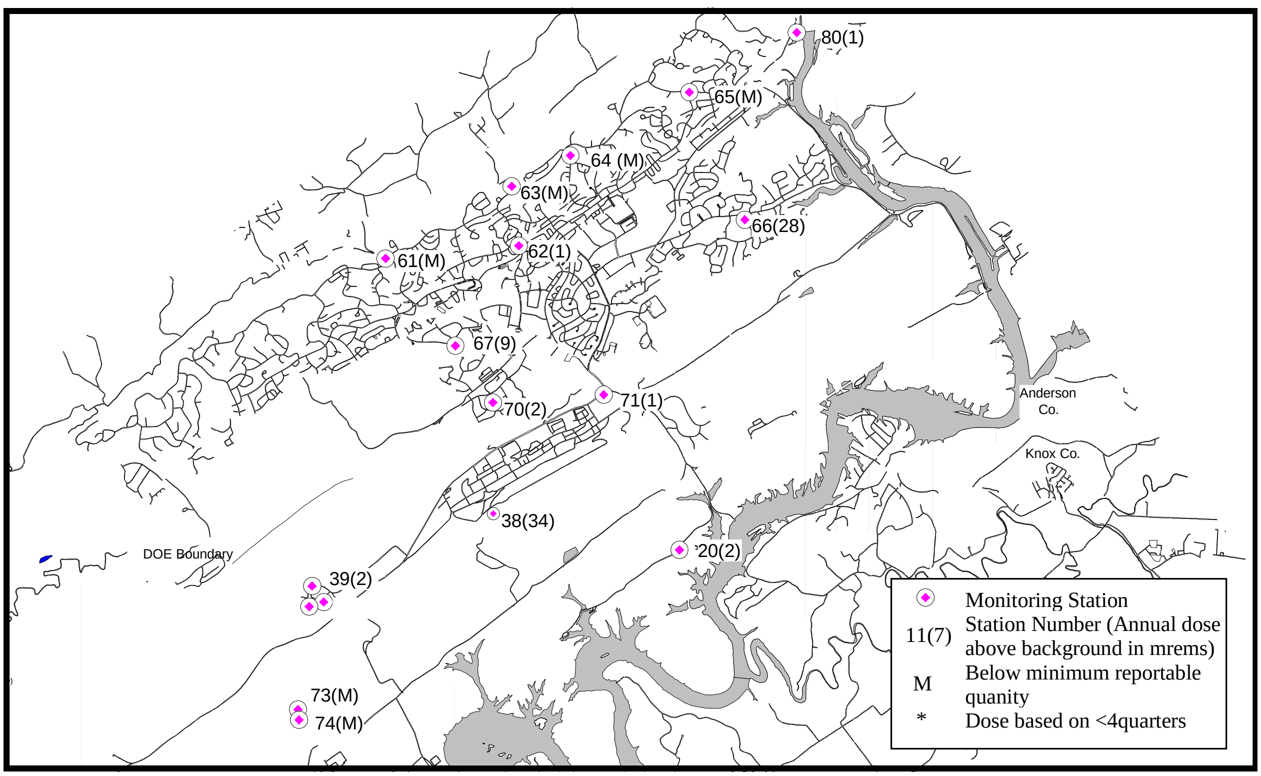

Figure 1: Approximate Locations of Environmental Dosimeters deployed in the Vicinity of the Y-12 Facility during the Year 2002

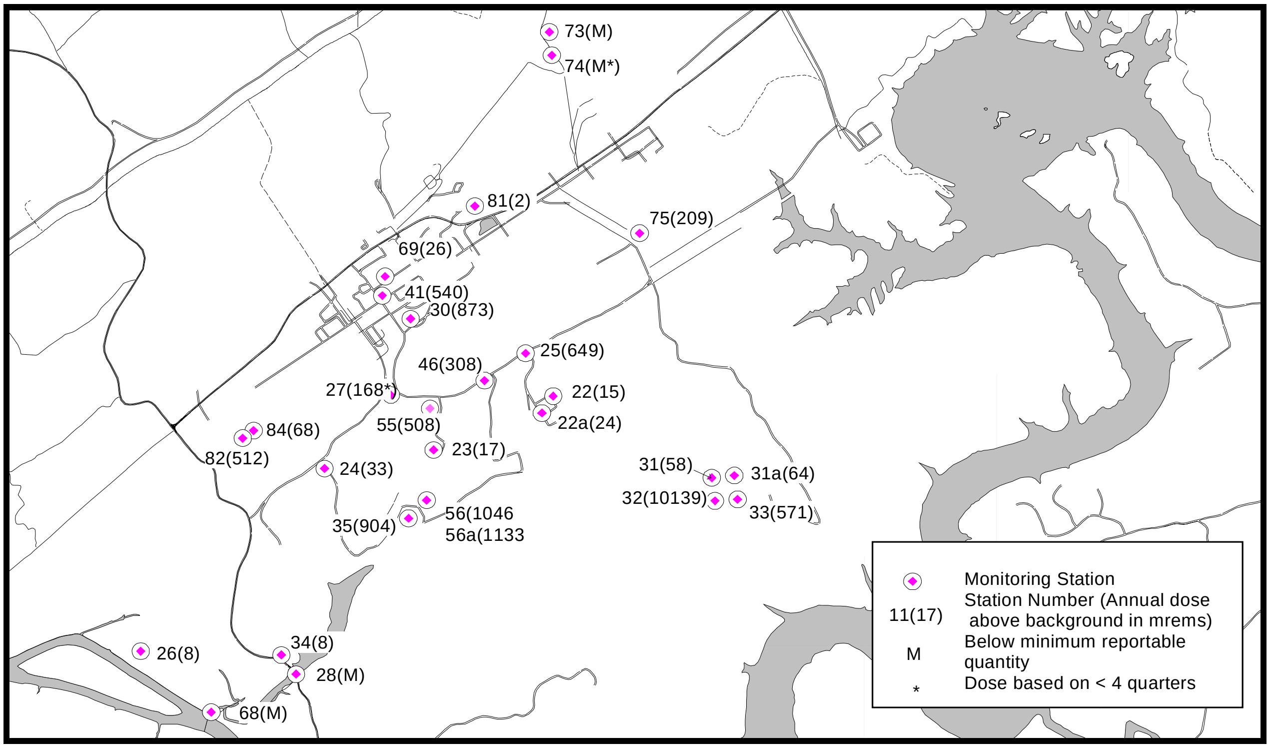

Figure 2: Approximate Locations of Environmental Dosimeters deployed in the Vicinity of the Oak Ridge National Laboratory during the Year 2002

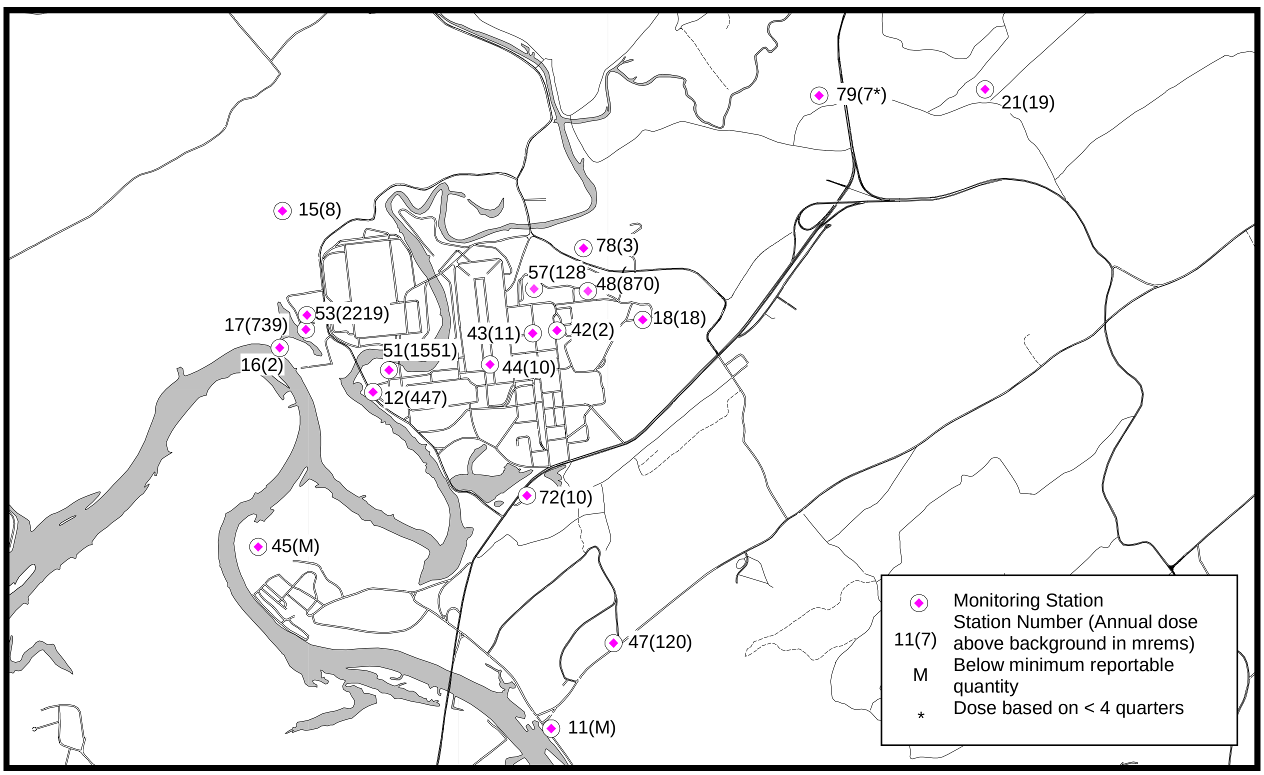

Figure 3: Approximate Locations of Environmental Dosimeters deployed in the Vicinity of the East Tennessee Technology Park during the Year 2002

Table 1: Results from Tennessee Department of Environment and Conservation Monitoring using Environmental Dosimetry for the year 2002

Station # (Dosimeter)	Location *Optically Stimulated Luminescent Dosimeter (OSLs) are reported quarterly* *Neutron Dosimeters are reported semi-annually*	Type of Radiation	Dose Reported for 2002 in mrems (*M = Below Minimum Reportable Quantity)*				Total Dose for 2002	Total Dose for 2001
			1st Qtr	2nd Qtr	3rd Qtr	4th Qtr		
9. (OSL)	Norris Dam Air Monitoring Station (Background)	Gamma	Lost	M	M	2	2*	6
11. (OSL)	ETTP Grassy Creek Embayment on the Clinch River	Gamma	M	M	LOST	M	M*	1
12. (Neutron)	ETTP UF_6 Cylinder Storage Yard K-1066-E	Neutron	20		M		447	995
		Gamma	319		108			
15. (OSL)	ETTP K-1070-A Burial Ground	Gamma	M	2	2	4	8	M
16. (OSL)	ETTP K-901 Pond	Gamma	M	M	M	2	2	3
17. (Neutron)	ETTP K-1066-K UF_6 Cylinder Yard (near K-895)	Neutron	20		M		738	939
		Gamma	380		338			
18. (OSL)	ETTP TSCA on fence across from Tank Farm	Gamma	M	5	M	9	14	11
20. (OSL)	ORNL Freels Bend Entrance	Gamma	M	M	M	2	2	4
21. (OSL)	ETTP White Wing Scrap Yard	Gamma	M	8	2	9	19	23
22. (OSL)	ORNL High Flux Isotope Reactor	Gamma	M	8	3	4	15	30
22a. (OSL)	ORNL High Flux Isotope Reactor (duplicate)	Gamma	2	10	4	8	24	27
23. (OSL)	ORNL Solid Waste Storage Area 5	Gamma	2	10	M	5	17	21
24. (OSL)	ORNL Building X-7819	Gamma	3	11	7	12	33	97
25. (OSL)	ORNL Molten Salt Reactor Experiment	Gamma	129	238	163	164	694	647
26. (OSL)	ORNL Cesium Fields	Gamma	M	M	M	8	8	9
27. (OSL)	ORNL White Oak Creek Weir @ Lagoon Rd	Gamma	56	86	LOST	26	168*	299
28. (OSL)	ORNL White Oak Dam	Gamma	M	M	M	M	M	2
30. (OSL)	ORNL X-3513 Impoundment	Gamma	141	191	261	280	873	674
31. (OSL)	ORNL @ Cesium Forest boundary	Gamma	9	20	9	20	58	66
31a. (OSL)	ORNL @ Cesium Forest boundary (duplicate)	Gamma	11	25	14	14	64	82
32. (OSL)	ORNL Cesium Forest on tree	Gamma	2,021	3,198	2,318	2,599	10,136	10,919
33. (OSL)	ORNL Cesium Forest Satellite Plot	Gamma	80	204	132	155	571	661
34. (OSL)	ORNL SWSA 6 on fence @ Highway 95	Gamma	M	4	M	4	8	23
35. (OSL)	ORNL confluence White Oak Cr. & Melton Br.	Gamma	165	252	268	219	904	966
38. (OSL)	Y-12 Uranium Oxide Storage Vaults	Gamma	M	9	6	19	34	51
39. (OSL)	Y-12 @ back side of Walk In Pits	Gamma	M	M	M	2	2	M
41. (OSL)	ORNL North Tank Farm	Gamma	62	165	133	180	540	463
42. (OSL)	ETTP east side of the K-1401 Building	Gamma	M	M	M	2	2	M
43. (OSL)	ETTP west side of the K-1401 Building	Gamma	M	5	M	6	11	22
44. (OSL)	ETTP K-25 Building	Gamma	M	2	M	8	10	10
45. (OSL)	ETTP K-770 Scrap Yard	Gamma	M	M	M	M	M	M*
46. (OSL)	ORNL Homogeneous Reactor Experiment Site	Gamma	61	102	72	73	308	451
47. (OSL)	Y-12 Bear Creek Rd ~2800 ft from Clinch River	Gamma	18	42	30	30	120	115
48. (OSL)	ETTP K-1420 Building	Gamma	186	331	186	167	870	899
51. (Neutron)	ETTP north side of the K-1066-E UF_6 Cylinder Storage Yard	Neutron	50		M		1,551	1,075
		Gamma	773		728			
53. (Neutron)	ETTP southwest corner of the K-1066-K UF_6 Cylinder Storage Yard	Neutron	20		M		2,219	2,506
		Gamma	1,156		1,043			
53a. (Neutron)	ETTP southwest corner of the K-1066-K UF_6 Cylinder Storage Yard (duplicate)	Neutron	20		M		1,896	2,542
		Gamma	970		906			
55. (OSL)	ORNL SWSA 5 True Waste Trench	Gamma	113	176	112	106	507	514
56. (OSL)	ORNL Old Hydrofracture Pond	Gamma	175	112	286	473	1,046	875

Table 1: Results from Tennessee Department of Environment and Conservation Monitoring using Environmental Dosimetry for the year 2002 (Continued)

Station # (Dosimeter)	Location *Optically Stimulated Luminescent Dosimeter (OSLs) are reported quarterly* *Neutron Dosimeters are reported semi-annually*	Type of Radiation	Dose Reported for 2002 in mrems (*M = Below Minimum Reportable Quantity)*				Total Dose for 2002	Total Dose for 2001
			1st Qtr	2nd Qtr	3rd Qtr	4th Qtr		
56a. (Neutron)	ORNL Old Hydrofracture Pond (duplicate)	Neutron	M		M		1,133	760
		Gamma	315		818			
57. (OSL)	ETTP UF6 Cylinder Storage Yard K-1066-B	Gamma	21	45	31	31	128	91
61. (OSL)	Off site Outer & Illinois Ave	Gamma	M	M	M	M	M	M
62. (OSL)	Off site East Pawley	Gamma	M	M	M	1	1	M
63. (OSL)	Off site Key Springs Road	Gamma	M	M	M	M	M	M
64. (OSL)	Off site Cedar Hill Greenway	Gamma	M	M	M	M	M	M*
65. (OSL)	Off site California Ave.	Gamma	M	M	M	M	M	M
66. (OSL)	Off site Emory Valley Greenway	Gamma	7	6	3	12	28	25*
67. (OSL)	Off site West Vanderbilt	Gamma	M	5	M	4	9	8*
68. (OSL)	ORNL White Oak Creek @ Coffer Dam	Gamma	M	M	M	M	M	M
69. (OSL)	ORNL Graphite Reactor	Gamma	2	11	4	9	26	39
70. (OSL)	Off site Scarboro Perimeter Air Station	Gamma	M	M	M	2	2	9*
71. (OSL)	Y-12 East Perimeter Air Monitoring Station	Gamma	M	M	M	1	1	1
72. (OSL)	ETTP Visitors Center	Gamma	M	3	M	7	10	15*
73. (OSL)	ORNL Spallation Neutron Source (north side)	Gamma	M	M	M	M	M	M*
74. (OSL)	ORNL Spallation Neutron Source (south side)	Gamma	M	M	LOST	M	M*	M*
75. (OSL)	ORNL Temp #5: hot spot on Haw Ridge	Gamma	40	71	44	54	209	222
78.(OSL)	ETTP Temp. #11: ED3 Quarry at Blair Road	Gamma	M	3	M	M	3	4
79. (OSL)	ETTP Temp.#12: ED1 on pole	Gamma	M	3	LOST	4	7*	9
80.(OSL)	Off site Temp.#13: Elza Gate	Gamma	M	M	M	1	1	M
81.(OSL)	ORNL visitors center	Gamma	M	M	M	2	2	M*
82.(OSL)	ORNL Wag 3	Gamma	147	212	144	9	512	617*
84.(OSL)	ORNL Temp. #2 Wag 3	Gamma	20	28	20	M	68	74*
86.(OSL)	Off site Fort Loudoun Dam Air Station	Gamma	M	M	M	2	2	New
86a. (Neutron)	Off site Loudoun Dam Air Station)	Neutron	M		M		8	New
		Gamma	7		1			

Notes: Two types of dosimeters are used in the program, optically stimulated luminescent dosimeters (OSLs) and neutron dosimeters. The OSLs measure the dose from gamma radiation, which is considered sufficient for most of the monitoring stations. The neutron dosimeters, which have been placed at selected locations, measure the dose from neutrons in addition to the gamma radiation. At the locations where the neutron dosimeters have been deployed, the total dose is the sum of the doses reported for neutrons and the dose reported for gamma radiation.

The primary dose limit for members of the public specified in both DOE Orders and 10 CFR Part 20 (Standards for Protection Against Radiation) is 100 mrem total effective dose equivalent exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical research programs. The NRC limit for a decommissioned facility is 25 mrem/yr.

To account for background radiation and any exposures that may be received in transit or storage, control dosimeters are provided by the vender. These dosimeters are stored at the division office and returned to the vender for processing along with the associated field deployed dosimeters. Any exposure received by the control dosimeters, which would include background radiation received while in storage at the division offices, is subtracted from the exposure reported above for the field deployed dosimeters.

M = Below minimum reportable quantity.
ETTP = East Tennessee Technology Park
ORNL = Oak Ridge National Laboratory
*= The dose reported for this station was based on the sum of less than four quarters of data.

Results and Discussion

The dose of radiation received at any given location is dependent on the intensity and the duration of the exposure. For example, an individual standing at a site where the dose rate is 1 mrem/hr would receive a dose of 2 mrem, if he stayed at the same spot for 2 hours. If he were exposed to the same level of radiation for 8 hours a day for the approximately 220 working days in a year (1,760 hours), he would receive a dose of 1,760 mrem in that year. It should be understood, the doses reported in the division's Ambient Radiation Monitoring Program are based on the exposure an individual would receive if he remained at the monitoring station 24 hours a day for a year (8,760 hours). Since this is very unlikely to be the actual case, the doses reported should be viewed as conservative estimates of the maximum dose an individual would receive at each location.

In the past, the division relied on the measurement of gamma radiation to estimate the radiation doses at the various monitoring stations. While gamma radiation is expected to be the major contributor to external exposures, an additional dose from neutrons was anticipated at sites near the uranium hexafluoride cylinder storage yards located at the East Tennessee Technology Park (ETTP). In 2000, staff began placing neutron dosimeters at monitoring stations near the storage yards. Results from these dosimeters have been were somewhat erratic, but indicative of a measurable neutron flux at several of the locations. This flux is attributed to the interaction of alpha particles emitted by uranium reacting with the nuclei of fluorine ($\alpha + {}^{19}F \rightarrow {}^{22}Na + n$) and/or the spontaneous fission of uranium isotopes. The neutron doses measured have been incorporated into the total doses reported in Table 1.

The monitoring locations and associated results for the program can be roughly organized into three categories: (1) stations located off the ORR; (2) sites on the ORR that are to some degree accessible to the public; and (3) locations within access-controlled areas of the reservation.

Stations off the ORR

The dosimeter placed at the background station (the Norris Dam Ambient Air Monitoring Station) for the first quarter 2002 measurement could not be found, so the dose reported (2 mrem) is based on three-quarters of data. The doses reported for other monitoring stations off the reservation (e.g., in residential areas) were all well below the 100 mrem dose limit for members of the public and to a large degree below the detection capabilities of the environmental dosimeters (1 mrem).

Stations Potentially Accessible to the Public

Since access to the reservation has been predominately restricted to employees of DOE or their contractors in the past, locations within the fenced areas of the reservation have traditionally been considered inaccessible to the general public. With the reindustrialization of portions of the reservation, there has been an influx of workers employed by businesses not directly associated with DOE operations. If these individuals are considered members of the general public, several of the sites within the boundaries of the ORR become problematic. For example, relatively high doses of radiation were measured at ETTP in the vicinity of the K-1420 Building (870 mrem) and the uranium hexafluoride cylinder storage yards. Under current conditions, these sites are potentially accessible to workers not employed by DOE or their contractors. In addition, the cylinders contained in the storage yards have deteriorated over the years and at least six of the cylinders are known to have leaked uranium hexafluoride in the past.

In 2002, dose measurements taken in the vicinity of the cylinder yards ranged from 447 to 2,542 mrem. Two of these locations, Stations 12 (447 mrem) and 51 (1,551 mrem), are located on the fence that separates the K-1066-E uranium hexafluoride cylinder storage yard from the Poplar Creek area, making them accessible from outside the facility boundary. Due to the elevated dose measurements observed in the vicinity of the cylinder yards, the division implemented a separate monitoring project in 1999 designed to gather more comprehensive data from the cylinder yards. Associated information can be found under the heading *Ambient Gamma Radiation Monitoring of the Uranium Hexafluoride (UF_6) Cylinder Yards at ETTP* (Platt, 2002). Based on the information at hand, the state considers the uranium hexafluoride cylinders to be a public hazard and have advocated their removal and / or stabilization.

Stations within Access Controlled Areas of the Reservation

While conditions could change, other sites monitored that reported results appreciably above the primary dose limit are currently located within access-controlled areas of the reservation. These sites are subject to remediation in accordance with the provisions of CERCLA and the Federal Facility Agreement (FFA) for the ORR. While it is beyond the scope of this report to address each of these sites individually, several merit comment.

The Cesium Forrest [Stations 32 (10,136 mrem), and 33 (571 mrem)]: The highest dose reported for 2002, 10,136 mrem, was from a dosimeter that has been placed on a tulip poplar tree (Station 32) at the Oak Ridge National Laboratory (ORNL) Cesium Forest. In 1962, a group of trees at this location were injected with a total of 360 millicuries of cesium-137, as part of a study on the isotope's behavior in a forest ecosystem (Witkamp, 1964). Based on current data, it appears a significant amount of the cesium-137 remains in the trees and local environment.

The 3513 Waste Holding Basin [Station 30 (873 mrem)]: Until 1977, the 3513 Waste Holding Basin served as a settling pond for ORNL effluents prior to their release to White Oak Creek. Sludge from the bottom of the basin has been estimated to contain over 200 curies of cesium-137, along with various other radionuclides including transuranics (Bechtel, 1992). In 1997, a CERCLA Record of Decision provided for the removal and disposal of sludge in the 3513 Basin and the adjacent 3524 Impoundment (which also received process wastes historically). In 2000/2001, sludge from the 3524 Basin was temporarily placed in the 3513 pond and the 3524 Basin was filled and capped. In 2001, DOE contractors began removing the sludge from the 3513 Basin (including the sludge previously in 3524). Once removed, the sludge is being dewatered, formed into bricks, and stored in preparation for disposal. In 2001, the dose reported at Station 30 (which is near the 3513 basin) went down from the 2,328 mrem measured in 2000 to 674 mrem. It should be noted the sludge bricks are currently being stored some distance from the monitoring station, which would account, in part, for the decreased dose reported. The radiation associated with the site should continue to decrease as the action progresses.

The North Tank Farm [Station 41 (540 mrem)] The North Tank Farm is located near the center of ORNL's main campus. In the past, a number of underground storage tanks were emplaced at this location to store and / or treat radioactive and hazardous wastes. In the late 1990s, one of these tanks, W-1A, was discovered to be the source of groundwater contamination. The Corehole 8 Plume covers a large area adjacent and to the west of the site. Contaminants associated with this plume include strontium-90, americium-241, plutonium-238, 239, 240, and curium-244 (Bechtel, 1992). These contaminants discharge to First Creek and are transported to White Oak Creek and beyond. DOE subsequently proposed to remove W-1A and the adjacent soils, which have developed into a secondary source of the contaminants feeding the plume.

The Old Hydrofracture Facility (OHF) Surface Impoundment [Station 56 (1046 mrem)]: From 1964 to 1980 radioactive wastes were transported through pipelines from the ORNL main complex to the Old Hydrofracture Facility, which is located in Melton Valley, east of Solid Waste Management Unit (SWSA) 5 South. Underground storage tanks at the OHF held this waste prior to it being mixed with grout and injected into the bedrock (approximately 1,000 feet beneath the ground surface). During this process, the tanks and the OHF surface impoundment (constructed to retain spills/overflow) were contaminated with fission products, activation products, and transuranic radionuclides. In this regard, the OHF pond exhibited some of the highest gamma emissions measured in the SWSA 5 area (DOE, 1998a). In 2000, contaminated sediments in the pond were grouted in place and the basin was filled and capped. While the action did not remove the contaminants (as originally planned), the grout and cover shields radiation being emitted by the radionuclides contained in the sediments. As a consequence, the dose measured at station 56 went down in 2002 from 3,612 mrem reported in 2000 to 1046 mrem.

Conclusion

The monitoring of radiation using environmental dosimeters has proven to be a relatively economic and effective method of estimating ambient gamma radiation levels on and in the vicinity of the ORR. Doses reported for 2002 at off-site locations were all below the state limit for members of the public. Although, several locations on the reservation that are considered potentially accessible to the public exhibited results in excess of the primary dose limit. These sites are primarily associated with uranium hexafluoride cylinder storage yards at ETTP, where DOE's reindustrialization initiative has resulted in an influx of businesses not directly related to DOE operations. As in the past, various sites located in restricted areas of the reservation exhibited annual doses in excess of the primary dose limit. These sites are subject to remediation in accordance with provisions specified in CERCLA and the FFA. Decreases in the doses reported at several of these locations can be attributed to associated remedial activities.

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CHAPTER 6 RADIOLOGICAL MONITORING

Facility Survey Program

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Abstract

Like other Department of Energy research facilities across the nation, the Oak Ridge Reservation released large quantities of chemical and radiological contamination into the surrounding environment during nearly five decades of nuclear weapons research and development. In response to this history, the Tennessee Department of Environment and Conservation, Department of Energy Oversight Division developed a Facility Survey Program to document the histories of facilities on the Reservation. The program looks at facilities' physical condition, inventories of hazardous chemical and radioactive materials, process history, levels of contamination, and present-day potential for release of contaminants to the environment under varying conditions ranging from catastrophic (i.e. tornado) to normal everyday working situations. This broad-based assessment supports the objectives of Section 1.2.3 of the *Tennessee Oversight Agreement,* which was designed to inform local citizens and governments of the historic and present-day character of all operations on the Reservation. This information is also essential for local emergency planning purposes. Since 1994 the division's survey team has characterized 168 facilities and found that almost thirty percent pose a relatively high potential for release of contaminants to the environment. In many cases, this high-potential-for-release relates to legacy contamination that escaped facilities through degraded infrastructures over decades of continual industrial use (e.g. leaking underground waste lines, substandard sumps and tanks, or ventilation ductwork). During 2002 the survey team evaluated 8 facilities and found that 5 posed a high potential for environmental release. Two of these facilities were at Y-12 (Y-9616-3, Y-9738), and three were at K-25 (K-1004-E, K-1015, K-633). Since the inception of the program, DOE corrective actions (including demolitions) have removed ten facilities from the division's list of "high" Potential Environmental Release facilities.

Beginning in 2002 the Facility Survey Program also began organized document reviews and visits to facilities that were targeted for demolition at the ORNL and Y-12. This activity was in response to formal, accelerated infrastructure reduction (demolition) programs at each of those sites. During 2002 staff made 90 site visits before and during the demolition of 31 facilities.

Introduction

The Tennessee Department of Environment and Conservation's (TDEC) Department of Energy Oversight Division (DOE-O), in cooperation with the Department of Energy (DOE) and DOE contractors, conducts a Facility Survey Program (FSP) on the Oak Ridge Reservation (ORR). The program provides a comprehensive independent assessment of active and inactive facilities on the reservation based on their (1) physical condition (2) inventories of radiological materials and hazardous chemicals (3) levels of contamination; and (4) operational history. The ultimate goal of the program is to fulfill 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 at the ORR and potential impacts on the human health and/or environment by the ORR." **The overall objective of the Facility Survey Program is to provide a detailed assessment of all potential hazards affecting or in any way associated with facilities on the Oak Ridge Reservation.** To this end, the program evaluates facilities' potential for release of contaminants to the environment under varying environmental conditions ranging from catastrophic (i.e. tornado, earthquake) to normal everyday working situations. This information is also essential for proper emergency preparedness planning.

Methods, Materials, and Evaluating the Potential for Environmental Release (PER)

Survey program staff take a historical research approach to evaluating each facility. Prior to commencing fieldwork they examine engineering documents, past contaminant release information, hazard-screening documents, drain databases, and radiological and chemical inventory data. They then perform a walk-through of the facility with the facility manager to gather interview information, and to validate previously reviewed documents. During the walk-through, calibrated radiation survey instruments are used to estimate radiation contamination and dose levels. At the end of the document review and walk-through process, a final report is produced, and information is entered into the division's Potential for Environmental Release (PER) database. This database helps the team characterize conditions at each facility based on its physical condition and potential for release of contaminants to the environment.

The PER database is composed of 10 "categories" that relate directly to the contents and condition of the operational infrastructure within and around each facility (Table 1). Each category is assigned a score from 0 to 5 (5 reflects the greatest potential) for each of the 10 "categories" (Table 2). As facilities are scored, totaled, and compared with each other, a relative ranking emerges. Special circumstances, such as legacy releases and professional judgment also influence category scoring. Scores are **not intended to reflect human health risk.** Rather, their sole purpose is to characterize facilities based on the conditions in and around them. This information is used within the division for information, comparison, and review purposes only.

The final facility survey report notifies DOE of the division's findings so that DOE has the opportunity to respond and formulate corrective actions. When the division receives written confirmation from DOE of corrective actions taken on a specific facility, the ranking for that facility is modified accordingly. The 10 "categories" that are scored and the "scoring criteria" are presented below in Tables 1 and 2. Table 3 provides a program summary.

Table 1: Categories to be 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
7.	Ventilation ducts and exit pathways to create outdoor air pollution
8.	Ventilation ducts and indoor air/building contamination threat
9.	Radiation exposure rates inside the facility escalated
10.	Radiation exposure rates outside the facility escalated

Table 2: Potential 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 threat**: no quantities of radiological or hazardous substances present.
1	**Minimal threat**: minimal quantities present, possibility of an insignificant release, very small probability of significant release, modern maintained containment.
2	**Moderate threat**: significant quantities of radiological or hazardous subs. present, structures stable in the near to long term, structures have integrity but are not state-of-the-art, adequate maintenance.
3	**Moderate threat**: structures unstable, in disrepair, containment failure clearly dependent on time, integrity bad, maintenance lacking, containment exists for the short term only.
4	**Imminent threat**: considerable quantities of radiological or hazardous subs. present. Containment for any period of time is questionable, migration to environment has not started.
5	**Release**: 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.	

Discussion and Results

The Facility Survey Program entered its ninth year in January 2002. As in previous years, inter-agency staff cooperation was excellent, which facilitated the flow of information related to corrective actions, changes in facility status or mission, decommissioning and decontamination activities, and onsite professional activities. During 2002 the survey program's Y-12 representative spent approximately one half of his time at the Y-12 site. This presence greatly enhanced program activities at that site.

In accordance with past TDEC policy, an individual survey conducted on a facility at K-25 that has been leased to private industry might only address those portions of the facility that are leased. Consequently, some older reports may not include adjacent areas in the same facility or related facilities. These adjacent areas and related facilities may be contaminated and/or exhibit safety problems that are not reflected in the report. Therefore, when reviewing these reports, it is important to look for the phrase "leased area of the facility." This phrase indicates that the survey report covers only the leased area of the facility, specifically, and is not intended to assess the entire facility or related facility problems (such as drain lines) that may exist outside of the leased area.

Since program staff is continually in the process of evaluating DOE corrective actions taken to address facility concerns, any current ranking may not reflect the most recent corrective actions. Since the inception of the FSP program, corrective actions (including demolition) have removed ten facilities (X-3525, X-7823-A, X-7827, X-7819, X-3505, K-1098-F, K-1200-C, Y-9404-3, Y-9208, Y-9620-2) from the DOE-O list of "high" Potential Environmental Release facilities.

In 2002 the team surveyed 8 facilities: one at ORNL (#7652), four at K-25 (#K-1015, #K-1004-E, #K-633, #K-633-D), and three at Y-12 (#9616-3, #9616-3TK3, #9738). Five of these facilities were ranked as having a "high" Potential for Environmental Release; two at Y-12 (#Y-9616-3, #Y-9738), and three at K-25 (#K-1015, #K1004-E, #K-633).

Table 3: Facility Survey Program Summary

	Totals	High PER Facilities	Removed High PER	Facilities Resurveyed	Demolition Visits
A. Facilities surveyed, 1994	15	9	0	0	
B. Facilities surveyed, 1995	35	11	0	0	
C. Facilities surveyed, 1996	34	9	0	0	
D. Facilities surveyed, 1997	23	8	0	0	
E. Facilities surveyed, 1998	8	2	1	2	
F. Facilities surveyed, 1999	14	2	0	0	
G. Facilities surveyed, 2000	14	4	3	0	
H. Facilities surveyed, 2001	17	8	1	1	
I. Facilities surveyed, 2002	8	5	5	0	
H. Totals	**168**	**58**	**10**	**3**	**90**

Description of the 48 Highest Scoring Facilities (1994-02)

The PER database attempts to reflect the overall condition of a facility. However, it is not the total score of the 10 categories that is always the best indicator. Rather, what appears to be the most accurate indicator is the number of categories for which a facility scores a four or five (Table 1). Of the 168 facilities scored since 1994, 48 stood-out with one or more categories scoring a four or five (Table 4). The following high-scoring facilities are arranged in descending order of total numbers of fours and fives in the PER database.

Table 4: Potential for Environmental Release for 48 High Scoring Facilities

	1	2	3	4	5	6	7	8	9	10		
	DRAIN	TANKS	TANKS	SUMPS	TRANSF	TRANSF	VENT TO	VENT	INT. EXP.	O. EXP.	NUMBER	SURVEY
	LINES	LINES	LINES	DRAINS	RAD.	HAZ.	OUTSIDE	INSIDE	RAD.	RAD.	OF	YEAR
BUILDING	SANI.	PROC.	LLLW	FLOOR	CONT.	CONT.	AIR	SYSTEM	SURVEY	SURVEY	4 and 5's	
X3028	0	4	4	3	4	4	4	5	5	3	7	1997
K1037-C	0	0	0	0	5	5	5	5	5	4	6	1998
K1025-A	0	0	0	4	4	4	4	3	4	4	6	1995
Y9401-2	1	4	1	4	1	5	4	4	1	0	5	2001
Y9204-3	3	5	2	3	4	5	4	4	2	1	5	2000
X3019-B	2	2	5	3	2	3	4	4	4	4	5	1995
K633	3	5	1	4	5	5	2	5	4	5	5	2002
K1004-B	5	0	0	5	2	5	2	5	2	0	4	2001
K1004-A	5	0	0	5	2	5	2	5	2	0	4	2001
X7700	4	0	0	3	5	4	2	2	3	5	4	1996
X7700C	4	4	0	4	2	1	2	0	0	4	4	1996
Y9201-4	2	5	0	2	2	4	5	5	2	1	4	1998
K1015	5	0	5	0	5	5	2	2	2	1	4	2002
K1004-J	5	5	0	4	3	0	0	0	1	1	3	2000
Y9203	4	2	0	4	2	4	2	2	2	0.5	3	1995
X2545	0	3	5	0	4	2	3	0	0	4	3	1995
K1200-C	1	3	0	1	3	1	2	0	1	3	0	1995
Y9769	1	1	0	4	4	2	1	2	4	2	3	1995
K1025-B	0	0	0	2	5	2.5	3	2	4	5	3	1996
X3020	0	0	5	5	5	0	2	0	0	1	3	1997
X3108	0	0	5	5	5	0	2	2	2	2	3	1997
X3091	0	0	5	5	5	1	2	2	3	2	3	1997
K1004-E	5	0	0	5	2	5	3	0	2	0	3	2002
Y9616-3	0	2	0	4	2	4	1	1	1	1	2	2002
Y9738	2	0	0	4	2	4	1	1	2	1	2	2002
Y9743-2	0	3	0	5	3	5	2	2	2	1	2	2001
X3592	0	3	3	2	4	4	3	3	3	2	2	2001
X3504	1	3	0	4	5	0	2	1	2	2	2	2001
X2531	1	1	2	1	5	2	2	1	2	4	2	2001
Y9213	3	1	5	3	3	5	1	1	1	1	2	2000
X7720	0	0	0	0	4	0	0	0	0	4	2	1996
X3001	3	1	2	3	3	2	4	4	3	3	2	1995
K1200-S	2	3	0	3	3	2	3	4	2.5	4	2	1995
X7701	4	3	0	4	2	0	2	0	0	3	2	1996
X7706	4	3	0	4	2	0	2	2	2	2	2	1996
X7707	4	0	0	4	2	3	2	2	0	0	2	1996
X3085	1	4	3	3	3	2	1	2	3	3	1	1994
X7602	0	2	0	2	4	2	1	3	2	1	1	1997
K1220-N	0	2	0	0	3	2	2	4	2	3	1	1995
X3002	0	2	0	2	3	1	2	3	4	1	1	1996
Y9210	1	0	0	4	1	1	1	2	1	0	1	1995
Y9224	1	0	0	4	1	1	1	2	1	0	1	1995

Y9211	1	0	0	4	1	1	1	2	1	0	1	1995
Y9207	2	0	0	1	1	4	3	1	1	0	1	1995
X7055	0	0	0	4	0	1	1	1	0	0	1	1997
X7700-B	0	0	0	0	3	0	2	0	0	4	1	1996
K1401-L3	1	0	0	1	4	2	1	2	3	1	1	1997
Y9201-3	2	1	0	2	3	5	2	2	2	1	1	1999
*X7819	0	0	0	0	0	0	0	0	0	0	0	1994
*X3505	0	0	0	0	0	0	0	0	0	0	0	2000
*Y9620-2	0	0	0	0	0	0	0	0	0	0	0	1994
*Y9208	0	0	0	0	0	0	0	0	0	0	0	1995
*Y9404-3	0	0	0	0	0	0	0	0	0	0	0	1994

* Denotes demolished facility

At **Y-12** fifteen facilities had at least one category score of 4 or 5: 9204-3, 9201-4, 9401-2, 9213, 9743-2, 9203, 9769, 9404-3, 9208, 9620-2, 9210, 9224, 9211, 9207, and 9201-3.

Facility Y-9204-3 (Beta 3) is one of the original isotope enrichment facilities at Y-12. It received two category scores of 5, three category scores of 4, and a total score of 33. This 250,000sq. ft. facility is now inactive and locked. The largest concerns are leaking PCB-contaminated mineral oil (Z-oil), and radiological contamination. The building has not been sampled above eight feet for radiological contamination, even though the probability of finding it is great. The building historically and presently vents directly to the environment without HEPA filtration.

Facility Y-9201-4 (Alpha 4) is also one of the original Y-12 uranium enrichment buildings. It received three category scores of 5, one category score of 4, and a total of 28. Mercury, mercury vapor, lithium hydroxide, PCBs, asbestos, and lead/chromium based paint are the contaminants of concern in this facility. Mercury is found throughout the process system; the containment integrity of this system is low and has resulted in breaches that have deposited mercury in unwanted places throughout the building. Evidence suggests that open (non-filtered) exhaust fans have distributed mercury vapor from the interior of the building to the environment for decades. Lithium hydroxide, PCBs, asbestos insulation, and chipping/flaking lead-based paint are also found deposited throughout the building.

Facility Y-9401-2 (Plating Shop) received four category scores of 4, one category score of 5, and a total of 25. All of these scores relate to a variety of chemical contamination issues.

Facility Y-9213 (Criticality Experiment Facility) received two category scores of 5, and a total of 24. This facility was built in 1951 and contains two underground neutralization tanks and an underground pit. The tanks and pit present a very high potential for radiological and chemical soil contamination. The areas around the tanks have not been sampled for contamination. The facility also exhibits extensive flaking of exterior lead-based paint.

Facility Y-9743-2 (Animal Quarters) received two category scores of 5, and a total of 20. These scores reflect the uncertainty associated with the lack of radiological and chemical sampling surveys, the complete lack of institutional and process knowledge and, the fact that there are interior tanks and bottles with unknown contents. The probability of biological and chemical contamination is high. There is also a total lack of facility maintenance.

Facility Y-9203 (Instrumentation, Characterization Department and Manufacturing Technology Development Center) has three category scores of 4 and a total score of 22.5. Despite much work that has been done to re-route process drains from terminating in the storm sewer system, these drains now go to the sanitary sewer system. This termination still presents a potential pathway to the environment and the public.

Facility Y-9769 (Analytical Services Organization) has three category scores of 4 and a total score of 21. The primary hazards associated with this facility are related to the wide variety of toxic materials maintained in the laboratory and the building's drain destination. Exit drains go to the Oak Ridge Sewage Treatment Facility and therefore represent a pathway for contaminants to the city's effluent and/or sludge. Also, the sub-basement area is posted as a contamination area and confined space. This area has legacy contamination of natural uranium. Depending on the quantity of natural uranium, a significant source term for radium-226 and radon-222 exists. Failure of containment could cause a release to East Fork Poplar Creek or to the atmosphere.

Facility Y-9201-3 (Alpha 3) received one category score of 5, and a total of 20. This facility is not receiving any maintenance on its exterior painted surface. Lead based paint is chipping and is being spread extensively around the building.

Facility Y-9404-3 (Z-oil pumphouse) at Y-12 was *demolished in 2002.*

Facility Y-9208 *was demolished in 2002.*

Facility Y-9616-3 received two category scores of 4 because of extensive interior and exterior peeling lead-based paint, and degraded asbestos-containing wall coverings and pipe insulation. The building is not receiving maintenance. There is a serious loss of process knowledge.

Facility Y-9738 received two category scores of 4, and a total of 17. This building contains foundry machinery and furnaces and spaces that are chemically and radiologically contaminated from past operations. It is assumed that some of this material has moved into the floor drain system. There is also extensive exterior paint peeling. There was a very limited knowledge of process history available to staff.

Facility Y-9620-2 (Oil Filtration Facility) *was demolished in 2002.*

Facilities Y-9210, Y-9211, Y-9224 (ORNL Biology) each had one category score of 4 with a total score of 11 for each facility. The original concern regarding each of these facilities was the questionable terminal destinations of their exit drains, which in some cases historically went to the storm sewer system. Written confirmation from the DOE contractor has since shown the correct terminations and corrective actions taken on some of these drains, but there are still undefined and/or inappropriate drain terminations (i.e. lab drains that terminate at the sanitary sewer).

Facility Y-9207 (Biology Complex) received one category score of 4, and a total score of 13. In this facility the sinks in a radiological area drain directly to the Oak Ridge sewer system, and thus represent a potential pathway for radiological materials to the city sewage and sludge.

At **ETTP** ten facilities had at least one category score of four or five: K-1037-C, K-1004-B, K-1004-A, K-1025A, K-1025B, K-1098-F, K-1200-S, K-1004-J, K-1220-N, and K-1401L3.

Facility K-1037-C (Nickel Smelter House) received five category scores of 5, one category score of 4, and a total of 29. This is an old facility in general disrepair. It has numerous roof leaks and is heavily contaminated, both radiologically and chemically. Large scrubber-type vessels located on the East End of the second floor of the barrier production area contain internal radioactive contamination. Discarded contaminated equipment is stored in the building. The facility is posted as a PCB hazard. No corrective actions have been completed at this facility (2001).

Facility K-1004-B (Analytical Chemistry Lab.) received four category scores of 5, and a total of 26. These scores were given for radiological contamination in the ventilation system, and chemical contamination in the drains. No corrective actions have been completed at this facility (2001).

Facility K-1004-A (Analytical Chemistry Lab.) received four category scores of 5, and a total score of 26. These scores were given primarily for chemical contamination in the drain and ventilation systems.

Facility K-633 received five category scores of 5, and two category scores of 4. There is extensive radiological contamination throughout the building, and extensive peeling exterior and interior paint, which contain PCBs, asbestos and lead. External soil contamination suggests radiological material has moved to the environment.

Facility K-1025-A (Radiological Source Control Building) received six category scores of 4, and a total score of 27. The entire building is a contamination zone with plugged floor drains. The building houses radiological sources, and there is evidence that water has been standing in the building. The integrity of the roof is suspect. Floor drains historically went into a French-drain system with an unknown termination point. Elevated radiological readings outside of the building indicate that drains exit into the yard, and that contamination has moved into the environment. No corrective actions have been taken on this facility (2001).

Facility K-1015 received four category scores of 5 and a total of 27. The facility has a contaminated drain system and has contaminated surrounding soils and the sewer system.

Facility K-1025-B (Drum Storage Warehouse) has one category score of 4, two category scores of 5, and a total score of 23.5. The primary concern with this facility is radiological contamination. Radiological contamination has moved from within the building via the floor drain system and has contaminated the soil in front of the building. Since a radiological survey map was not available, the magnitude of soil contamination is unknown. The division has not been notified of actions taken to address these issues.

Facility K-1004-E received three category scores of 5 and a total of 21. This facility has a chemically contaminated drain system, and exhibits extensive, peeling exterior lead-based paint.

Facility K-1200-S (Centrifuge Preparation Laboratory, South Bay) received two category scores of 4 and a total score of 26.5. The high score is primarily attributable to the uncertainty of radiological contamination associated with the ventilation system. The interior ductwork and portions of the roof where air is exhausted have not been surveyed for contamination. The potential for airborne release appears great. Equipment inside the facility contains uranium hexafluoride and other hazardous chemicals, and there are numerous radiologically contaminated storage areas. Confined space entry requirements prevented the division from performing a survey of the pits below the centrifuges. The greatest release potential for contaminants would be during decontamination and decommissioning activities. *Equipment removal and cleanup is ongoing at this facility. It is expected that the facility will in the future be removed from the DOE-O "high rankers" list (2001).*

Facility K-1004-J received two category scores of 5, one category score of 4, and a total of 19. This facility was constructed in 1948 and was originally used for uranium recovery from spent fuel solutions and centrifuge research. It originally included a hot cell, reinforced concrete vaults, and a 750 gal. "hot" tank, a 5,500 gal. underground Low Level Liquid Waste tank, and a laboratory. The facility was ranked high in the PER database because of the poor state of knowledge concerning facility infrastructure. First, there is considerable uncertainty over the location and number of active storage vaults under the facility. It is also unknown whether any of these vaults contain radioactive materials or contamination. There is also considerable uncertainty over drainpipe connections and their contribution of radiological and chemical contaminants to general area contamination. No corrective actions have been completed at this facility (2001).

Facility K-1220-N (Centrifuge Plant Demonstration Facility, North) received one category score of 4 and a total score of 18. The interior ductwork has not been surveyed for radiological contamination and the score reflects a high degree of uncertainty concerning the presence of radionuclides. Uranium residuals are present inside the centrifuge systems. After the centrifuge systems are removed and the criticality and security concerns are addressed, this facility is a candidate for reuse. No corrective actions have been conducted at this facility (2001).

Facility K-1401L3 received one category score of 4, and a total score of 15. This ranking was given because of extensive radiological contamination that encompasses the building and housed equipment.

At **ORNL** twenty one facilities had at least one category score of four or five: X-3028, X-3019-B, X-3001, X-7700, X-7700C, X-7701, X-7706, X-7707, X-7720, X-7700B, X-2545, X-3504, X-2531, X-3592, X-3002, X-3020, X-3108, X-3091, X-3085, X-7602, and X-7055.

Facility X-3028 received two category scores of five, five category scores of 4, and a total score of 36. The primary issue with this facility was the relatively large source term of radiological contamination distributed throughout the building. It also shows extensive peeling and chipping of interior wall paint that is supposed to serve as containment for plutonium contamination. Ongoing corrective actions are occurring at this facility.

Facility X-3505 (Metal Recovery Facility) *was demolished the last quarter of 2001.*

Facility X-3019-B (High Level Radiation Analytical Laboratory) at ORNL has four category scores of 4, one category score of 5, and a total score of 33. The primary concern with this facility is the very high levels of radiological contamination. The eight hot cells in this facility are “Very High Radiation Areas” and contain many different radionuclides from past operations. The in-cell steam pipes, the off-gas ventilation system, and the ventilation ductwork on the roof are also radiologically contaminated. Also, the Laboratory Off-Gas ductwork located above the hot cells contains perchlorates six times above the maximum recommended by the ORNL Perchloric Acid Committee Corrective. Perchlorates are shock sensitive and have the potential to react violently when disturbed. Signage identifying this hazard is posted, and the situation was recently upgraded from an “Off-normal” to an “Unusual Occurrence.”

Facility X-7819 (Old Decontamination Facility) *was demolished in 2001. The footprint and surrounding site were fully remediated in 2003.*

Facility X-3001 (Graphite Reactor) at ORNL has two category scores of 4, and a total score of 28. The primary concern with this facility is that there is considerable radiological contamination. The air exhaust shaft that vented the reactor pile is contaminated with cesium-137, strontium-90, and fission products. This is a source releasable to the outside environment if a fire or other event occurred in the ventilation system. Several corrective actions, such as the plugging of drains that went to the sewer system, were recently implemented at this facility.

Facilities X-7700, 7700C, 7701, 7706, 7707, 7720, 7700B (Towers, scrapyard, above-ground storage areas, waste storage tank, reactor pool, heat exchanger bldg., battery house, civil defense bunker, below-ground outside source storage area) are all part of the Tower Shielding Complex. A survey of this group of facilities resulted in two category scores of 5, and 14 category scores of 4. The primary issues at this complex of facilities are: soil contamination, uncovered activated and contaminated equipment and material, and drain lines that have direct connections to the environment. Ongoing corrective actions are being carried out at this facility.

Facility X-2545 (Coal Yard Runoff Collection Basins) at ORNL has one category score of 5, two category scores of 4, and a total score of 21. Orphaned, 2- and 6-inch diameter, cast iron Low Level Liquid Waste (LLLW) lines run through the facility property, and a LLLW line box is posted as a radiation area. The area has been chained off and is overgrown with vegetation. Due to the radiological postings, the cast iron LLLW lines are assumed to be degraded and leaking to the environment. ORNL Environmental Restoration staff has been notified of these lines and their condition, but TDEC has not received written confirmation concerning corrective actions.

Facility X-3504 (Geosciences Lab.) received one category score of 5, one score of 4, and a total of 20. The entire building is a posted contamination area. There is also underground and soil contamination outside of the building.

Facility X-2531 (Radiological Waste Evaporator Facility) received one category score of 5, one score of 4, and a total 21. This ranking includes #2537 (Evaporator Pit) and #2568 (HEPA filter bldg.). Even though this is a relatively clean, modern facility, it earned these scores because of several areas of transferable radiological contamination, and high radiological dose rates surrounding the evaporator pit.

Facility X-3592 (Coal Conversion Facility) received two category scores of 4, and a total of 27. Its original mission was to explore the potential for utilizing liquefied coal as an alternative fuel source. But in later years the facility performed Lithium isotope separation using massive quantities of mercury. The scores were given for transferable radiological contamination and mercury contamination in the drains.

Facility X-3002 (HEPA Filter House for the Graphite Reactor) has one category score of 4, and a total score of 18. The primary hazards associated with this building are related to the high level of airborne and other radiological contamination in the roughing filter room, the HEPA filter bank, and the ventilation system. Several corrective actions that were recommended by the division were implemented at this facility.

Facility X-3020 (Radiological stack for bldg. 3019A-B) received three category scores of 5, and a total score of 18. All of the major concerns noted for this facility were related to legacy features that are not part of the present-day operational infrastructure. There is an antiquated, contaminated drain line that was part of the ORNL LLLW system. This line leaked and contributed to surface and subsurface contamination of the general area from the 1940's through the 1970's. It was capped in the late 1970's, but is possibly still contributing contamination. There is also a contaminated, above-grade, single-walled concrete sump box attached to the floor drain system.

Facilities X-3108 and 3091 (HEPA filter houses for buildings 3019A-B and Radiological Stack 3020) each received three category scores of 5. #3108 received a total score of 23, and #3091 received a total score of 25. These two facilities are physically connected to the #3020 stack. And like the 3020 Stack situation described above, all major concerns noted with these facilities are related to their non-operational infrastructure. Associated with both facilities is a contaminated drain system that went to the LLLW system. This line leaked and contributed to general-area surface and subsurface contamination from the 1940's through the 1970's. It was capped in the late 1970's, but is possibly still contributing to contamination. Both facilities also contain significant levels of radiological contamination, considerable contaminated above-ground ductwork, and contaminated lower-level HEPA filter pits. Both facilities are non-state-of-the-art structures that are adequately maintained.

Facility X-3085 (Oak Ridge Research Reactor Pumphouse) received one category score of 4, and a total score of 25. This score was based on the possibility for underground leakage of contaminated water from the 10,000 gallon decay tank, and from the underground valve sump tank located in the front of the building. Two empty but internally contaminated, aboveground tanks are still tied to underground piping adjacent to the building. Several recommended corrective actions, such as the plugging of floor drains have been completed at this facility.

Facility X-7602 (Integrated Process Development Lab.) received one category score of 4, and a total score of 17. The primary concern with this building was the extensive transferable radiological contamination throughout the facility.

Facility X-7055 (Storage Bldg.) scored one category score of 4, and a total score of 7. The only concern with this building was that it has a floor drain system that is connected directly to the outside yard. Even though the building has changed missions and several corrective actions have been implemented, it still contains hazardous materials.

Conclusion

The historic release of chemical and radiological materials from buildings and other facilities on the Department of Energy's Oak Ridge Reservation has led to elevated levels of contaminants in regional terrestrial and aquatic ecosystems. In an effort to better understand more about the sources of these contaminants, the Tennessee Department of Environment and Conservation's DOE-Oversight Division investigates the historic and present-day potential for release of contaminants from facilities through its Facility Survey Program. During its seven-year history the program has examined 168 facilities and found that nearly thirty percent (48) pose a relatively high potential for release of some contaminant to the environment. In many cases legacy contamination from degraded facility infrastructure, such as underground waste lines, or substandard sumps and tanks, or ventilation ductwork, will force high scores until antiquated facilities are fully remediated. This is particularly the case at Oak Ridge National Laboratory where many facilities were connected to an aging low-level liquid waste line system. Inactive facilities that are no longer receiving adequate exterior or interior maintenance are also driving high scores. On many buildings, peeling lead-based paint is extensive, and will only get worse as time passes if not remediated. Accelerated infrastructure reduction programs that began at Y-12 and ORNL in 2002 will help mitigate some of these problem areas.

When facility concerns are noted by the DOE-Oversight Division they are relayed to the Department of Energy via the facility survey report so that corrective actions can be formulated. To date, many corrective actions have occurred, and six facilities have been removed from the division's list of high Potential Environmental Release facilities. Those concerns that have not been corrected to the extent that the division has reduced the Potential Environmental Release score to less than a "4" are reflected in this report. The rankings are changed when written documentation is received by the division from DOE. And, since the evaluation of corrective actions is an ongoing, time-consuming process, present scores may in some cases not reflect the most recent completed corrective actions.

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CHAPTER 6 RADIOLOGICAL MONITORING

Pilot Project for Radon Monitoring (RMO)

Principal Author: James Dunlap

Abstract

In 2001, the Tennessee Department of Environment and Conservation began a pilot study to assess the feasibility of monitoring radon emissions on the Department of Energy's Oak Ridge Reservation. The project was prompted by a concern that the disposal of uranium in reservation burial grounds may have resulted in elevated radon levels (radon is produced by the natural decay of radionuclides in the uranium decay series). The results from the initial study indicated radon levels could be measured and suggest the burial grounds have areas where the radon levels are above background concentrations. However, loss and damage to the detectors resulted in uncertainties that limited the use of the data. It was subsequently decided to continue the study, but deploy the detectors during the winter months in an effort to avoid some of the problems encountered in 2001. Results of the subsequent study will not be available until the spring/summer of 2003.

Introduction

Radon is a colorless, odorless gas formed by the normal radioactive of decay of radionuclides in the uranium decay chain. As radon itself decays, alpha radiation is released and daughter radionuclides are produced (e.g., polonium-218, polonium-214, bismuth-214, and lead-214). These radon daughters also emit radiation, which contributes to the total radiation dose associated with radon exposures. Since radon is a gas and the daughters (metals) tend to attach to air-borne particles, exposures to the radionuclides present an inhalation hazard. Over the years, millions of pounds of uranium have been disposed on the Oak Ridge Reservation (ORR), resulting in a concern that radon and its daughters could be present on the ORR at hazardous levels.

To assess the radon levels on the reservation, the Tennessee Department of Environment and Conservation, Department of Energy Oversight Division initiated a pilot study in 2001 designed to assess the feasibility of monitoring radon levels on the reservation. For this study radon detectors were placed at background locations and over uncapped portions of the Bear Creek Burial Grounds, where over 40 million pounds of uranium was disposed during operations. In October 2001, the detectors were collected and processed. The results from the burial grounds were then compared to the background data to determine if radon levels above background concentrations could be identified.

The results from the 2001 study indicated radon levels could be measured and suggested the burial grounds have areas where the radon levels are above background concentrations. However, data for the project proved to be highly variable. Also, various problems were encountered during the effort. For example, several of the detectors were damaged (presumably by insects or small mammals) during the monitoring period. The effects (if any) of this damage on the study results is unknown. Also, three of the detectors could not be found and are believed to have been displaced when the sites were mowed or possibly lost in high weeds. Given the quantity of data currently available and the uncertainty associated with these results, the data is currently viewed as preliminary. In 2002, it was decided to continue the study, but deploy the detectors during the winter months, in an effort to avoid some of the problems encountered in 2001. Results from this effort will be available in the spring/summer of 2003.

Methods and Materials

During the winter of 2002/2003, Radtrak® Radon Gas Detectors were placed at twenty-three locations over the Bear Creek Burial Grounds. Three detectors were also located over nearby areas believed to be unaffected by DOE waste operations. Based on recommendations from the vender, each detector was protected from the elements by housing constructed from five-gallon plastic buckets. After placement, the location of each detector was recorded (using a geographical positioning system) and the protective housing secured with tent stakes. After approximately six months, the detectors will be collected and shipped to the vendor (Landauer Inc., Glenwood, Illinois) for processing. When available, the results obtained from the detectors located on the burial grounds will be compared to data from the background stations and other locations across the nation.

Results

As previously noted the results for the second phase of monitoring will not be available until the spring/summer of 2003. The approximate locations of the radon detectors and the associated results for the initial (2001) study are provided in Figure 1. It should be understood, the sampling methodology was designed to capture radon emissions released from soils beneath the five-gallon containers: therefore, the measurements are not representative of ambient air concentrations, which should be much less because of the dilution afforded by the ambient environment.

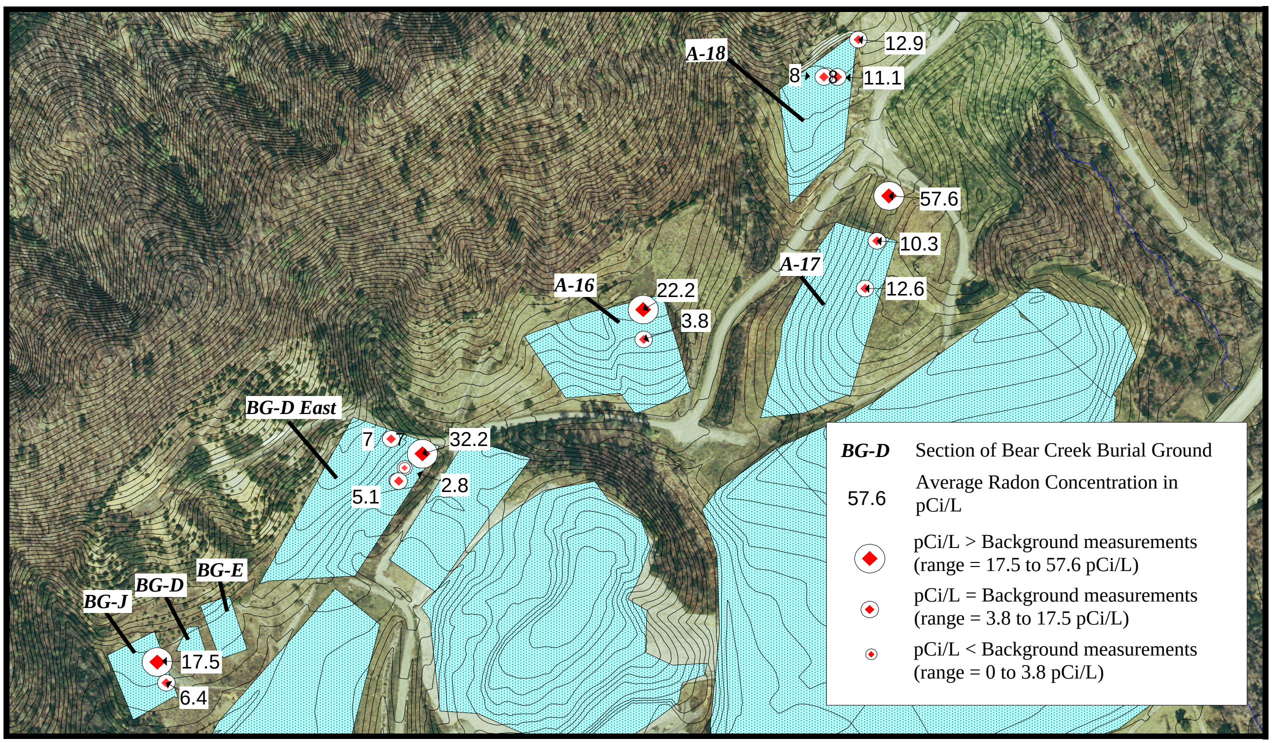

Figure 1: Locations of Radon Detectors placed in the Bear Creek Burial Grounds and Associated Results

Conclusions

Preliminary results from radon detectors placed in the Bear Creek Burial Grounds indicate that it is feasible to measure radon levels on the ORR. While highly variable, these results also suggest that concentrations of radon above background levels may be found over burial grounds on the ORR. While the elevated radon levels reported might be a result of the disposal of large amounts of uranium, the quantity of the preliminary data and uncertainties associated with the results make definitive conclusions premature and further investigation merited.

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CHAPTER 6 RADIOLOGICAL MONITORING

Real Time Ambient Gamma Monitoring of the Oak Ridge Reservation

Principal Author: Howard Crabtree

Abstract

The Tennessee Department of Environment and Conservation has used continuously recording exposure rate monitors to measure gamma radiation on the U.S. Department of Energy (DOE) Oak Ridge Reservation since 1996. Monitoring using these instruments is directed toward sites where exposure rates are expected to fluctuate significantly over relative short time periods and / or there is a potential for elevated releases of gamma emitting radionuclides. Data derived from the program, along with that generated by environmental dosimetry, are used to identify unplanned releases and assess the need and effectiveness of remedial activities.

In 2002, the gamma monitors were stationed at a background location (Fort Loudoun Dam), the Y-12 Industrial Landfill, Portal 4 at the East Tennessee Technology Park, the check-in station for the Environmental Management Waste Management Facility, the Corehole 8 Plume Reduction Remedial Action (Bethel Valley), and the Surface Impoundments Operable Unit Remedial Action (Bethel Valley). Measurements collected from these sites ranged from 0 μR/hr to 1,740 μR/hr. The highest exposure rates were recorded at the boundary of a radiation area surrounding sediments taken from surface impoundments at the Oak Ridge National Laboratory. Dose rates at this location averaged 1.73 mrem/hr. While not a DOE requirement, these values approach limits specified by state and Nuclear Regulatory Commission regulations requiring their licensees to conduct operations in such a manner that the external dose in any unrestricted area not exceed 2.0 mrem in any one hour.

Introduction

The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division has deployed continuously recording exposure rate monitors on the Oak Ridge Reservation (ORR) since 1996. While the environmental dosimeters used in the division's Ambient Monitoring Program provide the cumulative dose over the time period monitored, the results can not account for the specific time, duration, 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. The continuous exposure rate monitors record gamma radiation levels at short intervals (e.g., 1 minute), providing an exposure rate profile that can be correlated with activities or changing conditions at the site. The instruments have primarily been used to record exposure rates during remedial activities and supplement the integrated dose rates provided by the division's environmental dosimetry.

In 2002, the locations monitored with the exposure rate monitors included a background station and six sites associated with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) activities. These locations included: the Corehole 8 Plume Source Removal Action and Surface Impoundment Operable Unit (SIOU) Remedial Action at the Oak Ridge National Laboratory (ORNL); the Environmental Management Waste Management Facility (EMWMF); the Y-12 Industrial Landfill; and Portal 4 at the East Tennessee Technology Park (ETTP).

Methods and Materials

The exposure rate monitors used in the program are manufactured by Genitron Instruments and marketed under the trade name GammaTRACER®. Each unit contains two Geiger-Mueller tubes, a microprocessor controlled data logger, and lithium batteries sealed in a weather resistant case to protect the internal components. The instruments can be programmed to measure exposure rates from 1 μR/hr to 1 R/hr at predetermined intervals (one minute to two hours). The results reported are the average of the measurements recorded by the two Geiger-Mueller detectors, but data from each detector can be accessed, if needed. Information recorded by the data loggers is downloaded to a computer using an infrared transceiver and associated software.

Monitoring in the program focuses on the measurement of exposure rates under conditions where gamma emissions can be expected to fluctuate substantially over relatively short periods and / or there is a potential for the unplanned release of gamma emitting radionuclides to the environment. The results are compared to background measurements and appropriate standards. Candidate monitoring locations include: remedial activities, waste disposal operations, pre and post operational investigations, and emergency response activities.

Results and Discussion

The amount of radiation an individual can be exposed to is restricted by state and Federal regulations. The primary dose limit for members of the public specified by these regulations is a total effective dose equivalent* of 100 mrem in a year. Since there are no agreed upon levels where exposures to radiation constitute no risk, radiological facilities are also required to maintain exposures as low as reasonably achievable (ALARA). Table 1 provides some of the more commonly encountered dose limits.

Table 1: Commonly encountered Dose Limits for exposures to Radiation

Dose Limit	Application
5,000 mrem/year	Maximum annual dose for radiation workers
100 mrem/year	Maximum dose to a member of the general public
25 mrem/year	Limit required by State regulations for free release of facilities that have been decommissioned
2 mrem in any one hour period	The state limit for the maximum dose in an unrestricted area in any one hour period

The unit used to express the limits (rem) refers to the dose of radiation an individual receives: that is, the radiation absorbed by the individual. For alpha and neutron radiation, the measured quantity of exposure, roentgen (R), is multiplied by a quality factor to derive the dose. For gamma radiation, the roentgen and the rem are generally considered equivalent. It should be understood, the monitors used in this program only account for the doses attributable to external exposures from gamma radiation. Any dose contribution from alpha, beta, or neutron radiation would be in addition to the measurements reported.

* Dose equivalent is the product of the absorbed dose in tissue and a quality factor. Total Effective Dose Equivalent means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). The deep dose equivalent refers to the dose equivalent in tissue at 1 cm derived from external (penetrating) radiation. Dose contributions from background radiation and medical applications are not included in the dose calculation

In 2002, gamma monitoring stations for the program included the background location at Fort Loudoun Dam, Y-12's Industrial Landfill, Portal Four at ETTP, two sites associated with the SIOU Remedial Action at ORNL (the 3513 Basin and a storage area for sediments removed from the basin), the Corehole 8 Plume Source Removal Action at ORNL, and the weigh-in station for the recently opened Environmental Management Waste Management Facility.

Fort Loudoun Dam Background Station: Background exposure rates fluctuate over time due to various phenomena that alter the quantity of radionuclides in the environment and / or the intensity of radiation being emitted by these radionuclides. For example, the gamma exposure rate above soils saturated with water after a rain can be expected to be lower than that over dry soils, because the moisture shields radiation released by terrestrial radionuclides. To better assess exposure rates measured on the reservation and the influence that natural conditions have on these rates, staff members maintain one of the division's gamma monitors at Fort Loudoun Dam in Loudon County to collect background information. Figure 1 depicts the exposure rates measured at the background station from 03/24/99 to 12/03/02. Over this period exposure rates averaged 8.7 μR/hr and ranged from 7 to 17 μR/hr. During 2002, exposure rates averaged 8.4 μR/hr and ranged from 7 μR/hr to 13 μR/hr. As might be expected, the highest rates recorded were during the dryer seasons (summer & fall) and the lower rates were reported during the wetter seasons (winter & spring).

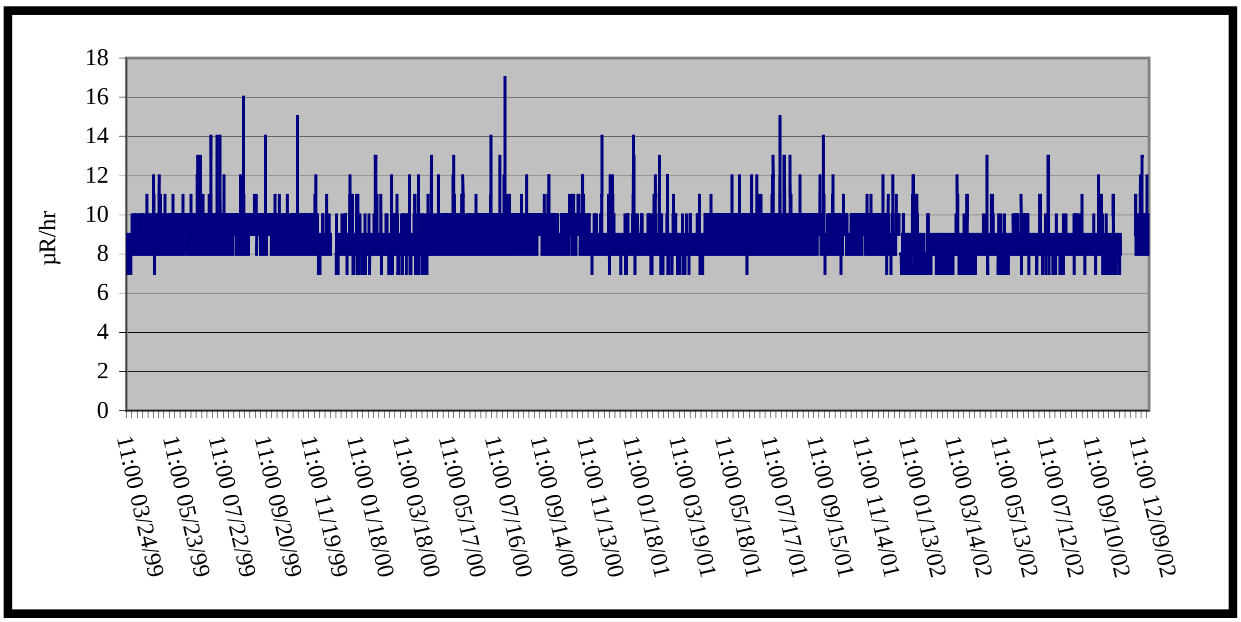
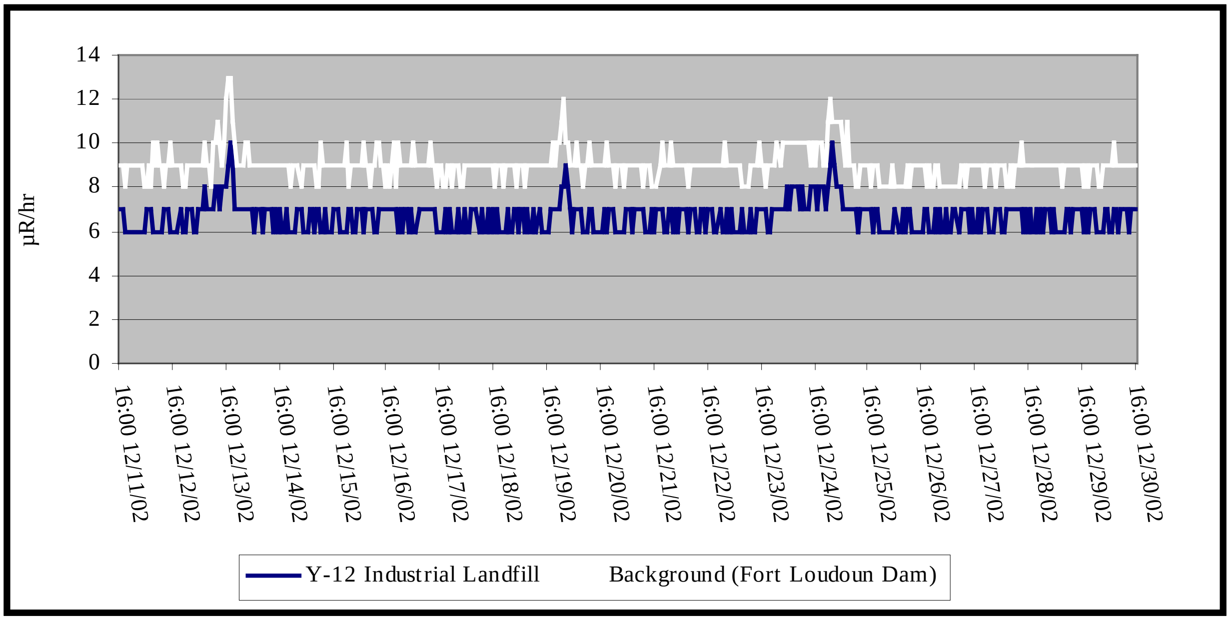


Figure 1: Results of Continuous Gamma Exposure Rate Monitoring at the Background Station located near Fort Loudoun Dam in Loudon County

On average, individuals in the United States receive a dose from natural sources of radiation of approximately 300 mrem per year. To put the dose limits in perspective, a person exposed to naturally occurring gamma radiation, alone, at the average level recorded at Fort Loudoun Dam would receive a dose equivalent to the primary dose limit (100 mrem/yr) in 479 days.

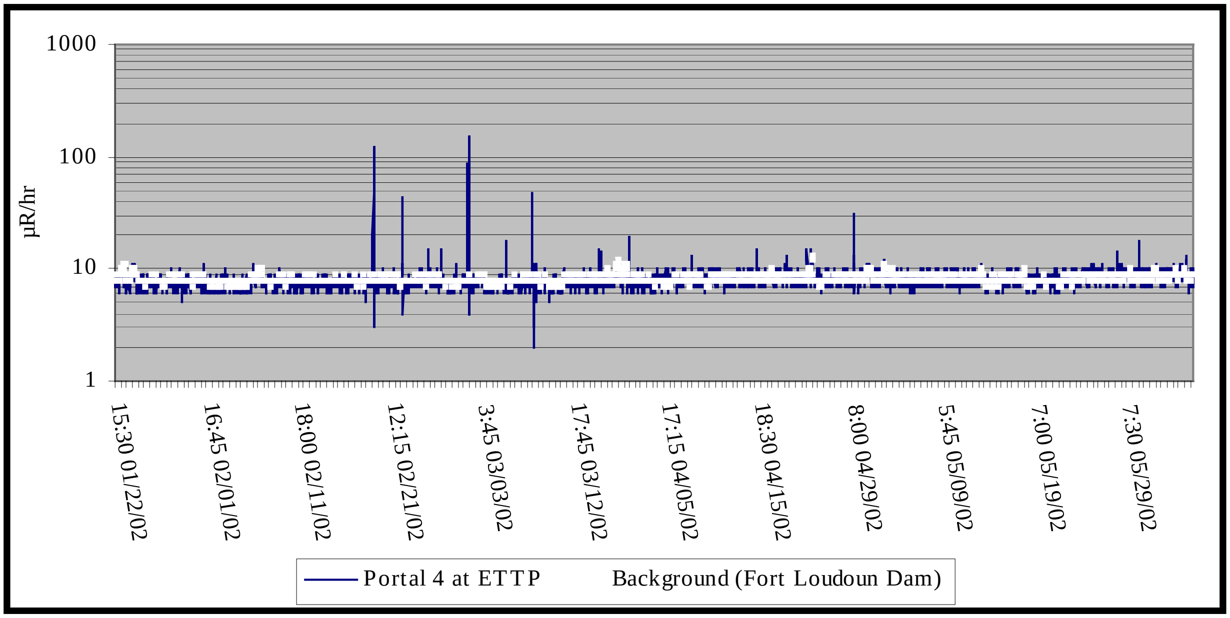
The Y-12 Industrial Landfill: The Y-12 Industrial Landfill is permitted by TDEC's Division of Solid Waste Management with the provision that the facility shall not dispose of radioactive wastes (defined for purposes of the agreement as wastes containing greater than 35 pCi/g of uranium). While wastes disposed at the facility are screened prior to disposal, instances have occurred where radionuclides have been found at the landfill in violation of this condition. On 12/11/02, staff placed one of the gamma monitors at the entrance of the facility to measure gamma activity as wastes were transported through the gate for disposal. The monitor was programmed to increase the frequency of measurements recorded from one hour to one minute intervals, if exposure levels exceeded 20 µR/hr. The measurements taken ranged from 6 to 10 µR/hr and averaged 6.67 µR/hr. As can be seen in Figure 2, the data recorded at the landfill were very similar to the results reported for the background station.



The state dose limit to an unrestricted area is 2 mrem (2,000 µR for gamma) in any one hour period. The State dose limit for members of the public is 100 mrem in a year,

Figure 2: Results of Continuous Gamma Exposure Rate Monitoring at the Entrance to the Y-12 Industrial Landfill and Background Measurements taken at Fort Loudoun Dam in Loudon County

Portal Four at the East Tennessee Technology Park: As clean-up activities continue at the East Tennessee Technology Park, wastes containing radioactive materials are transported off-site for disposal. To get an idea of the radioactivity associated with these wastes and assess the capability of the monitors to measure radiation from sources moving past the monitoring station, staff placed one of the gamma monitors next to the exit lane for Portal Four at ETTP. The monitor was programmed to increase the frequency of measurements recorded from 15 minute to 1 minute intervals, if exposures exceeded 20 µR/hr. The data collected from 01/22/02 through 06/05/02 indicate ambient gamma levels at the portal were a little less than background levels. As vehicles transporting radioactive materials stopped at the gates and were processed to exit the facility, the exposure rates rose substantially for short periods (Figure 3). For the period monitored, exposure rates recorded ranged from 2 to 150 µR/hr, but averaged only 8.2 µR/hr, which was near the average for measurements taken at the background station during the same period (8.1 µR/hr).



The state dose limit to an unrestricted area is 2 mrem (2,000 μR for gamma) in any one hour period. The state dose limit for members of the public is 100 mrem in a year.

Figure 3: Results of Continuous Gamma Exposure Rate Monitoring at the Portal Four Exit from the East Tennessee Technology Park and Background Measurements taken at Fort Loudoun Dam in Loudon County.

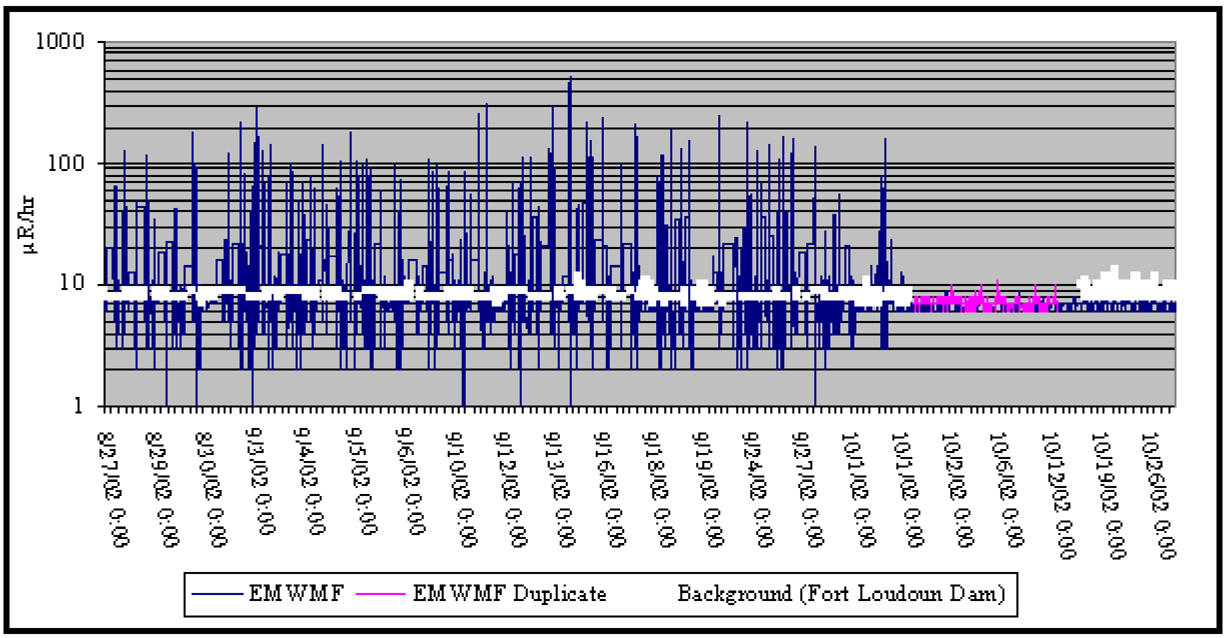
The Environmental Management Waste Management Facility (EMWMF): The EMWMF was constructed in Bear Creek Valley (near the Y-12 Plant) to dispose of wastes generated by CERCLA activities on the ORR. The facility began operation in June 2002 and disposed of over 104 tons of waste during the remainder or the year (SAIC, 2003). During this period, waste was disposed from Y-12's Boneyard-Burnyard, ETTP's K-1070-A Burial Ground, ETTP Demolition Projects, and ORNL's Interim Holding Pond (IHP).

The EMWMF relies on a waste profile provided by the generator to characterize waste disposed in the facility. This profile is based on an average of contaminants in a waste lot. The size of waste lots can vary from a single package to many truckloads of waste. Since the average concentration across the waste lot is used to profile the waste, the values cited are not necessarily representative of each load of waste transported to the facility. That is, some loads may have highly contaminated wastes while others are less contaminated.

To get an idea of the variability in radioactive waste disposed at the EMWMF, one of the gamma monitors was secured at the facility's check-in station on 08/27/02. Each truck transporting waste must stop at this location while the vehicle/waste is weighed and the driver processes the associated manifest. To provide a more accurate profile of radioactive waste moving through the system, the monitor was programmed to increase the frequency of measurements from 1/hr. to 1/min., if gamma emissions rose above 40 μR/hr. It should be remembered the gamma monitors do not measure alpha or beta radiation, nor would alpha or beta emissions be expected to penetrate the sides of the truck or a container.

From 08/27/02 to 12/30/02, the monitoring results taken at the EMWMF ranged from 0 to 526 μR/hr (Figure 4), but averaged only 14 μR/hr. Similar to the measurements taken at ETTP's Portal 4, data reflected ambient gamma levels near background measurements, punctuated by elevated readings as the radioactive waste passed through the weigh station. It is suspected the higher measurements were from sediments collected at ORNL's Intermediate Holding Pond (IHP), where cesium-137 and other gamma emitters collected in sediments from early operations. A succinct decrease in the magnitude of the elevated data occurred after 10/10/02 and the remaining measurements were below 15 μR/hr. Staff were advised by EMWMF personnel that the decline noted in the exposure rates was probably due to a decrease in gamma emitters contained in the waste lots disposed after 10/10/02.

Very low measurements (0 to 5 μR/hr) that can be noted in the data are below background levels, suggesting the monitor was not operating properly or something was shielding radiation from the unit. To check the operation of the monitor, a second unit was placed at the site from 10/17/02 to 11/27/02. During this period, 978 measurements were recorded with the two monitors varying no more than 1 μR/hr for each measurement. Given the above, it seems probable the monitor was shielded temporarily during part of the check-in process.



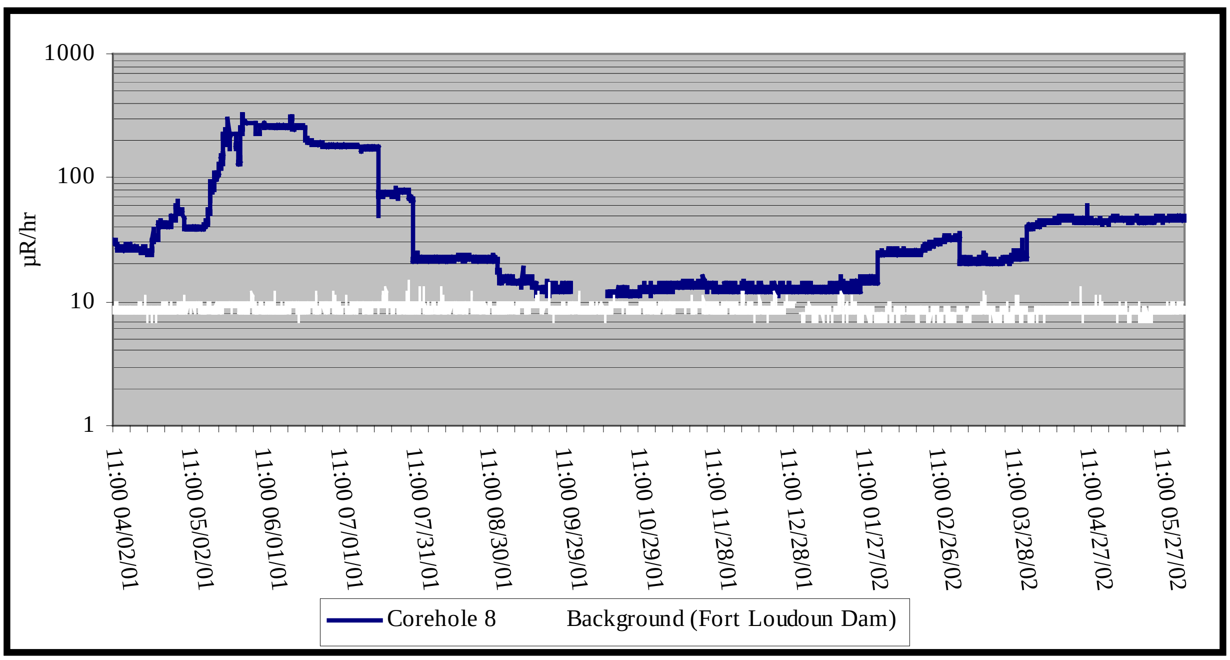
The state dose limit to an unrestricted area is 2 mrem (2,000 μR for gamma) in any one hour period. The state dose limit for members of the public is 100 mrem in a year.

Figure 4: Results of Continuous Gamma Exposure Rate Monitoring at the Weigh-In Station for the Environmental Management Waste Management Facility (EMWMF)

The Corehole 8 Removal Action: The North Tank Farm is located near the center of ORNL's main campus. In the past, a number of underground storage tanks were emplaced at this location to store and/or treat radioactive and hazardous wastes. In the 1990s, one of these tanks, W-1A, was discovered to be the source of contaminants feeding the Corehole 8 groundwater plume. This plume covers a large area west of the site. Associated contaminants enter First Creek, where they are transported to White Oak Creek and the Clinch River. Associated contaminants include: strontium-90, americium-241, plutonium-238, 239, & 240, and curium-244 (Bechtel, 1992).

In 1998, DOE proposed to remove W-1A and adjacent soils (which have developed into a secondary source of the contaminants feeding the plume). The removal action began in 2001. On 04/02/01, division staff secured one of the gamma monitors to a tree across from the North Tank Farm, approximately 75 feet from where Tank W-1A is located. This monitor was located next to a sidewalk used by pedestrian traffic to access ORNL's cafeteria. From 04/02/01 to 12/31/01, exposure rates at this location averaged 72 μR/hr and ranged from 11 to 324 μR/hr (Figure 5).

The soils above subsurface contaminants attenuate radiation emitted by the materials beneath. It can be expected that exposure rates will increase as contaminants are uncovered and brought to the surface during remediation. In Figure 5, an increase can be observed during May and June of 2001 when the tank and contaminated soils were uncovered in preparation for their removal. In this case, the contaminants included transuranic wastes that exhibited much higher radioactivity than had been anticipated by the contractors hired to perform the action. As a consequence, the contractors replaced and covered the materials that had been excavated, until alternate methods can be developed to handle the waste. The exposure rates subsequently decreased to near background levels at the monitoring location then rose somewhat in 2002. It is believed the increased measurements in 2002 were caused by the removal of equipment and safeguards that had previously shielded radiation coming from the area. Measurements from 01/01/02 to 06/05/02 ranged from 12 to 59 μR/hr and averaged 31 μR/hr.

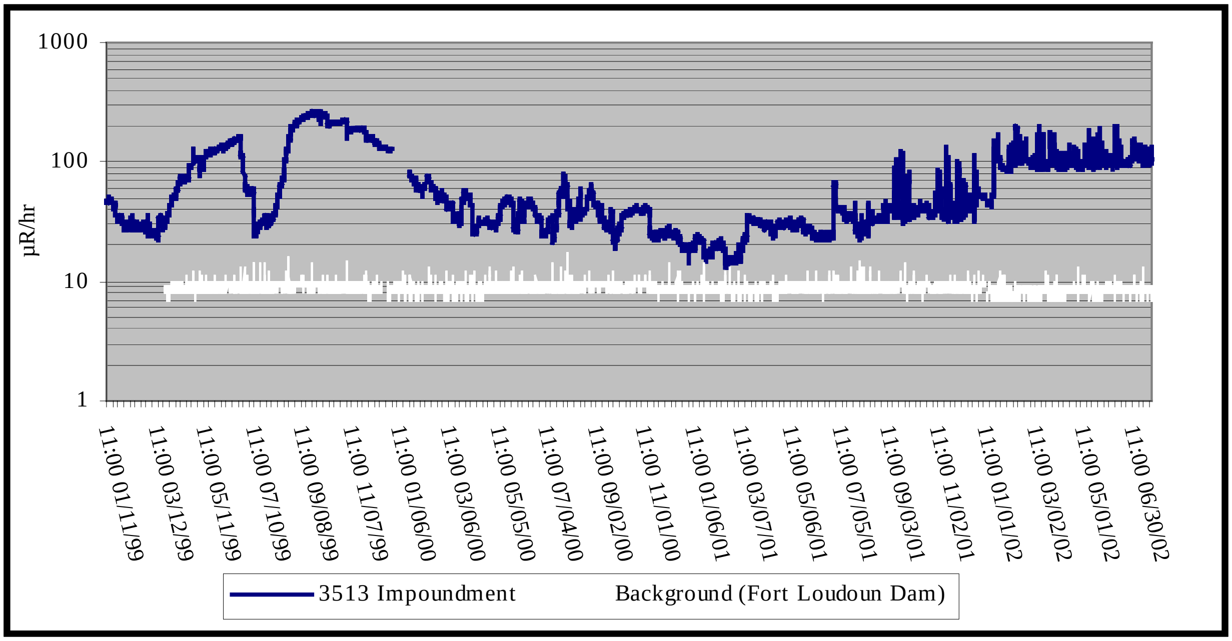


The state dose limit to an unrestricted area is 2 mrem (2,000 μR for gamma) in any one hour period. The state dose limit for members of the public is 100 mrem in a year.

Figure 5: Results of Continuous Gamma Exposure Rate Monitoring at the Corehole 8 Remedial Action and Measurements taken at Fort Loudoun Dam in Loudon County.

The Surface Impoundment Operable Unit (SIOU) Remedial Action-3513 Waste Holding Basin: The 3513 Waste Holding Basin is being remediated as part of the SIOU Remedial Action. From 1944 to 1976, the 3513 Basin served as a settling pond for ORNL effluents prior to their release to White Oak Creek. Consequently, sediments at the bottom of the basin accumulated significant amounts of radioactive materials. These wastes include an estimated 200 curies of cesium-137 (Bechtel, 1992): the radionuclide primarily responsible for elevated gamma emissions measured at the site. A CERCLA Record of Decision (September 24, 1997) provided for the removal and disposal of contaminated sediments in the 3513 Impoundment and the adjacent 3524 Equalization Basin (which also received radioactive wastes, historically).

In order to measure the effectiveness of this action, division staff attached an exposure rate monitor to a tree located approximately 28 feet from the 3513 Impoundment in 1999 (prior to remedial activities). From 01/11/99 to 07/24/02 the exposure rates measured at the basin averaged 69 μR/hr and ranged from 13 to 271 μR/hr. Figure 6 plots the exposure rates recorded at 3513 basin during this period, along with background data collected at Fort Loudoun Dam.



The state dose limit to an unrestricted area is 2 mrem (2,000 μR for gamma) in any one hour period. The state dose limit for members of the public is 100 mrem in a year.

Figure 6: Results of Continuous Gamma Exposure Rate Monitoring at the 3513 Waste Holding Basin and Background Measurements taken at Fort Loudoun Dam

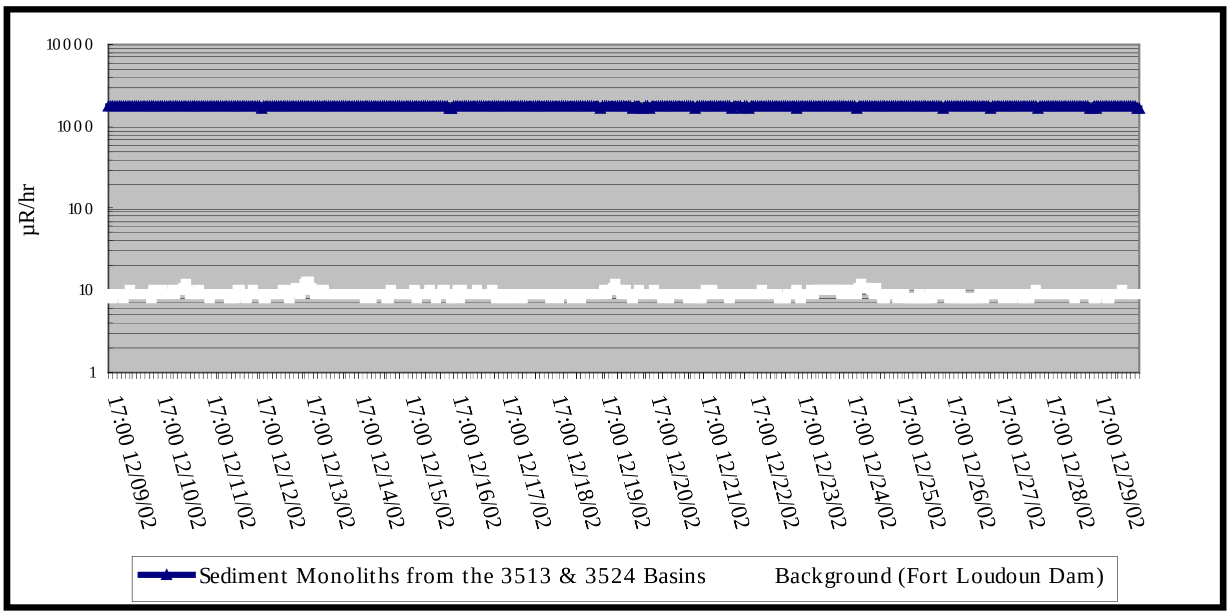
To a large degree, significant fluctuations in the exposure rates at the 3513 can be attributed to changes in the water level in the basin. In this regard, water in the impoundment shields gamma radiation emitted by the wastes contained in the sediments. The increased water levels during the wetter months and/or during storm events enhance this effect and provide shielding to previously exposed sediments at the basin perimeter, resulting in lower exposure rates. The peak that can be noted in Figure 6 during the summer of 1999 was due to the lowering of the water level in the basin to repair a seep that was observed in the berm that separates the basin from White Oak Creek. During 1999, the exposure rates averaged 272 μR/hr.

In the summer of 2000, sediments from the 3524 Equalization Basin were transferred to the 3513 Impoundment in preparation for their final removal and disposal. During this effort, the water level in the basin was maintained to reduce radiation emitted by the sediments and the potential for contaminants to becoming airborne. As a consequence, the exposure rates at 3513 decreased. In 2000, the exposure rates at the basin averaged 39.1 µR/hr.

In 2001, DOE contractors began removing the sediments from the 3513 basin (including those previously in 3524). The exposure rates in 2001 at the basin averaged 33 µR/hr. The sediment removal process continued through 2002. Unfortunately, the gamma monitor had to be removed in July 2002 for routine maintenance and calibration. From 01/03/02 to 07/04/02 measurements at 3513 were higher than the two previous years ranging from 88 to 107 µR/hr and averaging 105 µR/hr. The exact cause is currently unknown.

The Surface Impoundment Operable Unit (SIOU) Remedial Action Sediment Staging Area: As sediments are removed from the 3513 Basin, they are dewatered then mixed with cement to form concrete monoliths. The monoliths are packaged in a Department of Transportation liners and stored in radiation control areas. As of June 20, 2002, approximately 380 of these monoliths had been formed and stored at various locations on the ORNL campus awaiting disposal.

To assess the hazard the SIOU sediments might present, a gamma monitor was placed near the radiation area boundary at a sediment storage site located at ORNL's inactive coal yard. Measurements from 12/09/02 to 12/30/02 ranged from 1,708 µR/hr to 1,740 µR/hr and averaged 1,740 µR/hr (Figure 7). While not a DOE regulation, these values approach the state dose limit for unrestricted areas, 2 mrem in any one-hour period.



The state dose limit to an unrestricted area is 2 mrem (2,000 µR for gamma) in any one-hour period. The state dose limit for members of the public is 100 mrem in a year.

Figure 7: Results of Continuous Gamma Exposure Rate Monitoring at the Storage Area for Sediments excavated from the 3513 Waste Holding Basin and 3524 Equalization Basin

Conclusion

The radiation shielding capacity of water was evident in measurements taken at the 3513 Waste Holding Basin from 1999 through 2002. When the water level was low, contaminated sediments at the basin perimeter were exposed resulting in higher exposure rates. As the water level rose, shielding was provided from the radiation emitted by the previously exposed sediments and the exposure rates decreased. Exposure rates measured at the 3513 Impoundment substantially decreased in 2000, due to the water level being maintained during remedial activities. Increased exposure levels observed in 2001 and 2002 are believed to be due to the excavation, treatment, and accumulation of contaminated sediments from the basin. The highest exposure levels measured in 2002 (1,708 to 1,740 μR/hr) were in the vicinity of a storage area for these sediments.

In addition to moisture, soils can be expected to shield radiation emitted by contaminants beneath the ground surface. The highest exposure rates measured in 2001 were in association with the excavation of an underground storage tank (W-1A) and contaminated soils feeding the Corehole 8 ground water plume at ORNL. While the monitoring station was located approximately 75 feet from the excavation, exposure rates increased from approximately 30 μR/hr to 324 μR/hr as the tank and associated contaminants were uncovered. In this case, contaminants included transuranic wastes that exhibited much higher radioactivity than had been anticipated. As a consequence, the materials excavated were replaced lowering the exposure rates, until alternate methods for handling the waste can be developed.

Once removed from a remedial site, radioactive wastes must be transported to a disposal facility for final disposal. In 2002, three sites were monitored to assess exposure levels as trucks carrying waste moved past the monitoring stations. Results measured at Y-12's Industrial Landfill were indistinguishable from background measurements. At ETTP's Portal Four, exposure rates increased as radioactive materials were transported through the gate; however, the frequency and relatively short duration of the excursions resulted in average values very similar to background measurements. The highest exposure rates were observed at the weigh-in station for the EMWMF. These levels fluctuated from 0 to 526 μR/hr and averaged 14 μR/hr. The higher levels are believed to be due to wastes received at the facility from ORNL's Interim Holding Pond where high concentrations of cesium-137 and other gamma emitters collected in sediments from early operations.

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CHAPTER 6 RADIOLOGICAL MONITORING

Follow-up on Environmental Restoration Footprint Reduction Maintenance Actions on the Oak Ridge Reservation

Principal Author: Gerry Middleton, Robert Storms

Abstract

The Oak Ridge Reservation (ORR) was placed on the National Priorities List (NPL) in 1989. The purpose of Footprint Reduction was to identify portions of the ORR that have not been environmentally impacted by past federal Department of Energy (DOE) activities. The mission was to determine which land parcels could be conditionally released from Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements. CERCLA 120(h) was used as the guideline by the footprint team for the footprint investigations.

The goal was further identified as reducing the size and configuration of the area of the ORR designated as part of the NPL site and determining a No Further Investigation (NFI) status. The land parcels were assigned numerical identifiers ranging from 1 through 20.

Tennessee Department of Environment and Conservation - Department of Energy Oversight Division (hereinafter, "the division", or "division") performed a radiological walkover and reconnaissance survey of each parcel and adjacent land. The investigation focused on identifying potential anthropogenic sources of contamination and exit pathway releases on the ORR which could render the parcel(s) unfit for release. In summation, the division investigated 21,439 acres of ORR land during the footprint project.

In performance of the field investigation work, certain maintenance action items were identified on the various land parcels, i.e., "study areas" (see Appendix I). The division clearly emphasized these concerns to DOE in each footprint study area report released to the public. This current project revisited these sites to determine if action had in fact been taken by DOE to rectify the problems and other division concerns.

Introduction and Scope

The ORR was placed on the National Priorities List (NPL) in December 1989, as a high priority hazardous waste site requiring remediation. In 1992, the Department of Energy (DOE), the U. S. Environmental Protection Agency, and the division negotiated the Federal Facility Agreement (FFA) for environmental restoration activities on the ORR. DOE is responsible for cleaning up the ORR following the CERCLA process, which assesses the impacts of ORR areas on human health and the environment. To fulfill this requirement, potential contamination information was collected and reviewed to determine whether CERCLA response activities were needed followed by in the field investigation of ORR areas.

A proposal was submitted to the division in March 1996 outlining a process designed to identify portions of the ORR that have been environmentally affected by past federal activities. The DOE Environmental Restoration Footprint Reduction process was designed to investigate and assess those areas of the ORR likely to have been environmentally affected by past federal activities. In addition, determinations were made as to which land parcels could be conditionally released from CERCLA requirements and removed from NPL status. The focal regulatory requirement for the project was the CERCLA 120(h) investigative process, which is used to identify the presence or likely presence of hazardous substances on property being transferred by federal agencies. The CERCLA 120(h) investigative process uses the following information sources to identify the presence of hazardous substance contamination on federal land: historical land use information, aerial photography, remote sensing data including gamma aerial reconnaissance photos, and field investigation/verification.

The division performed a radiological walkover and reconnaissance survey of each parcel and adjacent land. The investigation focused on identifying potential anthropogenic sources of contamination and resulting release pathways on the ORR, which might render the parcel(s) unfit for release. The contamination could be in the form of solid waste, radiological waste, hazardous waste, or in surface water. Groundwater contamination will be addressed in detail if the property is released to the public.

Areas or facilities found to be contaminated within the various study areas during the parcel evaluation were added to Appendix C of the Federal Facility Agreement (FFA) as CERCLA maintenance action sites. Uncontaminated study areas or portions of study were recommended for No Further Investigation status under the Footprint Reduction program.

The goal of the program was to reduce the size and configuration of the “footprint” area acerage of the ORR (“behind the fence”) designated as part of the NPL site. Essentially, the effort was designed to distinguish “greenfield” from “brownfield” areas behind DOE institutional control boundaries.

During the execution of the fieldwork on each footprint study area, certain maintenance action items were determined in need of removal. Additional areas were found where abandoned field gear and trash from research projects needs clearing or removal. Each footprint parcel was investigated and a final report on the respective study area was generated and issued by the footprint team. The division clearly identified maintenance action problem areas to be addressed by DOE in each of the applicable 20 footprint study area reports (not all parcels had cleanup problems). During calendar year 2001 the division “follow-up footprint project” revisited all the previously determined maintenance action sites to determine compliance with the requested maintenance actions.

Finally, the division has folded the parcel ED-1 Mitigation Action Plan (MAP) requirements into this project as well. Required environmental monitoring by DOE and CROET per the MAP has become a concern. The division will do follow-up on this project with field excursions in addition to requesting DOE honor its responsibilities per the MAP document.

Methods and Materials

The purpose of Footprint Reduction was to identify portions of the ORR potentially impacted by past federal activities. The division performed a radiological walkover and reconnaissance survey of twenty parcels and adjoining land. The field investigation focused on possible anthropogenic sources of contamination that might render each parcel unfit for release. The parcels were investigated and walked over by division staff using field radiological detection instruments (i.e., Ludlum model 2221 scaler ratemeter with a 2 x 2 inch sodium iodide crystal). A portable gamma spectrometer equipment was used to identify isotopes present at sites where above background detections of radiation were discovered. The division also used a micro-rem meter that provides data in tissue dose equivalent units (rem). Global positioning system (GPS) technology was employed to locate field survey points and to confirm the location of anomalous features.

Historical land use investigations, aerial photography analysis, and remote sensing data were studied for evidence of federal activities that could have potentially resulted in adverse impacts to the environment. Magnetic and radiologic anomalies were plotted on maps prepared by the then Lockheed Martin Energy Research (LMER) Geographic Information Science and Technology (GIST) staff for field investigation applications. The division reviewed the map and other data furnished by LMER GIST staff, as well as all pertinent information and data from division files. The magnitude, sheer size of the area to be surveyed, and topography of the land parcels precluded the use of grid survey techniques. After a detailed study of survey techniques and requirements, it was determined that the survey effort would concentrate on mapped locations of magnetic and gamma flyover anomalies. Aerial photography was investigated and studied thoroughly to evaluate potential land use changes over time.

The division investigated the anomalies identified on the anomalies maps plus suspicious sites observed on historical aerial photos. Cultural changes, non-sequential vegetation changes, radiological anomalies, and geophysical anomalies were investigated. Karst features, springs, abandoned and existing roads, and other unusual sites were inspected when found in the field. Threatened and endangered plant species and Native American sites were on the list of potentially important sites to be considered for exclusion and protective status.

The physically demanding and time-consuming task of walking over the parcels provided the best method of coverage and obtaining the best quality and most reliable information. Routes were selected that would ensure maximum coverage of the parcels. Abandoned roads and trails were walked to determine if hazardous materials or wastes had been dumped on site. Magnetic anomalies were examined to ensure that there were no observable metals, wastes or structures present. Remote areas were investigated to determine if evidence of past Federal activities were present. Division staff concluded fieldwork on all of the 20 parcels in early 2000 (totaling approximately 24,754 acres - see Figure 2).

Results and Discussion

Division field teams located the pre-mapped anomalies in the field utilizing GPS technology. Measurements of ambient gamma radiation were taken at each anomalous site or survey site to determine if any contamination from DOE operations (or its federal predecessors) could be detected. Other points were selected and investigated on a random or functional as-needed basis.

Historical investigations, aerial photography analysis, and remote sensing data were studied for evidence of Federal activities that could have potentially resulted in adverse impacts to the environment. Magnetic, historical, and radiological anomalies were plotted on maps to assist the field investigation team.

During the course of the five plus year Footprint Reduction project, several maintenance action sites in need of remediation were identified. In addition, several new solid waste management units (SWMUs) were discovered and recommended for exclusion from the parcels (see Figure 1 for locations of all sites). All these sites were to be addressed by DOE at a later date (see Appendix I for the maintenance action list). The SWMU sites were given priority by DOE and it’s subcontractors for appropriate maintenance action. Identification numbers and names were assigned to the sites, and each SWMU was cordoned off with yellow and magenta rope (if radiologically contaminated), placarded, or otherwise flagged, and was added to the FFA Appendix C list. There was one small barn structure at ETTP that was found to have fixed contamination (radiological) on its floor. This facility was immediately provided with appropriate institutional controls as a radiological area.

The intent of this current "follow-up" project was to revisit those areas of concern and determine the status of the requested maintenance actions. All sites were compared to the Appendix C of the FFA to ensure inclusion. Unfortunately, due to budgetary cutbacks or lack of action on DOE's part, none of the maintenance action sites except for the SWMUs have received the requested attention or response.

Conclusions

During 2001, division staff returned to the locations of the 44 sites listed in Appendix I to investigate and determine if requested maintenance actions had been carried out by DOE to alleviate the problems. Essentially, no action has been taken to address the sites of concern. Therefore, concerns by the division continue to be justified for (public) human health and the environment due to DOE's lack of response. DOE appropriately addressed the new SWMU sites discovered by the division. Each SWMU was cordoned off with yellow and magenta rope (if radiologically contaminated), placarded, or otherwise flagged, and was added to the FFA Appendix C list.

Division staff will continue to vigorously follow-up on the areas of concern until the desired response by DOE is achieved thereby providing resolution of division concerns. The possibility that groundwater contamination will migrate from impacted areas of the ORR into the study areas exists and constitutes the need for groundwater use restrictions.

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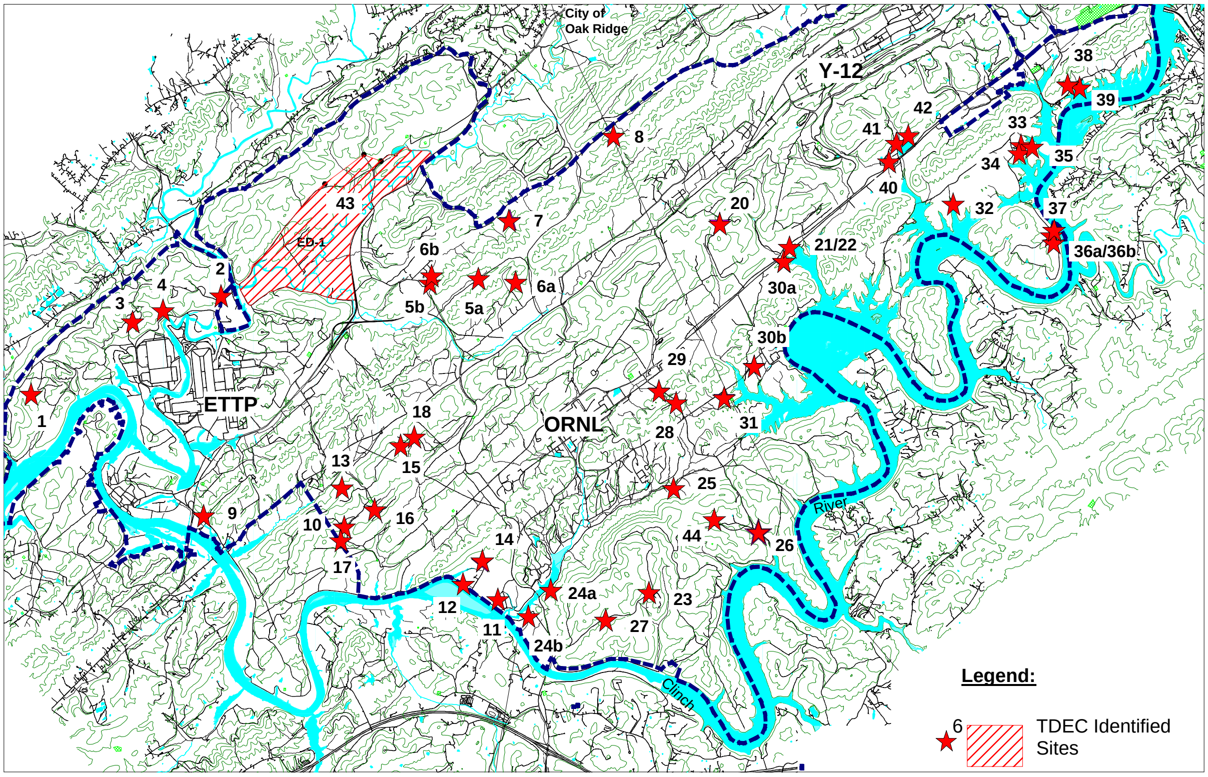

FIGURE 1: Footprint Reduction – Maintenance Action Sites

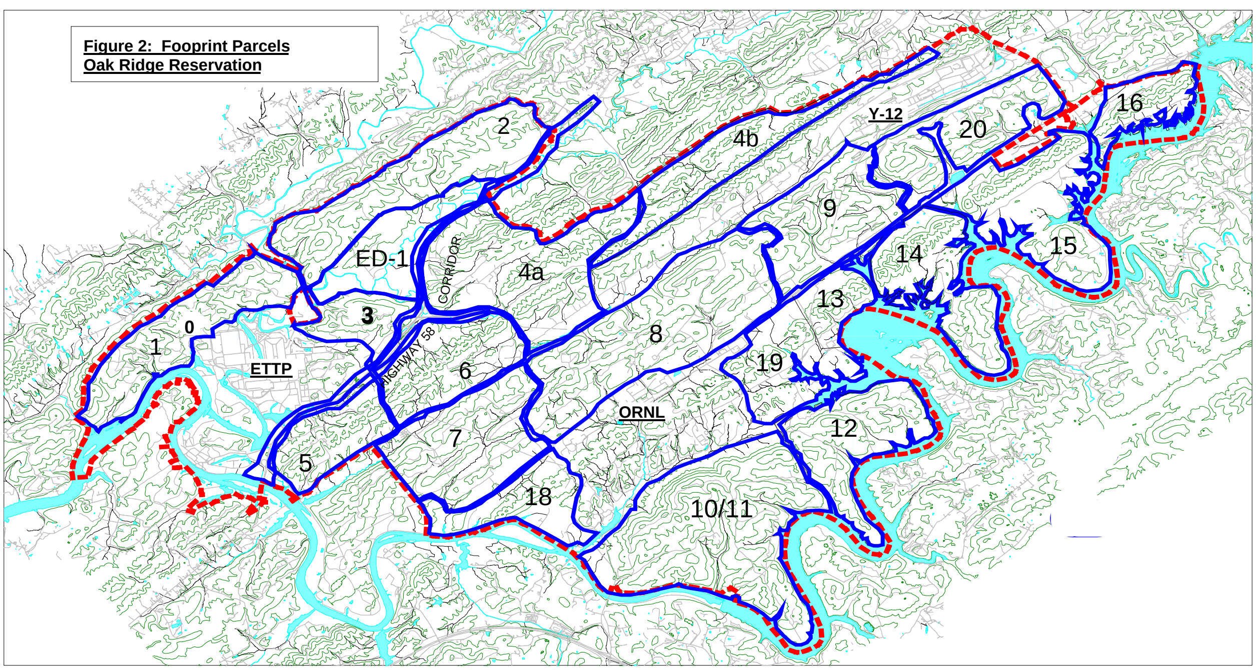

FIGURE 2: Footprint Parcels – Oak Ridge Reservation

APPENDIX I

LIST OF MAINTENANCE ACTION SITES IDENTIFIED BY TDEC FIELD SURVEYS (FOOTPRINT REDUCTION PROCESS)

Map Reference	Maintenance Action Concern and Site Description
	Parcel 1: West Black Oak Ridge Study Area
1	TDEC field station 101: Abandoned 55-gallon steel drum (empty)
2	TDEC field station 127: Old dumpsite (tires, roofing, scrap metal, etc.)
3	TDEC field station 129: Small shed with above background levels of fixed gamma contamination
4	TDEC field station 134: Large abandoned hollow fill
	Parcel 2: East Black Oak Ridge Study Area
	None specified
	Parcel 3: McKinney Ridge Study Area
	None specified
	Parcel 4a: East Fork Ridge/White Wing Study Area
5a/5b	TDEC field stations 24 & 125: Abandoned 55-gallon drums
6a/6b	TDEC field stations 105-124: Numerous abandoned hydrologic experimental equipment
7	TDEC field station 157: Remains of plywood shack and drums
	Parcel 4b: Pine Ridge Study Area
8	TDEC field station 89: Abandoned barrel with residual fuel oil
	Parcels 5/6: West Pine Ridge Study Area
9	TDEC field station 44: Old Dump Site at west end of Happy Valley Campsite
	[Radiological surveys should be conducted prior to use of federal land adjacent to the Consolidated Clinch River Industrial Park to ensure potential exposure is minimized]
	Parcels 7/18: West Chestnut Ridge/West Bethel Valley Study Area
10	TDEC field station 14: Abandoned 55-gallon drum
11	TDEC field station 26: Pile of scrap metal
12	TDEC field station 35: Abandoned automatic sampling equipment along small creek
13	TDEC field station 49: Experimental hydrologic site with abandoned equipment & test gear
14	TDEC field station 89: Abandoned hydrologic/precipitation experimental equipment
15	TDEC field station 103: Abandoned soil percolation test trenches and test gear
16	TDEC field station 105: Abandoned hydrologic experimental gear strewn about the hillside
17	TDEC field station 114: Abandoned experimental site and test gear
18	TDEC field station 193: Abandoned percolation test trench and equipment

LIST OF MAINTENANCE ACTION SITES IDENTIFIED BY TDEC FIELD SURVEYS (FOOTPRINT REDUCTION PROCESS) Cont'd

Map Reference	Maintenance Action Concern and Site Description
19a/19b	TDEC field stations 250/251: Abandoned hydrologic test site with copious amounts of abandoned equipment
	Parcel 8: Central Chestnut Ridge Study Area
20	TDEC field station 15: Debris & scrap metal strewn about the NOAA/ATDD facility
21	TDEC field station 168: SWMU 0.81 site including broken asphalt, concrete, scrap metal, & local dumping of trash; [same location as map reference 22]
	Parcel 9: Walker Branch Study Area
22	TDEC field station 77: Removal action requested for miscellaneous trash and debris associated with SWMU 0.81 located between Old and New Bethel Valley Roads [same location as map reference 21]
	[Removal action is recommended for abandoned experimental gear, scrap metal, hydrologic test equipment and trash strewn about the entire parcel]
	Parcel 11: Copper Ridge Study Area
23	TDEC field station 27: General vicinity of the Civil Defense Bunker needs trash picked up
24a/24b	TDEC field stations 119 & 297: Abandoned drums
25	TDEC field station 133: Gamma-contaminated site along old roadbed on ridge overlooking HFIR to the north
26	TDEC field station 250: Abandoned & unidentified waste dump (scrap metal, blocks, bricks, etc.)
27	TDEC field station 313: Tire dump
44	"Cesium Forest"
	Parcel 12: Park City Road Study Area
	None specified
	Parcel 13/19: West Haw Ridge/Bearden Creek Watershed Study Area
28	TDEC field station 12: Previously unidentified SWMU contaminated with Cs-137
29	TDEC field station 21: Small dump site adjacent to Melton Valley Access Road which is slightly rad-contaminated
30a/30b	TDEC field stations 50 & 139: Abandoned empty 55-gallon drums
31	TDEC field station 89: Previously SWMU dump (lab equipment, scrap metal, etc)
	Parcel 14: Gallaher Bend/Bull Bluff Study Area
	None specified
	Parcel 15: Freels Bend Study Area
32	TDEC field station 6: Abandoned 55-gallon drum partially submerged in a cove along the shoreline of Melton Lake
33	TDEC field station 20: VDRIF facility needs to have shielding blocks removed from the roof of the structure

LIST OF MAINTENANCE ACTION SITES IDENTIFIED BY TDEC FIELD SURVEYS (FOOTPRINT REDUCTION PROCESS) Cont'd

34	TDEC field station 21: Demolition debris needs cleared and removed
35	TDEC field station 23: Location of small subterranean vault which held lead source rods; reportedly sand filled
Map Reference	**Maintenance Action Concern and Site Description**
36a/36b	TDEC field stations 35 & 36: Existing barns need to be cleared of trash & veterinary IV needles/medicine bottles
37	TDEC field station 52: Trash and debris disposed in large sinkhole (standing water)
	Parcel 16: Scarboro/East Haw Ridge Study Area
38	TDEC field station 6: Anomaly 12 at contaminated trailer
39	TDEC field station 7: Building 1404-7 at the location of a radiologically-contaminated hopper
	Parcel 20: East Chestnut Ridge Study Area
40	TDEC field station 36: Abandoned scrap pile/refuse along the Brush Burn Access Road
41	TDEC field station 38: Abandoned scrap metal/asbestos pile located north of Rogers Quarry
42	TDEC field station 39: Abandoned scrap metal pile located north of the Rogers Quarry highwall
43	Parcel "ED-1"

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CHAPTER 6 RADIOLOGICAL MONITORING

Biological Sampling and Radiochemical Analysis of Aquatic Plants (Macrophytes) at Spring Habitats on the Oak Ridge Reservation

Principal Author: Gerry Middleton

Abstract

This project is a renewal and expansion of a pilot vegetation (watercress) sampling and radiochemical analysis effort begun by division staff in 1995 as part of environmental surveillance per the Tennessee Oversight Agreement. The project had been idle since that time due to inconclusive results and laboratory budget constraints. The current study was designed to correlate previous TDEC and DOE groundwater radiochemistry data with watercress/vegetation radiochemistry data sampled from the same ORR springs as an aid in determining if aquatic vegetation is bioaccumulating radiological contaminants. In other words, division staff gathered collateral vegetation monitoring data in support of the groundwater monitoring and sampling of springs and surface water impacted by hazardous substances. Sometimes, spring-fed creeks and ponds were sampled if adequate amounts of aquatic vegetation were present. "Vegetation" sampled included watercress (*Nasturtium officinale*), other aquatic macrophytes (i.e., *Salvinia sp*., *Sagittaria latifolia*,*Typha latifolia*, etc), and green algae. Thirty-seven (37) vegetation samples from reference springs/creeks/ponds (offsite) and onsite springs/creeks/ponds were sampled during 2002 ("Phase 1"). Collection times of samples were random as there was no need in this case to organize a schedule into wet and dry season sampling events.

Introduction

Aquatic macrophytes (i.e., watercress, water spangles, arrowhead, and cattails), lichens, mosses and green algae are environmental bioindicators and important pathways by which contaminants infiltrate the ORR ecosystem and food chain creating ecological and human health risks. Watercress, a floating, rooted, aquatic plant (macrophyte or angiosperm) was selected for its affinity to thrive around its natural habitat, in clear, lotic water near the mouth of springs and spring-fed creeks. Emerging spring water, if impacted by hazardous substances, will deposit these in sediments. In turn, plants will uptake the contaminants both from the water and the sediments. Watercress is naturally high in calcium, alkaline salts, sulfur, and potassium, so it is likely that strontium (beta emitter) would be up-taken as well, as calcium and strontium belong to the same group (Group IIA) of the periodic chart of the elements. Also, potassium and cesium belong to Group IA creating a similar scenario. Watercress sample analytical results collected during Phase 1 sampling support this theory as two samples showed low cesium-137 concentrations (see Table II). During the first year of this project, watercress was the main bioindicator sampled supplemented with a few green algae, periphyton and macrophyte samples. Sampling of algae or other aquatic macrophytes was initiated and substituted when watercress was absent or too sparse for collection at spring sampling habitats.

Green algae and periphyton (benthic algae – diatoms) occur in most all the aqueous and many terrestrial habitats on the ORR (algae is ubiquitous). Algae forms colonies or filamentous mats ("blooms" or slick gelatinous mucilage) often covering a large area of a pond, waterfall ledges, lentic (still) or lotic (moving) water, or lake being attached to various substrates such as submerged logs and snags, aquatic plants, sand, gravel, rocks, etc. Periphyton biomass is a primary producer generating much of the low-end of the food chain for many aquatic macroinvertebrates, fish, and herbivores. Periphyton are sensitive indicators of environmental physiochemical change in lotic waters and being benthic, the assemblage or population serves as a good bioindicator because of tolerance or sensitivity to specific changes in environmental condition known for many algal species including diatoms (modified from U.S. DOE, April 2001).

Prospective habitats both offsite and onsite ORR such as springs, seeps, wetlands, ponds, spring-fed creeks, etc., received priority for sampling. Onsite ORR locations were selected based on their potential for being impacted by hazardous substances. Table I provides field and sample data for each sampling station. Existing historical spring (groundwater) analytical data collected by both the division and DOE subcontractors was used to target sampling sites as well. Figures 1 and 2 show all locations of the sampling sites.

Methods and Materials

Procedures employed during the project are consistent with those contained in the TDEC DOE-O Work Plan for the Walkover Survey Program for field radiological surveys and aquatic sampling. Radiological instruments were used to scan bagged samples for beta and gamma radiation prior to delivery to the state environmental laboratory in Knoxville. Subsequently, the Knoxville laboratory forwards all radiological samples to Nashville (state of Tennessee Environmental Laboratories) for radiochemical analysis.

Arrangements were made with the appropriate TOA coordinators to expedite sampling in radiological control areas by having RADCON technicians available for sample and equipment screening. All samples collected in the field were double bagged in plastic zip-lock bags, marked and tagged, and packed in coolers with ice for transport to the lab. Field notes and chain-of-custody forms were recorded and documented at each field sampling station. Field samples were assigned consecutive identification numbers (i.e., "Cress-01", "Cress-02", etc). QA/QC measures and field sampling equipment decontamination procedures were practiced to prevent cross-contamination and mix-up of field samples. Field coordinates (latitude/longitude) were recorded at each sampling station using a Garmin GPS II Plus field unit. Field sampling protocols and methods followed currently accepted and suggested guidelines of the Federal Radiological Monitoring and Assessment Center (FRMAC, 1998), the USGS (Porter, et al., 1993), the ASTM (Patrick, 1973), the TDEC "Health, Safety, and Security Plan", and the EPA (Barbour, et al., 1999).

Target radionuclides being mobile and occurring in the ORR environment as contamination include but are not limited to:

(1) Cesium-137
(2) Strontium-90
(3) Cobalt-60
(4) Technetium-90
(5) Uranium Isotopes and Daughter Products

Samples were analyzed for gross alpha, gross beta, and gross gamma parameters. Samples are ashed in a muffle furnace and analyses are performed on the ashed sample material. The gamma analysis follows the standard EPA (gamma) 901.1 method. The gross alpha and gross beta analysis is determined by counting 2 grams of ashed sample for two separate counts of 100 minutes.

Results and Discussion

The objectives of this oversight activity and study are the detection and characterization of radionuclides being bioaccumulated by both aquatic macrophytes and algal species in ORR spring habitats and aquatic ecosystems affecting the low-end food chain. The division gathered thirty-seven (37) aquatic vegetation samples during 2002. We wanted to show that contaminated groundwater emerging from springs was also impacting aquatic plant species in the same sampling reach of the spring-fed creeks and streams. Historical spring groundwater sampling data from 2000 and 2001 was assimilated from both division and DOE monitoring data. Division vegetation samples were compared to this historical spring groundwater analytical data.

In a few cases, the data shows a clear correlation between groundwater impacted by gross beta contamination also detected in corresponding radiological data of vegetation sampled from the same sampling sites. For example, Cattail West Spring, Raccoon Creek Spring, and SS-5 Spring all demonstrate elevated levels of gross beta (although below the MCLs for Drinking Water) in both division and DOE groundwater and vegetation samples (see Table II). The state also noted that cesium-137 and cobalt-60 were present in vegetation samples collected from the White Oak Weir site.

Conclusions

Adequate evidence of vegetation bioaccumulation of radionuclides has been determined to warrant further investigations. The analytical concentrations (especially gross beta) per the Table II radiological data suggests a correlation between groundwater (pCi/L) and aquatic vegetation (pCi/g) samples collected from the same spring monitoring location(s). The division will continue to sample and monitor aquatic vegetation both offsite and on the ORR to monitor aquatic ecosystem health and stream recovery. Future monitoring will involve an increase in periphyton and green algae sampling. Also, metals analysis will be added to the 2003 sample analytical parameters.

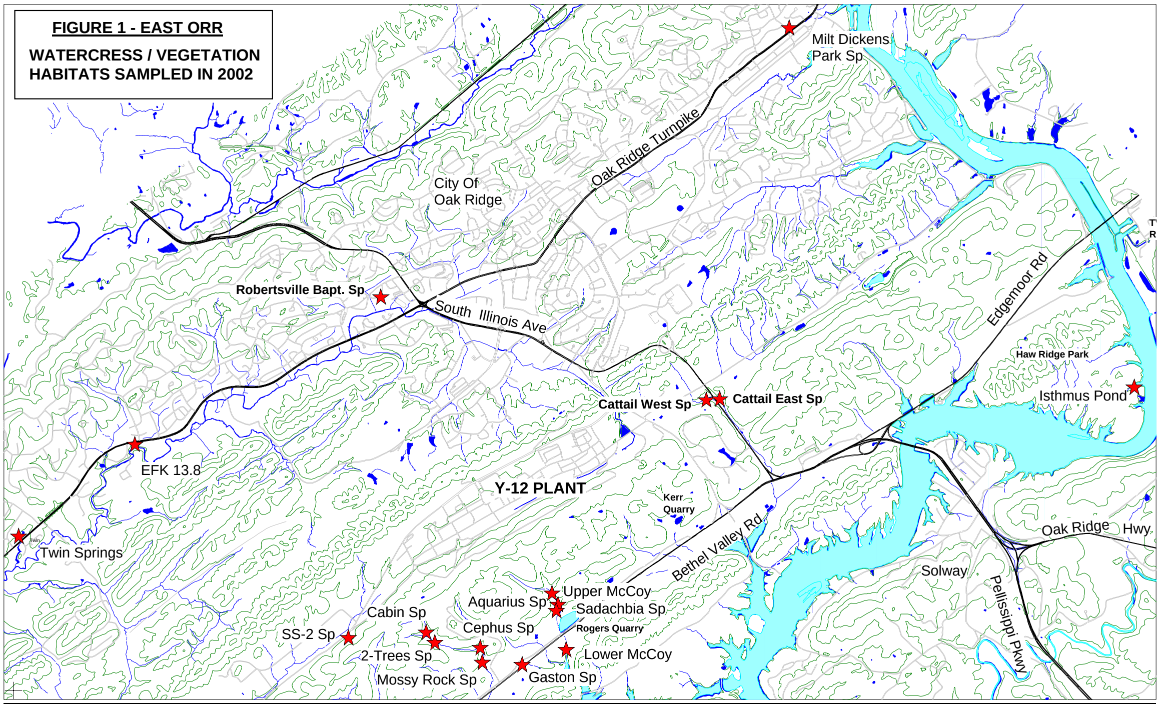
FIGURE 1 - EAST ORR
WATERCRESS / VEGETATION HABITATS SAMPLED IN 2002
Milt Dickens Park Sp
Oak Ridge Turnpike
City Of Oak Ridge
Robertsville Bapt. Sp
South Illinois Ave
Edgemoor Rd
Haw Ridge Park
Isthmus Pond
Cattail West Sp
Cattail East Sp
EFK 13.8
Y-12 PLANT
Kerr Quarry
Bethel Valley Rd
Oak Ridge Hwy
Twin Springs
Solway
Pellissippi Pkwy
Upper McCoy
Aquarius Sp
Sadachbia Sp
Rogers Quarry
Cabin Sp
Cephus Sp
SS-2 Sp
2-Trees Sp
Lower McCoy
Mossy Rock Sp
Gaston Sp

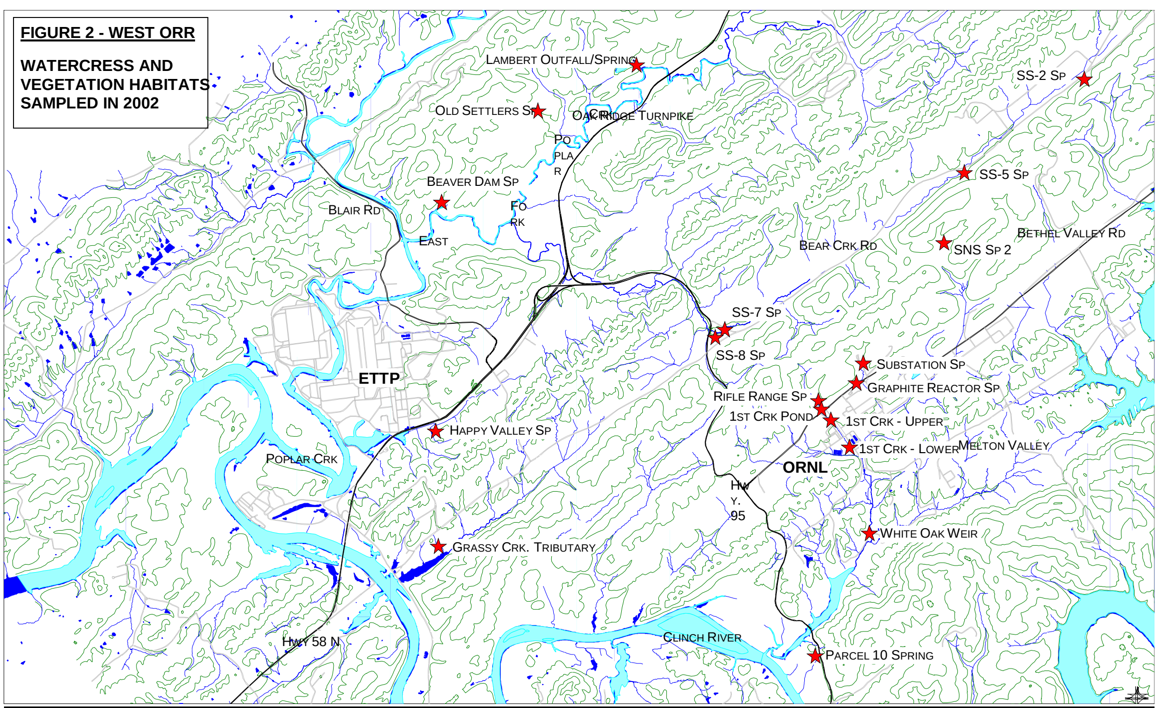
FIGURE 2 - WEST ORR
WATERCRESS AND VEGETATION HABITATS SAMPLED IN 2002
Lambert Outfall/Spring
SS-2 Sp
Old Settlers Sp
Oak Ridge Turnpike
SS-5 Sp
Beaver Dam Sp
Blair Rd
East
Bear Crk Rd
SNS Sp 2
Bethel Valley Rd
SS-7 Sp
SS-8 Sp
ETTP
Substation Sp
Graphite Reactor Sp
Rifle Range Sp
1st Crk Pond
1st Crk - Upper
1st Crk - Lower
Melton Valley
Happy Valley Sp
Poplar Crk
ORNL
95
White Oak Weir
Grassy Crk. Tributary
Clinch River
Hwy 58 N
Parcel 10 Spring

TABLE 1: AQUATIC VEGETATION FIELD SURVEY AND SAMPLING DATA

Laboratory Identification Number	Field Identification	Habitat	ORR Site	Longitude	Latitude	Date(s) Sampled	Media Sampled	Scientific Name (Taxa)	Lab Data Received
"Cress-01"	SS-2 Sp	Spring	Y-12	-84.2813	35.9693	12/5/01	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-02"	SS-7 Sp	Spring	Y-12	-84.3385	35.9375	2/26/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-03"	SS-5 Sp	Spring	Y-12	-84.3008	35.957	2/27/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-04"	Powerline Sp	Spring	ORNL	-84.3171	35.933	4/18/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-05"	Rifle Range Sp	Spring	ORNL	-84.324	35.9284	4/18/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-06"	Upper First Crk	Creek	ORNL	-84.3222	35.926	4/18/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-07"	Lower First Crk	Creek	ORNL	-84.3193	35.9225	4/18/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-08"	Cabin Sp	Spring	Y-12	-84.2701	35.969	5/8/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-09"	Two-Trees Sp	Spring	Y-12	-84.2687	35.9677	5/8/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-10"	Mossy Rock Sp	Spring	Y-12	-84.2612	35.9652	5/8/021	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-11"	Cephus Sp	Spring	Y-12	-84.2616	35.967	5/8/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-12"	Parcel 10 Spring (a.k.a. Jones island Sp)	Spring	ORNL	-84.3253	35.8961	5/16/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-13"	Happy Valley Sp	Spring	ETTP	-84.3835	35.9253	8/16/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-14"	Cattail West Sp	Spring	Offsite	-84.2259	35.9976	8/19/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-15"	White Oak Weir	Creek	ORNL	-84.3164	35.9116	8/23/02	Aquatic Macrophytes	Brassicaceae sp.	Yes
"Cress-16"	Twin Sp	Spring	Offsite	-84.333	35.9821	8/23/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-17"	Robertsville Bapt. Sp	Spring	Offsite	-84.2764	36.0114	8/23/02	Watercress & Aquatic Macrophytes	NASTURTIUM OFFICINALE Poaceae sp. Brassicaceae sp.	Yes
"Cress-18"	Milt Dickens Park Sp	Spring	Offsite	-84.2122	36.0444	8/23/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-19"	Graphite Reactor Sp	Spring	ORNL	-84.3182	35.9306	8/26/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-20"	SS-8 Sp	Spring	Y-12	-84.3401	35.9367	10/2/02	Aquatic Macrophytes	Brassicaceae sp.	Yes
"Cress-21"	First Crk Pond	Pond	ORNL	-84.3236	35.9273	10/2/02	Green Filamentous Algae	Chara sp.	Yes
"Cress-22"	Happy Valley Sp	Spring	ETTP	-84.3835	35.9253	10/16/02	Green Filamentous Algae	Spirogyra sp. Xanthophyceae sp.	Yes
"Cress-23"	SS-8 Sp	Spring	Y-12	-84.3401	35.9367	10/21/02	Green Filamentous Algae	Ulothrix sp. Xanthrophyceae sp.	Yes
"Cress-24"	Gaston Sp	Spring	Y-12	-84.2553	35.9646	10/25/02	Watercress	NASTURTIUM OFFICINALE	Yes
"Cress-25"	SNS Sp 2	Spring	ORNL	-84.3043	35.9482	11/4/02	Watercress & Aquatic Macrophytes	NASTURTIUM OFFICINALE Poaceae sp. Brassicaceae sp.	No Data
"Cress-26"	Grassy Crk Tributary	Creek	ORNL	-84.3833	35.911	11/8/02	Aquatic Macrophytes	Salvinia sp.	No Data
"Cress-27"	Lower McCoy	Creek	Y-12	-84.2484	35.9666	11/15/02	Aquatic Grass & Red Algae	Poaceae sp. Rhodophyta sp.	No Data
"Cress-28"	Upper McCoy	Creek	Y-12	-84.2504	35.9737	11/15/02	Watercress	NASTURTIUM OFFICINALE	No Data
"Cress-29"	Aquarius Sp	Spring	Y-12	-84.2495	35.9723	11/15/02	Green Filamentous Algae, Duckweed & Watercress	Vaucheria sp. Lemna sp. NASTURTIUM OFFICINALE	No Data
"Cress-30"	Sadachbia Sp	Spring	Y-12	-84.2499	35.9972	11/15/02	Green Filamentous Algae	Oedogonium Spirogyra Vaucheria	No Data
"Cress-31"	Olde Settlers Sp	Spring	ED-1	-84.3669	35.9657	11/18/02	Watercress & Green Filamentous Algae	NASTURTIUIM OFFICINALE Vaucheria sp.	No Data

Table 1: Aquatic Vegetation Field Survey and Sampling Data Cont'd

Laboratory Identification Number	Field Identification	Habitat	ORR Site	Longitude	Latitude	Date(s) Sampled	Media Sampled	Scientific Name (Taxa)	Lab Data Received
"Cress-32"	EFK 13.8	Creek	Offsite	-84.3145	35.9934	11/18/02	Aquatic Macrophytes	NASTURTIUM OFFICINALE Poaceae sp. Brassicaceae sp.	No Data
"Cress-33"	Beaver Dam Sp	Spring	ED-1	-84.382	35.9544	11/26/02	Green Filamentous Algae	Ulothrix sp. Cladophora sp.	No Data
"Cress-34"	Lambert Outfall/Sp	Spring	ED-1	-84.3514	35.9713	11/26/02	Watercress & Aquatic Grass	NASTURTIUM OFFICINALE Poaceae sp.	No Data
"Cress-35"	Cattail East Sp	Spring	Offsite	-84.224	35.9978	12/2/02	Watercress	NASTURTIUM OFFICINALE	No Data
"Cress-36"	Cattail East Sp	Spring	Offsite	-84.224	35.9978	12/2/02	Green Filamentous Algae	Zygnema sp. Cladophora sp.	No Data
"Cress-37"	Isthmus Pond	Pond	Offsite	-84.1597	35.9982	12/10/02	Green Filamentous Algae	Oedogonium sp. Ulothrix sp. Oscillatoria sp. Cladophora sp. .	No Data

Table I Ends

Table II: Aquatic Vegetation and Groundwater Sampling Analytical Data Comparison

ANALYTICAL DATA SETS	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Alpha	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Beta	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Gamma**	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Alpha	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Beta	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Gamma	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Alpha MCL: 15 pCi/L	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Beta MCL: 50 pCi/L	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Gamma
Field Identification	x (+/- error)*	x (+/- error)*	x (+/- error) *	x (+/- error) * Historic Data	x (+/- error)* Historic data	x (+/- error) * Historic data	x (+/- error)* Historic data	x (+/- error) * Historic data	x (+/- error) * Historic data
Aquarius Sp (a.k.a. SCR3.5SP)	0.078 (0.029)	2.512 (0.088)	K40 1.49 (0.14) Be7 0.896 (0.095) Pb212 0.0252(.0067)	1.13 (0.73) Wet 1.53 (0.88) Dry	1.92 (1.1) Wet 2.06 (1.09) Dry	N/A	N/A		N/A
Beaver Dam Sp	0.300 (0.095)	2.88 (0.17)	K40 1.28 (0.14) Ac228 0.206 (0.035)	N/A	N/A	N/A	N/A	N/A	N/A
Cabin Spring	0.74 (0.18)	4.81 (0.33)	K40 1.374 (0.079) Pb214 0.163 (0.0092)	N/A	N/A	N/A	-1.2 to 0.7 (NA) (2000 data)	0.8 to 2.4 (NA) (2000 data)	N/A
Cattail East Sp (watercress)	0.163 (0.071)	4.74 (0.23)	Be7 0.94 (0.11) Pb212 0.116 (0.012)	N/A	N/A	N/A	N/A	N/A	N/A
Cattail East Sp (green algae)	0.30 (0.10)	5.04 (0.27)	K40 2.54 (0.41) Pb212 0.213 (0.036)	N/A	N/A	N/A	N/A	N/A	N/A

TABLE II CONTINUED									
ANALYTICAL DATA SETS	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Alpha	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Beta	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Gamma**	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Alpha	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Beta	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Gamma	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Alpha MCL: 15 pCi/L	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Beta MCL: 50 pCi/L	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Gamma
Field Identification	x (+/- error) *	x (+/- error)*	x (+/- error) *	x (+/- error) * historic data	x (+/- error)* historic data	x (+/- error) * historic data	x (+/- error)* historic data	x (+/- error) * historic data	x (+/- error) * historic data
Cattail West Sp (a.k.a SCR7.1SP)	0.38 (0.15)	5.93 (0.34)	K40 2.24 (0.10) Pb212 0.154 (0.0069)	1.97 (1.27) Wet MDA (1.5) Dry	3.39 (1.19)Wet 3.65 (1.24) Dry	N/A	1.4 (3.2) Wet	2.2 (2.4) Wet	Bi214 23.9(4.3) Pb214 32.4(5.6)
Cephus Sp (a.k.a. SCR1.25SP)	0.69 (0.25)	5.71 (0.49)	K40 1.834 (0.096) Bi212 0.149 (0.029)	33.27(26.08) W 2.07 (1.12) Dry	MDA(36.13) Wet 1.69 (1.23) Dry	N/A	0.9-4.3 (1999) 0.4-6.8 (2000)	1.9-3.1 (1999) 2.7-4.6 (2000)	N/A
EFK 13.8	0.170 (0.046)	2.92 (0.13)	K40 1.83 (0.15) Tl208 0.0257(.0074)	N/A	N/A	N/A	N/A	N/A	N/A
First Crk Pond	0.34 (0.12)	3.60 (0.24)	K40 1.24 (0.12) Pb212 0.12 (0.0095)	N/A	N/A	N/A	N/A	N/A	N/A
Gaston Sp (a.k.a. SCR2.2SP)	0.113 (0.059)	2.24 (0.13)	K40 1.62 (0.12) Bi214 0.038(0.01)	MDA (4.3) Wet & Dry	MDA (7.6) Wet & Dry	N/A	7.10 (NA) (1999 data)	5.8 (NA) (1999 data)	N/A
Graphite Reactor Sp	0.044 (0.023)	2.688 (0.092)	K40 1.68 (0.10) Bi214 0.0634(0.0081)	N/A	N/A	N/A	N/A	N/A	N/A
Grassy Crk Tributary	0.101 (0.032)	3.147 (0.10)	K40 2.50 (0.30) Pb212 0.084 (0.021) Be7 0.63 (0.16)	N/A	N/A	N/A	N/A	N/A	N/A
Happy Valley Spring (Watercress)	0.043 (0.022)	3.46 (0.42)	K40 2.16 (0.13) Pb212 0.0202(.0050)	N/A	N/A	N/A	N/A	5.7 (NA) 1998 3.3 (NA) 1999 6.0 (NA) 2000	N/A
Happy Valley Spring (Green Algae)	0.32 (0.13)	6.53 (0.35)	K40 3.01 (0.25) Pb214 0.335 (0.028) Pb212 0.152 (0.016)	N/A	N/A	N/A	N/A	N/A	N/A
Isthmus Pond – Haw Rdg. Park	0.121 (0.037)	3.25 (0.12)	K40 2.05 (0.20) Tl208 0.041 (0.011)	N/A	N/A	N/A	N/A	N/A	N/A
Lambert Quar. Outfall/Sprng	0.171 (0.066)	2.99 (0.16)	K40 1.70 (0.11) Tl208 0.019 (0.0045)	N/A	N/A	N/A	N/A	N/A	N/A

TABLE II CONTINUED									
ANALYTICAL DATA SETS	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Alpha	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Beta	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Gamma**	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Alpha	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Beta	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Gamma	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Alpha MCL: 15 pCi/L	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Beta MCL: 50 pCi/L	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Gamma
Field Identification	x (+/- error) *	x (+/- error)*	x (+/- error) *	x (+/- error) * historic data	x (+/- error)* historic data	x (+/- error) * historic data	x (+/- error)* historic data	x (+/- error) * historic data	x (+/- error) * historic data
Lower First Crk	0.53 (0.10)	10.90 (0.29)	K40 1.62 (0.14) Be7 0.77 (0.14) Cs137 0.955 (0.026)	N/A	N/A	N/A	N/A	N/A	N/A
Low McCoy Br (aqua grass)	0.049 0.019	1.144 (0.052)	K40 0.540 (0.050) Be7 0.518 (0.043) Pb212 0.028 (0.0035)	N/A	N/A	N/A	N/A	N/A	N/A
Milt Dickens Park Sp	0.066 (0.038)	3.07 (0.12)	K40 1.99 (0.11) Bi214 0.0625(0.0094)	N/A	N/A	N/A	N/A	N/A	N/A
Mossy Rock Sp	0.045 (0.017)	2.394 (0.071)	K40 1.48 (0.13) Pb214 0.047(0.0094)	N/A	N/A	N/A	-0.3 to 5.0 (2000 data)	-0.9 to 3.8 (2000 data)	N/A
Olde Settlers Sp	0.139 (0.039)	2.62 (0.11)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Powerline Sp	0.077 (0.029)	3.24 (0.11)	K40 2.07(0.14) Bi214 0.127 (0.015)	N/A	N/A	N/A	minus 0.7 (2) Wet season	4.4 (2.2) Wet	Bi214 101(6.3) Pb214 95.2(6) Wet
Parcel 10 Spring (Watercress)	0.38 (0.10)	6.23 (0.28)	K40 2.85 (0.13) Pb212 0.125 (0.0069)	N/A	N/A	N/A	N/A	N/A	N/A
Rifle Range Spring	0.052 (0.019)	3.915 (0.097)	K40 2.33 (0.15) Bi214 0.062 (0.010)	N/A	N/A	N/A	N/A	N/A	N/A
Robertsville Bapt. Sp	0.036 (0.018)	2.702 (0.086)	K40 1.596 (0/091) Pb212 0.026(0.0038)	N/A	N/A	N/A	N/A	N/A	N/A

TABLE II CONTINUED									
ANALYTICAL DATA SETS	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Alpha	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Beta	(pCi/g) TDEC Aquatic Vegetation 2002 Lab Data Gross Gamma**	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Alpha	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Beta	(pCi/L) BWXT Y-12 Groundwater 2001 Lab Data Gross Gamma	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Alpha MCL: 15 pCi/L	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Beta MCL: 50pCi/L	(pCi/L) TDEC Groundwater 2001 Lab Data Gross Gamma
Field Identification	x (+/- error) *	x (+/- error)*	x (+/- error) *	x (+/- error) * historic data	x (+/- error) * historic data	x (+/- error) * historic data	x (+/- error)* historic data	x (+/- error) * historic data	x (+/- error) * historic data
Sadachbia sp	0.31 (0.11)	2.85 (0.21)	K40 1.29 (0.14) Be7 0.91 (0.11) Pb212 0.090 (0.012)	N/A	N/A	N/A	N/A	N/A	N/A
SNS #2 Spg	0.156 (0.034)	3.21 (0.10)	K40 1.682 (0.095) Ac228 0.146 (0.014) Tl208 0.0184 (.0034)	N/A	N/A	N/A	N/A	N/A	N/A
SS-2 Spring	0.258 (0.083)	2.70 (0.18)	K40 1.102 (0.085) Pb214 1.135 (0.011) Bi214 1.091 (0.010) Tl208 0.0257(0.0046)	N/A	N/A	N/A	N/A	N/A	N/A
SS-5 Spring	0.46 (0.14)	8.28 (0.35)	K40 2.55 (0.11) Pb214 0.1442 (.0096) Pb212 0.0973 (.0061)	N/A	N/A	N/A	24.9 '97 data 13.4-25.7 1998 48.6 1999 21.1-33.3 2000	37.5 '97 Data 12.1-44.1 1998 58.2 '99 data 11.3-19.3 2000	N/A
SS-7 Spring	0.149 (0.031)	4.14 (0.10)	K40 1.82 (0.12) Pb214 0.0292 (.0074) Pb212 0.0278 (.0055)	N/A	N/A	N/A	9.9 '97 Data 12.0 '98 data 14.0 2000	8.9 '97 Data 9.5 '98 data 15.9 1999 15.8 2000	N/A
SS-8 Spring (Elodea sp.)	0.65 (0.18)	8.07 (0.42)	K40 2.33 (0.12) Pb214 0.122 (0.011) Tl208 0.0495(.0063) Bi212 0.233 (0.040)	N/A	N/A	N/A	N/A	N/A	N/A
SS-8 Spring (Green Algae)	0.63 (0.15)	5.99 (0.32)	K40 1.38 (0.13) Bi214 0.163 (0.016) Ac228 0.174 (0.022)	N/A	N/A	N/A	N/A	N/A	N/A

TABLE II CONTINUED									
ANALYTICAL DATA SETS	(PCI/G) TDEC AQUATIC VEGETATION 2002 LAB DATA GROSS ALPHA	(PCI/G) TDEC AQUATIC VEGETATION 2002 LAB DATA GROSS BETA	(PCI/G) TDEC AQUATIC VEGETATION 2002 LAB DATA GROSS GAMMA**	(PCI/L) BWXT Y-12 GROUNDWATER 2001 LAB DATA GROSS ALPHA	(PCI/L) BWXT Y-12 GROUNDWATER 2001 LAB DATA GROSS BETA	(PCI/L) BWXT Y-12 GROUNDWATER 2001 LAB DATA GROSS GAMMA	(PCI/L) TDEC GROUNDWATER 2001 LAB DATA GROSS ALPHA MCL: 15 PCI/L	(PCI/L) TDEC GROUNDWATER 2001 LAB DATA GROSS BETA MCL: 50PCI/L	(PCI/L) TDEC GROUNDWATER 2001 LAB DATA GROSS GAMMA
FIELD IDENTIFICATION	X (+/- ERROR) *	X (+/- ERROR)*	X (+/- ERROR) *	X (+/- ERROR) * HISTORIC DATA	X (+/- ERROR) * HISTORIC DATA	X (+/- ERROR) * HISTORIC DATA	X (+/- ERROR)* HISTORIC DATA	X (+/- ERROR) * HISTORIC DATA	X (+/- ERROR) * HISTORIC DATA
TWIN SPRINGS	0.071 (0.031)	2.14 (0.10)	K40 0.888 (0.063) BI214 0.0523 (.0065) PB212 0.0312 (.0035)	N/A	N/A	N/A	N/A	N/A	N/A
TWO-TREES SP	0.25 (0.11)	2.92 (0.21)	K40 1.010 (0.075) BE7 0.452 (0.040) CS137 0.044 (.0047)	N/A	N/A	N/A	-0.8 TO –1.0 2000 DATA	0.0-1.9 2000 DATA	N/A
UPPER FIRST CRK	0.201 (0.053)	2.87 (0.13)	K40 1.76 (0.14) AC228 0.136(0.019)	N/A	N/A	N/A	N/A	N/A	N/A
UPP. MCCOY BR WATERCRS)	0.018 (0.0085)	2.212 (0.052)	K40 1.478 (0.094) PB212 0.0139 (.0035)	N/A	N/A	N/A	N/A	N/A	N/A
WHITE OAK WEIR (CARDAMINE)	0.087 (0.028)	19.49 (0.23)	CS137 20.23 (0.088) K40 1.64(0.11) CO60 0.0822(0.0058)	N/A	N/A	N/A	N/A	N/A	N/A
			NOTES: **GAMMA (PCI/G) DATA SHOW HIGH & LOW VALUES OF REPORTED RADIONUCLIDE LAB RESULTS (EXCEPT FOR PERTINENT DATA).				**N/A** = DATA NOT AVAILABLE		* SOME LAB ERROR DATA NOT AVAILABLE.

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CHAPTER 6 RADIOLOGICAL MONITORING

K-1066-E Cylinder Yard Soil Sampling

Principle Author: John McCall

Abstract

The Tennessee Department of Environment and Conservation, DOE-Oversight Division's Radiological Monitoring and Oversight Program conducted a soil sampling program in 2002 at the K-1066-E cylinder storage yard on the Oak Ridge Reservation's East Tennessee Technology Park. Division staff divided the cylinder yard into 10 zones, and selected sampling locations from each zone using a random number system. Staff collected one sample from each of these 20 randomly selected locations. Surface samples and subsurface samples were collected from each grid. The surface samples were taken at a depth of 0-5 centimeters. The subsurface samples were taken at a depth of 5-20 centimeters. Samples were analyzed for gross alpha and gross beta.

Gross alpha results ranged from 1.09 to 3.8 pCi/g with an average concentration of 2.3 pCi/g. Gross beta results ranged from 18 to 45.6 pCi/g with an average of 31.1 pCi/g. The results showed a relatively uniform distribution of both alpha and beta. These results do not indicate the gross transport of contamination away from the cylinder yard through the surrounding soil.

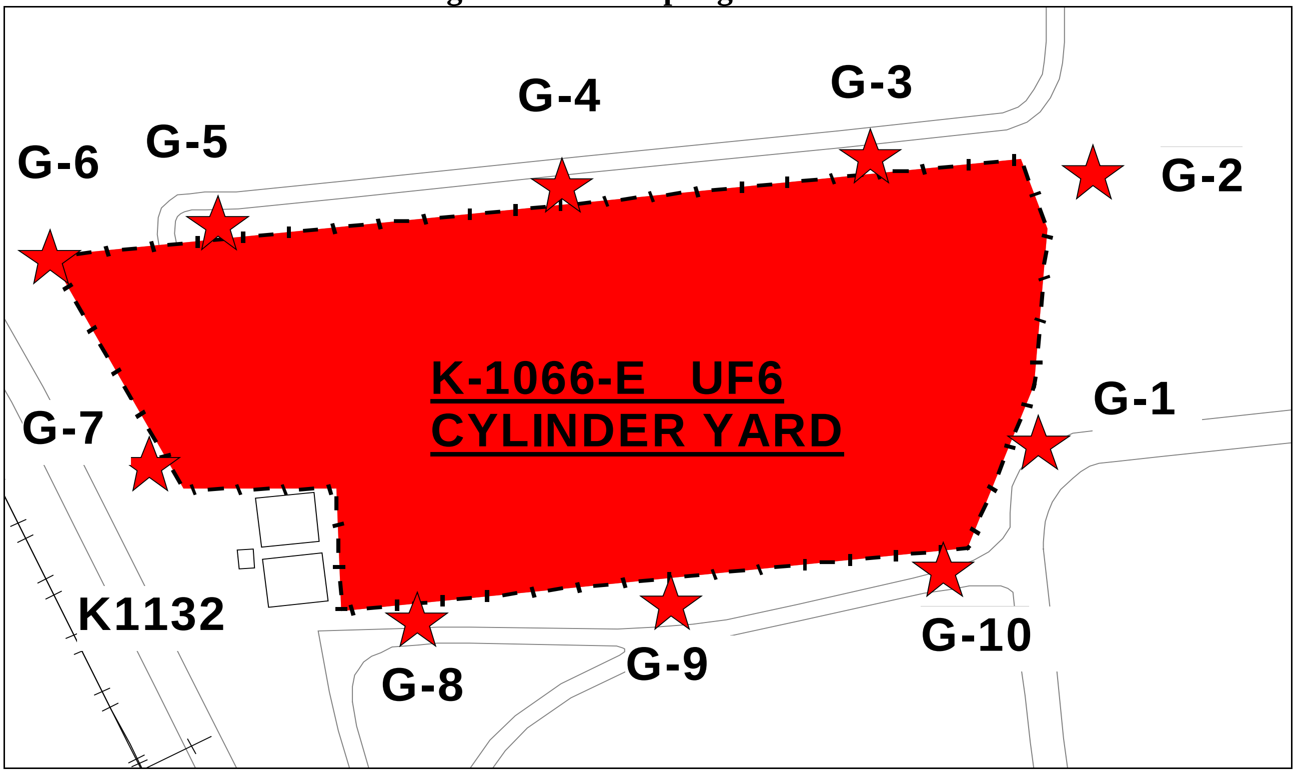
Introduction

As part of the Tennessee Consent Order of 1999, The Tennessee Department of Environment and Conservation (TDEC), Department of Energy Oversight Division reviews reports on surveillance and maintenance activities at the ETTP DUF_6 cylinder storage yards. In the event of cylinder breaches, the order specifies requirements for sampling to determine whether the surrounding environment has been impacted. Included in these requirements is the analysis of surface soil in any water runoff path. In October 2000, a cylinder breach was discovered at the K-1066-E cylinder storage yard. The contractor analyzed three surface soil samples at the edge of the pavement in the water runoff path. Results of those samples did not indicate a significant radiological contamination problem (alpha, beta concentrations at approximately 50 pCi/g, the remediation level for the Zone 1 industrial area of ETTP**).** At the same time, the contractor analyzed a "background" sample that was collected at a location approximately 60 feet east of the runoff samples. The "background" sample yielded results that were almost 10 times the remediation levels. The result of this sample indicates a potential of significant contamination due to events unrelated to the October 2000 breach. In March 2002, TDEC conducted a soil sampling project to determine whether previous events at the K-1066-E cylinder storage yard have resulted in contamination that is migrating away from the edge of the paved yard.

Methods and Materials

For this investigation, the perimeter of the cylinder yard was divided into 10 zones (3 zones along the long sides and 2 zones across the short sides). A random location was chosen from each zone using a computerized randomization program. Sampling locations are shown in Figure 1 and are identified as G1 through G10. At each location, a surface sample (from the 0–5 cm depth) and subsurface sample (from the 5–20 cm depth) were collected. A trowel was used for collecting surface sample and an auger was used for the subsurface samples. The contractor provided radiological monitoring of sample containers and equipment to ensure that they were not contaminated before leaving the site. All samples were analyzed for gross alpha and beta by the state radiological laboratory. Zones 1–7 are situated in the most likely migration pathway of contaminants from the yard. Zones 8-10 are upgradient and across a drainage ditch from the paved area and are unlikely to be affected by drainage from the K-1066-E yard.

Figure 1:Soil Sampling Locations



Results and Discussion

Sample results are shown in Table 1 and charted in Figure 2. Samples were analyzed for gross alpha and beta. The range of alpha concentration in all samples collected was 1.09 to 3.8 pCi/g with an average concentration of 2.3 pCi/g and the range of beta concentration was 18 to 45.6 pCi/g with an average concentration of 31.1 pCi/g. The results show a relatively uniform distribution of both alpha and beta.

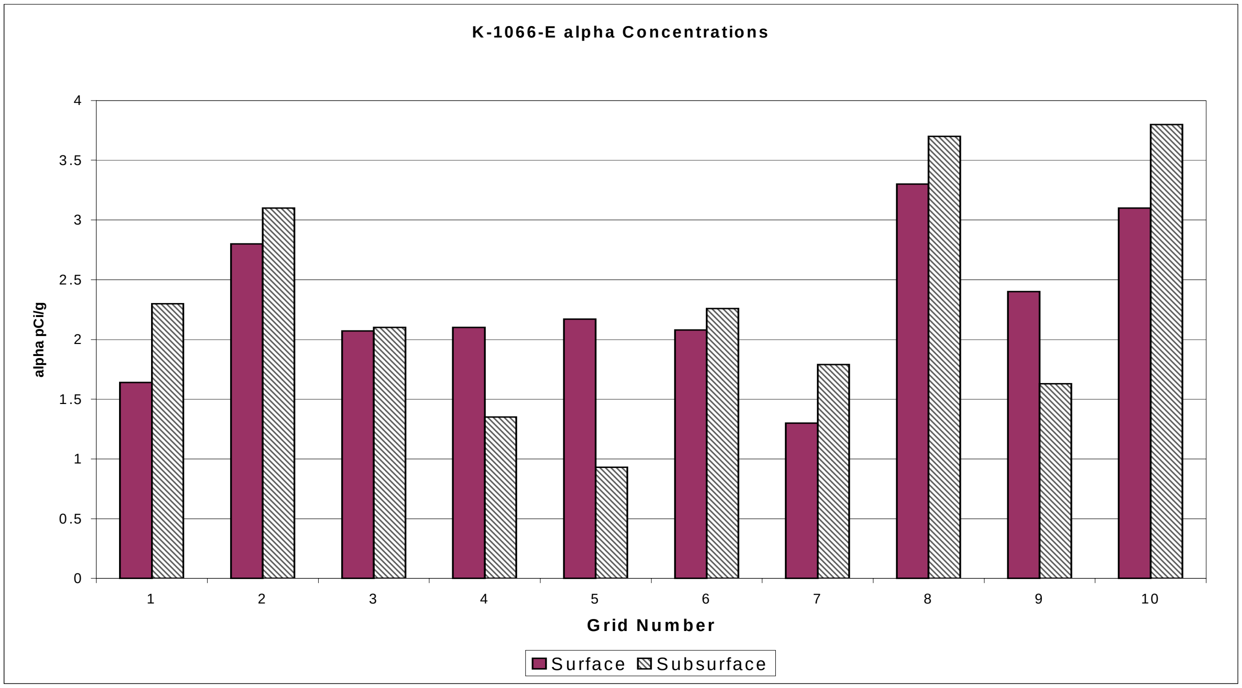
Releases from cylinders at the cylinder yard would be expected to cause alpha contamination associated with uranium. In fact, the samples taken by the contractor in 2000 showed alpha contamination at the edge of the paved yard with one sample as high as 463 pCi/g. The DOE-Oversight samples showed much lower levels of alpha. In addition, the results of samples collected in zones 1 through 7 are no higher than in zones 8 through 10 that are up-gradient from the yard. These results do not indicate the gross transport of contamination away from the cylinder yard through the surrounding soil. The high result reported by the contractor indicates that there may be some small, localized areas of radiological contamination which will be removed during the remediation of the cylinder yards after all cylinders are removed from the yard.

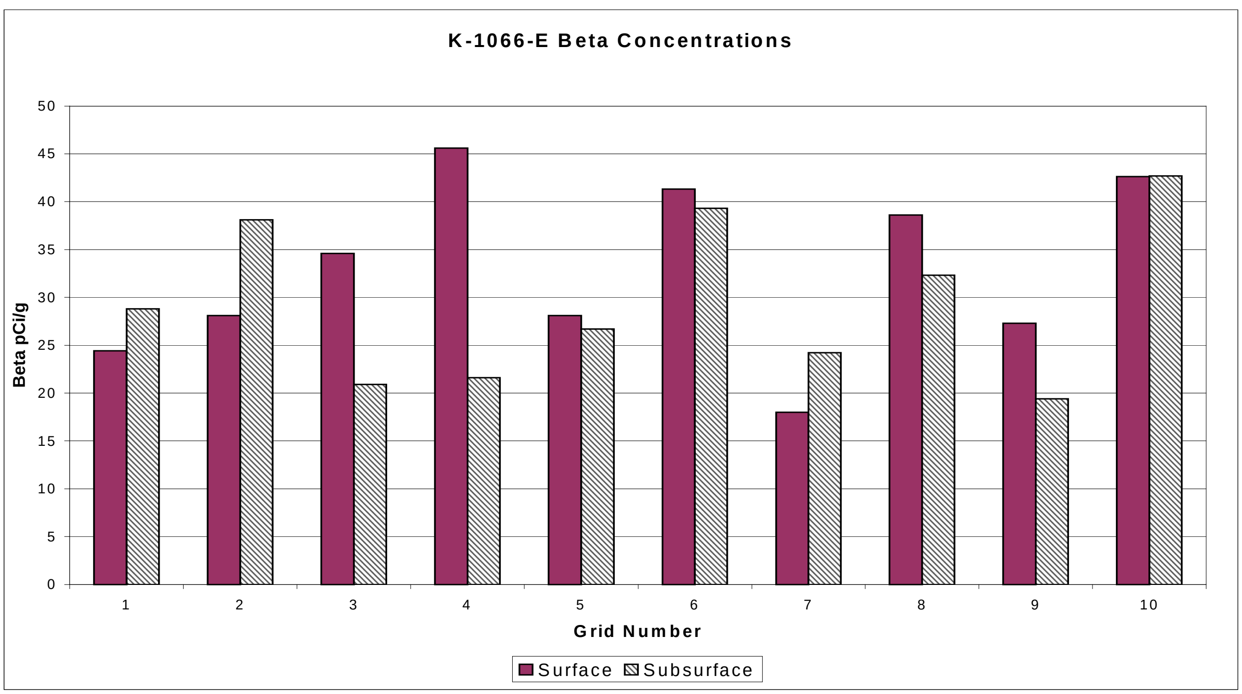
Table 1: Soil Sampling Results

K-1066-E Cylinder Yard Soil Sampling				
Date: 3/27/02				
Sampling Location			pCi/g dry wt.	
Sample Number	Grid Number	Type	Gross Alpha	Gross Beta
K1066EG1A	1	Surface	1.64	24.4
K1066EG1B	1	Subsurface	2.3	28.8
K1066EG2A	2	Surface	2.8	28.1
K1066EG2B	2	Subsurface	3.1	38.1
K1066EG3A	3	Surface	2.07	34.6
K1066EG3B	3	Subsurface	2.1	20.9
K1066EG4A	4	Surface	2.1	45.6
K1066EG4B	4	Subsurface	1.35	21.6
K1066EG5A	5	Surface	2.17	28.1
K1066EG5B	5	Subsurface	0.93	26.7
K1066EG6A	6	Surface	2.08	41.3
K1066EG6B	6	Subsurface	2.26	39.3
K1066EG7A	7	Surface	1.3	18
K1066EG7B	7	Subsurface	1.79	24.2
K1066EG8A	8	Surface	3.3	38.6
K1066EG8B	8	Subsurface	3.7	32.3
K1066EG9A	9	Surface	2.4	27.3
K1066EG9B	9	Subsurface	1.63	19.4
K1066EG10A	10	Surface	3.1	42.6
K1066EG10B	10	Subsurface	3.8	42.7

Type: Surface (0 - 2 in.) Subsurface (2-8 in.)

Figure 2:Soil Sampling Results





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CHAPTER 6 RADIOLOGICAL MONITORING

Ambient Gamma Radiation Monitoring of the Uranium Hexafluoride (UF6) Cylinder Yards at the East Tennessee Technology Park

Principle Author: Robert Storms

Abstract

The Tennessee Department of Environment and Conservation Department of Energy Oversight Division (TDEC DOE-O) in cooperation with the Department of Energy (DOE) and the Bechtel Jacobs Company is conducting a radiation dose rate survey of the East Tennessee Technology Park's (ETTP) Uranium Hexafluoride (UF_6) cylinder storage yards. Dose rate measurements are taken at the Perimeter fence lines using Landauer® Luxel® optically stimulated luminescence (Aluminum Oxide) dosimeters. Monitoring of ambient gamma levels at the UF_6 cylinder storage yards began in April 1999 and has continued to date. The data gathered is being used to determine if areas monitored have exceeded state and/or federal regulatory limits for exposure to members of the public. This data is also being used to determine if environmental concerns are warranted and what, if any, remediation actions are necessary before this property is free released and/or prior to occupation by companies during the planned reindustrialization of the ETTP site. In this study period from January 2002 to January 2003, dose rates in excess of the 100-mrem/yr state/federal exposure limit were observed at all five of the monitored cylinder yards. Specific location data has been obtained for all stations with the use of GPS instrumentation. This specific location data, along with its corresponding radiological data, will be incorporated into the MapInfo computer program. With this, the user has the ability to locate an individual monitoring point and view its radiological history.

Introduction

During the development and operation of the gaseous diffusion uranium enrichment process, containers, support equipment, and support facilities were designed, constructed, and used to store, transport, and process the depleted UF_6. After a significant inventory was produced, outdoor storage facilities (i.e., cylinder yards) evolved. Today, the Bechtel Jacobs Company operates the six ETTP UF_6 cylinder storage yards for the DOE. They are used for the temporary and long-term storage of UF_6 cylinders. The goal of the DOE-O UF_6 cylinder yard dose assessment program is to evaluate the level at which the public is protected from radiation doses emitted from the cylinder yards. This is especially important since DOE's mission is the continual transformation of ETTP into a commercial industrial park.

Materials and Methods

Dosimeters measure the dose from exposure to gamma radiation over time. The division's cylinder yard monitoring is performed using one type of dosimeter, Aluminum Oxide. They are obtained from Landauer®, Inc., Glenwood, Illinois. Aluminum Oxide dosimeters (minimum reporting value of 1 mrem) are generally placed in areas where exposures are expected to be significantly higher than background. The dosimeters are collected by division staff and shipped to Landauer® for processing. To account for exposures that may be received in transit or storage, control dosimeters are included in each shipment from the Landauer® Company. The control dosimeters are stored at the division office and returned to Landauer® with the field-deployed dosimeters for processing. Any exposure received by the control dosimeters, which would include background radiation received while in storage at the division office (761 Emory Valley Road, Oak Ridge, Tennessee), is subtracted from the exposure reported for the field deployed dosimeters. Annually, the quarterly exposures (minus the exposure obtained from the control dosimeter) are summed for each location. The resultant annual dose is compared to the state/DOE primary dose limit for members of the public (100 mrem/yr exposure).

Discussion and Results

The division's Ambient Gamma Radiation Monitoring program has determined that there is an elevated exposure potential to the public at all five of the monitored cylinder yards. At these yards, the total adjusted accumulated annual dose, as measured by dosimeter, has ranged from a low of 81 mrem at the K-1066-J and K-1066-B yard to a high of 9539 mrem at the K-1066-L yard. Within this range, there are numerous elevated data points that are shown in Tables 1-5. These results are compared with the state/DOE primary dose limit for members of the public (100 mrem/yr total exposure). The mapping and recording of dose rate data will ensure that workers/non-DOE workers under ETTP's reindustrialization plan and the public will be knowledgeable of and protected from the cylinder yard's radiation source.

The following ETTP cylinder yards under the dosimeter project are: K-1066-K, K-1066-E, K-1066-J, K-1066-B, K-1066-L. Current and future plans by ETTP to prepare cylinders for yard to yard movement and off-site shipment will necessitate "shuffling" cylinders between various yards. Due to this activity, there have been some wide variances in the dosimeter readings from quarter to quarter. These have all been checked and correlated with redistribution activity of the cylinders. Plans are in place for 2003 to evaluate the current positions of TLDs and relocate those necessary to insure perimeter coverage of the yards due to recent redistribution of the cylinders. K-1066-F yard is not being monitored due to the fact it does not have an outside perimeter fence that could be accessed by the public.

Table 1: Results From Dosimeters Deployed at ETTP UF_6 Cylinder Yards

K-1066-K Yard

	Period 1 (01/28/02 – 04/26/02) (88 Day Exposure)	**Period 2** (04/26/02 - 07/18/02) (83 Day Exposure)	**Period 3** (07/18/02 - 10/21/02) (95 Day Exposure)	**Period 4** (10/21/02-01/22/03) (93 Day Exposure)	Total Accumulated Dose Equivalent: 359days	Total Adjusted Dose to 365 days
Dosimeter Number	Dosimeter Reading (mrem)	Dosimeter Reading (mrem)	Dosimeter Reading (mrem)	Dosimeter Reading (mrem)	Mrem	mrem
1	40	68	79	79	266	270
2	359	350	458	410	1577	1603
3	697	665	907	845	3114	3166
4	1271	969	1435	1289	4964	5047
5	456	416	556	567	1995	2028
6	374	386	461	439	1660	1688
7	286	266	334	312	1198	1218
8	309	333	421	409	1472	1497
9	490	513	654	606	2263	2301
10	251	244	324	270	1089	1107
11	128	173	195	185	681	692
12	324	338	460	389	1511	1536

Table 1: Results From Dosimeters Deployed at ETTP UF_6 Cylinder Yards Cont'd

K-1066-K Yard

Dosimeter Number	**Period 1** (01/28/02 - 04/26/02) (88 Day Exposure) Dosimeter Reading (mrem)	**Period 2** (04/26/02 - 07/18/02) (83 Day Exposure) Dosimeter Reading (mrem)	**Period 3** (07/18/02 - 10/21/02) (95 Day Exposure) Dosimeter Reading (mrem)	**Period 4** (10/21/02- 01/22/03) (93 Day Exposure) Dosimeter Reading (mrem)	Total Accumulated Dose Equivalent: 359days Mrem	Total Adjusted Dose to 365 days mrem
13	1234	1237	1614	1487	5572	5665
14	1717	1910	2078	2270	7975	8108
15	1210	1285	1541	1439	5475	5566
16	882	952	1174	1048	4056	4124
17	427	467	551	467	1912	1944
18	940	985	1254	1075	4254	4325
19	1494	1694	1900	1708	6796	6909
20	1183	1337	1533	1326	5379	5469
21	138	155	183	164	640	651
22	360	376	458	403	1597	1624

- The primary dose limit for members of the public specified in both DOE Order 5400.5 (Radiation Protection of the Public and the Environment) and 10 CFR Part 20 (Standards for Protection against Radiation) is 100 mrem/yr total effective dose equivalent, exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical research programs. The NRC limit for a decommissioned facility is 25 mrem/yr.

* To account for background radiation and any exposures that may be received in transit or storage, control dosimeters are provided by the vender. These dosimeters are stored at the division office and returned to the vender for processing along with the associated field deployed dosimeters. Any exposure received by the control dosimeters, which would include background radiation received while in storage at the division office, is subtracted from the exposure reported above for the field deployed dosimeters.

M= Below minimum reportable quantity.

Table 2: Results From Dosimeters Deployed at ETTP UF_6 Cylinder Yards

K1066-E Yard

Dosimeter Number	**Period 1** (01/25/02 - 04/23/02) (88 Day Exposure) Dosimeter Reading (mrem)	**Period 2** (04/23/02 - 07/22/02) (90 Day Exposure) Dosimeter Reading (mrem)	**Period 3** (07/22/02 – 10/22/02) (92 Day Exposure) Dosimeter Reading (mrem)	**Period 4** (10/22/02 – 01/27/03) (97 Day Exposure) Dosimeter Reading (mrem)	Total Accumulated Dose Equivalent: 367 days Mrem	Total Adjusted Dose to 365 days mrem
23	543	569	702	583	2397	2384
24	667	571	624	627	2489	2475
25	815	171	114	115	1215	1208
26	1096	435	105	81	1717	1708
27	760	654	184	159	1757	1747
28	864	979	1181	1163	4187	4164
29	981	1042	1131	1187	4341	4317
30	1054	1127	841	624	3646	3626
31	436	531	954	978	2899	2883
32	293	403	677	635	2008	1997
33	236	285	834	711	2066	2055
34	844	852	426	387	2509	2495
35	169	208	179	179	735	731
36	314	330	382	377	1403	1395
37	348	344	318	317	1327	1320
38	423	402	242	209	1276	1269
39	326	265	205	193	989	984
76	69	70	61	64	264	263
77	186	116	76	73	451	449
78	91	91	74	63	319	317
79	228	227	136	128	719	715
80	345	422	414	401	1582	1573
81	341	400	429	445	1615	1606
82	359	428	400	335	1522	1514
83	216	280	340	320	1156	1150
84	141	208	197	208	754	750

* The primary dose limit for members of the public specified in both DOE Order 5400.5 (Radiation Protection of the Public and the Environment) and 10 CFR Part 20 (Standards for Protection against Radiation) is 100 mrem/yr total effective dose equivalent, exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical research programs. The NRC limit for a decommissioned facility is 25 mrem/yr.

* To account for background radiation and any exposures that may be received in transit or storage, control dosimeters are provided by the vender. These dosimeters are stored at the division office and returned to the vender for processing along with the associated field deployed dosimeters. Any exposure received by the control dosimeters, which would include background radiation received while in storage at the division office, is subtracted from the exposure reported above for the field deployed dosimeters.

M= Below minimum reportable quantity.

Table 3: Results From Dosimeters Deployed at ETTP UF_6 Cylinder Yards

K1066-J Yard

Dosimeter Number	**Period 1** (01/25/02 - 04/24/02) (89 Day Exposure) Dosimeter Reading (mrem)	**Period 2** (04/24/02 - 07/22/02) (89 Day Exposure) Dosimeter Reading (mrem)	**Period 3** (07/22/02 - 10/22/02) (92 Day Exposure) Dosimeter Reading (mrem)	**Period 4** (10/22/02- 01/28/03) (98 Day Exposure) Dosimeter Reading (mrem)	Total Accumulated Dose Equivalent: 368 days Mrem	Total Adjusted Dose to 365 days mrem
40	10	53	32	34	129	128
41	M	31	25	31	87	86
42	9	44	28	29	110	109
43	M	24	30	28	82	81
44	M	28	45	48	121	120
45	5	32	139	171	347	344
46	M	29	78	84	191	189
47	M	68	157	151	378	375
48	59	587	872	879	2397	2377
49	115	317	465	445	1342	1331
50	156	389	472	469	1486	1474
51	239	471	418	367	1495	1483
52	235	329	304	373	1241	1231
53	490	533	106	76	1205	1195
54	458	546	126	58	1188	1178
55	426	629	57	45	1157	1148
85	1	31	28	29	89	88
86	7	37	32	33	109	108
87	7	29	45	42	123	122
88	9	38	56	63	166	165
89	7	44	100	107	258	256
90	10	44	101	104	259	257
91	10	57	104	102	273	271
92	23	64	91	94	272	270

* The primary dose limit for members of the public specified in both DOE Order 5400.5 (Radiation Protection of the Public and the Environment) and 10 CFR Part 20 (Standards for Protection against Radiation) is 100 mrem/yr total effective dose equivalent, exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical research programs. The NRC limit for a decommissioned facility is 25 mrem/yr.

* To account for background radiation and any exposures that may be received in transit or storage, control dosimeters are provided by the vender. These dosimeters are stored at the division office and returned to the vender for processing along with the associated field deployed dosimeters. Any exposure received by the control dosimeters, which would include background radiation received while in storage at the division office, is subtracted from the exposure reported above for the field deployed dosimeters.

M= Below minimum reportable quantity.

Table 4: Results From Dosimeters Deployed at ETTP UF_6 Cylinder Yards

K1066-B Yard

Dosimeter Number	**Period 1** (01/22/02 - 04/26/02) (94 Day Exposure) Dosimeter Reading (mrem)	**Period 2** (04/26/02 - 07/22/02) (87 Day Exposure) Dosimeter Reading (mrem)	**Period 3** (07/22/02 – 10/22/02) (92 Day Exposure) Dosimeter Reading (mrem)	**Period 4** (10/22/02- 01/28/03) (98 Day Exposure) Dosimeter Reading (mrem)	Total Accumulated Dose Equivalent: 371 days mrem	Total Adjusted Dose to 365 days mrem
56	18	48	52	50	168	165
57	38	68	80	77	263	259
58	47	71	83	82	283	278
59	60	87	96	99	342	336
60	34	57	65	75	231	227
61	50	72	78	82	282	277
62	47	65	74	77	263	259
63	37	60	62	70	229	225
64	27	48	57	63	195	192
65	19	42	43	47	151	149
66	9	36	39	46	130	128
67	9	30	36	40	115	113
93	21	63	80	53	217	213
94	34	55	88	65	242	238
95	34	62	72	73	241	237
96	42	65	72	74	253	249
97	8	31	32	39	110	108
98	1	29	30	34	94	92
99	5	28	33	35	101	99
100	9	27	33	40	109	107
101	4	30	38	36	108	106
102	23	N/A	N/A	N/A	N/A	N/A
103	6	28	22	26	82	81

* The primary dose limit for members of the public specified in both DOE Order 5400.5 (Radiation Protection of the Public and the Environment) and 10 CFR Part 20 (Standards for Protection against Radiation) is 100 mrem/yr total effective dose equivalent, exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical research programs. The NRC limit for a decommissioned facility is 25 mrem/yr.
* To account for background radiation and any exposures that may be received in transit or storage, control dosimeters are provided by the vender. These dosimeters are stored at the division office and returned to the vender for processing along with the associated field deployed dosimeters. Any exposure received by the control dosimeters, which would include background radiation received while in storage at the division office, is subtracted from the exposure reported above for the field deployed dosimeters.
M= Below minimum reportable quantity.

Table 5: Results From Dosimeters Deployed at ETTP UF_6 Cylinder Yards

K1066-L Yard

Dosimeter Number	**Period 1** (01/25/02 - 04/24/02) (89 Day Exposure) Dosimeter Reading (mrem)	**Period 2** (04/24/02 - 07/22/02) (89 Day Exposure) Dosimeter Reading (mrem)	**Period 3** (07/22/02 - 10/22/02) (92 Day Exposure) Dosimeter Reading (mrem)	**Period 4** (10/22/02- 01/28/03) (98 Day Exposure) Dosimeter Reading (mrem)	Total Accumulated Dose Equivalent: 368 days mrem	Total Adjusted Dose to 365 days Mrem
68	40	69	81	90	280	278
69	44	72	92	91	299	297
70	48	81	99	111	339	336
71	1076	1217	1157	1651	5101	5059
72	2045	2094	2272	2318	8729	8657
73	2348	2245	2510	2514	9617	9539
74	1213	1231	1349	1324	5117	5075
75	814	843	941	1058	3656	3626

* The primary dose limit for members of the public specified in both DOE Order 5400.5 (Radiation Protection of the Public and the Environment) and 10 CFR Part 20 (Standards for Protection against Radiation) is 100 mrem/yr total effective dose equivalent, exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical research programs. The NRC limit for a decommissioned facility is 25 mrem/yr.
* To account for background radiation and any exposures that may be received in transit or storage, control dosimeters are provided by the vender. These dosimeters are stored at the division office and returned to the vender for processing along with the associated field deployed dosimeters. Any exposure received by the control dosimeters, which would include background radiation received while in storage at the division office, is subtracted from the exposure reported above for the field deployed dosimeters.
M= Below minimum reportable quantity.

Conclusions

The data are showing elevated readings at all five cylinder yards. These annual doses are in excess of the state/DOE primary dose limit for members of the public where the public has access. The yards may also produce ten or fifteen percent additional mrems in neutron as well as gamma doses. Neutron dosimetry is being gathered in another division program.

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