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Oak Ridge Reservation Annual Site Environmental Report for 2010

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Project director
Joan Hughes

Project coordinator
Sharon Thompson

Department of Energy Project manager and Oak Ridge Office coordinator
David Page

Technical coordinators

Wayne McMahon
Y-12 National Security Complex

Joan Hughes
Oak Ridge National Laboratory

Mike Coffey
East Tennessee Technology Park

Electronic publishers
Kathy Jones

Coordinating editor
Debbie Stevens

Graphic artists
Sherri Cotter, Cindy Johnson,
Judy Neeley, Jane Parrott

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Prepared by
Oak Ridge National Laboratory
P.O. Box 2008, Oak Ridge, TN 37831-2008
Managed by UT-Battelle, LLC,
for the Department of Energy under Contract No. DE-AC05-00OR22725
and by
the Y-12 National Security Complex
Oak Ridge, TN 37831-8169
Managed by B&W Technical Services Y-12 L.L.C.
for the Department of Energy under Contract No. DE-AC05-00OR22800
and by
East Tennessee Technology Park
P.O. Box 4699, Oak Ridge, TN 37831-4699
Managed by Bechtel Jacobs Company LLC
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Acronyms and Abbreviations

AAS	ambient air station
ACO	Analytical Chemistry Organization
ACM	asbestos-containing materials
ACOE	Army Corps of Engineers
AFV	alternative fuel vehicle
ALARA	as low as reasonably achievable
AOC	area of concern
AOEC	Agent Operations Eastern Command (NNSA OST)
ARAR	Applicable or Relevant and Appropriate Requirements
ARRA	American Recovery and Reinvestment Act
ASER	Annual Site Environmental Report
ATSDR	Agency for Toxic Substances and Diseases Registry
AWQC	ambient water quality criteria
B&W Y-12	Babcock &Wilcox Technical Services Y-12
BCG	biota concentration guide
BCK	Bear Creek kilometer
BGSP	biomass gasification steam plant
BJC	Bechtel Jacobs Company LLC
BMAP	Biological Monitoring and Abatement Program, Plan
BRW	bedrock well
CA	corrective action
CAA	Clean Air Act
CAP-88	Clean Air Assessment software
CCC	Complex Command Center
CD	Critical Design
CEDR	Consolidated Energy Data Report
CEMS	continuous emission monitoring system
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CNF	Central Neutralization Facility
COC	contaminants of concern
COD	Chemical oxygen demand
COROH	Center for Oak Ridge Oral History
CRK	Clinch River kilometer
CROET	Community Reuse Organization of East Tennessee
CRT	cathode ray tube
CSMA	Closed Scrap Metal Area
CWA	Clean Water Act

CX	categorical exclusion
CY	calendar year
D&D	deactivation and decommissioning
DAC	derived air concentration
DCE	Dichloroethane
DCG	derived concentration guide
DES	detailed energy survey
DNAPL	Dense Non-Aqueous Phase Liquid
DOE	U.S. Department of Energy
DOE-EM	U.S. Department of Energy Office of Environmental Management
DOE-HSS	Office of Health, Safety and Security
DOE-ORO	DOE Oak Ridge Operations Office
DRH	Division of Radiological Health
EB	existing building
EC&P	Environmental Compliance and Protection
ECD	Environmental Compliance Department
ECM	energy conservation measure
ECR	environmental compliance representative
ED	effective dose
EDE	effective dose equivalent
EERE/FEMP	Energy Efficiency Research /Federal Energy Management Program
EFPC	East Fork Poplar Creek
EM	Environmental Management
EMMIS	Environmental Monitoring Management Information System
EMPO	Emergency Management Program Office (Y-12)
EMS	environmental management system
EMWMF	Environmental Monitoring Waste Management Facility
EPA	U.S. Environmental Protection Agency
EPACT	Energy Policy Act
EPCRA	Emergency Planning and Community Right-to-Know Act
EPEAT	Electronic Product Environmental Assessment Tool
EPO	environmental protection officer
EPT	*Ephemeroptera*, *Plectoptera*, and *Trichoptera* (taxa)
EP&WSD	Environmental Protection and Waste Services Division
ER	Environmental Restoration
ERO	emergency response organization
ES&H	Environment, Safety, and Health
ESD	Environmental Science Division
ESPC	Energy Savings Performance Contract
ETTP	East Tennessee Technology Park
EU	exposure unit

FCK	First Creek kilometer
FEC	Federal Electronics Challenge
FEMP	Federal Energy Management Program
FFA	Federal Facilities Agreement
FFCA	Federal Facilities Compliance Agreement
FFK	Fifth Creek kilometer
FGR	Federal Guidance Report
FIRP	Facilities and Infrastructure Recapitalization Program
FPE	full-participation exercise
FSC	Federal Special Concern
FY	fiscal year
GCK	Grassy Creek kilometer
GEM-JV	Gem Technologies Inc., Joint Venture
GET	General Employee Training
GHG	greenhouse gas
HC	hydrocarbon
HCC	Halcyon Commercialization Center
HEMS	high-energy mission-specific
HEPA	high-efficiency particulate air
HEUMF	Highly Enriched Uranium Materials Facility
HFIR	High Flux Isotope Reactor
HMIS	Hazardous Materials Information System
HPSB	High-Performance Sustainable Building
HQ	hazard quotient
HRE	Homogeneous Reactor Experiment
HRIBF	Holifield Radioactive Ion Beam Facility
HSS	Health, Safety and Security
I/CATS	Issues/Corrective Action Tracking System
ICP	inductively coupled plasma
ICP-MS	inductively coupled plasma–mass spectrometer
IDP	industrial discharge permit
IFDP	Integrated Facility Disposition Project
ILA	industrial landscaping and agricultural
ISK	Ish Creek kilometer
ISMS	Integrated Safety Management System
ISO	International Organization for Standardization
IT	information technology
LCD	liquid crystal display
LEARN	Local Education Administration Requirements Network
LED	light-emitting diode

LEED	Leadership in Energy and Environmental Design
LGTF	Liquids and Gaseous Treatment Facility
LIMS	Laboratory Information Management System
LMES	Lockheed Martin Energy Systems
MACT	Maximum Achievable Control Technology
MBK	Mill Branch kilometer
MCCBK	McCoy Branch kilometer
MCL	maximum contaminant level
MDA	minimum detectable activity
MDL	method detection limit
MEI	maximally exposed individual
MEK	Melton Branch kilometer
MH	manhole
MIK	Mitchell Branch kilometer
MLF	Modernization of Laboratory Facilities
MLF	Multiprogram Laboratory Facility
MMES	Martin Marietta Energy Systems
MOA	Memorandum of agreement
MT	meteorological tower
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NNSA	National Nuclear Security Administration
NNSS	Nevada Nuclear Security Site
NOAA	National Oceanic and Atmospheric Administration
NOROH	Networking Oak Ridge Oral History
NOV	Notice of violation
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NSPS	New Source Performance Standard
NTRC	National Transportation Research Center
NTS	Nevada Test Site
NT-3	Boneyard/Burnyard
NWTK	Northwest Tributary kilometer
ODS	ozone-depleting substance
ORAU	Oak Ridge Associated Universities
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory

ORO	Oak Ridge Operations
ORPS	Occurrence Reporting and Processing System
ORR	Oak Ridge Reservation
ORRL	Oak Ridge Reservation Landfills
ORSSAB	Oak Ridge Site Specific Advisory Board
ORSTP	Oak Ridge Science and Technology Park
OST	Office of Secure Transportation
OSTI	Office of Scientific and Technical Information
PAH	polycyclic aromatic hydrocarbon
PAM	perimeter air monitoring (station)
PCBs	polychlorinated biphenyls
PCCR	phased construction completion report
PCE	tetrachloroethene
PHEV	plug-in hybrid electric vehicles
PM	particulate matter
POTW	publicly owned treatment works
PPTRS	Pollution Prevention Tracking and Reporting
PSD	Prevention of Significant Deterioration
QA	quality assurance
QC	quality control
RA	remedial action
Rad NESHAP	National Emission Standards for Hazardous Air Pollutants for Radionuclides
RATA	Relative Accuracy Test Audit
RAWP	Remedial Action Work Plan
RCK	Raccoon Creek kilometer
RCRA	Resource Conservation and Recovery Act
REC	Renewable Energy Certificate
RfC	reference concentration
RFID	radio frequency identification
RI/FS	Remedial Investigation/Feasibility Study
ROD	record of decision
RQ	radiation quotient
RQ	reportable quantity
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act
SBMS	Standards-Based Management System
SC	Office of Science
SCK	Scarboro Creek kilometer
SDWA	Safe Drinking Water Act
SEP	Supplemental Environmental Project

SIP	State Implementation Plan
SME	Subject matter expert
SMO	Sample Management Office
SNAP	Significant New Alternatives Program
SNM	special nuclear material
SNS	Spallation Neutron Source
SODAR	sonic detection and ranging
SOW	Statement of work
SPCC	spill prevention, control, and countermeasures (plan)
SPMD	semipermeable membrane device
SSP	Site Sustainability Plan
SSPP	Strategic Sustainability Performance Plan
STARRT	Safety Task Analysis Risk Reduction Talk
STP	sewage treatment plant
STWTF	Steam Plant Wastewater Treatment Facility
SU	standard unit
SWEIS	Site-wide environmental impact statement
SWHISS	Surface Water Hydrological Information Support System
SWP3	Storm Water Pollution Prevention Program
SWSA	solid waste storage area
TCA	tetrachloroethane
TCC&I	Tennessee Chamber of Commerce and Industry
TCE	trichlorethene
TDEC	Tennessee Department of Environment and Conservation
TEAM	Transformational Energy Action Management
TEMA	Tennessee Emergency Management Agency
TMDL	Total Maximum Daily Load
TNDA	Tennessee Department of Agriculture
TOA	Tennessee Oversight Agreement
TP3	Tennessee Pollution Prevention Partnership
TRO	total residual oxidant
TRU	transuranic
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TVA	Tennessee Valley Authority
TWA	time-weighted average
TWPC	Transuranic Waste Processing Center
TWRA	Tennessee Wildlife Resources Agency
UEFPC	Upper East Fork Poplar Creek
UMC	Unneeded Materials and Chemicals
UNW	unconsolidated well
UPF	Uranium Processing Facility

USDA	United States Department of Agriculture
USGBC	United States Green Building Council
UST	underground storage tank
UT	University of Tennessee
UV	ultraviolet
VOC	volatile organic compound
WAI	Wastren Advantage Inc.
WBK	Walker Branch kilometer
WCK	White Oak Creek kilometer
WCM	water conservation measure
WIPP	Waste Isolation Pilot Plant
WMF	waste management facility
WOC	White Oak Creek
WOD	White Oak Dam
WPF	Waste Processing Facility
WQC	water quality criteria
WRRP	Water Resources Restoration Program
WSR	Waste Services Representative
WWTS	Waste Water Treatment System
YSO	Y-12 Site Office

Units of Measure and Conversion Factors*

Units of measure and their abbreviations

Becquerel	Bq	milliliter	mL
centimeter	cm	millimeter	mm
curie	Ci	million	M
day	day	millirad	mrad
degrees Celsius	°C	millirem	mrem
degrees Fahrenheit	°F	millisievert	mSv
foot	ft	minute	min
gallon	gal	nephelometric turbidity unit	NTU
gallons per minute	gal/min	parts per billion	ppb
gram	g	parts per million	ppm
hectare	ha	parts per trillion	ppt
hour	h	picocurie	pCi
inch	in.	pound	lb
kilogram	kg	pounds per square inch	psi
kilometer	km	quart	qt
kilowatt	kW	rad	rad
liter	L	roentgen	R
megawatt	MW	roentgen equivalent man	rem
meter	m	second	s
metric ton	MT	sievert	Sv
microcurie	µCi	standard unit (pH)	SU
microgram	µg	ton, short (2000 lb)	ton
micrometer	µm	yard	yd
millicurie	mCi	year	year
milligram	mg		

Quantitative prefixes

tera	$\times 10^{12}$	pico	$\times 10^{-12}$
giga	$\times 10^{9}$	nano	$\times 10^{-9}$
mega	$\times 10^{6}$	micro	$\times 10^{-6}$
kilo	$\times 10^{3}$	milli	$\times 10^{-3}$
hecto	$\times 10^{2}$	centi	$\times 10^{-2}$
deka	$\times 10^{1}$	deci	$\times 10^{-1}$

* Due to differing permit reporting requirements and instrument capabilities, various units of measurement are used in this report. The provided listing of units of measure and conversion factors is intended to help readers convert numeric values presented herein as needed for specific calculations and comparisons.

Unit conversions

Unit	Conversion	Equivalent	Unit	Conversion	Equivalent
		Length			
in.	× 2.54	cm	cm	× 0.394	in.
ft	× 0.305	m	m	× 3.28	ft
mile	× 1.61	km	km	× 0.621	mile
		Area			
acre	× 0.405	ha	ha	× 2.47	acre
ft^2	× 0.093	m^2	m^2	× 10.764	ft^2
$mile^2$	× 2.59	km^2	km^2	× 0.386	$mile^2$
		Volume			
ft^3	× 0.028	m^3	m^3	× 35.31	ft^3
qt (U.S. liquid)	× 0.946	L	L	× 1.057	qt (U.S. liquid)
gal	× 3.7854118	L	L	× 0.264172051	gal
		Concentration			
ppm	× 1	mg/L	mg/L	× 1	ppm
		Weight			
lb	× 0.4536	kg	kg	× 2.205	lb
ton	× 907.1847	kg	kg	× 0.00110231131	ton
		Temperature			
°C	°F = (9/5) °C + 32	°F	°F	°C = (5/9) (F – 32)	°C
		Activity			
Bq	$\times 2.7 \times 10^{-11}$	Ci	Ci	$\times 3.7 \times 10^{10}$	Bq
Bq	× 27	pCi	pCi	× 0.037	Bq
mSv	× 100	mrem	mrem	× 0.01	mSv
Sv	× 100	rem	rem	× 0.01	Sv
nCi	× 1000	pCi	pCi	× 0.001	nCi
mCi/km^2	× 1	nCi/m^2	nCi/m^2	× 1	mCi/km^2
dpm/L	$\times 0.45 \times 10^{9}$	$\mu Ci/cm^3$	$\mu Ci/cm^3$	$\times 2.22 \times 10^{9}$	dpm/L
pCi/L	$\times 10^{-9}$	µCi/mL	µCi/mL	$\times 10^{9}$	pCi/L
pCi/m^3	$\times 10^{-12}$	$\mu Ci/cm^3$	$\mu Ci/cm^3$	$\times 10^{12}$	pCi/m^3

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ENVIRONMENTAL MANAGEMENT

Carrie Barber
Mary Blevins
Betsy Brucken
Neil Burchfield
Tom Conrad
Kevin Crow
Melanie Dahle
Steve Douglas
Steve Foster
Glen Galen
Suzy Gately
Stephen Goodpasture
Dan Hughel
Mona Johnson
Charles Justice
Richard Ketelle
Rodney Kingrea
Bruce McElhoe
JoNell Mullins
Jeff Murphy
Tammy Phillips
Tony Poole
Roxianne Sherles
Lisa Shipe
Steven Wood
Bryan Woods

ORNL

Cathy Alstatt
Kevin Birdwell
Terry Bonine
Brian Bowers
Rac Cox
Susan Cange
Jim Eaton
Rich Franco
Neil Giffen
Wes Goddard
Mark Greeley
Scott Gregory
James Hall
Julia Hancock
Regis Loffman
Diane Maddox
Courtney Manrod
Susan Michaud
Lori Muhs
Kim Myers
Frank O’Donnell
Anne Ostergaard
Greg Palko
Pat Parr
Mark Peterson
Larry Pounds
John Powell
Sharon Robinson
Kyle Rutherford
Denise Saunders
Pat Scofield
Jeff Sickau
David Skipper
Linda Smith
Charlie Valentine

Y-12 COMPLEX

Gary Beck
Rebekah Bell
Mary Anna Bogle
Mark Burris
Terry Cothron
Sara Cornwell
Laura Cunningham
Jessica Davis
Jennifer Dixon
Stan Duke
Jan Jackson
Kim Hanzelka
Russ Harden
Gail Harp
Cindy Hartsell
Clarence Hill
William Hurst
Robert Johnson
Steve Jones
Ivy Lalonde
Cathy McCoy
Jane Nations
Terry Nore
Bobby Oliver
Aprell Patterson
Larry Petrowski
Beth Schultz
Mark Shedden
Brad Skaggs
Johnny Skinner
Rose Smith
Lenny Vaughn
Jeannette Widman
Mick Wiest

1. Introduction to the Oak Ridge Reservation

The Oak Ridge Reservation (ORR) is a 13,574-ha (33,542-acre) federally owned site located in the counties of Anderson and Roane in eastern Tennessee. The ORR is home to two major U.S. Department of Energy (DOE) operating components, the Oak Ridge National Laboratory (ORNL) and the Y-12 National Security Complex (Y-12 Complex). Also located on the ORR are the East Tennessee Technology Park (ETTP), site of a former gaseous diffusion plant that is undergoing environmental restoration; the Oak Ridge Institute for Science and Education (ORISE) South Campus, which includes training facilities, laboratories, and support facilities; a variety of smaller government-owned, contractor-operated facilities involved in environmental restoration; and the government-owned, government-operated Agent Operations Eastern Command of the Office of Secure Transportation.

The ORR was established in the early 1940s as part of the Manhattan Project for the purposes of enriching uranium and pioneering methods for producing and separating plutonium. The missions of the ORR have evolved over the years, as it continues to adapt to meet the changing basic and applied research and national security needs of the United States.

The *Oak Ridge Reservation Annual Site Environmental Report* and supporting data are available at http://www.ornl.gov/sci/env_rpt.

Due to differing permit reporting requirements and instrument capabilities, various units of measurement are used in this report. The list of units of measure and conversion factors provided on page xxv is intended to help readers convert numeric values presented herein as needed for specific calculations and comparisons.

1.1 Background

The *Oak Ridge Reservation Annual Site Environmental Report* is prepared annually and presents summary environmental data to (1) characterize environmental performance, (2) summarize environmental occurrences reported during the year, (3) confirm compliance with environmental standards and requirements, and (4) highlight significant program activities. The report fulfills the requirement contained in DOE Order 231.1A, *Environment, Safety and Health Reporting* (DOE 2004) that an integrated annual site environmental report be prepared.

The results summarized in this report are based on data collected prior to and through 2010. This report is not intended to nor does it present the results of all environmental monitoring associated with the ORR. Data collected for other site and regulatory purposes, such as environmental restoration/remedial investigation reports, waste management characterization sampling data, and environmental permit compliance data, are presented in other documents that have been prepared in accordance with applicable DOE guidance and/or laws and are referenced herein as appropriate. Appendix A to this report identifies corrections to the 2009 report. Appendix B contains a glossary of technical terms that may be useful for understanding the terminology used in this document.

Environmental monitoring on the ORR consists primarily of two major activities: effluent monitoring and environmental surveillance. Effluent monitoring involves the collection and analysis of samples or measurements of liquid and gaseous effluents at the points of release to the environment; these measurements allow the quantification and official reporting of contaminant levels, assessment of radiation and chemical exposures to the public, and demonstration of compliance with applicable standards and permit requirements. Environmental surveillance consists of direct measurements and collection and analysis of samples taken from the site and its environs exclusive of effluents; these activities provide information on contaminant concentrations in air, water, groundwater, soil, foods, biota, and other media. Environmental surveillance data support determinations regarding environmental compliance and, when combined with data from effluent monitoring, support chemical and radiation dose and exposure assessments of the potential effects of ORR operations, if any, on the local environment.

1.2 History of the Oak Ridge Reservation

The ORR area was first occupied by Native Americans more than 10,000 years ago, and members of the Overhill Cherokee tribe still lived in the East Tennessee region when European settlers arrived in the late 1700s. These settlers lived on farms or in four small communities called Elza, Robertsville, Scarboro, and Wheat. All but Elza were founded shortly after the Revolutionary War. In the early 1940s approximately 1,000 families inhabited the area.

In 1942, the area that was to become the ORR was selected for use in the Manhattan Project because the Clinch River provided ample supplies of water, nearby Knoxville was a good source of labor, and the Tennessee Valley Authority (TVA) could supply the huge amounts of electricity needed. About 3,000 residents received court orders to vacate within weeks the homes and farms that their families had occupied for generations. The site's wartime name was "Clinton Engineering Works."

The workers' city, named Oak Ridge, was established on the reservation's northern edge. The city grew to a population of 75,000 and was the fifth largest in Tennessee; however, it was not shown on any map. At the Y-12 Complex, south of the city, an electromagnetic separation method was used to separate ^{235}U from natural uranium. A gaseous diffusion plant, later known as K-25, was built on the reservation's western edge. Near the reservation's southwest corner, about 16 km (10 miles) from Y-12, was a third facility, known as X-10 (or Clinton Laboratories), where the Graphite Reactor was built. The X-10 facility was a pilot plant for the larger plutonium production facilities built at Hanford, Washington. Two years after World War II ended, Oak Ridge was shifted to civilian control, under the authority of the U.S. Atomic Energy Commission. In 1959, the city was incorporated and a city manager and city council form of government was adopted by the community.

Since that time, the missions of these three major installations have continued to evolve and operations adapted to meet the changing defense, energy, and research needs of the United States. Their current missions, as well as the missions of several smaller DOE facilities/activities on the ORR, are described in Sect. 1.4 of this document.

1.3 Site Description

1.3.1 Location and Population

The ORR lies within the Great Valley of East Tennessee between the Cumberland and Great Smoky Mountains and is bordered on two sides by the Clinch River (Fig. 1.1). The Cumberland Mountains are 16 km (10 miles) to the northwest; the Great Smoky Mountains are 51 km (31.6 miles) to the southeast. The ORR encompasses about 13,574 ha (33,542 acres) of mostly contiguous land owned by the federal government and under the management of the DOE (Fig. 1.2). Most of it lies within the corporate limits of the city of Oak Ridge; some of the area west of ETTP lies outside the city limits. Approximately 4,667 ha (11,533 acres) of the ORR is situated in Anderson County, and approximately 8,906 ha (22,008 acres) is in Roane County. The population of the 10-county region surrounding the ORR is about 946,830 with less than 2% of its labor force employed on ORR (Fig. 1.3). Other municipalities within approximately 30 km (18.6 miles) of the reservation include Oliver Springs, Clinton, Lake City, Lenoir City, Farragut, Kingston, and Harriman (Fig. 1.4).

Knoxville, the major metropolitan area nearest Oak Ridge, is located about 40 km (25 miles) to the east and has a population of about 185,100. Except for the city of Oak Ridge, the land within 8 km (5 miles) of the ORR is semirural and is used primarily for residences, small farms, and cattle pasture. Fishing, hunting, boating, water skiing, and swimming are popular recreational activities in the area.

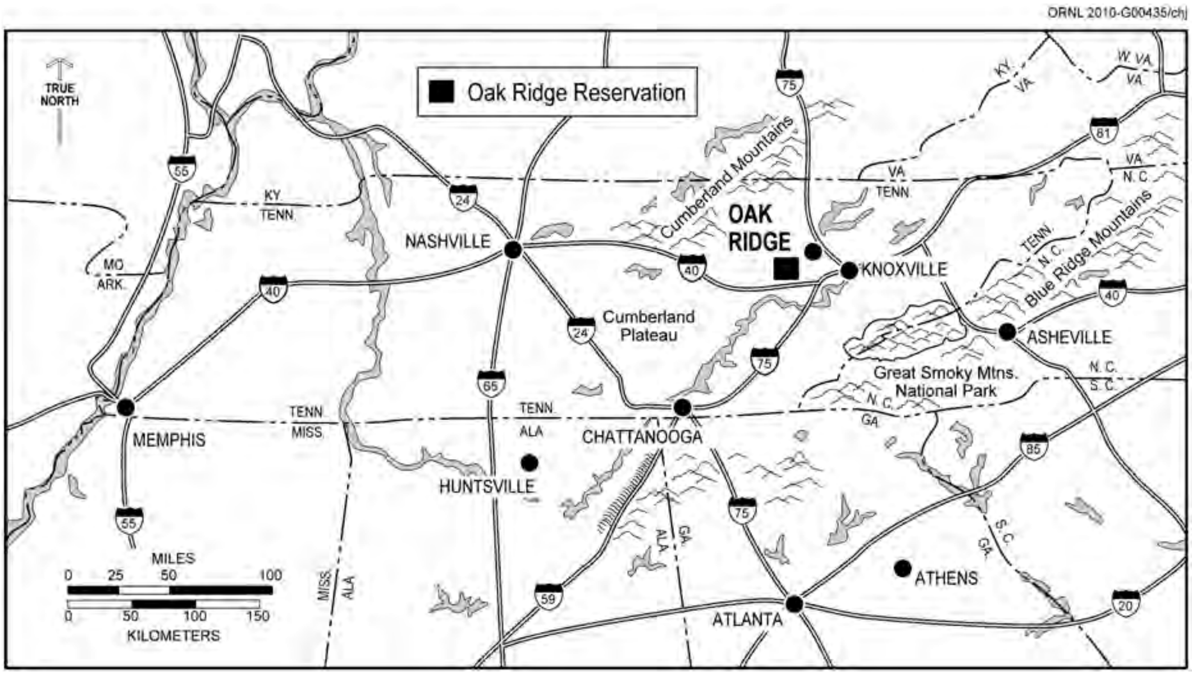

Fig. 1.1. Location of the city of Oak Ridge.

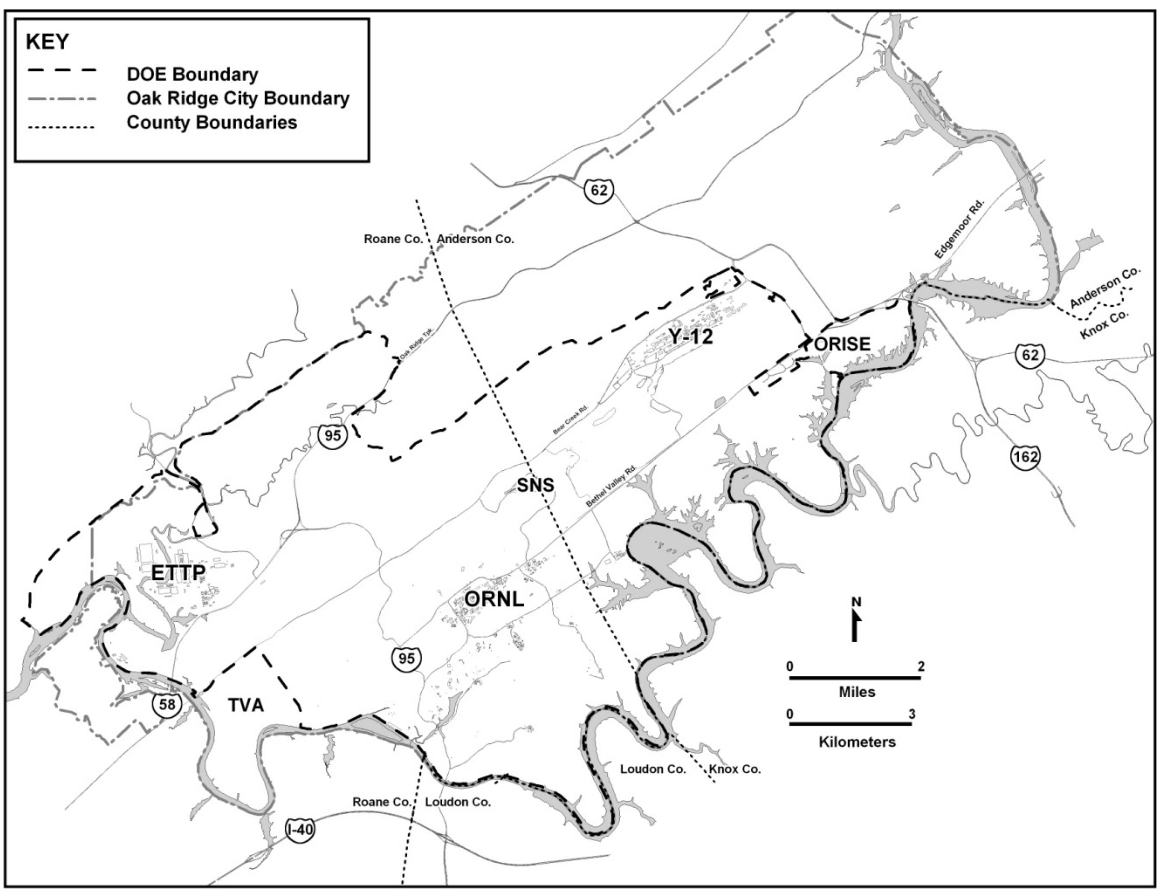

Fig. 1.2. The Oak Ridge Reservation.

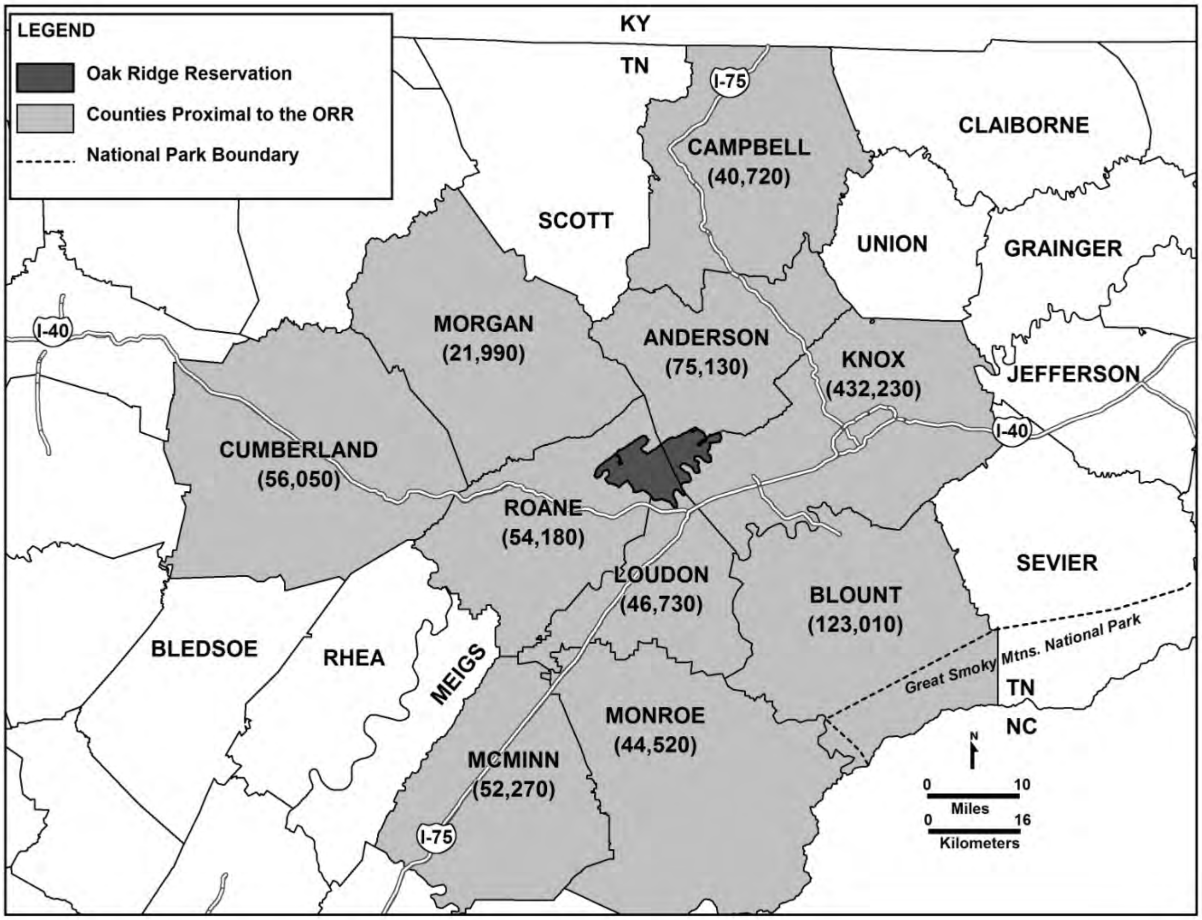

Fig. 1.3. Population by county in the 10-county region surrounding the Oak Ridge Reservation.

1.3.2 Climate

The climate of the Oak Ridge region may be broadly classified as humid subtropical and is characterized by significant temperature changes between summer and winter. The 30-year mean temperature for the period of 1981–2010 is 14.7°C (58.5°F). The average temperature for the Oak Ridge area during 2010 was 14.9°C (58.8°F). The coldest month is usually January, with temperatures averaging about 3.1°C (37.5°F). During 2010, January temperatures averaged below normal at 1.2°C (34.1°F). July tends to be the warmest month, with average temperatures of 25.7°C (78.1°F). July 2010 temperatures averaged 27.2°C (81°F), above the 30-year mean.

Average annual precipitation in the Oak Ridge area for the 30-year period from 1981 to 2010 was 1,342.7 mm (52.85 in.), including about 17 cm (6.7 in.) of snowfall annually (NOAA 2010). Total rainfall during 2010 (measured at the Oak Ridge National Weather Service meteorological tower) was 1,391 mm (54.76 in.), and total 2010 snowfall was 28.2 cm (11.1 in.). Precipitation during 2010 was near the 30-year average, but snowfall was above average. Monthly summaries of precipitation averages, extremes, and 2010 values are provided in Appendix C, Table C.1.

In 2010, wind speeds at ORNL Tower C (MT2) measured at 10 m (32.8 ft) above ground level averaged 1.1 m/s (3.7 ft/s). This value increased to about 2.8 m/s (9.1 ft/s) for winds at 100 m (328 ft) above the ground (about the height of local ridgetops). The local ridge-and-valley terrain reduces average wind speeds at valley bottoms, resulting in frequent periods of nearly calm conditions, particularly during clear, early morning hours. Wind direction and speed frequencies for the ORR towers during 2010 and during precipitation events over the 10-year representative period from 1998–2007 can be viewed at http://www.ornl.gov/~das/web/page6.cfm.

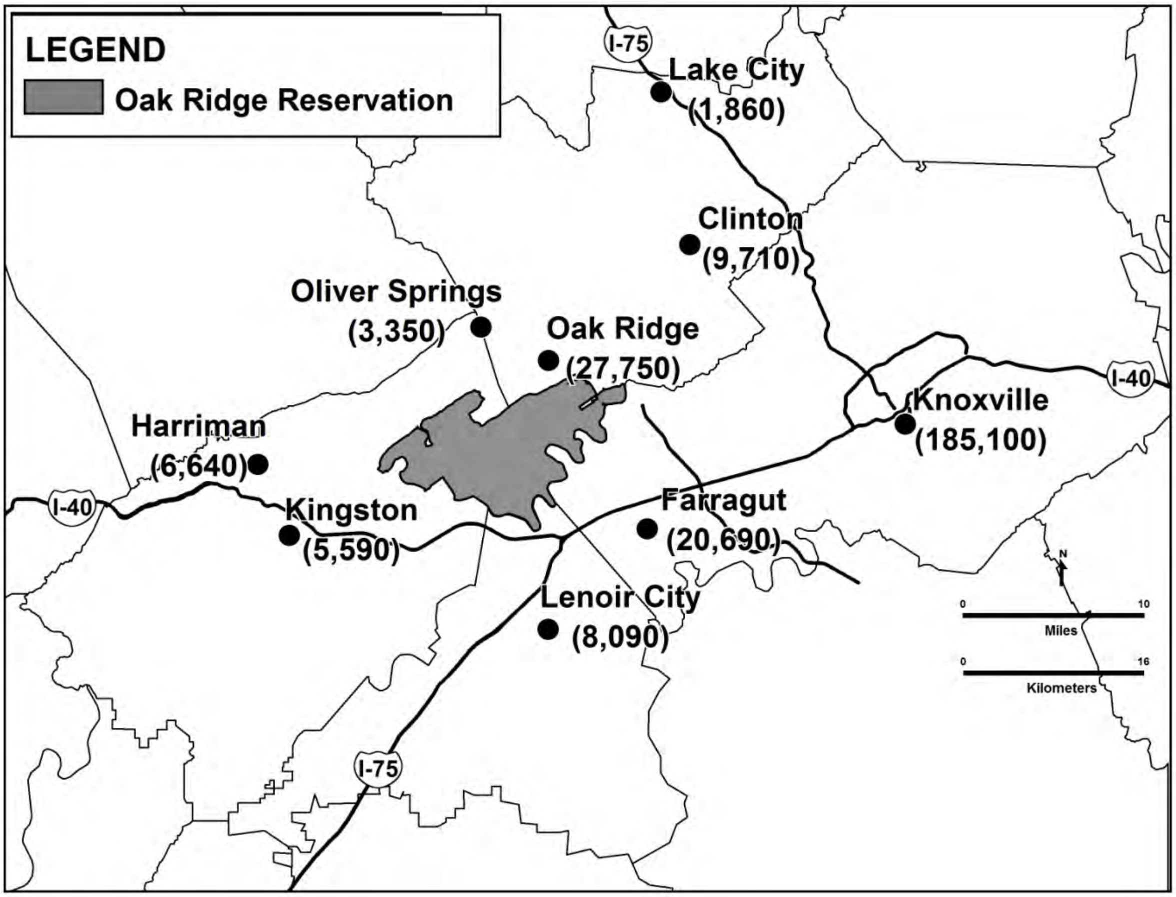

Fig. 1.4. Locations and populations of towns nearest to the Oak Ridge Reservation.

More detailed information on the climate of the Oak Ridge area is available in *Oak Ridge Reservation Physical Characteristics and Natural Resources* (Parr and Hughes 2006) and in Appendix C of this document.

1.3.3 Regional Air Quality

The Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards (NAAQS) for key principal pollutants, which are called "criteria" pollutants. These pollutants are sulfur dioxide (SO_2), carbon monoxide (CO), carbon dioxide (CO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), particles with an aerodynamic diameter less than or equal to 10 µm (PM_{10}), and fine particulate matter with an aerodynamic diameter less than or equal to 2.5 µm ($PM_{2.5}$). EPA evaluates NAAQS based on ambient (outdoor) levels of the criteria pollutants. Areas that satisfy NAAQS are classified as attainment areas, whereas areas that exceed the NAAQS for a particular pollutant are classified as nonattainment areas for that pollutant.

The ORR is located in Anderson and Roane counties in Air Quality Control Region 207 (East Tennessee–Southeastern Virginia). The EPA has designated Anderson County as a basic nonattainment area for the 8-hour (h) O_3 standard as part of the larger Knoxville 8-h basic O_3 nonattainment area, which encompasses several counties. In addition, the EPA has designated Anderson, Knox, and Blount counties as a nonattainment area for the $PM_{2.5}$ air quality standard. EPA designated the portion of Roane County surrounding the Kingston Steam Plant as a nonattainment area for $PM_{2.5}$ as well. Air quality in the greater Knoxville and Oak Ridge area is classified as an attainment area with the NAAQS for all other criteria pollutants for which EPA has made attainment designations.

1.3.4 Surface Water

The ORR lies within the Valley and Ridge Physiographic Province, which is composed of a series of drainage basins or troughs containing many small streams feeding the Clinch River. Surface water on the ORR drains into a tributary or series of tributaries, streams, or creeks within different watersheds. Each of these watersheds drains into the Clinch River that, in turn, flows into the Tennessee River.

The largest of the drainage basins is Poplar Creek, which receives drainage from a 352 km^2 (136 $mile^2$) area, including the northwestern sector of the ORR. It flows from northeast to southwest, approximately through the center of the ETTP, and discharges directly into the Clinch River.

East Fork Poplar Creek, which discharges into Poplar Creek east of the ETTP, originates within the Y-12 Complex and flows northeast along the south side of the Y-12 Complex. Bear Creek also originates within the Y-12 Complex and flows southwest. Bear Creek is mostly affected by storm water runoff, groundwater infiltration, and tributaries that drain former waste disposal sites in the Bear Creek Valley Burial Grounds Waste Management Area and the current Environmental Management Waste Management Facility (EMWMF).

Both the Bethel Valley and Melton Valley portions of ORNL are in the White Oak Creek drainage basin, which has an area of 16.5 km^2 (6.4 $mile^2$). White Oak Creek headwaters originate on Chestnut Ridge, north of ORNL, near the Spallation Neutron Source (SNS) site. At the ORNL site, the creek flows west along the southern boundary of the developed area and then flows southwesterly through a gap in Haw Ridge to the western portion of Melton Valley, where it forms a confluence with Melton Branch. The headwaters of Melton Branch originate in Melton Valley east of the High Flux Isotope Reactor (HFIR) Complex. It has a drainage basin area of approximately 3.8 km^2. The waters of White Oak Creek enter White Oak Lake, which is an impoundment formed by White Oak Dam. Water flowing over White Oak Dam enters the Clinch River after passing through the White Oak Creek embayment area.

1.3.5 Geological Setting

The ORR is located in the Tennessee portion of the Valley and Ridge Physiographic Province, which is part of the southern Appalachian fold-and-thrust belt. As a result of thrust faulting and differential erosion rates, a series of parallel valleys and ridges have formed that trend southwest–northeast.

Two geologic units on the ORR, designated as the Knox Group and the Maynardville Limestone of the Upper Conasauga Group, consisting of dolostone and limestone, respectively, comprise the most significant water-bearing hydrostratigraphic unit in the Valley and Ridge Province (Zurawski 1978) as well as on the ORR. Being composed of the fairly soluble minerals, these bedrock formations are prone to dissolution as slightly acidic rainwater and percolating recharge water come in contact with mineral surfaces. This dissolution increases fracture apertures and can form caverns and extensive solution conduit networks under some circumstances. This hydrostratigraphic unit is referred to locally as the "Knox Aquifer." A combination of fractures and solution conduits in the aquifer control flow over substantial areas, and large quantities of water may move long distances. Active groundwater flow can occur at substantial depths in the Knox Aquifer [91.5 to 122 m (300 to 400 ft) deep]. The Knox Aquifer is the primary source of groundwater to many streams (base flow), and most large springs on the ORR receive discharge from the Knox Aquifer. Yields of some wells penetrating larger solution conduits are reported to exceed 3,784 L/min (1,000 gal/min). The high productivity of the Knox Aquifer is attributed to the combination of its abundant and sometimes large solution conduit systems and frequently thick overburden soils that promote recharge and storage of groundwater.

The remaining geologic units on the ORR (the Rome Formation, the Conasauga Group below the Maynardville Limestone, and the Chickamauga Group) are composed predominantly of shales, siltstones, and sandstones with a subordinate and locally variable amount of carbonate bedrock. These formations are predominantly composed of insoluble minerals such as clays and quartz that were derived from ancient continental erosion. Groundwater occurs and moves through fractures in those bedrock units. Groundwater availability in such settings is dependent on the abundance and interconnectedness of fractures as well as connection of fractures to sources of recharge, such as alluvial soils along streams that can provide some sustained infiltration. The shale and sandstone formations are the poorest aquifers in the

Valley and Ridge Province (Zurawski 1978). Well yields are generally low in the Rome, Conasauga, and Chickamauga bedrock formations except in very localized areas, where carbonate beds may provide greater groundwater storage than adjacent clastic bedrock (Fig. 1.5). Detailed information on ORR groundwater hydrology and flow is available in *Oak Ridge Reservation Physical Characteristics and Natural Resources* (Parr and Hughes 2006).

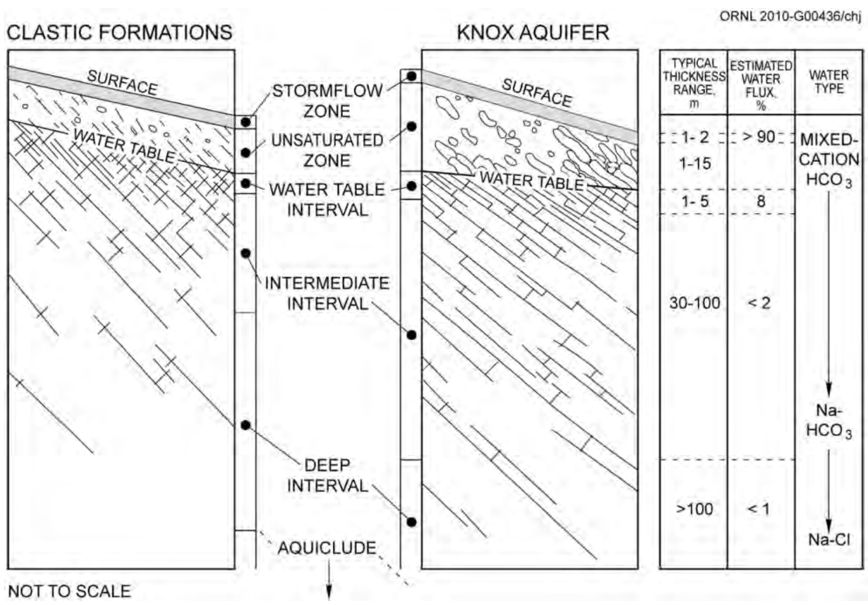

Fig. 1.5. Vertical relationships of flow zones of the Oak Ridge Reservation: estimated thicknesses, water flux, and water types.

1.3.6 Natural, Cultural, and Historic Resources

The ORR contains a unique variety of natural, cultural, and historic resources. Ongoing efforts continue to focus on preserving the rich diversity of these resources.

1.3.6.1 Wetlands

About 243 ha (600 acres) of wetlands have been identified on the ORR, most are classified as forested palustrine, scrub/shrub, and emergent wetlands. Wetlands occur across the ORR at low elevations, primarily in riparian zones of headwater streams and receiving streams as well as in the Clinch River embayments (Fig. 1.6). Wetlands identified to date range in size from several square meters at small seeps and springs to approximately 10 ha (25 acres) at White Oak Lake. Surveys of wetlands resources presented in *Identification and Characterization of Wetlands in the Bear Creek Watershed* (MMES 1993), *Wetland Survey of Selected Areas in the Oak Ridge Y-12 Plant Area of Responsibility, Oak Ridge, Tennessee* (LMES 1997), and *Wetland Survey of the X-10 Bethel Valley and Melton Valley Groundwater Operable Units at Oak Ridge National Laboratory* (Rosensteel 1996) serve as references to support wetlands assessments for upcoming projects and activities. In addition, wetlands maps have been developed for selected areas of the ORR in response to project-specific requirements. These are also consulted, and verified by site inspections, when appropriate.

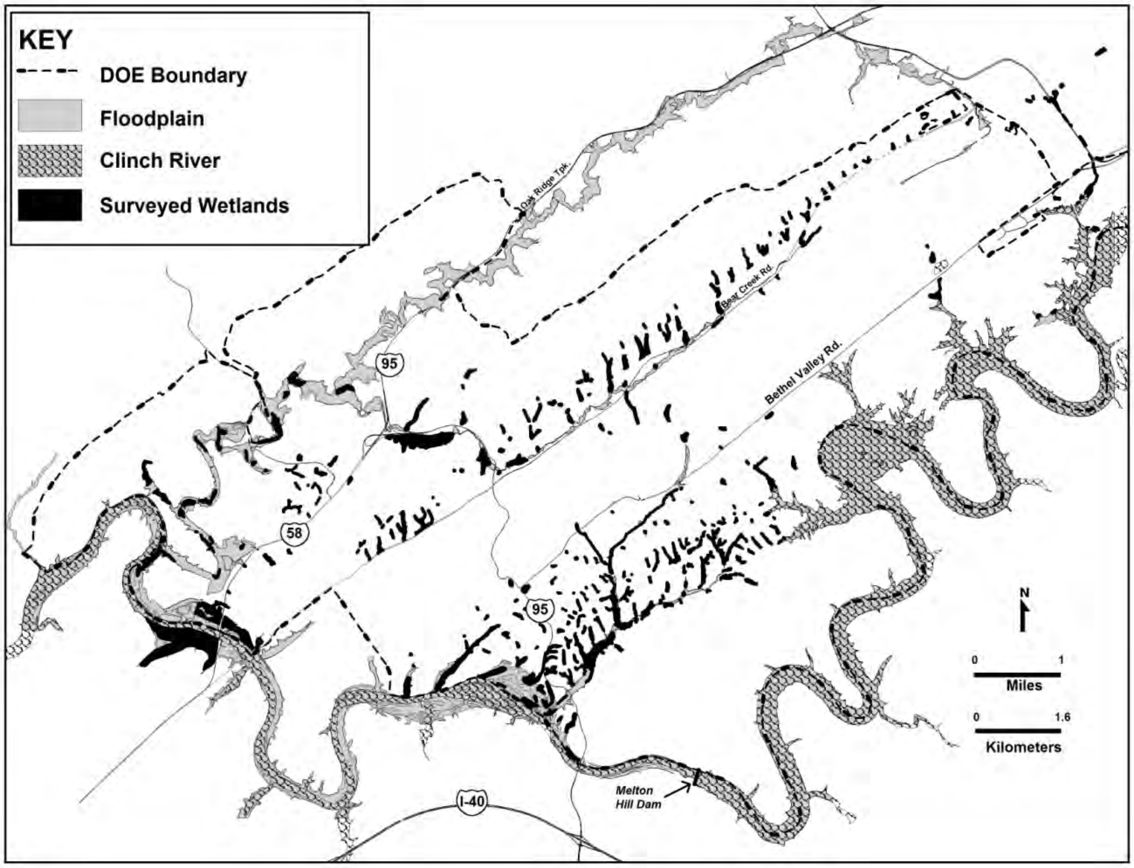

Fig. 1.6. Oak Ridge Reservation wetlands.

Wetlands that have been created at the former ORNL Emergency Waste Basin solid waste storage area (SWSA) 6 and the former ORNL Intermediate Holding Pond (SWSA 4) were evaluated in June–September 2010 to determine if these areas have maintained characteristics of jurisdictional and other ORR wetlands. These wetlands were created to provide mitigation for impacts to several small wetlands in the Melton Valley due to construction activities. The created wetlands were flagged to determine acreage and were evaluated for the presence of hydrology, hydrophytic vegetation, and hydric soils. Biological conditions within the wetlands were further evaluated by surveying certain indicator wildlife populations (i.e., birds, reptiles, and amphibians). Both wetlands were found to exhibit characteristics that meet the Army Corps of Engineers (ACOE) wetlands criteria very strongly for vegetation and hydrology; however, the nature of these recently created wetland has not allowed enough time for development of classic wetland soils. Proper landscape positioning and contour design has resulted in successful wetland creations. Both sites provide a self-perpetuating hydro period that supports a diversity of wetland plants and is used by a number of wetland fauna species. Successful seeding, planting, and colonization have resulted in the establishment of sites dominated by wetland plants. The encroachment of sericea lespedeza, a highly invasive non-native plant, was noted at both sites. Eurasian water-milfoil was noted in the pond at the Emergency Waste Basin site. This highly aggressive green sunfish was plentiful in the pond at the southern end of the Intermediate Holding Pond site.

Instability and erosion evaluations were conducted along two relocated streams in the vicinity of the SWSA 5 cap at ORNL in June–September 2010. A portion of Melton Branch was relocated to facilitate construction of the southwestern corner of the cap and to optimize the location of a downgradient groundwater collection trench in that area. Two reaches of the Homogeneous Reactor Experiment (HRE) tributary on the east side of SWSA 5 were also relocated in areas where they infringed upon the cap boundary. The Melton Branch relocation was evaluated using habitat metrics collected as part of the

Biological Monitoring and Abatement Program (BMAP) fish and benthic community monitoring of Melton Branch, along with additional data collected on the use of riparian habitat by wildlife (mainly birds). The HRE tributary was evaluated by visual surveys of stream instability and erosion features, habitat parameter measurements, and data collected on wildlife (mainly birds) using the riparian habitat. Both the Melton Branch and HRE tributary reaches maintain "non-impaired" status, based on the habitat assessments conducted. The Melton Branch reach successfully provides habitat for epifaunal colonization and fish cover. This reach also provides favorable and diverse substrate for benthic macroinvertebrates, with conditions more favorable than most in the White Oak Creek watershed. The site provides suitable habitat for fish populations with similar fish species diversity and higher densities and biomass than several other ORR tributaries. Adjacent riparian zones are generally of sufficient width and habitat quality to support a number of bird species, including two species specifically dependent on riparian zone habitat. The narrowness of the riparian zone on the north side of the reach has an impact on habitat quality and creates some runoff and erosion issues. The presence of steep unvegetated banks is impacting habitat quality in certain portions of the reach. The HRE tributary also successfully provides habitat for epifaunal colonization and fish cover. Bank stability and vegetative cover are good along most of this reach, enhancing the quality of habitat in the tributary. Although habitat is fragmented in the area, the riparian zone is being utilized by a number of bird species, including one species known specifically for riparian habitats. The presence of steep unvegetated banks in the area of the initial stream diversion at this site is impacting the habitat quality at that specific location. The presence of deep pools along this reach would further enhance habitat quality in the tributary. The narrowness of the riparian zone on both sides of the tributary has some impact on habitat quality and creates some runoff and erosion issues.

A wetland assessment was also conducted in 2010 on the ORNL White Oak Creek floodplain just north of the existing Transuranic (TRU) Waste Processing Center (TWPC) facility. The assessment was conducted to determine the presence of jurisdictional wetlands in an area that may be impacted by the expansion of the TWPC facility. The area was evaluated for hydrology, wetland soils, and wetland vegetation. The general area that included the proposed site for the TWPC expansion contained a large area that satisfies soils, hydrologic, and vegetation criteria of the ACOE wetland protocols. The site contained numerous seeps and varying densities of wetland vegetation. Areas were broadly flagged to encompass these sensitive areas. In addition to the delineation of large wetland areas on the floodplain, a smaller bermed wetland area was also flagged on the site. Based on these wetland delineations, Wastren Advantage Inc. (WAI) began the development of a plan that would minimize impacts to wetlands and the floodplain. The limits of clearing for the current project are outside delineated wetland boundaries and the 500-year and 100-year floodplains. The current project also provides a buffer from Melton Branch. However, the project will result in the loss of some second growth bottomland forest, which could result in some impacts to forest wildlife. Additional bottomland forest exists to the north and west of the site.

A wetland assessment was conducted at sites associated with the proposed Uranium Processing Facility (UPF) at the Y-12 National Security Complex in early FY 2010. The assessment was conducted to determine if jurisdictional wetlands were present in the area of the proposed UPF project. The area was evaluated for hydrology, wetland soils, and wetland vegetation. A total of nine wetlands that satisfied soils, hydrologic, and vegetation criteria of the ACOE wetland protocols were identified at the proposed UPF site. The total acreage of wetlands delineated was 1.43 acres. The wetland evaluation was also used to successfully identify and design 3.02 acres of wetland mitigation off-set acreage for the project.

1.3.6.2 Wildlife/Endangered Species

Animals listed as species of concern known to be present on the reservation (excluding the Clinch River bordering the reservation) are listed along with their status in Table 1.1. The list illustrates the diversity of avian species on the ORR, which is also habitat for many unlisted species, some of which are in decline nationally or regionally. Some of these (e.g., anhinga) have been seen only once or a few times; others (e.g., sharp-shinned hawk, southeastern shrew) are comparatively common and widespread on the reservation. Other listed species may also be present, although they have not been observed recently. These include several species of mollusks (such as the spiny river snail), amphibians (such as the hellbender), birds (such as Bachman's sparrow), and mammals (such as the smoky shrew).

Table 1.1. Animal species of concern reported from and sensitive wildlife species recently found on the Oak Ridge Reservation[a]

Scientific name	Common name	Status[b]		
		Federal	State	PIF[c]
	MAMMALS			
Myotis grisescens	Gray bat	E	E	
Sorex longirostris	Southeastern shrew		NM	
Zapus hudsonius	Meadow jumping mouse		NM	
	FISH			
Phoxinus tennesseensis	Tennessee dace		NM	
	AMPHIBIANS AND REPTILES			
Cryptobranchus alleganiensis	Hellbender	MC	NM	
Hemidactylium scutatum	Four-toed salamander		NM	
	BIRDS			
	Darters			
Anhinga anhinga	Anhinga		NM	
	Bitterns and Herons			
Ardea alba	Great egret		NM	
Egretta caerulea	Little blue heron		NM	
Egretta thula	Snowy egret		NM	
	Kites, Hawks, Eagles, and Allies			
Haliaeetus leucocephalus	Bald eagle[d]		NM	
Circus cyaneus	Northern harrier		NM	
Accipiter striatus	Sharp-shinned hawk		NM	
Buteo platypterus	Broad-winged hawk			RI
	Falcons			
Falco peregrines	Peregrine falcon[e]		E	RI
	Grouse, Turkey, and Quail			
Bonasa umbellus	Ruffed grouse			RI
Colinus virginianus	Northern bobwhite			RI
	Rails, Gallinules, and Coots			
Gallinula chloropus	Common moorhen		NM	
	Owls			
Aegolius acadicus	Northern saw-whet owl	MC	T	RI
Tyto alba	Barn owl		NM	

Table 1.1 (continued)

Scientific name	Common name	Status[b]		
		Federal	State	PIF[c]
	Goatsuckers			
Caprimulgus carolinensis	Chuck-will's-widow			RI
Caprimulgus vociferous	Whip-poor-will			RI
	Swifts			
Chaetura pelagic	Chimney swift			RI
	Kingfishers			
Megaceryle alcyon	Belted kingfisher			RI
	Woodpeckers			
Melanerpes erythrocephalus	Red-headed woodpecker			RI
Sphyrapicus varius	Yellow-bellied sapsucker	MC	NM	
Picoides pubescens	Downy woodpecker			RI
Colaptes auratus	Northern flicker			RI
	Tyrant Flycatchers			
Contopus cooperi	Olive-sided flycatcher		NM	RI
Contopus virens	Eastern wood-pewee			RI
Empidonax traillii	Willow flycatcher			RI
Empidonax virescens	Acadian flycatcher			RI
	Swallows			
Progne subis	Purple martin			RI
	Titmice and Chickadees			
Poecile carolinensis	Carolina chickadee			RI
	Nuthatches			
Sitta pusilla	Brown-headed nuthatch			RI
	Kinglets, Gnatcatchers, and Thrushes			
Hylocichla mustelina	Wood thrush			RI
	Thrashers and Mockingbirds			
Toxostoma rufum	Brown thrasher			RI
	Shrikes			
Lanius ludovicianus	Loggerhead shrike	MC	NM	RI
	Vireos			
Vireo flavifrons	Yellow-throated vireo			RI

Table 1.1 (continued)

Scientific name	Common name	Status[b] Federal	State	PIF[c]
	Wood Warblers			
Vermivora chrysoptera	Golden-winged warbler	MC	NM	RI
Vermivora pinus	Blue-winged warbler			RI
Dendroica cerulean	Cerulean warbler		NM	RI
Dendroica discolor	Prairie warbler			RI
Dendroica fusca	Blackburnian warbler			RI
Mniotilta varia	Black-and-white warbler			RI
Helmitheros vermivorum	Worm-eating warbler			RI
Seiurus motacilla	Louisiana waterthrush			RI
Oporornis formosus	Kentucky warbler			RI
Wilsonia Canadensis	Canada warbler			RI
Wilsonia citrine	Hooded warbler			RI
Icteria virens	Yellow-breasted chat			RI
	Tanagers			
Piranga olivacea	Scarlet tanager			RI
Piranga rubra	Summer tanager			RI
	Cardinals, Grosbeaks, and Allies			
Passerina cyanea	Indigo bunting			RI
	Towhees, Sparrows, and Allies			
Pipilo erythrophthalmus	Eastern towhee			RI
Spizella pusilla	Field sparrow			RI
Ammodramus savannarum	Grasshopper sparrow			RI
Pooecetes gramineus	Vesper sparrow		NM	
	Blackbirds and Allies			
Sturnella magna	Eastern meadowlark			RI

[a]Land and surface waters of the ORR exclusive of the Clinch River, which borders the ORR
[b]Status codes
E = endangered
T = threatened
MC = species of management concern
NM = in need of management
RI = regional importance
[c]Partners in Flight was launched in 1990 in response to growing concerns about declines in the populations of many land bird species, and to emphasize the conservation of birds not covered by existing conservation initiatives.
[d]The bald eagle was federally delisted effective August 8, 2007.
[e]The peregrine falcon was federally delisted effective August 25, 1999.

Birds, fish, and aquatic invertebrates are the most thoroughly surveyed animal groups on the ORR. The only federally listed animal species that has been observed on the ORR in recent years is the gray bat, which was observed over water bordering the ORR (the Clinch River) in 2003 and over a pond on the ORR in 2004. Three gray bats were mist-netted outside a cave on the ORR in 2006. The peregrine falcon, listed by the state of Tennessee as endangered, and the northern saw-whet owl, listed by the state as threatened, are only very rare transients on the site (Fig. 1.7). Similarly, several state-listed bird species, such as the anhinga, olive-sided flycatcher, and little blue heron, are uncommon migrants or visitors to the reservation; however, the little blue heron is believed to be increasing in numbers. The cerulean warbler, listed by the state as in need of management, has been recorded during the breeding season; however, this species is not actually known to breed on the reservation. The bald eagle, also listed by the state as in need of management, is increasingly seen at all times of the year, and one nest was confirmed on the reservation in 2011. Others, such as the northern harrier, great egret, and yellow-bellied sapsucker, are migrants or winter residents that do not nest on the reservation. The golden-winged warbler, listed by the state as in need of management, has been sighted once on the reservation. Barn owls have been known to nest on the reservation in the past.

One species of fish, the spotfin chub (*Erimonax monacha*), which is listed as threatened by both the state and the federal government, has been sighted and collected in the city of Oak Ridge and may be present on the ORR. The Tennessee dace, listed by the state as being in need of management, has been found in Bear Creek watershed, tributaries to lower East Fork watershed, and Ish Creek and may occur in some sections of Grassy Creek (upstream of Scientific Ecology Group, Inc., and International Technology Corporation at Clinch River Kilometer 23).

1.3.6.3 Threatened and Endangered Plants

Four species (spreading false-foxglove, Appalachian bugbane, tall larkspur, and butternut) have been under review for listing at the federal level and were listed under the formerly used “C2” candidate designation. These species are now informally referred to as “special concern” species by the U.S. Fish and Wildlife Service.

The most recent addition (2009) to the ORR list of state-protected plants (Table 1.2) is American barberry, which is listed as a species of special concern by the state. Also early in 2011 butternut was confirmed to be currently extant on the ORR.

The Tennessee Heritage Program scientific advisory committee met in 2009 to revise the state list, but its changes to the state list are not yet official. These changes are expected to add one species to the ORR list while deleting two. In addition, the ORR list (Table 1.2) reflects changes made by the state to the scientific names used for plants.

1.3.6.4 Historical and Cultural Resources

Efforts continue to preserve the rich prehistoric and historic cultural resources of the ORR. The reservation contains more than 45 known prehistoric sites (primarily burial mounds and archeological evidence of former structures), more than 250 historic pre-World War II structures, 31 cemeteries, and several historically significant Manhattan Project–era structures. Six historic ORR properties are individually listed in the *National Register of Historic Places*:

- Freels Bend Cabin,
- Graphite Reactor,
- New Bethel Baptist Church and Cemetery,
- Oak Ridge Turnpike Checking Station,
- George Jones Memorial Baptist Church and Cemetery, and
- Scarboro Road Checking Station.

Although not yet listed in the *National Register*, an area known as the Wheat Community African Burial Grounds was dedicated in June 2000, and a memorial monument was erected.

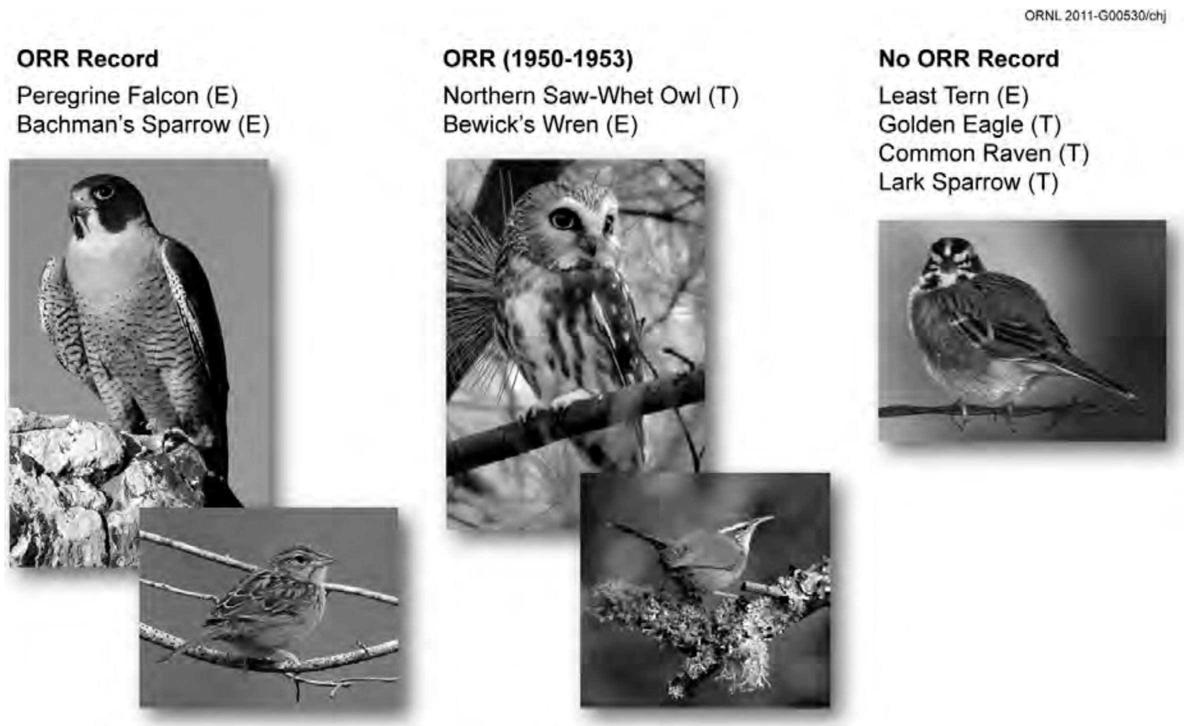

Fig. 1.7. Tennessee birds—threatened and endangered.

The DOE Oak Ridge Office (ORO) *Cultural Resource Management Plan* (DOE 2001) was developed to identify, assess, and document historic and cultural resources on the ORR and establish a management strategy.

Table 1.2. Vascular plant species listed by state or federal agencies, 2011

Species	Common name	Habitat on ORR	Status code[a]
Currently known or previously reported from the ORR			
Aureolaria patula	Spreading false-foxglove	River bluff	FSC, S
Berberis Canadensis	American barberry	Rocky bluff	S
Bolboschoenus fluviatilis	River bulrush	Wetland	S
Carex gravid	Heavy sedge	Forest	S
Carex oxylepis var. pubescens[b]	Hairy sharp-scaled sedge	Shaded wetlands	S
Cimicifuga rubifolia	Appalachian bugbane	Forested River slope	FSC, T
Cypripedium acaule	Pink lady's-slipper	Dry to rich woods	E, CE
Delphinium exaltatum	Tall larkspur	Barrens and woodlands	FSC, E
Diervilla lonicera	Northern bush-honeysuckle	Rocky River bluff	T
Draba ramosissima	Branching whitlow-grass	Limestone cliff	S
Elodea nuttallii	Nuttall waterweed	Pond, embayment	S
Fothergilla major	Mountain witch-alder	Woods	T
Helianthus occidentalis	Naked-stem sunflower	Barrens	S
Hydrastis Canadensis	Golden seal	Rich woods	S, CE
Juglans cinerea	Butternut	Lake shore	FSC, T
Juncus brachycephalus	Small-head rush	Open wetland	S
Lilium canadense	Canada lily	Moist woods	T
Lilium michiganense[c]	Michigan lily	Moist woods	T
Liparis loeselii	Fen orchid	Forested wetland	E
Panax quinquifolius	Ginseng	Rich woods	S, CE

Table 1.2. (continued)

Species	Common name	Habitat on ORR	Status code[a]
Currently known or previously reported from the ORR (cont)			
Platanthera flava var. herbiola	Tuberculed rein-orchid	Forested wetland	T
Ruellia purshiana	Pursh's wild-petunia	Dry, open woods	S
Spiranthes lucida	Shining ladies-tresses	Boggy wetland	T
Thuja occidentalis	Northern white cedar	Rocky river bluffs	S
Viola tripartite var. tripartite	Three-parted violet	Rocky woods	S
Rare plants that occur near and could be present on the ORR			
Agalinis auriculata	Earleaf false foxglove	Calcareous barren	FSC, E
Allium burdickii or A. tricoccom[d]	Ramps	Moist woods	S, CE
Pseudognaphalium helleri	Heller's catfoot	Dry woodland edge	S
Lathyrus palustris	A vetch	Moist meadows	S
Liatris cylindracea	Slender blazing star	Calcareous barren	E
Lonicera dioica	Mountain honeysuckle	Rocky river bluff	S
Meehania cordata	Heartleaf meehania	Moist calcareous woods	T
Pedicularis lanceolata	Swamp lousewort	Calcareous wet meadow	T
Pycnanthemum torrei	Torrey's mountain-mint	Calcareous barren edge	S
Solidago ptarmicoides	Prairie goldenrod	Calcareous barren	E

[a]Status codes:
CE = Status due to commercial exploitation.
E = Endangered in Tennessee.
FSC = Federal Special Concern; formerly designated as C2. See *Federal Register*, February 28, 1996.
S = Special concern in Tennessee.
T = Threatened in Tennessee.

[b]*Carex oxylepis var. pubescens* has not been observed during recent surveys.

[c]*Lilium michiganense* is believed to have been extirpated from the ORR by the impoundment at Melton Hill.

[d]Ramps have been reported near the ORR, but there is not sufficient information to determine which of the two species is present or if the occurrence may have been introduced by planting. Both species of ramps have the same state status.

1.4 DOE Offices and Sites

1.4.1 The DOE Oak Ridge Office

The ORR is home to a world-leading research and manufacturing park, with major federal programs in the areas of science, environmental management, nuclear fuel supply, and national security. The DOE-ORO oversees and manages these programs at three primary sites: ORNL, ETTP, and ORISE.

The DOE presence in Oak Ridge has a major financial impact on the area as well; it serves as an economic engine, driving local, regional, and statewide development. DOE is credited with providing a $3.6 billion increase in the gross state product. It supports some 44,889 full-time jobs statewide, results in $76.9 million in state and local sales tax, and is the fourth-largest employer in Tennessee.

With a federal and contractor workforce in Oak Ridge of more than 12,000 people, DOE is committed to continuing its strong ties to the communities in East Tennessee. The support of local communities has enabled ORO to undertake some of the most complex work in the department, and there is more to come as ORO advances public and private-sector growth in the areas of science, manufacturing, national security, and reindustrialization.

1.4.2 The National Nuclear Security Administration Y-12 Site Office

The National Nuclear Security Administration (NNSA) is a semiautonomous agency within DOE that works in partnership with the U.S. Department of Defense and the other components of the national security enterprise to perform routine maintenance and repair of nuclear weapons components, dismantlement of retired nuclear weapons, and refurbishment of nuclear warheads and to maintain the capability to design, manufacture, and certify new nuclear warheads.

The NNSA Y-12 Site Office (YSO), located on the Y-12 Complex, is responsible for operation of the Y-12 Complex. YSO employees perform contract and program management oversight, contract and administrative management, and technical evaluation and assessment.

1.4.3 Oak Ridge National Laboratory

Oak Ridge National Laboratory is DOE's largest science and energy laboratory (Fig. 1.8). Managed since April 2000 by a partnership of the University of Tennessee and Battelle, ORNL was established in 1943 as a part of the Manhattan Project to pioneer a method for producing and separating plutonium. During the 1950s and 1960s, ORNL became an international center for the study of nuclear energy and related research in the physical and life sciences. With the creation of DOE in the 1970s, ORNL's mission broadened to include a variety of energy technologies and strategies. Today the laboratory supports the nation with a peacetime science and technology mission.

ORNL 2010-G00437/chj

Fig. 1.8. The Oak Ridge National Laboratory.

As an international leader in a range of scientific areas that support DOE's mission, ORNL has six major mission roles: neutron science, energy, high-performance computing, systems biology, materials science at the nanoscale, and national security. ORNL's leadership role in the nation's energy future includes hosting the U.S. project office for the ITER fusion experiment and the BioEnergy Science Center, which is sponsored by the DOE Office of Science.

The TWPC is managed by Wastren Advantage, Inc. (WAI) for DOE. The mission of TWPC is to receive TRU wastes from ORNL for processing, treatment, repackaging, and shipment to designated facilities for final disposal. Processed TRU waste is shipped to the Waste Isolation Pilot Plant (WIPP) for disposal. Waste that is determined to be non-TRU (e.g., low-level radioactive waste, mixed low-level waste) is shipped to the Nevada Test Site or other approved facility.

Isotek Systems LLC (Isotek) manages activities at ORNL's Building 3019 Complex for DOE and is responsible for activities associated with processing, down-blending, and packaging the DOE inventory of ^{233}U stored in the Building 3019 Complex.

Approximately 5 ha (15 acres) in the central portion of the ORNL has been leased to Halcyon, LLC, a subsidiary of the Community Reuse Organization of East Tennessee (CROET) for development into the

Oak Ridge Science and Technology Park (ORSTP). The ORSTP will provides space for private companies doing research at ORNL, partner universities, start-up companies built around ORNL technologies, and ORNL contractors to conduct business within a short distance of ORNL researchers and DOE user facilities such as the SNS, the Center for Nanophase Materials Sciences, and the HFIR. Construction of the first ORSTP facility, Pro2Serve's 115,000-ft^2 National Security Engineering Center, was completed in 2009, and the company has moved into the building. In addition, the former Building 2033, which has been leased to Halcyon, LLC, and is now known as the Halcyon Commercialization Center (HCC), continues to attract tenants. Currently, the largest tenant in the HCC is Roane State Community College, which is offering job training classes on site in the areas of carbon fiber and solar energy. Other tenants in the HCC include several consulting firms and a carbon fiber manufacturer that is partnering with ORNL for research. Expansion of the ORSTP will continue as more environmental cleanup in ORNL's central campus is completed.

There is currently no construction occurring within the ORSTP.

1.4.4 The Y-12 National Security Complex

The original Y-12 Complex (Fig. 1.9) was constructed as part of the World War II Manhattan Project and began operations in November 1943. The first site mission was the separation of ^{235}U from natural uranium by an electromagnetic separation process. At its peak in 1945, more than 22,000 workers were employed at the site.

Today, as part of the NNSA Nuclear Security Enterprise, Y-12 performs critical roles in strengthening national security and reducing the global threat from weapons of mass destruction through work in support of the nation's nuclear weapons stockpile, nuclear nonproliferation, and naval reactors. Y-12 also provides unique and highly specialized manufacturing and software technologies to other federal agencies through the DOE Work for Others program.

Fig. 1.9. Y-12 National Security Complex.

1.4.5 East Tennessee Technology Park

What is now known as the ETTP site was originally named the K-25 site, on which was located the nation's first gaseous diffusion plant for enriching uranium (Fig. 1.10), as part of the Manhattan Project.

In the postwar years, additional uranium enrichment facilities were built adjacent to K-25, forming a complex officially known as the Oak Ridge Gaseous Diffusion Plant. Uranium enrichment operations at the site ceased in 1987. The site was renamed the East Tennessee Technology Park in 1996 and began undergoing cleanup for ultimate conversion to a private-sector industrial park called the Heritage Center. Restoration of the environment, decontamination, and decommissioning of facilities, disposition of wastes, and reindustrialization are the major activities at the site.

ORNL 2010-G00441/chj

Fig. 1.10. East Tennessee Technology Park.

1.4.6. Environmental Management Waste Management Facility

The EMWMF is located in eastern Bear Creek Valley near the Y-12 Complex and is operated by Bechtel Jacobs, Inc., LLC. The EMWMF was built for disposal of waste resulting from the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup actions on the ORR. The original design was for the construction, operation, and closure of a projected 1.3 million m^3 (1.7 million yd^3) disposal facility. The approved capacity was subsequently increased to 1.8 million m^3 (2.4 million yd^3) to maximize utilization of the footprint designated in a 1999 record of decision. The facility currently consists of six disposal cells. A fifth cell was completed in 2010 and is awaiting final regulatory approval for use. Construction began on a sixth cell in May 2010.

EMWMF is an engineered landfill that accepts low-level, mixed low-level, and hazardous wastes from DOE sites on the ORR that meet specific waste acceptance criteria developed in accordance with the agreements with state and federal regulators. Waste types that qualify for disposal include soil, dried sludge and sediment, solidified wastes, stabilized waste, building debris, scrap equipment, and secondary waste such as personal protective equipment, all of which must meet the land disposal restrictions. In addition to the solid waste disposal facility, EMWMF operates a leachate collection system. The leachate is treated at the ORNL Liquids and Gaseous Treatment Facility (LGTF), which is operated by UT-Battelle.

1.4.7 Oak Ridge National Environmental Research Park

In 1980, DOE established the Oak Ridge National Environmental Research Park (Fig. 1.11). Consisting of about 8,000 ha (19,760 acres), the Research Park serves as an outdoor laboratory to evaluate the environmental consequences of energy use and development as well as the strategies to mitigate those effects. It contains large blocks of forest and diverse communities of vegetation that offer unparalleled resources for ecosystem-level and large-scale research. Major national and international collaborative research initiatives use it to address issues such as multiple stress interactions, biodiversity, sustainable development, tropospheric air quality, global climate change, innovative power conductors, solar radiation monitoring, ecological recovery, and monitoring and remediation.

ORNL 2010-G00440/chj

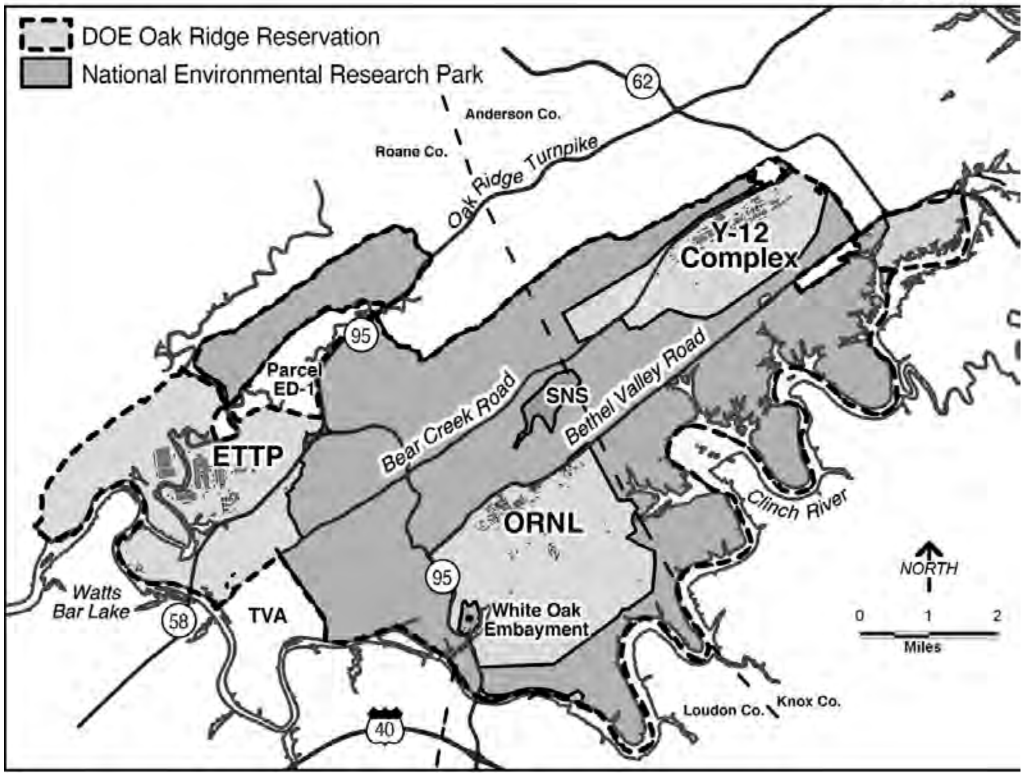

Fig. 1.11. The Oak Ridge National Environmental Research Park covers about 8000 hectares (19,760 acres) on the reservation.

Field sites at the Research Park provide maintenance and support facilities that permit sophisticated and well-instrumented environmental experiments. These facilities include elaborate monitoring systems that enable users to precisely and accurately measure environmental factors for extended periods of time. Because the park is under the jurisdiction of the federal government, public access is restricted, and experimental sites and associated equipment are, therefore, not disturbed.

National recognition of the value of the Research Park has led to its use as a component of both regional- and continental-scale research projects. Various Research Park sites offer opportunities for aquatic and terrestrial ecosystem analyses of topics such as biogeochemical cycling of pollutants resulting from energy production, landscape alterations, ecosystem restoration, wetlands mitigation, and forest and wildlife management.

1.4.8 Oak Ridge Institute for Science and Education

The Oak Ridge Institute for Science and Education (ORISE) is a DOE institute, which is managed by Oak Ridge Associated Universities (ORAU). ORISE addresses national needs in assessing and analyzing environmental and health effects of radiation, beryllium, and other hazardous materials; developing and operating medical and national security radiation emergency management and response capabilities; and managing education programs to help ensure a robust supply of scientists, engineers, and technicians to meet future science and technology needs. ORISE creates opportunities for collaboration through partnerships with other DOE facilities, federal agencies, academia, and industry in a manner consistent with DOE objectives and the ORISE mission.

ORISE includes a 94-ha (232-acre) area on the southeastern border of the ORR that from the late 1940s to the mid-1980s was part of an agricultural experiment station owned by the federal government and, until 1981, was operated by the University of Tennessee. The site houses offices, laboratories, and storage areas for the ORISE program offices and support departments.

1.4.9 The National Nuclear Security Administration Office of Secure Transportation, Agent Operations Eastern Command

Since 1947, DOE and its predecessor agencies have moved nuclear weapons, weapons components, special nuclear materials, and other important national security assets by commercial and government transportation modes. In the late 1960s, worldwide terrorism and acts of violence prompted a review of procedures for safeguarding these materials. As a result, a comprehensive new series of regulations and equipment was developed to enhance the safety and security of these materials in transit. Thus, modified and redesigned transport equipment to incorporate features that more effectively enhance self-protection and that deny unauthorized access to the materials was established. Also during this time, the use of commercial transportation systems was abandoned, and a totally federal operation was implemented. The organization within DOE/NNSA responsible for this mission is the Office of Secure Transportation (OST).

The NNSA OST Agent Operations Eastern Command (AOEC) Secure Transportation Center and Training Facility is located on the ORR. The NNSA OST AOEC is situated on approximately 485 ha (1,198 acres) on the ORR and operates under a user permit agreement with DOE ORO. The NNSA OST AOEC implements its assigned mission transportation operations, maintains applicable fleet and escort vehicles, and continues extensive training activities for its federal agents.

1.5 References

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2. Compliance Summary and Community Involvement

DOE operations on the ORR are required to be in conformance with environmental standards established by a number of federal and state statutes and regulations, executive orders, DOE orders, contract-based standards, and compliance and settlement agreements. Principal among the regulating agencies are the Environmental Protection Agency and the Tennessee Department of Environment and Conservation. These agencies issue permits, review compliance reports, participate in joint monitoring programs, inspect facilities and operations, and oversee compliance with applicable regulations.

When environmental concerns or problems are identified during routine operations or during ongoing self-assessments of compliance status, the issues are typically discussed with the regulatory agencies. The following sections summarize major environmental statutes and 2010 status for DOE operations on the ORR. A number of facilities at the East Tennessee Technology Park and the Oak Ridge Science and Technology Park sites have been leased to private entities over the past several years through the DOE Reindustrialization Program. The compliance status of these lessee operations is not discussed in this report.

Due to different permit reporting requirements and instrument capabilities, various units of measurement are used in this report. The list of units of measure and conversion factors provided on page xxvii is intended to help readers convert numeric values presented herein as needed for specific calculations and comparisons.

2.1 Laws and Regulations

Table 2.1 summarizes the principal environmental standards applicable to DOE activities on the reservation, the 2010 status, and references to the report sections that provide more detailed information.

2.2 Release of Property

DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, establishes standards and requirements for operations of DOE and its contractors with respect to protection of members of the public and the environment against undue risk from radiation. (In 2011 this order was cancelled and replaced with DOE Order 458.1, *Radiation Protection of the Public and the Environment*, but during this reporting year, DOE Order 5400.5 was the applicable order.) In addition to discharges to the environment, the release of property containing residual radioactive material is a potential contributor to the dose received by the public, and DOE Order 5400.5 specifies limits for unrestricted release of property to the public.

Babcock & Wilcox Y-12 (B&W Y-12), UT-Battelle, and the Bechtel Jacobs Company (BJC) each use a graded approach for release of material and equipment for unrestricted public use. The Wastren Advantage, Inc. (WAI) and Isotek return all government material, equipment, and property from nonradiological areas, other than what is outlined below, to UT-Battelle for appropriate management. Material has been categorized so that in some cases an administrative release can be accomplished without a radiological survey. Such material originates from nonradiological areas and includes the following:

- documents, mail, diskettes, compact disks, and other office media;
- nonradioactive items or materials received that are immediately (within the same shift) determined to have been misdelivered or damaged (nonradioactive items or materials received at the TWPC can be returned or recycled even if they are not immediately determined to be damaged);
- personal items or materials;

Table 2.1. Applicable laws/regulations and 2010 status

Regulatory program description	2010 Status	Report sections
The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides the regulatory framework for remediation of releases of hazardous substances and of inactive hazardous waste disposal sites.	The Oak Ridge Reservation (ORR) has been on the U.S. Environmental Protection Agency (EPA) National Priorities List (NPL) since 1989. The ORR Federal Facility Agreement was initiated in 1992 among EPA, the Tennessee Department of Environment and Conservation (TDEC) and Department of Energy (DOE). The Federal Facility Agreement establishes the framework and schedule for developing, implementing, and monitoring remedial actions on the ORR. There were no Notices of Violation issued for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)–related ORR actions during CY 2010. Under the authority of CERCLA, a review must be conducted of remedial actions "that result in any hazardous substances, pollutant, or contaminant remaining at the site…to assure that human health and the environment are being protected by the remedial action being implemented" [CERCLA §121 (c)]. Five-year reviews are required for sites, which, upon attainment of the cleanup levels, still have hazardous substances remaining above levels that allow for unlimited use and unrestricted exposures. A 5-year review was conducted of ORR actions in 2006, and the next 5-year review will occur in 2011.	3.3.10 4.3.7 5.3.7
The National Environmental Policy Act (NEPA) requires consideration of how federal actions may impact the environment and an examination of alternatives to the actions. NEPA also requires that decisions include public input and involvement through scoping and review of NEPA documents.	During 2010, DOE activities on the ORR were in compliance with NEPA requirements.	3.3.4 4.3.2 5.3.1
The National Historic Preservation Act (NHPA) provides protection for the nation's historical resources by establishing a comprehensive national historic preservation policy.	The ORR has several facilities eligible for inclusion in the *National Register of Historic Places*. Proposed activities are reviewed to determine potential adverse effects on these properties, and methods to avoid or minimize harm are identified. During 2010, activities on the ORR were in compliance with NHPA requirements.	3.3.4 4.3.2 5.3.1
The Clean Air Act (CAA) and Tennessee environmental conservation laws regulate the release of air pollutants through permits and air quality limits. Emissions of airborne radionuclides are regulated by EPA via the National Emission Standards for Hazardous Air Pollutants (NESHAPs) authorizations. Greenhouse gas emissions inventory tracking and reporting are regulated by EPA.	In 2010, all ORR activities were conducted in accordance with CAA requirements.	3.3.5 4.3.3 5.3.2

Table 2.1. (continued)

Regulatory program description	2010 Status	Report sections
The Clean Water Act (CWA) seeks to improve surface water quality by establishing standards and a system of permits. Wastewater discharges are regulated by National Pollutant Discharge Elimination System (NPDES) permits issued by TDEC.	Discharges to surface water at each of the three sites are governed by NPDES permits. A compliance rate of greater than 99% was achieved by the three major ORR sites in 2010.	3.3.6 4.3.4 5.3.3
The Safe Drinking Water Act (SDWA) establishes minimum drinking water standards and monitoring requirements	The city of Oak Ridge supplies potable water to the facilities on the ORR and meets all regulatory requirements for drinking water.	3.3.7 4.3.5 5.3.4
Emergency Planning and Community Right-to-Know Act, also referred to as the Superfund Amendments and Reauthorization Act (SARA) Title III), requires reporting emergency planning information, hazardous chemical inventories, and environmental releases of certain toxic chemicals to federal, state, and local authorities.	DOE facilities on the ORR were in full compliance with emergency planning and reporting requirements.	3.3.12 4.3.9.2 5.3.9
The Resource Conservation and Recovery Act (RCRA) governs the generation, storage, handling, and disposal of hazardous wastes. RCRA also regulates underground storage tanks containing petroleum and hazardous substances, universal waste, and recyclable used oil.	The Y-12 Complex, Oak Ridge National Laboratory (ORNL), and East Tennessee Technology Park (ETTP) are defined as large-quantity generators of hazardous waste because each generates >1,000 kg of hazardous waste per month. Each site is also regulated as a handler of universal waste. In addition, several permits have been issued for hazardous waste management units on the ORR. During 2010 each site operated in accordance with the RCRA permits that govern waste treatment, storage, and disposal units.	3.3.8 4.3.6 5.3.5
The Toxic Substances Control Act (TSCA) regulates the manufacture, use, and distribution of all chemicals.	The ORR facilities manage TSCA-regulated materials, including polychlorinated biphenyls (PCBs). The ORR PCB Federal Facilities Compliance Agreement between EPA and DOE continues to provide a mechanism to address legacy PCB-use issues across the ORR. The agreement specifically addresses the unauthorized use of PCBs, storage and disposal of PCB wastes, PCB spill cleanup and/or decontamination, PCBs mixed with radioactive materials, PCB research and development, and records and reporting requirements for the ORR. EPA is updated annually on the status of DOE actions with regard to management and disposition of PCBs covered under the ORR PCB Federal Facilities Compliance Agreement. There were no TSCA-related issues reported to regulators in 2010.	3.3.11 4.3.8 5.3.8

Table 2.1. (continued)

Regulatory program description	2010 Status	Report sections
ORR Floodplains Management Programs are established to avoid, to the extent possible, adverse impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative	ORR Floodplains Management Programs incorporate management and protection goals into planning, regulatory, and decision-making processes through each site's NEPA program. Goals include flood-loss reduction, minimization of the impact of floods, and the restoration and preservation of ORR floodplains	3.3.4 4.3.2 5.3.1
ORR Protection of Wetlands Programs are implemented to minimize the destruction, loss, or degradation of ORR wetlands and to preserve and enhance their beneficial values.	Protection of approximately 243 ha of ORR wetlands was implemented through each site's NEPA program, and surveys for the presence of wetlands are conducted on a project- or program-as-needed basis.	1.3.6.1 3.3.4 4.3.2
The Endangered Species Act prohibits activities that would jeopardize the continued existence of an endangered or threatened species, or cause adverse modification to a critical habitat.	The ORR is host to several plant and animal species that are categorized as endangered, threatened, or of special concern and that were protected in accordance with this Act.	1.3.6.2
DOE Order 231.1A, *Environment, Safety, and Health Reporting,* ensures timely collection, reporting, analysis, and dissemination of information on environment, safety, and health issues.	The ORR Annual Site Environmental Report will summarize ORR environmental activities during 2010 and characterize environmental performance.	All chapters
DOE Order 435.1, Change 1, ***Radioactive Waste Management***, is implemented to ensure that all DOE radioactive waste is managed in a manner that protects workers, public health and safety, and the environment.	Waste certification programs that are protective of workers, the public, and the environment have been implemented for all activities on the ORR to ensure compliance with this DOE order.	3.8.1 4.2.3.4.2 5.8.8
DOE Order 450.1A, *Environmental Protection Program*, has the objective of implementing sound stewardship practices that protect the air, water, land, and other natural and cultural resources affected by DOE operations. DOE facilities meet this objective by implementing environmental management systems.	All DOE contractors on the ORR have implemented environmental management systems which are incorporated with the contractors' integrated safety management systems to promote sound stewardship practices and to ensure compliance with this DOE order.	3.2 4.2 5.2
DOE Order 5400.5, *Radiation Protection*, was established to protect members of the public and the environment against undue risk from radiation. This order establishes standards and requirements for operations of DOE and DOE contractors. This order has been substantially cancelled by DOE Order 458.1, Change 1,with the exception of Chapter III, "Derived Concentration Guides," and Fig. IV-1, Surface Contamination Guidance.	A dose assessment, performed to ensure that the total dose to members of the public from all DOE ORR pathways did not exceed the 100 mrem annual limit established by this order, estimated the maximum 2010 dose to a hypothetically exposed member of the public from all ORR sources could have been about 4 mrem. The derived concentration guides provided in DOE Order 5400.5 are employed on the ORR to ensure that effluents and emissions result in doses that meet the dose limits and "as low as reasonably achievable" policy.	2.2 Chap. 7

Table 2.1. (continued)

Regulatory program description	2010 Status	Report sections
Executive Order (EO) 13423, "Strengthening Federal Environmental, Energy, and Transportation Management," instructs federal agencies to conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions in an environmentally, economically, and fiscally sound, integrated, continuously improving, efficient, and sustainable manner. **Executive Order (EO) 13514, "Federal Leadership in Environmental, Energy, and Economic Performance,"** expands on the energy reduction and environmental performance requirements for federal agencies identified in EO 13423 and establishes an integrated strategy towards sustainability in the federal government to make reduction of greenhouse gas emissions a priority for federal agencies.	In 2010 the DOE sites' "executable plans," previously developed annually to update and report energy use, were renamed "site sustainability plans" and expanded to cover the requirements of Executive Orders 13423 and 13514 and DOE's *Strategic Sustainability Performance Plan, Discovering Sustainable Solutions to Power and Secure America's Future*.[a] Progress towards achieving DOE sustainability goals are summarized in this report. The ORR activities complied with the planning and reporting requirements of these EOs in 2010.	3.2.3 4.2.6.3 5.2.1.4.2

[a]DOE.2010. *Strategic Sustainability Performance Plan, Discovering Sustainable Solutions to Power and Secure America's Future*, Report to The White House Council on Environmental Quality and Office of Management and Budget, Washington, D.C., September 2010.

- paper, plastic products, aluminum beverage cans, toner cartridges, and other items released for recycling;
- office trash;
- nonradiological area housekeeping materials and associated waste;
- break-room, cafeteria, and medical wastes;
- medical and bioassay samples; and
- other items with an approved release plan.

Items originating from nonradiological areas within the sites' controlled areas not in the listed categories are surveyed prior to release to the public, or a process knowledge evaluation is conducted to ensure that material has not been exposed to radioactive material or beams of radiation capable of creating radioactive material. In some cases both a radiological survey and a process knowledge evaluation are performed (e.g., a radiological survey is conducted on the outside of the item, and a process knowledge form is signed by the custodian for inaccessible surfaces). When the process knowledge approach is employed, the item's custodian is required to sign a statement that specifies the history of the material and confirms that no radioactive material has passed through or contacted the item. Items advertised for public sale via an auction are also surveyed on a random basis by state of Tennessee personnel, giving further assurance that material and equipment are not being released with inadvertent contamination.

A similar approach is used for material released to state-permitted landfills on the ORR. The only exception is for items that could be internally contaminated; these items are also sampled by laboratory analysis to ensure that landfill permit criteria are met.

ORR contractors continue to follow the requirements of the scrap metal suspension. No scrap metal directly released from radiological areas is being recycled.

As the Spallation Neutron Source (SNS) and the High-Flux Isotope Reactor (HFIR) Cold Source at ORNL reach full user capacity, it will be necessary to release small samples of material that have been exposed to neutrons as part of various material research experiments. Because these samples have been exposed to neutrons, there is the potential for production of radioactivity within the volume of the sample due to neutron activation reactions. The amount of radioactivity will depend on many factors, including time in the neutron beam, beam energy and intensity, and decay time after removal from the beam. Like other material from radiological areas, these samples will be evaluated prior to release using the requirements specified in DOE Order 5400.5. For material with potential residual radioactivity in volume, the order specifies that authorized limits must be developed using a limiting dose of 1 mrem/year under a conservative exposure scenario and must be approved by DOE prior to implementation. UT-Battelle has developed an authorized limits request package for neutron experiment samples from SNS and HFIR. This request outlines the dose assessment process used to derive specific release limits for groups of radionuclides expected in neutron-scattering experiment samples that will ensure that potential doses to the general public from using or handling such samples will be well below 1 mrem/year. When the authorized limits are approved, samples will be released to researchers only after careful review of predicted activation levels and measurement of actual post-experiment levels to verify that the residual radioactivity is below authorized limits for release.

2.3 External Oversight and Assessments

Inspections of ORR environmental activities by regulatory agencies were conducted during 2010 and are summarized in Table 2.2. This table does not include internal DOE or DOE contractor assessments, audits, or evaluations.

The state of Tennessee also conducts a program of independent monitoring and oversight of DOE activities on the ORR through the Tennessee Oversight Agreement (TOA). The TOA is a voluntary agreement between DOE and the state of Tennessee and is designed to assure the citizens of Tennessee that their health, safety, and environment are being protected through existing programs and substantial new commitments by DOE. More information on the TOA and reporting of monitoring conducted under the TOA is available at http://www.state.tn.us/environment/doeo/.

Table 2.2. Summary of regulatory environmental evaluations, audits, inspections, and assessments conducted at ORR

Date	Reviewer	Subject	Issues
		ORNL (including UT-Battelle, Isotek, and WAI activities)	
January 14	TDEC	Annual CAA Inspection	0
February 9	Knox County	Annual CAA Inspection for NTRC Facility	0
May 10–12	TDEC	Annual RCRA Inspection	0
May 25	TDEC	Underground Storage Tanks	0
November 16–18	TDEC	Annual RCRA Inspection of UT-Battelle facilities at Y-12 Complex	0
		ETTP	
February 8–10	TDEC	Annual RCRA Compliance Inspection	0
September 21	TDEC - Knoxville	CNF NPDES Compliance Evaluation Inspection	0
October 7	EPA	TSCA Incinerator – PCB Site Visit	0
		Y-12 Complex	
November 16–18	TDEC	TDEC Annual RCRA Inspection	0

Abbreviations

CAA	Clean Air Act
CNF	Central Neutralization Facility
EPA	Environmental Protection Agency
NPDES	National Pollutant Discharge Elimination System
NTRC	National Transportation Research Center
RCRA	Resource Conservation and Recovery Act
TDEC	Tennessee Department of Environment and Conservation
TSCA	Toxic Substances Control Act
TWPC	Transuranic Waste Processing Center

2.4 Reporting of Oak Ridge Reservation Spills and Releases

Comprehensive Environmental Response and Compensation Act (CERCLA) hazardous substances are substances that are considered to be severely harmful to human health and the environment. Many are commonly used substances that are harmless in their normal uses but are quite dangerous when released. CERCLA also establishes a corresponding reportable quantity (RQ) for each hazardous substance. Any hazardous substance release exceeding a RQ triggers reports to the National Response Center, the State Emergency Response Center, and community coordinators. Discharges of oil must be reported if they “cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines” (40 CFR 110.3(b)).

There was one reported oil sheen on the ORR during 2010, and one related release of a hazardous substance exceeding CERCLA reportable quantities.

The reported oil sheen was the result of a reportable release associated with BJC operations at ORNL in 2010. While performing excavation operations at the White Oak Dam near ORNL on July 8, 2010, a hydraulic line on an excavator ruptured, releasing a small quantity (approximately ½ gallon) of hydraulic fluid to White Oak Creek Embayment of the Clinch River. This resulted in a visible sheen on the water, which required notification to the National Response Center. The sheen was cleaned up, and subsequent monitoring has revealed no detectable adverse impact to the environment from the spill. In addition, operational changes were instituted to prevent a recurrence.

There were no releases of hazardous substances exceeding an RQ. There was one release of wastewater into upper East Fork Poplar Creek (see Sect. 4.3.9.4) that resulted in a fish kill.

2.5 Notices of Violations and Penalties

In August 2009, TDEC and DOE entered into a RCRA Compliance Agreement. The purpose of the Compliance Agreement was to formally resolve notices of violation (NOVs) that were issued by TDEC as a result of RCRA compliance inspection at the Y-12 Complex and ETTP in December 2005 and February 2006, respectively. Although the specific violations identified during the 2005 and 2006 inspections had been previously corrected, the Compliance Agreement provides the framework by which DOE and BJC will avoid future violations associated with the storage of newly discovered hazardous waste. Specifically, the Compliance Agreement requires BJC to provide periodic reports to TDEC on the status of waste characterization and disposal activities and requires all characterization activities to be completed by June 30, 2011.

- No NOVs or penalties were issued to UT-Battelle during 2010.
- No NOVs or penalties were issued to WAI, or Isotek during 2010.
- No NOVs, penalties, or consent orders were issued to ETTP activities in 2010.
- No NOVs, penalties, or consent orders were issued to Y-12 activities in 2010.

2.6 Community Involvement

2.6.1 Public Comments Solicited

Public input and comments were solicited on a variety of proposed actions, documents, and plans in 2010 including the following.

- Draft Global Nuclear Energy Partnership Programmatic Environmental Impact Statement, which provides an analysis of the potential environmental consequences of the reasonable alternatives to support expansion of domestic and international nuclear energy production
- Proposed approval of the radioactive, remote-handled transuranic waste characterization program implemented by the Central Characterization Project in Oak Ridge
- Revision of DOE’s Freedom of Information Act regulations, which streamlines DOE’s procedures for determining the release of information and updates the requirement for reproduction of the documents
- Proposal for major modifications to the Federal Facility Agreement that would add new Integrated Facility Disposition Program work scope and extend the environmental management (EM) cleanup completion time frame
- Parcel ED-8 Covenant Deferral Request, which addresses the transfer of approximately 37 ha (91 acres) located in the southern portion of ETTP to Heritage Center, LLC
- National resource damage assessment evaluation of contaminant-related losses in Watts Bar reservoir and gains from the Black Oak Ridge conservation easement
- K-792 Switchyard Covenant Deferral Request, which addresses the transfer of the switchyard to Heritage Center, LLC
- Request for proposal to sell approximately 13,900,000 kg (15,300 tons) of radiologically contaminated nickel scrap recovered from enrichment operations in Oak Ridge and in Paducah, Kentucky
- Environmental impact statement for the long-term management and storage of elemental mercury, which will evaluate alternatives for a storage facility
- Notice of implementation of permit modification of the Tennessee Hazardous Waste Management Act Part B Permit for the Y-12 National Security Complex. Environmental Protection Agency Identification TN3 89 009 0001 Oak Ridge, Tennessee 37831, February 18, 2010.
- Notice of Availability to notify the public of a proposed revision to the Site Treatment Plan (STP) that governs certain aspects of mixed waste (waste containing both hazardous and radioactive constituents) on the ORR, April 27, 2010.

To keep the public informed of comment periods and other matters related to cleanup activities on the ORR, DOE publishes a monthly newsletter, *Public Involvement News* (see http://www.oakridge.doe.gov/external/). DOE also keeps the public informed by publishing notices in local newspapers and conducting public meetings.

2.6.2 Oak Ridge Site Specific Advisory Board

The Oak Ridge Site Specific Advisory Board (ORSSAB) is a federally appointed citizens' panel that provides independent advice and recommendations to the DOE-Oak Ridge Environmental Management (EM) Program. The board was formed in 1995 and is composed of up to 20 members, chosen to reflect a diversity of gender, race, occupation, views, and interests of persons living near the ORR. Members are appointed by DOE and serve on a voluntary basis, without compensation. The ORSSAB continued its mission during FY 2010 with a number of activities.

2.6.2.1 Museum Kiosk

In April 2010 ORSSAB debuted a new three-sided kiosk as part of its exhibit at the American Museum of Science and Energy in Oak Ridge. The kiosk features three touch-screen monitors that lead visitors through key aspects of the DOE EM program: site cleanup activities, history, and long-term stewardship. Each monitor allows museum visitors to explore these three aspects in-depth with detailed programs and videos.

Located on the second floor of the museum, the ORSSAB exhibit was first installed in February 2005 and features a variety of displays and posters that tell the story of the Oak Ridge EM program. The museum is located at 300 South Tulane Avenue in Oak Ridge. Additional information is available on the museum's web site at www.amse.org.

2.6.2.2 EM SSAB Chairs Meeting

On April 28–29, 2010, ORSSAB hosted the SSAB chairs meeting at the DoubleTree Hotel in Oak Ridge. Chairs of SSABs from across the DOE complex meet twice a year to hear presentations and discuss EM projects and policy, share ideas and concerns among sites, and identify and work on common issues.

On the first day of the meeting, DOE Assistant Secretary for EM Inés Triay provided an update on the EM program. Other topics on the agenda included a round-robin presentation from the chairs outlining issues specific to their sites, a detailed presentation on how EM develops its budget and prioritizes projects, and a discussion of waste disposition issues. The second day of the meeting was devoted to stewardship issues, including a background overview, stewardship at closed and ongoing mission sites, and the next steps for stewardship.

2.6.2.3 Support and Public Outreach for EM Projects

During FY 2010, ORSSAB was actively involved in providing a public forum for major projects that had significant impact on the Oak Ridge EM program this year and that will continue to have ramifications for years to come. Through presentations at the ORSSAB board and committee meetings, the public was provided detailed briefings on a variety of topics, such as the following.

- Groundwater treatability study that is under way at ETTP
- Engineering study to remove fuel salt from the Molten Salt Reactor
- Transuranic Waste Processing Facility
- Building 3019/U-233 Project
- Corehole 8/Tank W-1A Removal Project
- American Recovery and Reinvestment Act (ARRA) projects

2.6.2.4 Recommendations

In FY 2010 the board made 12 recommendations on local cleanup-related issues. ORSSAB also worked with the chairs of the other seven SSABs that comprise the national EM SSAB to draft joint recommendations to DOE on two important topics: the 2012 baseline budget and inclusion of option periods in all future DOE requests for proposals for prime contracts.

2.6.3 DOE Information Center

The DOE Information Center, located at 475 Oak Ridge Turnpike, Oak Ridge, Tennessee, is a one-stop information facility that maintains a collection of more than 40,000 documents describing environmental activities in Oak Ridge. The center is open Monday through Friday, 8 a.m. to 5 p.m. The DOE ORO web site (www.oakridge.doe.gov) includes a Public Activities tab, which describes DOE program activities for the general public. The Online Catalog tab, under the Information Center tab of Public Activities, can be used to search for DOE documents by author, title, date, and other fields. The recently added New Documents tab provides links to recently published documents.

2.6.3.1 Telephone Contacts

- DOE Information Center: (865) 241-4780; toll free 1-800-382-6938 (option 6)
- DOE Public Affairs Office: (865) 576-0885
- DOE-ORO Public Information Line: 1-800-382-6938
- Oak Ridge Site Specific Advisory Board: (865) 241-4583, (865) 241-4584, 1-800-382-6938
- Tennessee Department of Environment and Conservation, DOE Oversight Division: (865) 481-0995
- U.S. Environmental Protection Agency Region IV: 1-800-241-1754
- Agency for Toxic Substances and Disease Registry: 1-800-232-4636

2.6.3.2 Internet Sites

- DOE Main Web Site: www.energy.gov
- DOE-ORO Home Page: www.oakridge.doe.gov
- DOE-ORO Environmental Management Program: www.oakridge.doe.gov/external (Click on “Programs” then select “Environmental Management”)
- Oak Ridge Site Specific Advisory Board: www.oakridge.doe.gov/em/ssab/recc.htm
- Agency for Toxic Substances and Disease Registry: www.atsdr.cdc.gov
- U.S. Environmental Protection Agency: www.epa.gov/region4/
- Tennessee Department of Environment and Conservation: www.state.tn.us/environment/
- Tennessee Department of Environment and Conservation, DOE Oversight Division: http://www.state.tn.us/environment/doeo/
- DOE Information Center: www.oakridge.doe.gov/info_cntr
- American Recovery and Reinvestment Act: www.recovery.gov and www.energy.gov/recovery

2.7 Reference

CFR. 2005. Discharge of oil in such quantities as “may be harmful” pursuant to section 311(b)(4) of the Act. 40 CFR 110.3(b). July 1.

3. East Tennessee Technology Park

ETTP was originally built during World War II as part of the Manhattan Project. Known as the K-25 Site, its primary mission was to enrich uranium for use in atomic weapons. After the war, the mission was changed to include the enrichment of uranium for nuclear reactor fuel elements and recycling of uranium recovered from spent fuel, and the name was changed to the Oak Ridge Gaseous Diffusion Plant. In the 1980s, a reduction in the demand for nuclear fuel resulted in the shutdown of the enrichment process, and production ceased. The emphasis of the mission then changed to environmental management and restoration operations, and the name was changed to the East Tennessee Technology Park. Environmental management and remediation operations consist of such operations as waste management, the cleanup of outdoor storage and disposal areas, the demolition and/or cleaning up of the facilities, land restoration, and environmental monitoring. Proper disposal of the huge quantities of waste that were generated over the course of production operations is also a major task. Beginning in the 1990s, reindustrialization (the conversion of underutilized government facilities for use by the private sector) also became a major mission at ETTP. Reindustrialization allows private industry to lease underutilized facilities, thus providing both jobs and a new use for facilities that otherwise would have to be demolished. Bechtel Jacobs Company LLC (BJC) is the prime environmental contractor for the ETTP environmental monitoring and surveillance program, under which two main activities are performed: effluent monitoring and environmental surveillance. State and federally mandated effluent monitoring and environmental surveillance at ETTP involve the collection and analysis of samples of air, water, soil, sediment, and vegetation from ETTP and the surrounding area. Data from the monitoring are used to assess exposures to members of the public and the environment, to assess the performance of treatment systems, to help identify areas of concern and plan remediation efforts, and to evaluate the efficacy of these remediation efforts. In 2010, there was better than 99% compliance with permit standards for emissions from ETTP operations.

3.1 Description of Site and Operations

Construction of ETTP, originally known as the K-25 site, began in 1943 as part of the World War II Manhattan Project (Fig. 3.1). The plant's original mission was the production of enriched uranium for nuclear weapons. Enrichment was initially carried out in the S-50 thermal diffusion process facility that operated for 1 year and the K-25 and K-27 gaseous diffusion process buildings. Later, the K-29, K-31, and K-33 buildings were built to increase the production capacity of the original facilities by raising the assay of the feed material entering K-27. Following the war years, the site became officially known as the Oak Ridge Gaseous Diffusion Plant (ORGDP).

After military production of highly enriched uranium was concluded in 1964, the two original process buildings were shut down. For the next 20 years, the plant's primary missions were the production of only low enriched uranium to be fabricated into fuel elements for nuclear reactors. Other missions during the latter part of this 20-year period included development and testing of the gas centrifuge method of uranium enrichment and the laser isotope separation research and development (R&D).

By 1985, the demand for enriched uranium had declined, and the gaseous diffusion cascades at ORGDP were placed in standby mode. That same year, the gas centrifuge program was canceled. The decision to permanently shut down the diffusion cascades was announced in late 1987, and actions necessary to implement that decision were initiated soon thereafter. Because of the termination of the original and primary missions, ORGDP was renamed the "Oak Ridge K-25 Site" in 1990. Figure 3.2 shows the K-25 Site areas prior to the start of decontamination and decommissioning (D&D) activities. In 1997, the K-25 Site was renamed the "East Tennessee Technology Park" to reflect its new mission.

ORNL 2010-G00441/chj

Fig. 3.1. East Tennessee Technology Park.

PLACEHOLDER

Fig. 3.2. ETTP prior to D&D activities (year 1991).
[In development – BJC Gary Lay, copy in CDM review 5/5/11]

Figure 3.3 shows the ETTP areas for the D&D activities during 2010.The ETTP mission is to reindustrialize and reuse site assets through leasing excess or underutilized land and facilities and through incorporating commercial industrial organizations as partners in the ongoing environmental restoration, D&D, and waste treatment and disposal.

PLACEHOLDER

Fig. 3.3. ETTP in 2010.
[In development – CDM S. Gately & ORNL Sherri Cotter

DOE’s long-term goal for ETTP is to convert as much as possible of the site into a private mixed-use business and industrial park. The site is undergoing environmental cleanup of its land as well as D&D of most of its buildings. The reuse of key facilities through title transfer is part of the site’s closure plan. The cleanup approach makes land and various types of buildings (e.g., office, manufacturing) suitable for private industrial use and for title transfer to the Community Reuse Organization of East Tennessee (CROET) or other entities, such as the city of Oak Ridge. The facilities may then be subleased or sold, with the goal of stimulating private industry and recruiting business to the area.

Bechtel Jacobs Company LLC (BJC), the environmental management contractor for ETTP, supports DOE in the reindustrialization program that transferred three building and two land parcels to the CROET as it continued its effort to transform ETTP into a private-sector industrial park. In 2010, buildings and land parcels at ETTP were transferred to private companies. Construction was also completed on speculative buildings on two of the parcels. Unless otherwise noted, information on non-DOE entities located on the ETTP site is not provided in this document.

3.2 Environmental Management System

As required by DOE Order 450.1A, the BJC Environmental Management System (EMS) is integrated with the Integrated Safety Management System (ISMS). BJC’s EMS is based on a graded approach for a closure and remediation contract and reflects the elements and framework contained in International Organization for Standardization 14001:2004 (ISO 14001:2004). BJC is committed to incorporating sound environmental management, protection, and sustainability practices in all work processes and activities that are part of the DOE environmental management (EM) program in Oak Ridge, Tennessee. BJC’s environmental policy states, “…it is inherent in our mission to complete environmental cleanup safely with reduced risks to the public, workers, and the environment.” In order to achieve this, BJC’s environmental policy adheres to the following principles:

- **Management Commitment**—Integrate responsible environmental practices into project operations.
- **Environmental Compliance and Protection**—Comply with all environmental regulations and standards.

- **Sustainable Environmental Stewardship**—Minimize the effects of our operations on the environment through a combination of source reduction, recycling, and reuse; sound waste management practices; and pollution prevention (P2).
- **Partnership/Stakeholder Involvement**—Maintain partnerships through effective two-way communications with our customer and other stakeholders.

3.2.1 Environmental Stewardship Scorecard

The Environmental Stewardship Scorecard is used to track and measure site-level progress in EMS progress, performance, and successes. BJC continues to receive green scores for their EMS performance and 2010 Pollution Prevention Performance Measures. Figure 3.4 shows BJC's recycling data by types and quantities for 2010.

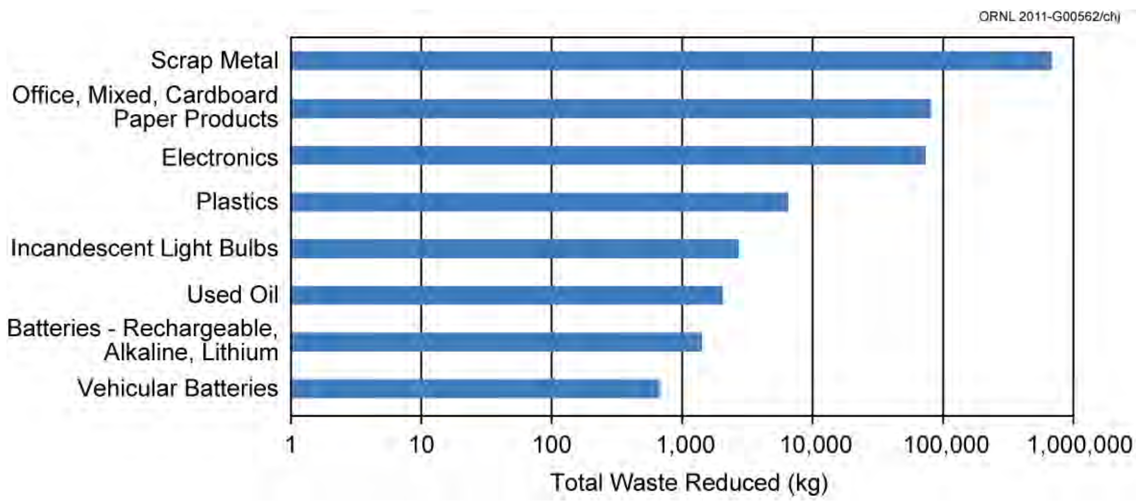


Fig. 3.4. Pollution prevention recycling activities at ETTP related to solid waste reduction in 2010.

Additionally, in July 2010, BJC donated 25 wooden utility poles that had been removed from service at ETTP to the Boy Scouts of America, a nonprofit agency. DOE approved the donation, a work package was developed by BJC, and the poles were surveyed and cleared for delivery The donation provided beneficial reuse of the poles for needed electrical improvements to Camp Pellissippi in Anderson County, Tennessee, in addition to freeing up short-term storage space for more utility poles being removed from service in the future, and eliminated the need for disposal of the poles in a landfill.

3.2.2 Environmental Compliance

BJC maintains various layers of oversight to ensure compliance with legal and other requirements. The methods of evaluations range from independent assessments by outside parties, management assessments conducted by functional or project organizations, and routine field walkdowns conducted by a variety of functional and project personnel. Management and independent assessments are performed in accordance with *Management Assessments*, BJC-PQ-1420, and *Independent Assessments*, BJC-PQ-1401. Assessments are scheduled in accordance with BJC-PQ-1420 on the BJC Assessments SharePoint Site. Records are maintained for all formal assessments and audits. Issues identified in assessments are handled as required by ISO 14001, Section 4.5.3, "Nonconformity, Corrective Action, and Preventive Action."

In addition, external assessments and regulatory inspections are performed by DOE and regulatory agencies such as the Tennessee Department of Environment and Conservation (TDEC) and the EPA.

As required by DOE Order 450.1A, an independent assessment of BJC's EMS in accordance with BJC-PQ-1401 will be conducted every 3 years. In addition, during years when an independent assessment is not conducted, a management assessment of the EMS program will be performed in accordance with BJC-PQ-1420. Also, routine functional environmental compliance management assessments evaluate the various elements of ISO 14001. Independent and management assessments are scheduled in advance, and the schedule is maintained on a SharePoint Site on BJC's intranet.

Results of all assessments are provided to management, and corrective actions (CAs) are tracked in BJC Issues and Corrective Action Tracking System (I/CATS) in accordance with *Issues Management Program*, BJC-PQ-1210, as required by ISO 14001, Section 4.5.3, "Nonconformity, Corrective Action, and Preventive Action."

Initial validation of BJC's EMS occurred in December 2005. An internal independent assessment was performed in September 2007, and an evaluation by an outside party, as required by DOE Order 450.1A, was conducted in March 2009. BJC formally declared conformance with EMS requirements contained in DOE Order 450.1A on May 6, 2009. A DOE-led verification assessment of BJC's ISMS/EMS was conducted in December 2010. It was concluded from the assessment that "the criteria and objectives for environmental protection are met through implementation of the ISO 14001-conforming and DOE Order 450.1A-compliant EMS. The BJC EMS follows the ISMS framework." No findings were identified during the assessment.

3.2.3 Environmental Aspects/Impacts

Using a graded approach appropriate for the Environmental Management Closure Contract, the EMS includes an environmental policy that provides a unified strategy for the management, conservation, and protection of natural resources, the control and attenuation of risks, and the establishment and attainment of all environmental, safety and health (ES&H) goals. BJC works continuously to improve the EMS in order to reduce impacts from activities and associated effects on the environment (i.e., environmental aspects) and to communicate and reinforce this policy to our internal and external stakeholders.

At the program/company level, environmental aspects are documented and are reviewed at least annually and updated as necessary. Significant environmental aspects are identified using a systematic process that considers various risk factors (e.g., regulatory risk, environmental risk, mission impact, and probability) in determining significance. This process is described in *Evaluation of BJC Activities and Ranking of Environmental Aspects/Impacts* (BJC 2008). BJC's work activities, services, and products were initially reviewed to determine the associated environmental aspects and impacts and are reevaluated on an ongoing basis as new work activities are initiated.

Continuous improvement opportunities are identified in a number of ways including, but not limited to, ongoing independent and management assessments, external DOE assessments, regulatory inspections, worker feedback, and senior management reviews of BJC's EMS components. Figure 3.5 provides a model that illustrates the components and key steps of BJC's EMS.

The BJC corporate policy emphasizes the company's core values by promoting a commitment to an ISMS. The objective of the ISMS is to systematically integrate ES&H, pollution prevention (P2), waste minimization, and quality assurance (QA) into management and work practices at all levels so that workers, the public, and the environment are protected while the missions are accomplished, in addition to obtaining feedback for continuous improvement.

The Environmental Compliance and Protection (EC&P) Oversight Program is an integral part of the BJC EMS mandated by Presidential Executive Order 13423, "Strengthening Federal, Environmental, Energy, and Transportation Management," and its implementing document, DOE Order 450.1A, *Environmental Protection Program*. This order requires each DOE operation to implement an EMS as part of the existing ISMS that was established pursuant to DOE Policy 450.4, *Safety Management System Policy*. BJC uses its ISMS to implement the EMS, including EC&P considerations, into the line Oversight Program at DOE sites managed by BJC. DOE Order 450.1A also requires implementation and development of P2 and sustainable environmental stewardship goals.

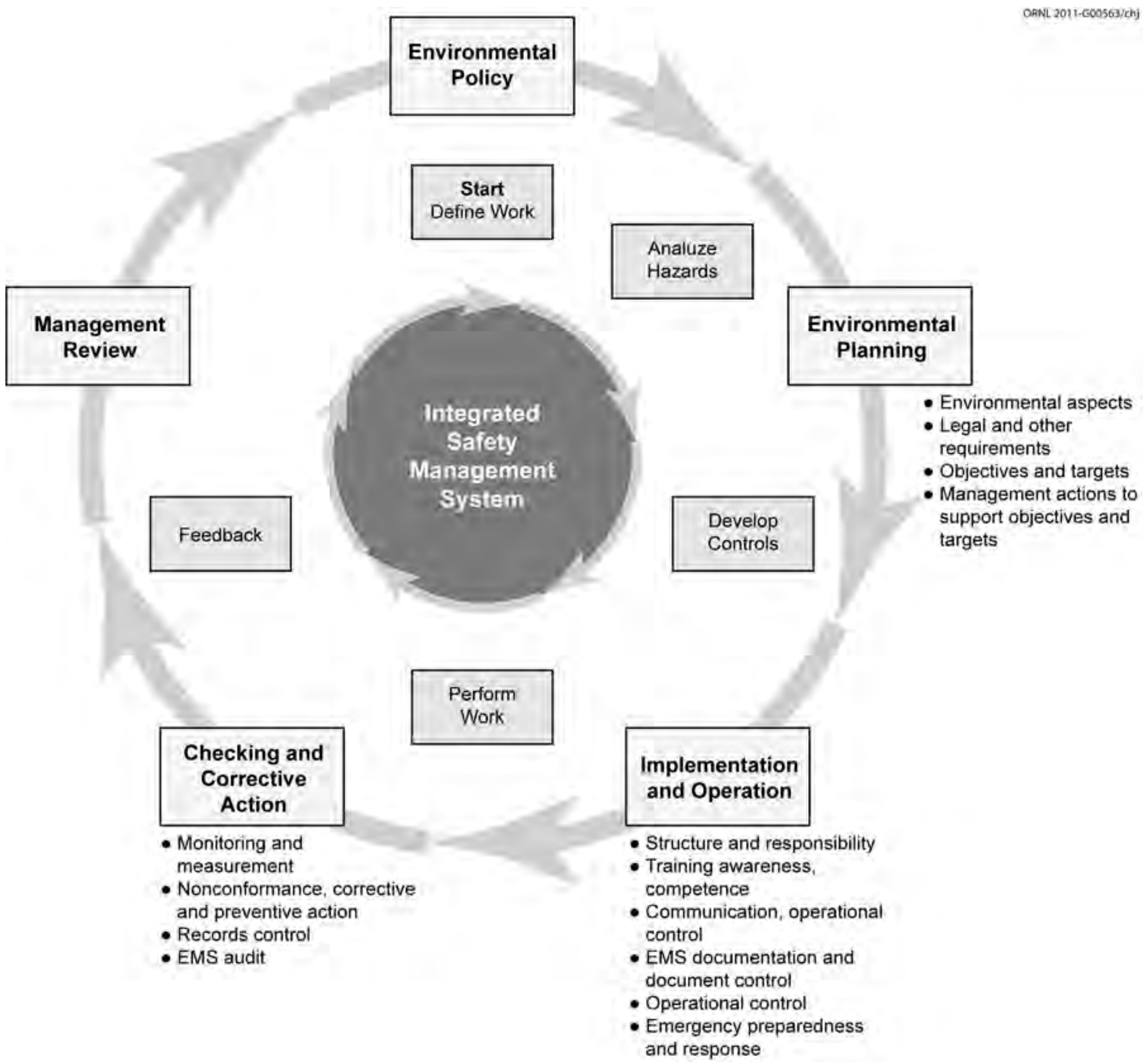


Fig. 3.5. BJC EMS key elements.

3.2.4 Environmental Performance Objectives and Targets

BJC conserves and protects environmental resources by incorporating environmental protection and the elements of an enabling EMS into the daily conduct of business; fostering a spirit of cooperation with federal, state, and local regulatory agencies; and using appropriate waste management, treatment, storage, and disposal methods. The environmental performance objectives are to achieve zero unpermitted discharges to the environment; comply with all conditions of environmental permits, laws, regulations, and DOE orders; integrate EMS and environmental considerations as part of the ISMS; and, to the extent practicable, reduce waste generation, prevent pollution, maximize recycle and reuse potential, and encourage environmentally preferable procurement of materials with recycled and bio-based content.

BJC has established a set of core EMS objectives that remain relatively unchanged from year to year. These objectives are generally applicable to all operations and activities throughout BJC's work scope. The core environmental objectives are based on complying with applicable legal requirements and sustainable environmental practices contained in DOE Order 450.1A and include the following:

- comply with all environmental regulations, permits, and regulatory agreements;
- encourage reducing or eliminating the generation and/or toxicity of waste and other pollutants at the source through P2;

- encourage reducing or eliminating acquisition, use, and release of toxic, hazardous, and radioactive materials and greenhouse gases by acquiring environmentally preferable products and conduct of operations;
- reduce degradation and depletion of environmental resources through post-consumer material recycling and energy, fuel, and water conservation efforts, and the use or promotion of renewable energy;
- reduce or eliminate the environmental impact of electronics assets;
- reduce the environmental impact of BJC operations on surface water and groundwater resources.

In addition to the core objectives listed above, BJC establishes company-level ad hoc objectives and targets each year that are established based on changing priorities, changing legal requirements, and other areas of emphasis. Each year, the complete list of core and ad hoc environmental objectives and targets are distributed by the BJC President for the upcoming calendar year. The list also includes designation of responsibility and time frames by which actions are to be taken to facilitate achievement of the objectives and targets. The status of objectives and targets are periodically reviewed throughout the year at EC&P leads meetings and management reviews.

Project-specific EMS objectives and targets are developed annually near the beginning of each calendar year and are based on company-level objectives and targets, taking into consideration significant environmental aspects and legal requirements of their project operations. The status of the environmental objectives and targets at the project level are reviewed periodically by the EC&P lead with project management as well as with the EC&P Program Manager during EC&P leads meetings.

The EMS is part of the ISMS in that it relies on the existing ISMS five core functions, seven guiding principles, and worker participation to fully integrate EC&P considerations into all work processes. As previously stated, BJC's EMS is based on the elements and framework contained in ISO 14001. Each element is addressed in BJC's *EMS Implementation Description—General Requirements, Environmental Policy, Environmental Planning, Implementation and Operations, Checking, and Management Review.* For each element, this document provides the related implementing documents, implementation description, and roles and responsibilities. Depending on the scope of work involved, there are EMS attributes or actions related to the environment that an individual could apply at each of the five core functions. Such actions are specifically relevant to environmental compliance, protection of natural resources, prevention of pollution, and minimization of waste. When EMS attributes or actions are applied through the ISMS process, the elements of the EMS Program become an integral part of a continuing cycle of planning, implementing, evaluating, and improving processes and actions. The EMS is supported at each of the five core functions of ISMS, and the ISMS provides the framework for implementing EMS policies, processes, and tools in all phases of work. BJC's definition of "safety" embodies protection of workers and the public health as well as the environment.

3.2.5 Implementation and Operations

BJC protects the safety and health of workers and the public by identifying, analyzing, and mitigating aspects, hazards, and impacts and by implementing sound work practices. All BJC employees and subcontractors are held responsible for complying with all ES&H requirements during all work activities and are expected to correct noncompliant conditions immediately. BJC internal management assessments also provide a measure of how well EMS attributes are integrated into work activities through the ISMS. BJC has embodied its program for environmental compliance and protection of natural resources in a company-wide environmental management and protection policy. The policy is BJC's fundamental commitment to incorporating sound environmental management practices into all work processes and activities.

3.2.6 Pollution Prevention/Waste Minimization

BJC's work control process requires that source reduction be evaluated for all waste-generating activities and product substitution be used to produce a less toxic waste when possible. The reuse or recycling of building debris or other wastes generated is evaluated in all cases.

BJC recycles office and mixed paper, cardboard, phone books, newspapers, magazines, aluminum cans, antifreeze, engine oils, batteries (lead acid, universal waste, and alkaline), universal waste bulbs, plastic bottles, all types of #1 and #2 plastics, and surplus electronic assets such as computers (CPUs and laptops) and monitors (CRT and LCD). Other recycling opportunities include unique structural steel, stainless steel structural members, transformers, and electrical breakers. Figure 3.4 shows the P2 recycling activities at ETTP related to solid waste reduction.

BJC's electronic stewardship is award winning. For 2010, BJC and ETTP were recognized by the Office of Federal Environmental Executive and the U.S. Environmental Protection Agency with the 2010 Federal Electronics Challenge Award (Silver) at the White House Conference Center in Washington, D.C. (Fig. 3.6). The award was given, in part, for the Radio Frequency Identification Device (RFID), which is utilized for the electronic waste management tracking system that provides a paperless and otherwise enhanced transportation logistics to track and monitor onsite waste shipments to the Environmental Management Waste Management Facility (EMWMF). An electronic tracking station is shown in Fig. 3.7. The system eliminated errors associated with manual data entry, improved cycle times by 25 minutes per truck shipment (i.e., saving large quantities of fuel and paper and significantly reducing greenhouse gas emissions), improved performance of vehicle searches at truck stations when exiting controlled areas, and has centralized logistics for all shipments to EMWMF. The overall project cost savings of $9.8 million from utilizing the RFID is shown in Table 3.1.

Additionally, BJC was recognized for six projects for P2, the Radio Frequency Information Device (RFID) technology was expanded beyond BJC, the use of "green" products was increased, and EMS and P2 employee awareness was raised through an increase in communications.

ORNL 2011-G00564/chj

Fig. 3.6. BJC and ETTP win the 2010 Federal Electronics Challenge Award (Silver).

ORNL 2011-G00565/chj

Fig. 3.7. A waste shipment passing an electronic tracking station as it prepares to enter the haul road from ETTP, enroute to EMWMF.

Table 3.1. Radio Frequency Identification Device (RFID) sustainable results

Sustainable Factor	Results
Diesel use avoidance	50,509 liters
NO_x and SO_x emissions avoidance	2,312 and 132,031 kilograms
Paper and trees saved	1.5 metric tons and 40 trees
Electricity saved	24,750 megajoules
Water use avoided	44,433 liters
Air pollution avoided	45.4 kilograms
Total project cost savings	**$9.8 million**

3.2.7 Competence, Training, and Awareness

The BJC training and qualification process ensures that needed skills for the workforce are identified and developed. The process also documents knowledge, experience, abilities, and competencies of the workforce for key positions requiring qualification. This process is described in the procedure “Training Program,” BJC-HR-0702. Completion and documentation of training, including required reading, are managed by the Local Education Administration Requirements Network (LEARN).

A number of training modules and awareness tools have been developed and used to increase general knowledge and awareness of BJC’s environmental policy and to communicate roles and responsibilities for all employees.

Additionally, employees and subcontractors involved in a work activity that may have a significant impact on the environment are provided additional information through review of work packages, procedures, pre-job briefings, and review of Safety Task Analysis Risk Reduction Talk (STARRT) cards, which address potential environmental issues and concerns.

In addition to the formal training modules and project-specific work briefings, BJC uses a number of tools and mechanisms to constantly reinforce awareness and knowledge of BJC’s EMS.

3.2.8 Communication

BJC has a written communication plan that addresses both internal and external communication of important company information, including information related to EMS.

BJC has decided to communicate externally regarding environmental aspects on the BJC public website, which includes a summary environmental policy statement and a list of environmental aspects as well as a link to the ISMS Description (BJC 2010). A number of other documents and reports are also published and made available to the public that address environmental aspects and cleanup progress (e.g., the Annual Site Environmental Report, Annual Cleanup Progress Report). BJC participates in a number of public meetings related to environmental activities at the site [e.g., Site Specific Advisory Board meetings; permit review public meetings; and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) decision document public meetings]. Written communications from external parties are tracked using the weekly Open Action Report.

3.2.9 Benefits and Successes of EMS Implementation

BJC utilizes EMS objectives and targets, a P2 recognition program, environmentally preferable purchasing, work control processes, and a recycle program to meet sustainability and stewardship goals and requirements. The approach is outlined in BJC's P2/Waste Minimization (WMin) Program Plan (BJC 2009d).

BJC has initiated energy conservation measures that saved money, energy, and subsequently, pollution from power generation or vehicle emissions as follows:

- The reindustrialization organization purchased and installed sensors that automatically turn lights off when people are not present, as well as reminding personnel to turn off lights when leaving a room.
- Energy Star appliances are purchased whenever possible. These appliances meet strict energy-efficient guidelines set by EPA and DOE. Energy Star is an international standard for energy-efficient consumer products.
- The IT department purchases only Electronic Product Environmental Assessment Tool (EPEAT) silver- or gold-certified computers and monitors. EPEAT is an easy-to-use online tool that helps institutional purchasers evaluate, compare, and select electronic products based on their environmental attributes. Additionally, the IT department is creating awareness and is implementing desktop energy-saving measures for computers, monitors, printers, and copiers.
- The Space Consolidation/Utilization Project eliminated facility/trailer types resulting in an energy use avoidance.
- The RFID Shipping Project implemented during FY 2010 avoided the use of 50,509 liters of diesel fuel, electricity savings of 24,750 megajoules, paper and tree savings of 1.5 metric tons and 40 trees, water use avoidance of 44,433 liters, and air pollution avoidance of 45.4 kilograms.
- General Maintenance purchases WaterSense replacement parts when performing repairs. WaterSense is an EPA program designed to encourage water efficiency through the use of a special label on consumer products such as toilets, flushing urinals, bathroom sink faucets, and accessories.
- Garage personnel use recycled content coolant (ethylene glycol) that is a 50/50 blend of recycled/new coolant and several bio-based products including oils and cleaners, which result in less toxic or non-toxic waste generation.

3.2.10 Management Review

Senior management review of the EMS is performed at several layers and frequencies. A formal annual review/presentation with BJC senior management is conducted at least once per year that addresses the requirement elements contained in this section. BJC senior management includes the President/General Manager, Vice President/Deputy General Manager, and Manager of Safety Systems Integration. At least two of the senior managers are present for management reviews. Also, as part of the ISMS annual report, a narrative report of the EMS and its effectiveness is published that addresses each requirement element. The ISMS Description (BJC 2010) is updated annually and signed by the BJC

President to address improvements, lessons learned, and to update objectives and targets as necessary. The environmental policy is also reviewed during the management review annually and revised as necessary.

In addition to the formal annual reviews, monthly reviews of key DOE metrics are submitted to DOE. These metrics relate to the compliance-based EMS objectives and targets. On a periodic basis, the status of EMS objectives and targets are reviewed at the monthly EC&P Leads meetings and project meetings as appropriate.

ETTP achieved 24 of 26 environmental targets on schedule in 2010. Highlights included increased recycling and recycling initiatives, 100% purchase of EPEAT silver- or gold-certified computer equipment, zero reportable releases to the environment, zero unpermitted discharges, and zero environmental notices of violation.

3.3 Compliance Programs and Status

During 2010 ETTP operations were conducted in compliance with contractual and regulatory environmental requirements with one exception. A single National Pollutant Discharge Elimination System (NPDES) permit noncompliance attributable to an unpermitted discharge to the storm water drainage system occurred on January 20, 2010. A contractor maintenance worker for an on-site commercial firm poured the contents of two 5-gallon paint cans into a storm drain catch basin. Details of the NPDES noncompliance are provided in Section 3.3.6.

No Notices of Violation or penalties were issued to ETTP operations in 2010. The following sections provide more detail on each compliance program and the activities in 2010.

3.3.1 Environmental Permits

Table 3.2 contains a list of environmental permits that were effective in 2010 at ETTP.

3.3.2 Notices of Violations and Penalties

ETTP did not receive any notices of violations or penalties from regulators in 2010.

3.3.3 Audits and Oversight

Table 3.3 presents a summary of environmental audits conducted at ETTP in 2010.

3.3.4 National Environmental Policy Act/National Historic Preservation Act

NEPA provides a means to evaluate the potential environmental impact of proposed federal activities and to examine alternatives to those actions. ETTP maintains compliance with NEPA through the use of site-level procedures and program descriptions that establish effective and responsive communications with program managers and project engineers to establish NEPA as a key consideration in the formative stages of project planning.

During 2010, ETTP continued to operate under site-level, site-specific procedures that provide requirements for project reviews and NEPA compliance. These procedures call for a review of each proposed project, activity, or facility to determine the potential for impacts to the environment. To streamline the NEPA review and documentation process, DOE-ORO has approved generic categorical exclusions (CXs) that cover certain proposed activities (i.e., maintenance activities, facilities upgrades, personnel safety enhancements). A CX is one of a category of actions defined in 40 CFR 1508.4 that does not individually or cumulatively have a significant effect on the human environment and for which neither an environmental assessment nor an environmental impact statement is normally required. BJC activities on the ORR are in full compliance with NEPA requirements, and procedures for implementing NEPA requirements have been fully developed and implemented. At ETTP, a checklist incorporating NEPA and EMS requirements has been developed as an aid for project planners. For routine operations,

Table 3.2. Permit actions at East Tennessee Technology Park

Regulatory driver[a]	Permit title/description	Permit No.	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Operating permit—Tennessee Air Quality Act for K-1407-U VOC Air Stripper.	045253P	06-20-96	10-01-00	DOE	BJC	BJC
CAA	Operating permit—Tennessee Air Quality Act for K-1425 Waste Oil/Solvent Storage Tank Farm	029895P	09-21-90	10-01-95	DOE	BJC	BJC
CAA	Operating permit—Tennessee Air Quality Act for K-1435-C Liquid Waste Tank Farm	037460P	03-31-94	10-18-98	DOE	BJC	BJC
CAA	Permit to construct—Tennessee Air Quality Act for K-1423 TSCA Solids Waste Repack Facility	958435P	10-10-05	10-10-06	DOE	BJC	BJC
CAA	Permit to construct—Tennessee Air Quality Act for TSCA Incinerator	957808I	01-25-05	Permit Surrendered 03-30-10	DOE	BJC	BJC
CWA	National Pollutant Discharge Elimination System (NPDES) permit for the Central Neutralization Facility Wastewater Treatment System	TN0074225	10-29-10	12-31-13	DOE	BJC	BJC
CWA	NPDES permit for treated liquid effluent	TN0002950	02-26-10	12-31-13	DOE	DOE	BJC
CWA	State operating permit—Waste Transportation Project; Blair Road and Portal 6 Sewage Pump and Haul Permit	SOP-05068	02-28-06	02-28-09	DOE	URS	URS
CWA	State operating permit—K-1310-DF and K-1310-HG Trailers	SOP-99033	04-29-05	04-29-10	DOE	BJC	BJC

Table 3.2. (continued)

Regulatory driver[a]	Permit title/description	Permit No.	Issue date	Expiration date	Owner	Operator	Responsible contractor
CWA	State operating permit—K-1065 Facility; Trailer K-1310-BS added in March 2009	SOP-01042	11-30-06	05-31-10	DOE	BJC	BJC
CWA	State operating permit—EMWMF. 5000 gallon holding tank and trailers 998T-74 and 998T-75	SOP-01043	07-31-07	07-31-12	DOE	BJC	BJC
CWA	TSCA Incinerator PCB treatment authorization	Not applicable	05-27-08	Ongoing	DOE	BJC	BJC
CWA	Authorized/certified USTs at K-1414 Garage	Customer ID 30166 Facility ID 073008	03-20-89	Ongoing	DOE	BJC	BJC
RCRA	K-25 Site TSCA Incinerator	TNHW-015	09-28-87	09-28-97	DOE	BJC	BJC
RCRA	ETTP Container and Tank Storage and Treatment Units	TNHW-133	09-28-07	09-28-17	DOE	BJC	BJC
RCRA	ETTP Container Storage and Treatment Units	TNHW-117	09-30-04	09-30-14	DOE	BJC	BJC
RCRA	Hazardous Waste Corrective Action Permit (encompasses the entire ORR)	TNHW-121	09-28-04	09-28-14	DOE	DOE/All[b]	DOE/All[b]

[a]CAA Clean Air Act
CWA Clean Water Act
EMWMF Environmental Management Waste Management Facility
RCRA Resource Conservation and Recovery Act
TSCA Toxic Substances Control Act
PCB polychlorinated biphenyl
UST underground storage tank
[b]DOE and all Oak Ridge Reservation (ORR) co-operators of hazardous waste permits.

Table 3.3. Regulatory oversight, assessments, inspections, and site visits at East Tennessee Technology Park, 2010[a]

Date	Reviewer	Subject	Issues
January 14	TDEC	Annual CAA Inspection	0
February 8–10	TDEC	Annual RCRA Compliance Inspection	0
September 21	TDEC-Knoxville	CNF NPDES compliance evaluation inspection	0
October 7	EPA	TSCA Incinerator – PCB site visit	0

[a] CAA = Clean Air Act; EPA = Environmental Protection Agency; PCB = polychlorinated biphenyl; RCRA = Resource Conservation and Recovery Act; TDEC =Tennessee Department of Environment and Conservation; TSCA= Toxic Substances Control Act

generic CXs have been issued. During 2010, one CX was issued (storage of TRU and mixed TRU waste at ORNL), and six review reports (five for reindustrialization projects and one for storage of reusable uranium material) were prepared. A review report is generated when a NEPA review is conducted and the activity is found to fall within one of the DOE-ORO generic CXs.

Compliance with the National Historic Preservation Act (NHPA) at ETTP is achieved and maintained in conjunction with NEPA compliance. The scope of proposed actions is reviewed in accordance with the *Cultural Resource Management Plan* (DOE 2001). At ETTP, there are 135 facilities eligible for inclusion on the National Register of Historic Places. A memorandum of agreement states that two of these facilities will be maintained (the north end of K-25 and Portal 4). The other facilities are scheduled to be demolished as part of the site-wide remediation project. To date, more than 220 facilities have been demolished. Artifacts of historical and/or cultural significance are identified prior to demolition and are cataloged in a database to aid in historic interpretation of the ETTP.

3.3.5 Clean Air Act Compliance Status

The Clean Air Act (CAA), passed in 1970 and amended in 1977 and 1990, forms the basis for the national air pollution control effort. This legislation establishes comprehensive federal and state regulations to limit air emissions and includes five major regulatory programs: the National Ambient Air Quality Standards, State Implementation Plans (SIPs), New Source Performance Standards (NSPS), Prevention of Significant Deterioration (PSD) permitting programs, and National Emission Standards for Hazardous Air Pollutants (NESHAPs). Airborne discharges from DOE Oak Ridge facilities, both radioactive and nonradioactive, are subject to regulation by EPA and the TDEC Division of Air Pollution Control.

In 2010, there was one permitted source requiring tracking of criteria pollutants, and one permitted major radionuclide source that required continuous environmental sampling, seven minor radionuclide sources, and numerous demonstrations of compliance with generally applicable air quality protection requirements (asbestos, stratospheric ozone, etc.). TDEC personnel performed one inspection of ETTP CAA permitted operations in 2010. No issues or concerns were noted by the TDEC inspector. In summary, there were no ETTP CAA violations or exceedances in 2010. Section 3.4 provides detailed information on 2010 ETTP activities conducted in support of the CAA.

3.3.6 Clean Water Act Compliance Status

The objective of the Clean Water Act (CWA) is to restore, maintain, and protect the integrity of the nation's waters. This act serves as the basis for comprehensive federal and state programs to protect the waters from pollutants (see Appendix D for water reference standards). One of the strategies developed to achieve the goals of the CWA was EPA's establishment of limits on specific pollutants allowed to be discharged to U.S. waters by municipal sewage treatment plants and industrial facilities. The EPA established the NPDES permitting program to regulate compliance with pollutant limitations. The program was designed to protect surface waters by limiting effluent discharges into streams, reservoirs, wetlands, and other surface waters. EPA has delegated authority for implementation and enforcement of the NPDES program to the state of Tennessee. ETTP discharges to the waters of the state of Tennessee under two individual NPDES permits:

- NPDES Permit No. TN0002950, which regulates storm water discharges, and
- NPDES Permit No.TN0074225, which regulates industrial discharges from the Central Neutralization Facility (CNF).

In 2010, compliance with the ETTP NPDES storm water permit was determined by approximately 420 laboratory analyses, field measurements, and flow estimates. The NPDES permit compliance rate for all discharge points for 2010 was nearly 100%. A single NPDES permit noncompliance attributable to an unpermitted discharge to the storm water drainage system occurred on January 20, 2010. A contractor maintenance worker from an on-site commercial firm poured the contents of two 5-gallon paint cans into a storm drain catch basin that is part of the storm water outfall 100 drainage network. The material that was poured into the catch basin was dilute cleanup water from office painting that was being conducted inside an ETTP building. No harm to aquatic species was seen during investigation of the incident. The exceedance did not result in any discernable ecological impact. Section 3.5 contains detailed information on the activities and programs carried out at 2010 by ETTP in support of the CWA.

In 2010, compliance with the ETTP NPDES permit for industrial wastewater from the Central Neutralization Facility (CNF) was determined by more than 2000 laboratory analyses and field measurements. The CNF NPDES permit compliance rate for 2010 was 100% with no noncompliances.

3.3.7 Safe Drinking Water Act Compliance Status

ETTP's water distribution system is designated as a non-transient, non-community water system by TDEC's Division of Water Supply. The *Tennessee Regulations for Public Water Systems and Drinking Water Quality*, Chap. 1200-5-1 (TDEC 2009a), sets limits for biological contaminants and for chemical activities and chemical contaminants. TDEC requires sampling for the following constituents for compliance with state and federal regulations:

- chlorine residual levels,
- bacteriological (total coliform),
- lead and copper, and
- disinfectant by-products (trihalomethanes and haloacetic acids).

The city of Oak Ridge supplies potable water to the ETTP water distribution system. The water treatment plant, located on the ORR, southwest of the ETTP, is owned and operated by the city of Oak Ridge.

3.3.8 Resource Conservation and Recovery Act Compliance Status

ETTP is regulated as a large-quantity generator of hazardous waste because the facility generates more than 1,000 kg of hazardous waste per month. This amount includes hazardous waste generated under permitted activities (including repackaging or treatment residuals). At the end of 2010, ETTP had approximately four generator accumulation areas for hazardous or mixed waste.

ETTP is also regulated as a handler of universal waste (e.g., fluorescent lamps, batteries, and other items regulated under 40 CFR 273). Mercury-containing equipment at ETTP is managed as universal waste.

Additionally, some batteries are managed according to 40 CFR Part 266.80. This applies to the management of spent lead-acid batteries that are being reclaimed.

ETTP is registered as a large-quantity generator under EPA ID No. TN 0890090004 and is permitted to transport hazardous wastes and to operate Resource Conservation and Recovery Act (RCRA)–permitted hazardous waste treatment and storage units. During 2010, 20 units operated as permitted units.

ETTP's RCRA storage and treatment facilities (or units) operate under three permits: TNHW-117, TNHW-133, and TNHW-015. The permits are modified when necessary. TDEC approved two permit modifications in 2010. Combustion operations at the Toxic Substance Control Act Incinerator ceased in

December 2009. Operations in 2010 centered on decontamination and decommissioning activities (see Section 3.8.1).

3.3.9 RCRA Underground Storage Tanks

Underground storage tanks (USTs) containing petroleum and hazardous substances are regulated under Subtitle I of RCRA (40 CFR 280). EPA granted TDEC authority to regulate USTs containing petroleum under TDEC Rule 1200-1-15; however, EPA still regulates hazardous-substance USTs.

ETTP has two USTs registered with TDEC under Facility ID Number 0730088.

3.3.10 Comprehensive Environmental Response, Compensation, and Liability Act Compliance Status

CERCLA, also known as Superfund, was passed in 1980 and was amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA). Under CERCLA, a site is investigated and remediated if it poses significant risk to health or the environment. The EPA National Priorities List (NPL) is a comprehensive list of sites and facilities that have been found to pose a sufficient threat to human health and/or the environment to warrant cleanup under CERCLA.

In 1989, the ORR was placed on the NPL. In 1992, the ORR Federal Facility Agreement among EPA, TDEC, and DOE became effective and established the framework and schedule for developing, implementing, and monitoring remedial actions on the ORR. ETTP's primary mission is D&D of surplus facilities. The on-site CERCLA Environmental Management Waste Management Facility (EMWMF), located in Bear Creek Valley, is used for disposal of contaminated waste resulting from CERCLA cleanup actions on the ORR. The EMWMF is an engineered landfill that accepts low-level radioactive, hazardous, asbestos, and polychlorinated biphenyl (PCB) wastes and combinations of the aforementioned wastes in accordance with specific waste acceptance criteria under an agreement with state and federal regulators. Uncontaminated CERCLA waste is disposed of at the ORR sanitary landfill.

3.3.10.1 ETTP RCRA-CERCLA Coordination

The ORR Federal Facility Agreement is intended to coordinate the corrective action processes of RCRA required under the Hazardous and Solid Waste Amendments permit with CERCLA response actions.

RCRA groundwater monitoring data are reported yearly to TDEC and EPA in the annual CERCLA Remediation Effectiveness Report (DOE 2010a) for the ORR.

Periodic updates of proposed construction and demolition activities and facilities at ETTP have been provided to managers and project personnel from the TDEC DOE Oversight Division and EPA Region 4. A CERCLA screening process is used to identify proposed construction and demolition projects and facilities that warrant CERCLA oversight. The goal is to ensure that modernization efforts do not adversely impact the effectiveness of previously completed CERCLA environmental remedial actions or future CERCLA environmental remedial actions.

3.3.11 Toxic Substances Control Act Compliance Status

3.3.11.1 Polychlorinated Biphenyls

On April 3, 1990, DOE notified EPA Headquarters (as required by 40 CFR 761.205) that ETTP is a generator with on-site storage, a transporter, and an approved disposer of PCB wastes.

PCB waste generation, transportation, disposal, and storage at ETTP is regulated under the EPA ID number TN0890090004. In 2010, ETTP operated approximately 19 PCB waste storage areas in ETTP generator buildings and, when longer-term storage of PCB/radioactive wastes was necessary, RCRA-permitted storage buildings. The continued use of authorized PCBs in electrical systems and/or equipment (e.g., transformers, capacitors, rectifiers) is regulated at ETTP. Most Toxic Substances Control Act

(TSCA)–regulated equipment at ETTP has been disposed of. However, some ETTP facilities continue to use (or store for future reuse) PCB-contaminated equipment (i.e., transformers).

Because of the age of many of ETTP's facilities and the varied uses for PCBs in gaskets, grease, building materials, and equipment, DOE self-disclosed unauthorized use of PCBs to EPA in the late 1980s. As a result, the DOE Oak Ridge Office and EPA Region 4 consummated a major compliance agreement known as the Oak Ridge Reservation Polychlorinated Biphenyl Federal Facilities Compliance Agreement, which became effective December 16, 1996. The agreement specifically addresses the unauthorized use of PCBs in ventilation ducts and gaskets, lubricants, hydraulic systems, heat transfer systems, and other unauthorized uses; storage for disposal; disposal; cleanup and/or decontamination of PCBs and PCB items including PCBs mixed with radioactive materials; and records and reporting requirements on the ORR. A major focus of the agreement is the disposal of PCB waste. As a result of that agreement, DOE and BJC continue to notify EPA when additional unauthorized uses of PCBs, such as PCBs in paint, adhesives, electrical wiring, or floor tile, are identified at ETTP.

ETTP is home to the TSCA Incinerator (Fig. 3.8). On December 2, 2009, the TSCA Incinerator ceased operations as a waste incinerator and transitioned to a facility closure and decommissioning mode.

In 2010, the primary focus at the TSCA Incinerator was preparing it for RCRA and TSCA closure, so the facility could go into a surveillance and maintenance mode in 2011.

ORNL 2010-G00444/chj

Fig. 3.8. TSCA Incinerator.

3.3.12 Emergency Planning and Community Right-to-Know Act Compliance Status

The Emergency Planning and Community Right-to-Know Act (EPCRA) and Title III of SARA require that facilities report inventories and releases of certain chemicals that exceed specific release thresholds. The reports are submitted to the local emergency planning committee and the state emergency response commission. ETTP complied with these requirements in 2010 through the submittal of reports under EPCRA Sections 302, 303, 311, and 312. ETTP had no releases of extremely hazardous substances, as defined by EPCRA, in 2010.

3.3.12.1 Material Safety Data Sheet/Chemical Inventory (Section 312)

Inventories, locations, and associated hazards of hazardous and extremely hazardous chemicals were submitted in an annual report to state and local emergency responders as required by the Sect. 312 requirements. Of the chemicals identified for CY 2010 on the ORR, 16 were located at ETTP.

Private-sector lessees associated with the reindustrialization effort were not included in the 2010 submittals. Under the terms of their lease, lessees must evaluate their own inventories of hazardous and extremely hazardous chemicals and must submit information as required by the regulations. In 2010, the reported materials include Sakrete (type “N” or type “S”), rock salt (for road maintenance), sand (for road maintenance), and lead metal (largely in the form of lead-acid batteries).

3.3.12.2 Toxic Chemical Release Reporting (Section 313)

DOE submits annual toxic release inventory reports to EPA and TDEC on or before July 1 of each year. The reports cover the previous calendar year and address releases of certain toxic chemicals to air, water, and land as well as waste management, recycling, and pollution prevention activities. Threshold determinations and reports for each of the ORR facilities are made separately. Operations involving toxic release inventory chemicals were compared with regulatory thresholds to determine which chemicals exceeded the reporting thresholds based on amounts manufactured, processed, or otherwise used at each facility. After threshold determinations were made, releases and off-site transfers were calculated for each chemical that exceeded one or more of the thresholds. In 2010, the only chemicals that met the reporting requirements were diisocyanates associated with foaming activity to stabilize deposits in pipes undergoing remediation actions.

3.4 Air Quality Program

The state of Tennessee has relegated authority to convey the clean air requirements that are applicable to ETTP operations. New projects are governed by construction permits, and eventually, the conditions for operating would be incorporated into a site-wide Title V operating permit. To date ETTP operations under Bechtel Jacobs Company LLC (BJC) responsibility have not been issued said operating permit by TDEC. Until such time that TDEC issues a Title V permit or ongoing reductions of ETTP operations no longer require one, all existing sources continue to operate compliantly under their most recent issued permits. All operations are still subject to applicable regulations as specified in the individual permits and all generally applicable requirements. Examples include requirements associated with asbestos controls, control of stratospheric ozone-depleting chemicals, and control of fugitive emissions. Other major requirements include 40 CFR 61 National Emission Standards for Hazardous Air Pollutants for radionuclides (Rad NESHAP) requirements and the numerous requirements associated with emissions of criteria pollutants and other hazardous nonradiological air pollutants.

Ambient air monitoring, while not generally required by a condition of a permit, is conducted at ETTP to satisfy DOE order requirements, as a best-management practice and/or provide evidence of sufficient programmatic control of certain emissions. Ambient air monitoring conducted at ETTP is supplemented by additional monitoring conducted by ORNL and by both on-site and off-site monitoring conducted by TDEC. In addition, compliance with the Clean Air Act is ensured using a management program that includes internal audits and external audits, such as the annual inspection conducted by the state of Tennessee personnel.

3.4.1 Construction and Operating Permits

In 2010, ETTP had only one construction air permit. The construction permit for the Toxic Substance Control Act (TSCA) Incinerator was surrendered in March 2010 following the permanent shutdown of the facility in December 2009.

There were four active operating permits for ETTP air emission sources under BJC operations during 2010. Two of the permits are for tank farms used to receive, store, blend, and feed liquid wastes into the TSCA Incineration. Following the permanent shutdown of TSCAI, other than liquids used to flush and clean these tanks, no new wastes were processed through these facilities during 2010. The K-1423 Solid Waste Repacking Facility is permitted due to potential radionuclide emission levels. Compliance is demonstrated using the EPA-approved use of ambient air monitoring. Waste processing in this facility ceased in September 2009 but remained available for use. The K-1407 Central Neutralization Facility volatile organic compound (VOC) air stripper is permitted for total VOC emissions. Compliance is demonstrated by monitoring total wastewater processed and the results of wastewater influent sampling. All permitted facilities operated in full compliance of their associated permits during 2010.

3.4.1.1 Generally Applicable Permit Requirements

ETTP is subject to a number of generally applicable requirements that involve management and control. Asbestos, ozone-depleting substances, and fugitive particulate emissions are specific examples.

3.4.1.1.1 Control of Asbestos

ETTP's asbestos management program ensures all activities involving demolitions and all other actions impacting asbestos-containing materials (ACM) are fully compliant with 40 CFR 61, Subpart M. This includes using approved engineering controls and work practices, inspections, and monitoring for proper removal and waste disposal of ACM. ETTP has numerous buildings and equipment that contain ACM. Major demolition activities during 2010 involve the abatement of significant quantities of ACM that were subject to the requirements of 40 CFR 61, Subpart M. Most demolition and ACM abatement activities are governed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Under this act, notifications of asbestos demolition or renovations as specified 40 CFR 61.145(b) are incorporated into CERCLA document regulatory notifications. All other non-CERCLA planned demolition or renovation activities were individually reviewed for applicability to the TDEC notification requirements of the rule. The rule also requires an annual notification for all nonscheduled minor asbestos renovations if the accumulated total amount of regulated or potentially regulated asbestos exceeds stipulated thresholds. For 2010 the total projected nonscheduled amount was below thresholds that would require the submittal of an annual notification to TDEC. No releases of reportable quantities of ACM occurred at ETTP during 2010.

3.4.1.1.2 Stratospheric Ozone Protection

The management of ozone-depleting substances (ODS) at ETTP is subject to regulations in 40 CFR Part 82, Subpart F, Recycling and Emissions Reduction; these regulations include documentation required to establish that actions necessary to reduce emissions of Class I and Class II refrigerants to the lowest achievable level have been observed during maintenance activities at ETTP. The applicable actions include, but may not be limited to, the service, maintenance, repair, and disposal of appliances containing Class I and Class II refrigerants, including motor vehicle air-conditioners. In addition, the regulations apply to refrigerant reclamation activities, appliance owners, manufacturers of appliances, and recycling and recovery equipment.

A review is conducted annually that documents the use of ODS at ETTP, the regulatory requirements for management of ODS, and the mechanisms that demonstrate compliance. This report does not include information pertaining to private tenants at ETTP. This review incorporates all compliance requirements specified in 40 CFR 82.166.

There were four purchase requisitions of Class I and Class II refrigerants [3–30 lb cylinders of R-22, 2–30 lb cylinders of R-12] that totaled 150 lb for ETTP for the period of January 1, 2010, to December 31, 2010, for servicing of chiller units and small appliances. There were no alternative refrigerants (e.g., R-134-A) purchased during CY 2010.

The inventory as of December 31, 2010, from the Hazardous Materials Information System (HMIS), included 586 lb of Class I and Class II refrigerants and 150 lb of alternative refrigerants. Figure 3.9 demonstrates the effect of ongoing actions that are eliminating the use of Class I and Class II refrigerants at ETTP.

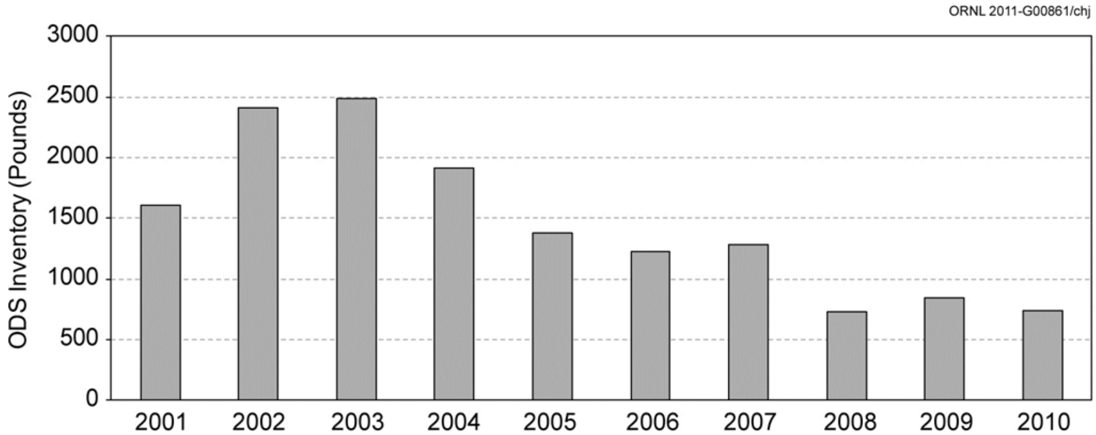


Fig. 3.9. ETTP total on-site ODS inventory history.

3.4.1.1.3 Fugitive Particulate Emissions

ETTP has been the location of major building demolition activities and waste debris transportation with the potential for the release of fugitive dust. All planned and ongoing activities include the use of dust control measures to minimize the release of visible fugitive dust beyond the project perimeter. This includes the use of specialized demolition equipment and water misters. Gravel roads in and around ETTP that are under DOE control are wetted as needed to minimize airborne dusts caused by vehicle traffic.

3.4.1.2 Radionuclide National Emission Standard for Hazardous Air Pollutants

Radionuclide airborne emissions from ETTP are regulated under 40 CFR 61 National Emission Standards for Hazardous Air Pollutants: Department of Energy Facilities (Rad NESHAP). Characterization of the impact on public health of radionuclides released to the atmosphere from ETTP operations was accomplished by conservatively estimating the dose to the maximally exposed member of the public. The dose calculations were performed using the Clean Air Assessment Package (CAP-88) computer codes, which were developed under EPA sponsorship for use in demonstrating compliance with the 10-mrem/year effective dose (ED) Rad NESHAP emission standard for the entire DOE ORR. Source emissions used to calculate the dose are determined using EPA-approved methods ranging from continuous sampling systems to conservative estimations based on process and waste characteristics. Continuous sampling systems are required for radionuclide-emitting sources that have the potential dose impact of not less than 0.1 mrem per year to any member of the public. The K-1423 Solid Waste Repack Facility (K-1423) is the only ETTP source remaining that requires a continuous sampling system. With EPA approval, ambient air sampling is used for K-1423 Rad NESHAP compliance in lieu of in-stack continuous sampling. Historically, the only ETTP unit that required an in-stack continuous sampling system was the TSCA Incinerator that ceased operations in December 2009. ETTP Rad NESHAP sources—Waste Water Treatment Facility Sludge Press, K-413 Pipe Cutting, K-1407 CNF Air Stripper, K-2527-BR Grouting Facility, and the K-2500-H Segmentation Shops A, C, and D—are considered minor based on emissions evaluations using EPA-approved calculation methods. A minor Rad NESHAP source is defined as having a potential dose impact on the public not in excess of 0.1 mrem/year.

The K-1423 air permit does not require direct monitoring of stack radionuclide emission. Compliance is demonstrated using on-site ambient air environmental sampling at Station K11 for determining the dose impacts on members of the public. Figure 3.10 displays the K11 historical dose impact that would represent impact to an onsite member of the public. For 2010, the dose at this location was only 0.06 mrem. This station collects samples that are potentially impacted by all ETTP sources of radionuclide emissions, including both stack and fugitive emissions. This ensures reporting a conservative dose impact to an actual on-site member of the public.

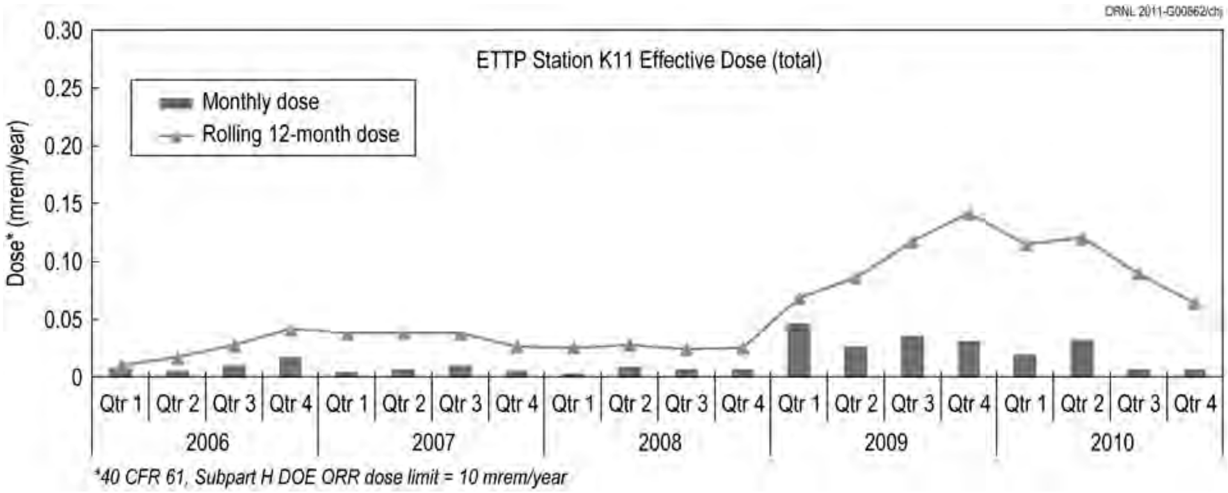


Fig. 3.10. Station K11 radionuclide monitoring results: 5-year rolling 12-month dose history up through 2010.

All ETTP sources combined are far below the 10 mrem/year effective dose (ED), which is the Rad NESHAP regulatory limit and the applicable standard for combined radionuclide emissions from all ORR facilities. Emissions from all ETTP stationary sources of radionuclides are included in the annual dose assessment report submitted by June 30 of each year as required under Rad NESHAP regulations. For the 2010 reporting year, the total ORR ED was only 0.4 mrem. The total ED contribution from all ETTP stationary source radionuclide emissions was only 5.7E-03 mrem or 1.4% of the total ORR dose.

3.4.1.3 Quality Assurance

Quality assurance activities for the Rad NESHAP program are documented in Quality Assurance Program Plan for Compliance with Radionuclide National Emission Standards for Hazardous Air Pollutants. The plan satisfies the quality assurance (QA) requirements in 40 CFR 61, Method 114, for ensuring that the radionuclide air emission measurements from ETTP are representative to known levels of precision and accuracy and that administrative controls are in place to ensure prompt response when emission measurements indicate an increase over normal radionuclide emissions. The requirements also referenced in TDEC regulation 1200-3-11-.08. The plan ensures the quality of ETTP radionuclide emission measurement data from continuous samplers and minor radionuclide release points. Only EPA pre-approved methodologies are referenced through the *Compliance Plan National Emission Standards for Hazardous Air Pollutants for Airborne Radionuclides on the Oak Ridge Reservation*, DOE/ORO/2196 (DOE 1994a).

3.4.1.4 Greenhouse Gas Emissions

The EPA Mandatory Reporting of Greenhouse Gases (GHGs) Rule was enacted September 30, 2009, under 40 Code of Federal Regulations (CFR) Part 98.2. According to the rule, in general, the stationary source emissions threshold for reporting requirement is 25,000 metric tons or more of GHG per year (CO_2 equivalents per year). The Rule defines GHGs as follows.

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs) and
- Sulfur Hexafluoride (SF_6)

A review was performed of ETTP processes and equipment categorically identified under 40 CFR 98.2 whose emissions must be included as part of a facility annual GHG report starting with the calendar year 2010 reporting period. Based on total GHG emissions from all ETTP stationary sources, ETTP would not exceed the annual threshold limit and therefore would not be subject to mandatory annual reporting under the GHG Rule beginning with the 2010 calendar year. The total GHG emissions for any continuous 12-month period beginning with calendar year 2008 have not exceeded 12,390 metric tons of GHG. The decrease in emissions is due to the permanent shutdown of the TSCA Incinerator. Figure 3.11 shows the historical trend of ETTP total GHG stationary emissions including contributions from the TSCA Incinerator. For the 2010 calendar year period, GHG emissions totaled only 365 metric tons.

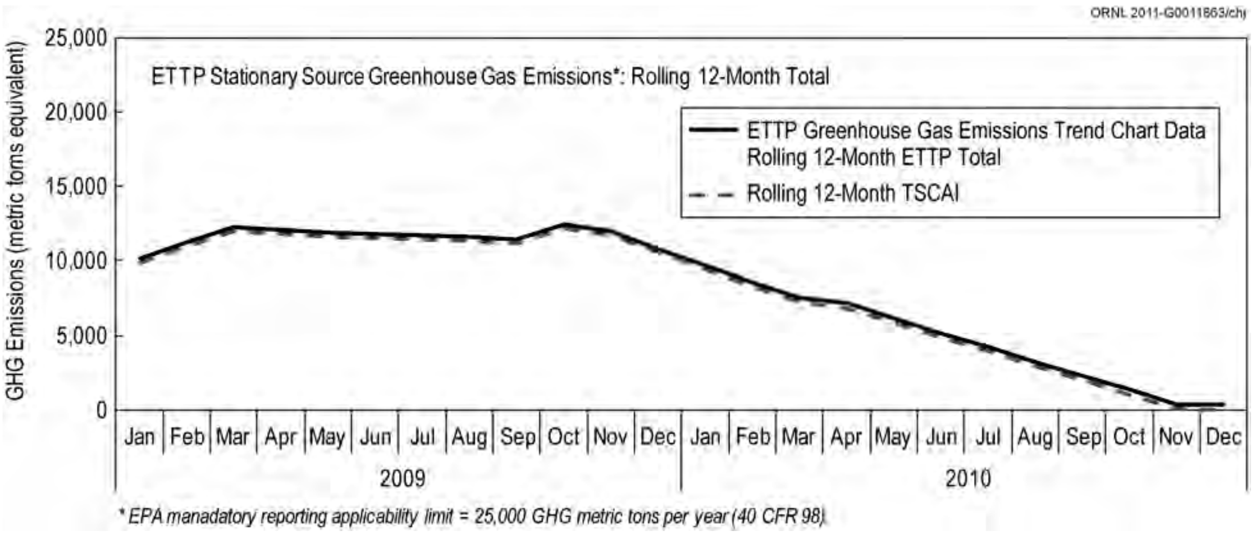


Fig. 3.11. ETTP stationary source GHG emissions tracking history.

Executive Order (EO) 13514, "Federal Leadership in Environmental, Energy, and Economic Performance," was signed by President Obama on 5 October 2009. The purpose of this order is to establish policies for federal facilities that will increase energy efficiency; measure, report, and reduce GHG emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and stormwater management; and eliminate waste, recycle, and prevent pollution at all of their facilities. While the order deals with a number of environmental media, only its applicability to GHG is considered here. The EO defines three distinct scopes for purposes of reporting. Scope 1 is essentially direct greenhouse gas emissions from sources that are owned or controlled by the Federal agency; Scope 2 encompasses greenhouse gas emissions resulting from the generation of electricity, heat, or steam purchased by a Federal agency, and Scope 3 involves greenhouse gas emissions from sources not owned or directly controlled by a Federal agency but related to agency activities such as vendor supply chains, delivery services, and employee business travel and commuting. Figure 3.12 displays the fiscal year trend toward the 28% total Scope 1 and 2 GHG emissions reduction target by 2020, as stated in the DOE Strategic Sustainability Performance Plan (DOE 2010b). Figure 3.13 shows the relative contribution of ETTP FY 2010 GHG emissions for each Scope.

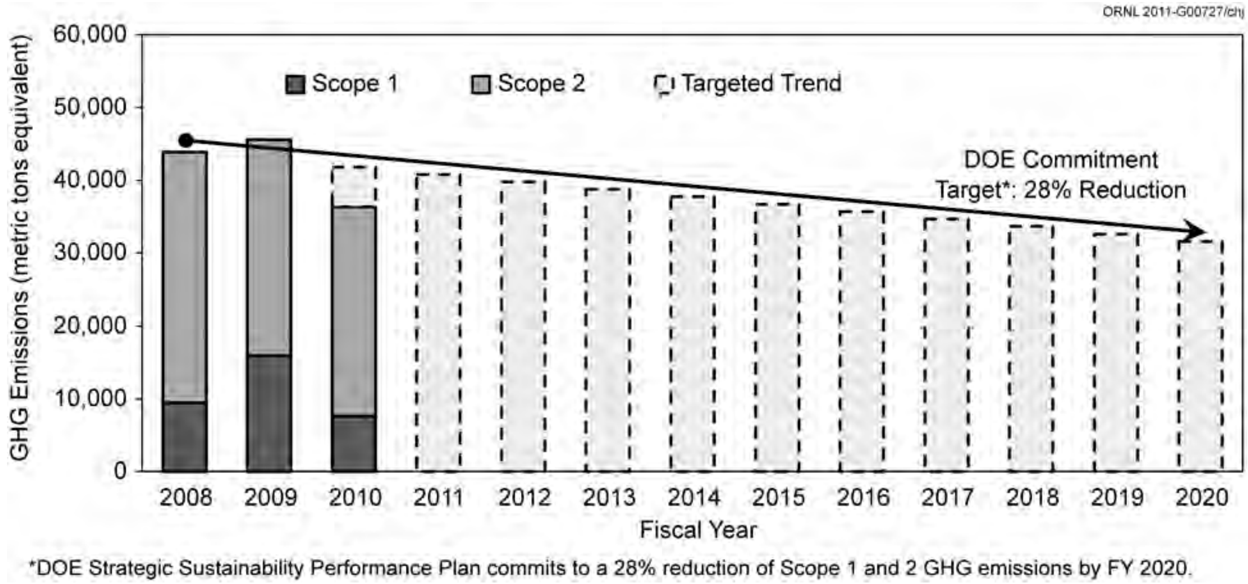


Fig. 3.12. ETTP GHG emissions trend and targeted reduction commitment.

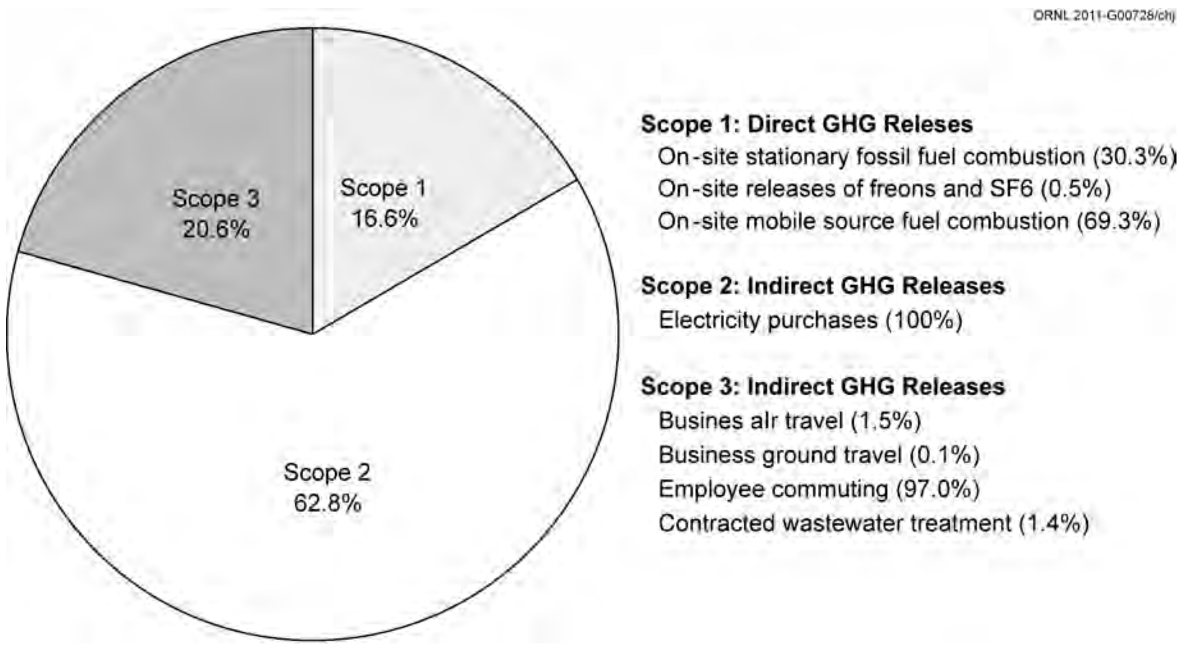


Fig. 3.13. Fiscal year 2010 ETTP GHG percent contribution by Scope.

3.4.1.5 Source-Specific Criteria Pollutants

ETTP operations during 2010 included only one stationary source with permit restrictions for non-radiological emissions: the CNF volatile organic compound (VOC) air stripper. All process data records and the calculated maximum VOC emission rate for the CNF air stripper were within permitted limits for 2010. The calculated maximum VOC emission rate was only 0.3 lb/hr as compared to the permitted limit of 1.0 lb/hr. All other stationary sources were evaluated and determined to be below any emission level that would require permitting.

ETTP operations released airborne pollutants from a variety of other minor pollutant-emitting sources, such as stacks, vents, and fugitive and diffuse activities. With the exception of the CNF air stripper, all other stack and vent emissions are calculated as allowed based on their low emissions to document the verification of their minor source permit exempt status under all applicable state and federal regulations.

3.4.1.6 Hazardous Air Pollutants (Nonradionuclide)

Unplanned releases of hazardous air pollutants are regulated through the Risk Management Planning regulations. ETTP personnel have determined that there are no processes or facilities containing inventories of chemicals in quantities exceeding thresholds specified in rules pursuant to Clean Air Act, Title III, Sect. 112(r), “Prevention of Accidental Releases.” Therefore, ETTP is not subject to that rule. Procedures are in place to continually review new processes, process changes, or activities against the rule thresholds.

3.4.2 Ambient Air

Compliance of fugitive and diffuse sources is demonstrated based on environmental measurements. The ETTP Ambient Air Quality Monitoring Program is designed to provide environmental measurements and to accomplish the following:

- track long-term trends of airborne concentration levels of selected air contaminant species;
- measure the highest concentrations of the selected air contaminant species that occur in the vicinity of ETTP operations; and
- evaluate the impact of air contaminant emissions from ETTP operations on ambient air quality.

The sampling stations in the ETTP area are designated as base, supplemental, or ORR perimeter air monitoring (PAM) stations. Figure 3.14 illustrates the locations of all ambient air samplers in and around ETTP. The base program consists of two locations using high-volume ambient air samplers. Supplemental locations are typically temporary, project-specific stations that would utilize samplers specific to a type of potential emissions. Samplers typically include high-volume systems, depending on the source emission evaluation of the project. All base, supplemental, and PAM samplers operate continuously with exposed filters collected weekly.

The radiological monitoring results for samples collected at the two ETTP area PAM stations were provided by UT-Battelle ORNL staff and are included in the ETTP network for comparative purposes. Figure 3.14 shows the location of all ambient air sampling stations that were active during the CY 2010 reporting period. Figure 3.15 shows an example of a typical ETTP air monitoring station.

All pollutant parameters were chosen with regard to existing and proposed regulations and with respect to activities at ETTP. Supplemental station K9 covered the remediation activities in the K-770 Scrap yard area that have the potential to produce fugitive airborne emissions. Supplemental station K11 is located to demonstrate compliance with permitted radiological emissions from K-1423. Changes of emissions from ETTP may warrant periodic reevaluation of the parameters being sampled. Ongoing ETTP reindustrialization efforts also introduce new locations for members of the public that may require adding or relocating monitoring site locations. To ensure protection of the public, a survey of all on-site tenants is conducted no less frequent than every 6 months.

All base and supplemental stations collect continuous samples for radiological and selected metals analyses. Inorganic analytical techniques are used to test samples for the following nonradiological pollutants: As, Be, Cd, Cr, and Pb, and total uranium. Radiological analyses of samples from the ETTP stations test for the isotopes ^{237}Np, ^{238}Pu, ^{239}Pu, ^{99}Tc, ^{234}U, ^{235}U, ^{236}U, and ^{238}U; samples from ORR stations are analyzed for ^{234}U, ^{235}U, and ^{238}U.

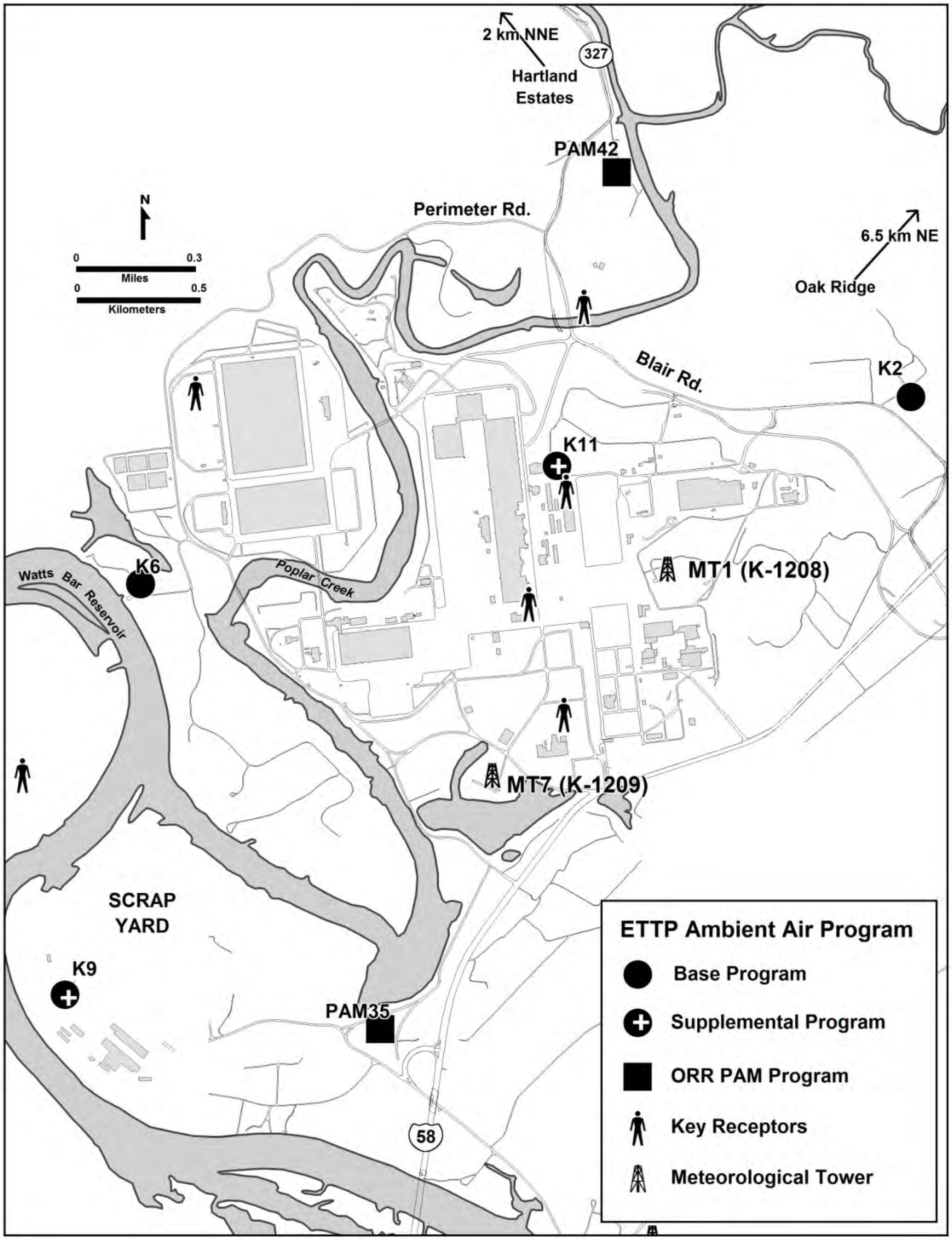


Fig. 3.14. ETTP ambient air monitoring station locations.

ORNL 2010-G00449/chj

Fig. 3.15. ETTP ambient air monitoring station.

Figures 3.16a through 3.16e illustrate the air concentrations of As, Be, Cd, Cr, and Pb for the past 5 years based on quarterly composites of weekly continuous samples. All samples were analyzed by the inductively coupled plasma–mass spectrometer (ICP-MS) analytical technique. The results are compared with any applicable air quality standards for each pollutant. Also, the minimum detectable concentration is shown for all metals, including uranium. The annualized levels of As, Be, Cd, and Pb all show results well below the indicated annual standards. Results for 2010 have all dropped significantly lower than results reported for 2009. The chromium results are conservatively compared with the EPA standard for hexavalent chromium. The drop-in airborne emissions of metals is coincidental to the December 2009 shutdown of the TSCA Incinerator. Lead measurement results indicate that all levels are well within the National Ambient Air Quality Standard (NAAQS) of 0.15 $\mu g/m^3$.

Total uranium metal was measured as a quarterly composite of continuous weekly samples from stations K2, K6, K9 and K11. The total uranium mass for each sample was determined by ICP-MS. Figure 3.17 illustrates the air concentrations of uranium metal for the past 5 years based on quarterly composites of weekly continuous samples. The uranium averages and maximum individual concentration measurements for all sites are presented in Table 3.4. The averaged results ranged from a minimum of approximately 0.000005 $\mu g/m^3$ up to 0.000068 $\mu g/m^3$. The highest 12-month average result (0.000068 $\mu g/m^3$) was measured at Station K11. The annual average value for all stations due to uranium was 0.000022 $\mu g/m^3$.

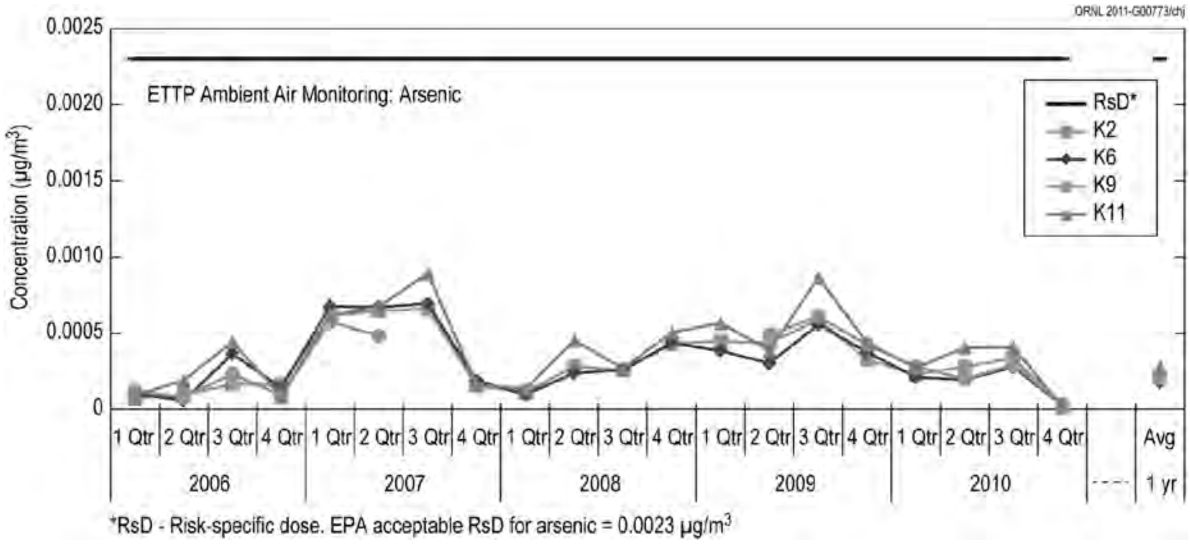


Fig. 3.16a. Arsenic monitoring results: 5-year history up through 2010.

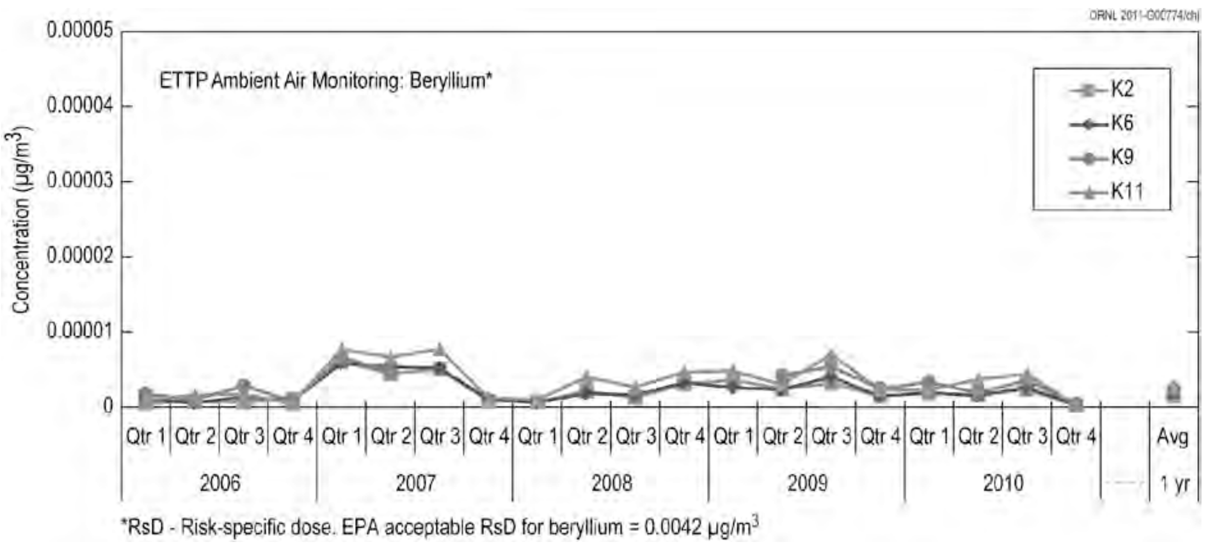


Fig. 3.16b. Beryllium monitoring results: 5-year history up through 2010.

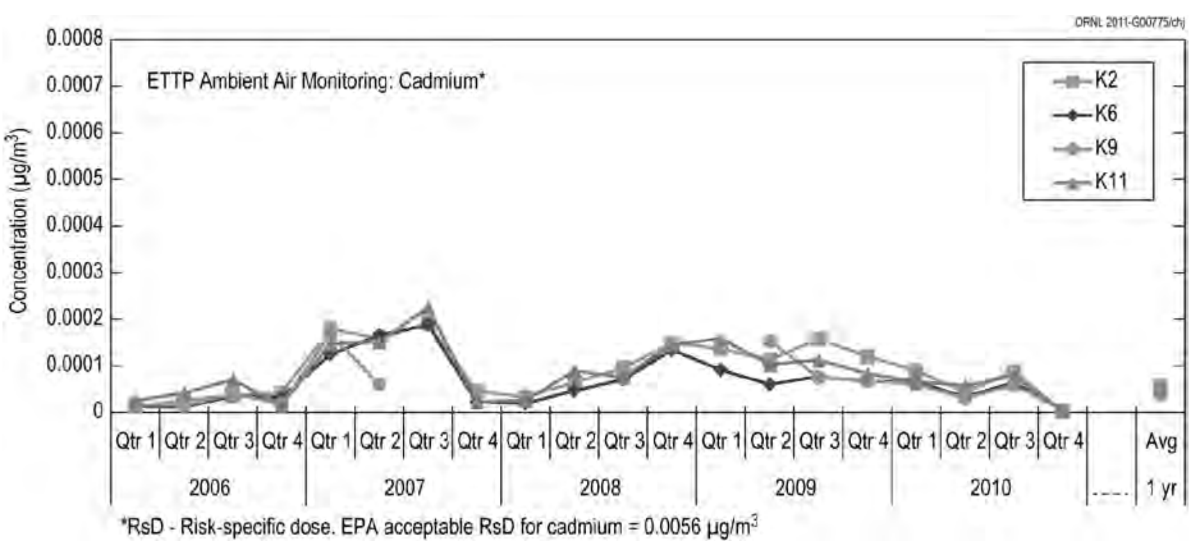
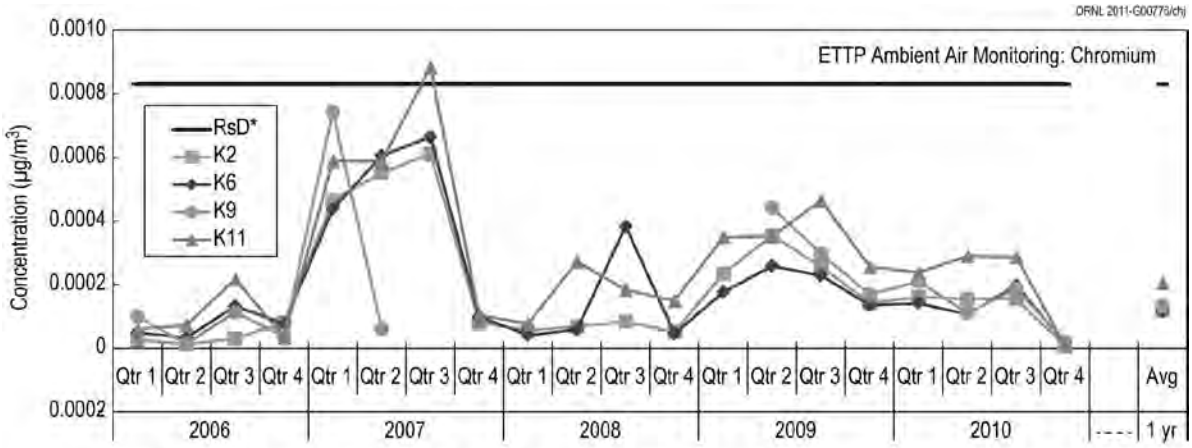
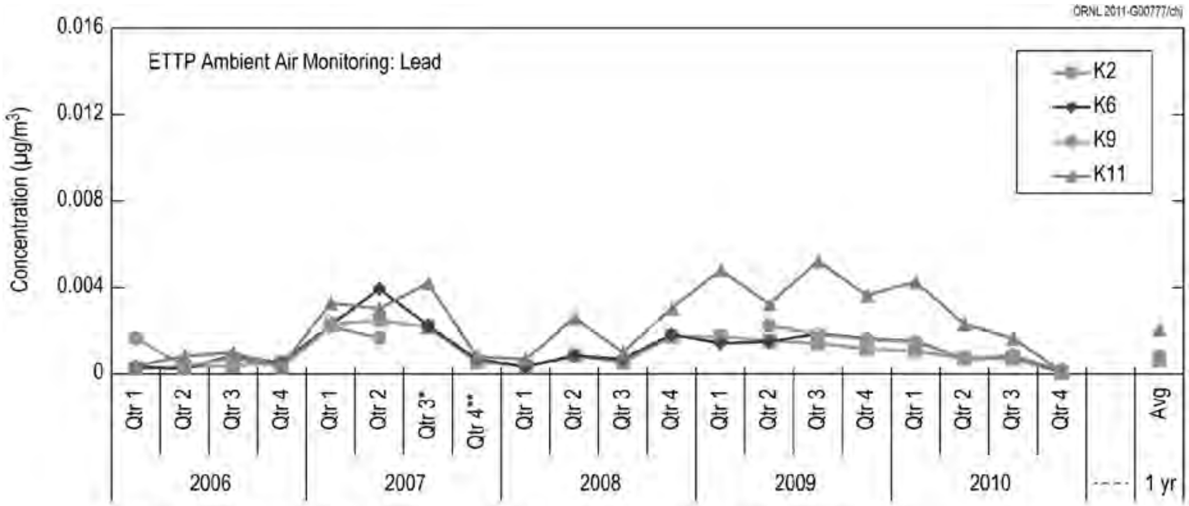


Fig. 3.16c. Cadmium monitoring results: 5-year history up through 2010.



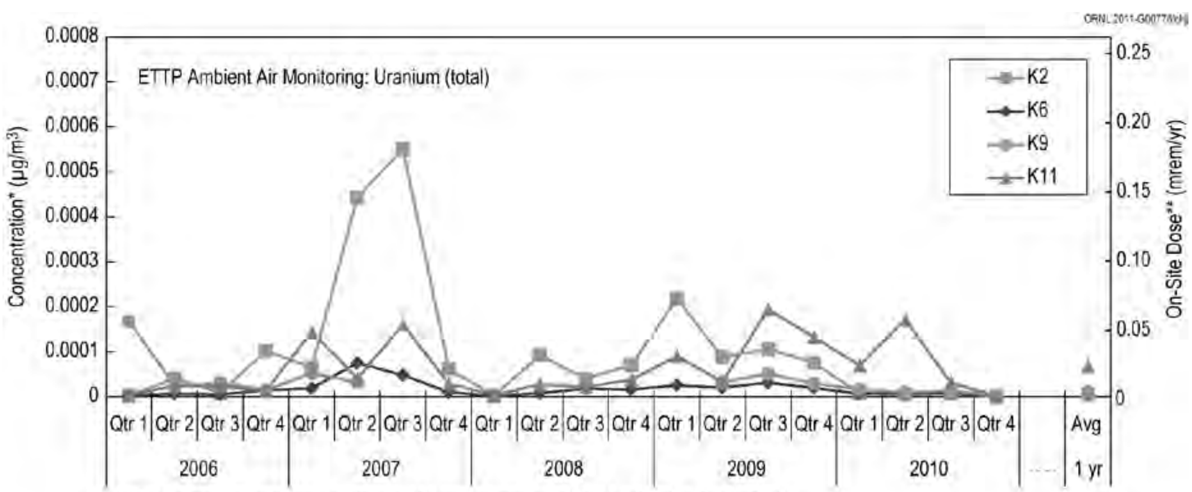
*RsD - Risk-specific dose. EPA acceptable RsD for chromium = 0.00083 µg/m³

Fig. 3.16d. Chromium monitoring results: 5-year history up through 2010.



*National Ambient Air Quality Standard (NAAQS) for lead = 1.5 µg/m³ per quarter through Sept. 2008.
**NAAQS for lead = 0.15 µg/m³ per quarter beginning Oct. 2008.

Fig. 3.16e. Lead monitoring results: 5-year history up through 2010.



*DCG for natural uranium resulting in 100 mrem/year is 1.03E-13 µCi/m³ = 0.15 µg/m³.
**EPA approved ORR on-site business receptor dose assumes a 50% annual occupancy.

Fig. 3.17. Uranium metal monitoring results: 5-year history up through 2010.

Table 3.4. Total uranium in ambient air by ICP-MS at the ETTP

Station	Analyzed Samples	Concentration[a] (µg/m^3) Avg	Concentration[a] (µg/m^3) Max[c]	Concentration[a] (µCi/mL) Avg	Concentration[a] (µCi/mL) Max	Percent of DCG[b] (%) Avg	Percent of DCG[b] (%) Max
K2	4	0.000005	0.000007	3.26E-18	4.96E-18	0.00	0.00
K6	4	0.000006	0.000009	3.69E-18	5.67E-18	0.00	0.01
K9	4	0.000010	0.000016	6.70E-18	1.09E-17	0.01	0.01
K11	4	0.000068	0.000170	4.54E-17	1.14E-16	0.05	0.11
ETTP Total	16	0.000022	0.000170	1.48E-17	1.14E-16	0.01	0.11

[a] Mass-to-curie concentration conversions assume a natural uranium assay of 0.717% ^{235}U

[b] DOE Order 5400.5 Derived Concentration Guide (DCG) for naturally occurring uranium is an annual concentration of 1 × 10^{13} µCi/mL, which is equivalent to a 100-mrem annual dose.

[c] Maximum individual sample analysis result with dose calculations conservatively assuming the value to be an annual concentration.

The ICP-MS results are compared with the derived concentration guide (DCG) for natural uranium as listed in DOE Order 5400.5. The DCG is based on an annual air concentration exposure that would give a dose of 100 mrem. The highest annual result (K11) only corresponds to 0.05% of the DCG. The single sampling location with the highest quarterly concentration (0.000170 µg/m^3) during 2010 was at station K11. If this concentration were extrapolated to a 12-month exposure, it would only represent 0.11% of the DCG.

Radiochemical analyses were initiated during CY 2000 on quarterly composite samples collected at all stations. The selected isotopes of interest were ^{237}Np, ^{238}Pu, ^{239}Pu, ^{99}Tc, and isotopic uranium (^{234}U, ^{235}U, ^{236}U, and ^{238}U). Table 3.5 presents the concentration and dose results for each of the radionuclides for 2010.

Table 3.5. Radionuclides in ambient air at ETTP, 2010

Station	Concentration (µCi/mL) ^{237}Np	^{238}Pu	^{239}Pu	^{99}Tc	^{234}U	^{235}U	^{238}U	Total U
K2		7.57E-18	6.99E-18	4.78E-17	1.26E-17	4.54E-19	1.94E-17	3.25E-17
K6	ND	1.86E-18	5.56E-19	6.21E-17	1.52E-17	ND	5.32E-18	2.05E-17
K9	ND	2.16E-18	6.67E-19	5.37E-17	2.55E-17	ND	1.04E-17	3.58E-17
K11	ND	4.48E-18	4.46E-18	3.16E-16	1.43E-16	6.05E-18	3.33E-17	1.82E-16
	40 CFR 61, Effective Dose (mrem/year)[b]							
Station	^{237}Np	^{238}Pu	^{239}Pu	^{99}Tc	^{234}U	^{235}U	^{238}U	Total U
K2	ND	0.0161	0.0148	0.0002	0.0067	0.0002	0.0091	0.0160
K6	ND	0.0039	0.0012	0.0003	0.0088	ND	0.0027	0.0116
K9	ND	0.0046	0.0014	0.0002	0.0135	ND	0.0049	0.0184
K11	ND	0.0095	0.0095	0.0013	0.0759	0.0030	0.0157	0.0946

[a]ND = not detected

[b]40 CFR 61, Subpart H limit = 10 mrem/year for DOE ORR combined radionuclide airborne emissions to the most exposed member of the public.

The U. S. Environmental Protection Agency (EPA) requires facilities to utilize approved computer models to determine the ED. The potential for public exposure to radionuclide emissions as measured at all ETTP area ambient air stations is assessed using the EPA's CAP88-PC (Version 3) model. Figure 3.18 is a 5-year historical summary chart of CAP88-based dose-calculation results of ETTP ambient air sampling isotopic radionuclide analyses. Each quarterly result is the total dose from all measured radionuclides during the applicable measurement period. The 12-month rolling dose total is the summation of the previous four quarterly results. All data show potential doses well below the 10-mrem annual dose limit.

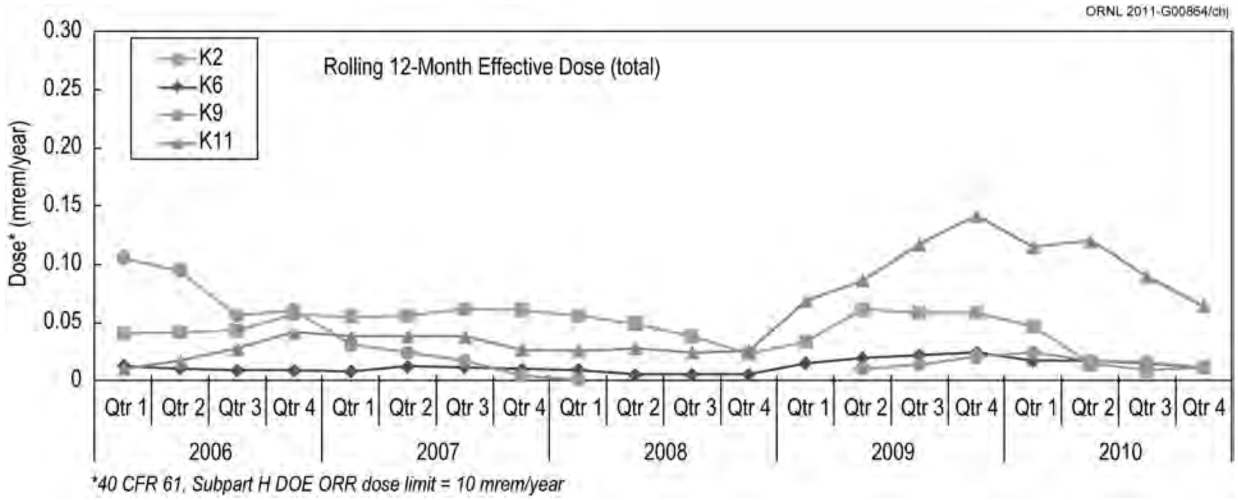


Fig. 3.18. Radionuclide monitoring results: 5-year rolling 12-month dose history up through 2010.

3.5 Water Quality Program

3.5.1 ETTP NPDES Permit History

The CWA/NPDES Program at ETTP ensures compliance with applicable state and federal regulations, DOE orders, and site-specific policies and procedures for ETTP activities that produce discharges to waters of the United States. It also provides management, oversight, and guidance to ETTP organizations to ensure compliance with applicable regulations and requirements.

Because the ETTP is an operating facility that discharges wastewater to several bodies of surface water, it is required to have a NDPES permit. EPA issued ETTP its first NPDES permit in 1975; the permit was to remain in effect until 1980. This permit established technology-based effluent limitations for nine outfalls.

In 1980, the site submitted an application for renewal of the permit within the required 180 days of the expiration date of the permit. The permit was not renewed, and the site operated under the expired permit until 1984. EPA issued the site a new NPDES permit in 1984 that remained in effect until February 1989. Under this permit, ETTP had eight NPDES monitoring locations, including the K-1700 weir, K-1203 Sewage Treatment Plant (STP), K-1007-P1 Pond, K-901-A Pond, K-710 STP, K-1515-C Holding Lagoon, K-1407-E/F Ponds, and the CNF.

EPA granted the state of Tennessee primacy for administration of the NPDES permitting program in 1986. The ETTP submitted an application for renewal of the NPDES permit to TDEC in August 1988. Because of staffing shortages at TDEC, permit negotiations were delayed until early 1992. Written approval was granted by TDEC to allow the site to continue operating under the conditions of the expired permit until a renewed permit could be issued.

On October 1, 1992, NPDES Permit TN0002950 became effective. Several of the eight monitoring locations specified in the previous ETTP NPDES permit were re-designated as ambient surface water monitoring locations. Effluent limitations in the 1992 NPDES permit were water quality based, which reflected the trend toward considering the effects of industrial discharges on the quality of the receiving streams. In accordance with the federal regulations requiring the inclusion of storm water discharges in the NPDES permitting program, each of the 137 storm water outfalls that had been identified at ETTP were included in this permit, in addition to several other major treatment facility outfalls. Also, the development of a Storm Water Pollution Prevention Program (SWP3) sampling and analysis plan was required. TDEC issued a major modification to this NPDES permit that became effective June 1, 1995. This modification included (1) removal of outfalls 010 and 012 to reflect shutdown treatment operations; (2) changes to monitoring requirements for outfall 014 to allow for treatment of contaminated groundwater; (3) changes to outfall 005 permit limits to make them more consistent with other sewage treatment plants; (4) clarification of some ambiguous permit language; and (5) updating of storm water outfall numbers.

ETTP NPDES Permit TN0002950 expired on September 29, 1997. An application for renewal of the ETTP NPDES permit was submitted to TDEC in March 1997. To facilitate the privatization of ETTP facilities, separate permits were requested for the K-1203 STP, the CNF, the K-1515 Sanitary Water Plant, and the ETTP storm water outfalls. A general permit for the K-1515 Sanitary Water Plant (permit number TN0074233) was issued by TDEC and became effective on March 1, 2000. A permit for the K-1203 STP (permit number TN0074241) was issued by TDEC and became effective on August 1, 2003. The prior permit for the CNF (permit number TN0074225) was issued by TDEC and became effective on November 1, 2003. The newly issued permit for CNF became effective on December 1, 2010, with an expiration date of December 31, 2013.

The prior ETTP NPDES storm water permit expired on March 31, 2008. The NPDES Permit renewal application was submitted to TDEC by September 30, 2007. On September 8, 2008, a letter was issued by TDEC – Division of Water Pollution Control acknowledging the receipt of the permit application. The letter authorized continued discharges from the ETTP storm drain system via administrative extension of the current NPDES permit. ETTP operated under NPDES permit TN0002950 that was issued by TDEC and became effective on April 1, 2004, for the ETTP storm water outfalls. Although this permit expired on March 31, 2008, submission of the application for a new permit in September 2007 allowed ETTP to continue to discharge storm water under the expired NPDES permit until issuance of a new permit.

For the first quarter of 2010, the ETTP operated under NPDES permit TN0002950 that was effective on April 1, 2004, for the ETTP storm water outfalls. The new NPDES permit for ETTP was issued by TDEC on February 26, 2010, with an effective date of April 1, 2010, and an expiration date of December 31, 2013.

Management of the sanitary sewer system at ETTP has been turned over to the city of Oak Ridge as part of an agreement among DOE, CROET, and the city of Oak Ridge. Under this agreement, sewage from ETTP is now being piped to the Rarity Ridge sanitary sewage treatment plant located approximately 1 mile west of ETTP. The NPDES permit for this facility is assigned to the city of Oak Ridge, which performs all monitoring and reporting required by the permit.

All BJC connections to the sewage colleciton system are covered by a “No Discharge Certification” process derived from the city of Oak Ridge wastewater control requirements in accordance with the City Sewage Treatment Plant NPDES permit. The No Discharge Certification states that BJC Operations will only discharge waste associated with normal quantities of material associated with normal human habitation to the city of Oak Ridge sewage collection system. These discharges primarily include waste from break rooms, restrooms, change houses, etc. As part of the No Discharge Certification process, notification is provided to the city of Oak Ridge by BJC when planned operational changes are made to BJC facilities that could affect the city of Oak Ridge sewage collection system. ETTP is also subject to the provisions of the city of Oak Ridge’s sewer use ordinance, which defines the terms and conditions under which the city of Oak Ridge accepts discharges to its sewage collection system.

3.5.2 ETTP NPDES Permit Description – Previous NPDES Permit

ETTP NPDES Permit No. TN0002950 that was issued in 2004, remained in effect for the first quarter of calendar year (CY) 2010 before the new NPDES permit became effective on April 1, 2010. The former permit regulated the discharge of storm water runoff, groundwater infiltration, groundwater from sumps, non-contact cooling water, and steam condensate from ETTP to Mitchell Branch, Poplar Creek, and the

Clinch River. There were 121 permitted storm water outfalls at ETTP under the former NPDES Permit No. TN0002950. A total of 38 storm water outfalls and one alternate outfall were required to be sampled as being representative of the groups. The outfalls were grouped into four categories based on the types of flows being discharged through the outfalls.

- **Group IV storm water outfalls** (Table 3.6) generally flow continuously. They may discharge storm water runoff, groundwater infiltration, and groundwater from sumps. These outfalls receive storm water runoff from site industrial operations that have the greatest potential for contamination. The representative outfalls in this group must be monitored weekly for flow and pH and quarterly for oil and grease and total suspended solids (TSS).
- **Group III storm water outfalls** (Table 3.7) flow continuously or intermittently. They may discharge storm water runoff, groundwater infiltration, and groundwater from sumps. These outfalls receive storm water runoff from site industrial operations with potential for contamination. The representative outfalls in this group must be monitored monthly for flow and pH and quarterly for oil and grease and TSS.
- **Group II storm water outfalls** (Table 3.8) flow intermittently. They may discharge storm water runoff, groundwater infiltration, and groundwater from sumps. These outfalls do not have a significant potential to discharge contaminants. The representative outfalls in this group must be monitored quarterly for flow and pH and annually for TSS.
- **Group I storm water outfalls** (Table 3.9) flow intermittently. They receive flow from remote areas of the site, from administrative and other nonindustrial operation areas, and from site roads and railways. They may discharge storm water runoff, groundwater infiltration, and groundwater from sumps. These outfalls pose little or no threat of discharging significant amounts of contaminants. The representative outfalls in this group must be monitored semiannually for flow and pH.

3.5.3 NPDES Permit Description – New NPDES Permit

As part of the NPDES permit that became effective on April 1, 2010, several of the storm water outfalls from the previous NPDES permit were recategorized. In general outfalls that were included as part of the Group I and Group II outfalls in the previous NPDES permit were combined into a single group. This group is designated as Group I. Generally outfalls that were included as part of the Group III and Group IV outfalls in the previous NPDES permit have also been combined into a single group. This group is designated as Group II.

Some of the Group I and Group II outfalls in the previous NPDES permit that flow on a continuous or almost continuous basis became Group II outfalls. Several outfalls that were in Group II or Group III in the previous NPDES permit have been designated as Group I outfalls.They will no longer be monitored as frequently as in the previous permit. Also, several of the outfalls that were monitored as part of the previous NPDES permit are no longer monitored as part of this NPDES permit. These modifications were made due to the flow characteristics of the outfalls, their history of compliance with the previous NPDES permit, and remediation of the areas drained by the outfalls.

There are currently 108 NPDES-permitted storm water outfalls at ETTP. The previous NPDES storm water permit covered 121 storm water outfalls. Thirteen of these outfalls are no longer permitted and were removed from coverage under the NPDES permit that became effective on April 1, 2010.

As part of the newly issued NPDES permit, the storm water outfalls are listed in two groups based on the types of flows being discharged through the outfalls. A total of 32 storm water outfalls will be sampled as being representative of these groups. Several changes were made in the parameters for each group, and the proposed monitoring frequencies are lower than in the previous NPDES permit. These modifications were based on the long-term sample result trends that have been established over the past 15 years. The groups are briefly described as follows. Tables 3.10 and 3.11 show the outfall groupings and the monitoring requirements for the representative outfalls in each group.

Table 3.6. Group IV storm water outfalls[a]

The following storm water outfall was sampled as being representative of Group IV as specified below:
Outfall 100

Parameter	Method	Frequency	Sample type	Minimum	Maximum	Screening level
Flow (MGD)	Estimated[b]	1/Week	NA	NA	NA	NA
pH (standard units)	EPA-150.1	1/Week	Grab[c]	6.0	9.0	<6.4 or >8.4
TSS (mg/L)	EPA-160.2	1/Quarter	Grab	NA	NA	70
Oil and Grease (mg/L)	EPA-1664A	1/Quarter	Grab	NA	NA	8.0

[a]The following Group IV storm water outfalls were not sampled: 128 and 130.

[b] TR55 method with rainfall data was used by the Environmental Compliance and Protection (EC&P) Organization to estimate flows. Flow was reported in million gallons per day (MGD) as estimated daily maximum values. No flow field measurements were required.

[c] The pH analyses were performed within 15 minutes of sample collection.

Table 3.7. Group III storm water outfalls[a,b]

The following storm water outfalls were sampled as being representative of Group III as specified below:
Outfalls 05A, 154, 158, 170, 180, 190, 195, 210, 230, 280, 294, 340, 350, 360, 382, 390, 430, 490, 710, 724/760a, 992

Parameter	Method	Frequency	Sample type	Minimum	Maximum	Screening level
Flow (MGD)	Estimated[c]	1/Month	NA	NA	NA	NA
pH (standard units)[d]	EPA-150.1	1/Month	Grab[b]	4.0	9.0	<6.0 or >8.4
TSS (mg/L)	EPA-160.2	1/Quarter	Grab	NA	NA	70
Oil and Grease (mg/L)	EPA-1664A	1/Quarter	Grab	NA	NA	8.0

[a]The following Group III storm water outfalls were not sampled: 156, 160, 162, 168, 200, 240, 270, 292, 330, 362, 387, 440, 700, 720, 730, 740, 750, 770, and 970.

[b]Outfall 724 will be sampled as being representative of this group, if possible. However, if seasonal fluctuations in the depth of the Clinch River cause this storm water outfall to become flooded, which will preclude sample collection efforts, storm water outfall 760 will be sampled as the representative of this group.

[c] TR55 method with rainfall data was used by the EC&P Organization to estimate flows. Flow waste reported in MGD as estimated daily maximum values. No flow field measurements were required.

[d] The pH analyses were performed within 15 minutes of sample collection.

Table 3.8. Group II storm water outfalls[a]

The following storm water outfalls were sampled as being representative of Group II as specified below:
Outfalls 124, 142, 150, 250, 380, 510, 570, 690 and 890

Parameter	Method	Frequency	Sample type	Minimum	Maximum	Screening Level
Flow (MGD)	Estimated[b]	1/Quarter	NA	NA	NA	NA
pH (standard units)[c]	EPA-150.1	1/Quarter	Grab[b]	4.0	9.0	<6.0 or >8.4
TSS (mg/L)	EPA-160.2	1/Year	Grab	NA	NA	70

[a]The following Group II storm water outfalls were not sampled: 120, 129, 140, 144, 146, 148, 262, 296, 297, 300, 310, 320, 530, 540, 550, 560, 580, 600, 610, 620, 640, 680, 692, 694, 696, 780, 800, 820, 830, 860, 870, 880 and 892.

[b] TR55 method with rainfall data was used by the EC&P Organization to estimate flows. Flow was reported in MGD as estimated daily maximum values. No flow field measurements were required.

[c]The pH analyses shall be performed within 15 minutes of sample collection.

Table 3.9. Group I storm water outfalls[a]

The following storm water outfalls were sampled as being representative of Group I as specified below:
Outfalls 198, 334, 410, 532, 660, 900 and 996

Parameter	Method	Frequency	Sample type	Minimum	Maximum	Screening level
Flow (MGD)	Estimated[b]	2/Year	NA	NA	NA	NA
pH (standard units)[c]	EPA-150.1	2/Year	Grab[b]	4.0	9.0	<6.0 or >8.4

[a]The following Group I storm water outfalls were not sampled: 196, 197, 220, 322, 326, 332, 400, 420, 450, 460, 470, 500, 520, 522, 590, 650, 670, 897, 910, 920, 929, 930, 934, 940, 950, 960, 980 and 990.

[b] TR55 method with rainfall data was used by the EC&P Organization to estimate flows. Flow was reported in MGD as estimated daily maximum values. No flow field measurements were required.

[c] The pH analyses were performed within 15 minutes of sample collection.

Table 3.10. Group I storm-water outfalls permit information
Outfalls 195, 198, 250, 280, 410, 660, 930, and 992

Effluent characteristic (units)	Method	Effluent limitations	Screening level	Monitoring requirements	
				Measurement frequency	Sample type
Flow (MGD)	Estimate[a]	Report	NA	2/Year	Estimate[a]
pH (standard units)	SM-4500-H^+ B	Within range 6.0 – 9.0	<6.4 or >8.4	2/Year	Grab[b]
TSS (mg/L)	SM-2540 D	Report daily maximum concentration	70	2/Year	Grab

The following Group I storm water outfalls will not be sampled: 146, 156, 162, 168, 196, 197, 262, 270, 296, 297, 300, 310, 320, 387, 390, 400, 420, 500, 520, 522, 532, 540, 550, 570, 580, 620, 640, 650, 670, 680, 692, 696, 780, 800, 820, 830, 860, 870, 880, 892, 934, 940, 950, 960, 970, 980, 990, and 996.

[a] Flow shall be reported in MGD as estimated daily maximum values. Flow will be calculated by EC&P personnel using the Soil Conservation Service TR-55 storm water runoff model.

[b] The pH analyses shall be performed within 15 min of sample collection.

Table 3.11. Group II storm-water outfalls permit information
Outfalls 05A, 100, 142, 150, 170, 180, 190, 230, 294, 334, 340, 350, 380, 382, 430, 490, 510, 560, 690, 694, 700, 710, 724, 890

Effluent characteristic (units)	Method	Effluent limitations	Screening level	Monitoring requirements	
				Measurement frequency	Sample type
Flow (MGD)	Estimate[a]	Report	NA	2/Year	Estimate[a]
pH (standard units)	SM-4500-H^+ B	Within range 6.0 – 9.0	<6.4 or >8.4	2/Year	Grab[b]
TSS (mg/L)	SM-2540 D	Report daily maximum concentration	70	2/Year	Grab
Oil and grease (mg/L)	EPA-1664 A	Report daily maximum concentration	8.0	2/Year	Grab

The following Group II outfalls will not be sampled: 140, 144, 148, 154, 158, 160, 200, 210, 220, 240, 292, 322, 326, 330, 332, 360, 362, 440, 530, 590, 600, 610, 720, 730, 740, 750, 760, 770

[a] Flow shall be reported in MGD as estimated daily maximum values. Flow will be calculated by EC&P personnel using the Soil Conservation Service TR-55 storm water runoff model.

[b] The pH analyses shall be performed within 15 min of sample collection.

3.5.3.1 Group I Storm Water Outfalls

The Group I storm water outfalls flow on an intermittent basis. These outfalls receive storm water runoff from minor site industrial operation areas that do not have a significant potential to contain contaminants. They may also receive runoff from minor decontamination and decommissioning (D&D) and remedial action (RA) activities. These areas do not have outside material storage that poses a risk of contaminating runoff. These outfalls also receive storm water runoff from remote areas of the site, including drainage from fields, grassy areas, and forested areas that have not been used for industrial purposes; administration and other nonindustrial operation areas; site roads and railways; employee access roads and parking areas; and internal site transportation routes. These outfalls may also discharge uncontaminated groundwater from infiltration or sumps. In addition, these outfalls may periodically receive sanitary and fire suppression system water from maintenance and testing activities, lawn watering, routine external wash down of administration buildings without detergent, and uncontaminated pavement wash waters without detergent. Effluent from Group I outfalls poses little or no threat of containing significant pollutants. Table 3.10 contains information on the Group I outfalls.

The following storm water outfalls will be sampled as representative of Group I as specified in Table 3.10.

3.5.3.2 Group II Storm Water Outfalls

Many of the Group II storm water outfalls flow on a continuous basis. These outfalls receive storm water runoff from site industrial operations where there is a higher potential for contamination than Group I. These areas include soil storage yards, outside radiological areas and other areas that pose a risk of potential contamination. Group II outfalls may also receive industrial and administrative area roof drainage, cooling tower blowdown, railroad runoff, runoff from areas undergoing D&D and soil remediation activities, drainage from fields and grassy areas, fire suppression system water from maintenance and testing activities, and radiological area runoff. Group II outfalls may also discharge potentially contaminated groundwater from infiltration or sumps, burial ground seeps, and cooling tower blowdown. These outfalls may also receive effluents described for Group I storm water outfalls. Table 3.11 contains information on the Group II outfalls.

The following storm water outfalls will be sampled as representative of Group II as specified in Table 11.

Additional monitoring of selected Group II outfalls will be performed for specific parameters as part of the newly issued NPDES permit.

The following outfalls will be monitored as specified in Tables 3.12 and 3.13.

3.5.4 Outfalls Grouped by Sub-watershed

ETTP is divided into seven distinct sub-watersheds. Each of these sub-watersheds is drained by several storm water outfalls. Representative outfalls have been chosen for each sub-watershed, and these representative outfalls will be sampled as part of this NPDES permit.

Tables 3.14–3.20 contain information on all of the outfalls in each designated sub-watershed, whether the outfall is a Group I or Group II outfall, and which of these outfalls will be sampled as representative of the outfalls in the sub-watershed.

3.5.5 ETTP Storm Water Pollution Prevention Program

The development of the ETTP SWP3 was required by Part IV of the ETTP NPDES Permit No. TN0002950. The purpose of the SWP3 sampling program is to evaluate and characterize storm water runoff from ETTP. The sampling effort incorporates an increased emphasis on the identification of specific sources of pollutants that may be transported by storm water. This information is used to support the site cleanup program that is being conducted in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements. In addition, data collected as part of the ETTP SWP3 sampling effort will be used to complete the application for the next ETTP NPDES Permit renewal.

Analytical parameters to be monitored at each storm water outfall are chosen based on the following criteria:

- a review of available analytical data from previous storm water sampling efforts;
- knowledge of various processes and functions that have been conducted at ETTP;
- current and past material storage and handling practices; and
- current and past waste disposal practices employed at ETTP.

The ETTP SWP3 was originally implemented in 1993 as part of the requirements of the ETTP NPDES Permit that became effective in October 1992. An ETTP SWP3 was also included as a requirement in both the former ETTP NPDES Permit for storm water discharges that became effective on April 1, 2004, and the current ETTP NPDES Permit for storm water discharges that became effective April 1, 2010. Since the basic requirements for the SWP3 stated in the ETTP NPDES Permit that became effective in April 2010 are mostly the same as the requirements for the SWP3 defined in the ETTP NPDES Permit that became effective in April 2004, the format for documenting and reporting modifications to the SWP3 will be largely unchanged.

Table 3.12. Mercury monitoring at specified outfalls
Outfalls 05A, 170, 180, and 190

Effluent characteristic (units)	Method	Effluent limitations	Screening level	Monitoring requirements	
				Measurement frequency	Sample type
Total mercury[a] (mg/L)	EPA-1631	Report daily maximum concentration	0.000035	Quarterly	Grab

[a] Following four quarterly samples, a reevaluation will be considered of the need for further monitoring.

Table 3.13. Hexavalent chromium and total chromium monitoring at specified outfalls
Outfall 170

Effluent characteristic (units)	Method	Effluent limitations	Screening Level	Monitoring requirements	
				Measurement frequency	Sample type
Total chromium[a] (mg/L)	EPA-200.8	Report daily maximum concentration	0.008	Quarterly	Grab
Hexavalent chromium[a] (mg/L)	SM-3500-Cr D or ASTM D 5257	Report daily maximum concentration	0.008	Quarterly	Grab

[a] Following four quarterly samples, a reevaluation will be considered of the need for further monitoring**.**

Table 3.14. Storm water outfalls that discharge to Mitchell Branch (Sub-watershed MB1)

Outfall	Group I	Group II	Deleted Outfalls
140	--	X	--
142[a]	--	X	--
144	--	X	--
146	X	--	--
148	--	X	--
150[a]	--	X	--
154	--	X	--
156	X	--	--
158	--	X	--
160	--	X	--
162	X	--	--
168	X	--	--
170[a]	--	X	--
180[a]	--	X	--
190[a]	--	X	--
195[b]	X	--	--
196	X	--	--
197	X	--	--
198[b]	X	--	--
200	--	X	--
210	--	X	--
220	--	X	--

[a]These storm water outfalls will be sampled as representatives of Group II.
[b] These storm water outfalls will be sampled as representatives of Group I.

Table 3.15. Storm water outfalls that discharge to Poplar Creek (Sub-watershed PC1)

Outfall	Group I	Group II	Deleted Outfalls
929	--	--	X
930[a]	X	--	--
934	X	--	--
940	X	--	--
950	X	--	--
960	X	--	--
970	X	--	--
980	X	--	--
990	X	--	--
992[a]	X	--	--
996	X	--	--

[a] These storm water outfalls will be sampled as representatives of Group I.

Table 3.16. Storm water outfalls that discharge to the east side of Poplar Creek (Sub-watershed PC2)

Outfall	Group I	Group II	Deleted Outfalls
05A[a]	--	X	--
230[a]	--	X	--
240	--	X	--
250[b]	X	--	--
262	X	--	--
270	X	--	--
280[b]	X	--	--
292	--	X	--
294[a]	--	X	--
296	X	--	--
297	X	--	--
300	X	--	--
310	X	--	--
320	X	--	--
322	--	X	--
326	--	X	--
330	--	X	--
332	--	X	--
334[a]	--	X	--
340[a]	--	X	--
350[a]	--	X	--
360	--	X	--
362	--	X	--
380[a]	--	X	--
382[a]	--	X	--
387	X	--	--
390	X	--	--
400	X	--	--
410[b]	X	--	--
420	X	--	--
430[a]	--	X	--
440	--	X	--
450	--	--	X
460	--	--	X
470	--	--	X

[a]These storm water outfalls will be sampled as representatives of Group II.
[b]These storm water outfalls will be sampled as representatives of Group I.

Table 3.17. Storm water outfalls that discharge to the west side of Poplar Creek (Sub-watershed PC3)

Outfall	Group I	Group II	Deleted Outfalls
500	X	--	--
510[a]	--	X	--
520	X	--	--
522	X	--	--
530	--	X	--
532	--	X	--
540	X	--	--
550	X	--	--
560[a]	--	X	--
570	X	--	--
580	X	--	--
590	--	X	--
600	--	X	--
610	--	X	--
620	X	--	--
640	X	--	--
650	X	--	--
660[b]	X	--	--
670	X	--	--
680	X	--	--
690[a]	--	X	--
692	X	--	--
694[a]	--	X	--
696	X	--	--
720	--	X	--

[a]These storm water outfalls will be sampled as representatives of Group II.
[b] These storm water outfalls will be sampled as representatives of Group I.

Table 3.18. Storm water outfalls that discharge to Poplar Creek via the K-1007-P1 Pond (Sub-watershed PC4)

Outfall	Group I	Group II	Deleted Outfalls
100[a]	--	X	--
120	--	--	X
124	--	--	X
128	--	--	X
129	--	--	X
130	--	--	X
490[a]	--	X	--

[a] These storm water outfalls will be sampled as representatives of Group II.

Table 3.19. Storm water outfalls in the Powerhouse area that discharge to the Clinch River (Sub-watershed CR1)

Outfall	Group I	Group II	Deleted Outfalls
724[a]	--	X	--
730	--	X	--
740	--	X	--
750	--	X	--
760	--	X	--
770	--	X	--
780	X	--	--
800	X	--	--
820	X	--	--
830	X	--	--
860	X	--	--
870	X	--	--
880	X	--	--
890[b]	--	X	--
892	X	--	--
897	--	--	X
900	--	--	X
910	--	--	X
920	--	--	X

[a] These storm water outfalls will be sampled as representatives of Group II.

Table 3.20. Storm water outfalls that discharge to the Clinch River via the K-901-A Pond (Sub-watershed CR2)

Outfall	Group I	Group II	Deleted Outfalls
700[a]	--	X	--
710[a]	--	X	--

[a]These storm water outfalls will be sampled as representatives of Group II.

The ETTP NPDES Permit issued in April 2010 includes a requirement to review and update, if necessary, the SWP3 Plan, at least annually. This requirement is met by publishing the ETTP SWP3 Annual Update Report, which includes SWP3 monitoring results, site inspection summaries, and other information from the fiscal year that is ending.

Additionally, the SWP3 Baseline Document, which was originally created in September 1994 to serve as a reference document for implementing and conducting the required elements of the ETTP SWP3, will continue to be utilized as part of the ETTP SWP3 specified in the ETTP NPDES Permit that became effective on April 1, 2010. The SWP3 Baseline Document contains

- background information on ETTP and the ETTP storm water drainage network,
- best management practices used at the ETTP,
- guidance on conducting inspections that are required by the SWP3,
- organizational roles and responsibilities for conducting the SWP3, and
- general information on storm water sampling and analysis.

Most of the information presented in the baseline document changes very little from year to year. Therefore, the baseline document is reviewed annually and updated as necessary.

3.5.5.1 Comparison of the Storm Water Pollution Prevention Program (SWP3) Sampling Results to Screening Levels

The SWP3 sampling provides information required as part of the ETTP NPDES permit renewal process. The sampling effort also incorporates an increased emphasis on the identification of specific sources of pollutants that may be transported by storm water. This information is used to support the site cleanup program that is being conducted in accordance with CERCLA requirements.

Analytical results from the SWP3 sampling effort conducted in 2010 were compared with applicable screening levels to identify locations where storm water runoff could be contributing pollutants to receiving waters. These screening levels were applied to all data collected as part of the 2010 SWP3 storm water sampling effort. In general, the most stringent criterion that could be identified in the references given for a particular parameter was chosen as the screening level for that parameter. Applicable screening levels for data collected as part of the SWP3 sampling program are listed in Table 3.21.

Table 3.21. Project quantitation[a] levels, screening levels, and reference standards for storm water monitoring at ETTP

Parameter	Project quantitation level	Screening level	Reference standard	Units
Radionuclides				
Gross alpha	5	15	15	pCi/L
Gross beta	5	50	50	pCi/L
^{60}Co	10	200	5,000	pCi/L
^{90}Sr	4	40	1,000	pCi/L
^{99}Tc	12	4,000	100,000	pCi/L
^{228}Th	1	16	400	pCi/L
^{230}Th	1	12	300	pCi/L
^{232}Th	1	2	50	pCi/L
^{226}Ra	0.3	4	100	pCi/L
^{3}H	300	80,000	2,000,000	pCi/L
^{234}U	1	20	500	pCi/L
^{235}U	1	24	600	pCi/L
^{236}U	1	20	500	pCi/L
^{238}U	1	24	600	pCi/L
Total U	1	31	770	µg/L
^{137}Cs	10	120	3,000	pCi/L
^{237}Np	0.4	1.2	30	pCi/L
^{238}Pu	1	1.6	40	pCi/L
$^{239/240}$Pu	1	1.2	30	pCi/L
Volatile organic compounds (VOCs)				
1,1,1-Trichloroethane	2	75	100	µg/L
1,1,2,2-Tetrachloroethane	2	30	40	µg/L
1,1,2-Trichloroethane	2	75	100	µg/L
1,1-Dichloroethane	2	75	100	µg/L
1,1-Dichloroethene	2	24	32	µg/L
1,2-Dichloroethane	2	75	100	µg/L
1,2-Dichloropropane	2	75	100	µg/L
2-Butanone	10	75	100	µg/L
2-Hexanone	10	75	100	µg/L
4-Methyl-2-pentanone	10	75	100	µg/L
Acetone (2-Propanone)	10	75	100	µg/L

Table 3.21 (continued)

Parameter	Project quantitation level	Screening level	Reference standard	Units
Benzene	2	75	100	µg/L
Bromodichloromethane	2	75	100	µg/L
Bromoform	2	75	100	µg/L
Bromomethane (methyl bromide)	2	75	100	µg/L
Carbon disulfide	10	75	100	µg/L
Carbon tetrachloride	2	12	16	µg/L
Chlorobenzene	2	75	100	µg/L
Chloroethane	2	75	100	µg/L
Chloroform	2	75	100	µg/L
Chloromethane (methyl chloride)	2	75	100	µg/L
Cis-1,2-Dichloroethene	2	75	100	µg/L
Cis-1,3-Dichloropropene	2	75	100	µg/L
Dibromochloromethane	2	75	100	µg/L
Ethylbenzene	2	75	100	µg/L
Methylene chloride	2	75	100	µg/L
Styrene	2	75	100	µg/L
Tetrachloroethene	2	25	33	µg/L
Toluene	2	75	100	µg/L
Trans-1,2-Dichloroethene	2	75	100	µg/L
Trans-1,3-Dichloropropene	2	75	100	µg/L
Trichloroethene	2	75	100	µg/L
Vinyl chloride	2	18	24	µg/L
Xylenes (dimethyl benzene)	2	75	100	µg/L
Polychlorinated biphenyls (PCBs)				
PCBs	0.5	detectable	0.00064	µg/L
Metals				
Aluminum	100	N A	NA	µg/L
Antimony	00	480	640	µg/L
Arsenic	6	7	10	µg/L
Barium	100	NA	NA	µg/L
Beryllium	5	75	100	µg/L
Boron	100	NA	NA	µg/L
Cadmium	1	Detectable	0.25	µg/L
Calcium	100	NA	NA	µg/L
Chromium, total	25	75	100	µg/L
Chromium, VI	5	8	11	µg/L
Cobalt	100	NA	NA	µg/L
Copper	3	6.8	9.0	µg/L
Iron	100	NA	NA	µg/L
Lead	2	2	2.5	µg/L
Lithium	5	75	100	µg/L
Magnesium	100	NA	NA	µg/L
Manganese	100	NA	NA	µg/L
Mercury	0.1	Detectable	0.051	µg/L
Nickel	5	39	52	µg/L
Potassium	100	NA	NA	µg/L
Selenium	2	3.8	5	µg/L
Silver	1	2.4	3.2	µg/L
Sodium	100	NA	NA	µg/L
Thallium	5	Detectable	0.47	µg/L
Vanadium	100	NA	NA	µg/L
Zinc	2	90	120	µg/L

Table 3.21 (continued)

Parameter	Project quantitation level	Screening level	Reference standard	Units
		Field readings		
Dissolved oxygen (minimum)	4.0–8.0	<6.0	5.0	mg/L
pH (maximum)	14.0	>8.4	9.0	Standard units
pH (minimum)	1.0	<6.4	6.0	Standard units
Temperature	0–100	>27	NA	^{o}C

[a] Quantitation is defined as the lowest amount of analyte in a sample that can be quantitatively determined with suitable precision and accuracy.

Screening levels for which immediate notifications are required are provided to the analytical laboratories, in order to receive early notification that a result is approaching or has exceeded an effluent limitation. Early notification can lead to actions that prevent a noncompliance or multiple noncompliances with the permit. Notification of storm water screening level exceedances are sent automatically from designated subcontract laboratories to the BJC Sample Management Office (SMO) upon completion of sample analysis and verification of analytical results. The SMO is responsible for immediately notifying ETTP Environmental Compliance and Protection (EC&P) personnel that the screening level exceedance has occurred so that investigation can be initiated to determine if best management practices or other corrective measures may be required. When necessary, corrective actions will be implemented to ensure that an NPDES permit limit or other reference standard is not exceeded during subsequent sampling events.

The screening level for a specific radionuclide is equal to 4% of the derived concentration guide (DCG) for that radionuclide in water, as listed in DOE Order 5400.5, Chap. 3; the reference standard is the DCG for each radionuclide. Four percent of the DCG represents the DOE criterion of 4 millirem effective dose equivalent (EDE) from ingestion of drinking water. Screening levels and reference standards are 15 pCi/L for gross alpha and 50 pCi/L for gross beta per the National Primary Drinking Water regulations, Subparts B and G (40 CFR 141).

Screening levels and reference standards for other parameters are generally based on Tennessee water quality criteria (WQC), Rules of Tennessee Division of Water Pollution Control, Chap. 1200-4-3 (TDEC 2009), and the criteria listed in the ETTP NPDES Permit TN0002950, Part III, A, Toxic Pollutants.

3.5.5.2 Storm Water Monitoring Conducted as Agreed to in CERCLA Phased Construction Completion Reports

On January 5, 2007, a meeting was held with TDEC/DOE-O personnel to discuss monitoring expectations for contaminated slabs that remain following building demolition and that await remediation. A review of the *Balance of Site—Laboratory Phased Construction Completion Reports* (PCCRs) (DOE 2007, 2007a, 2007b) by TDEC personnel raised issues about monitoring of the building slabs. TDEC personnel expressed concern about the potential release of contaminants from the slabs and did not believe that the PCCRs currently describe the monitoring effort in sufficient detail. TDEC agreed that DOE meets the requirements of 10 CFR 835 and DOE Order 5400.5 through the Radiation Protection Program, storm water compliance monitoring, and ambient watershed exit pathway sampling. However, TDEC personnel stated that the PCCRs needed to be more specific in describing the location and frequency of monitoring for the slab in question.

To obtain additional analytical information to address some of TDEC's stated concerns with the PCCRs, sampling of storm water runoff was conducted at various locations where radiological contamination may be present on the concrete pads or footprints of buildings that have recently been demolished. Samples of storm water runoff from the concrete pads/building footprints in each of the areas were collected at nearby storm water catch basins or directly from the building pads. The samples were collected to obtain data that would be considered as the worst-case radiological discharge from these areas. Runoff samples collected directly from the building pads were collected from areas where the flow is most prevalent or most concentrated into a distinct discharge.

Samples were collected when runoff from the pads was sufficient to allow all of the samples for the given analytical parameters to be collected, regardless of the amount or intensity of the rainfall event. Storm water outfalls were sampled as close as possible to the time that the building pads, or catch basins that drain to them, were sampled. This was done to allow some correlation of the contaminant levels in the runoff samples from the building pads with the levels of contaminants in the storm water outfall samples. Samples collected from each of the locations listed in Table 3.22 were analyzed for gross alpha/gross beta radiation, isotopic uranium, total uranium, and ^{99}Tc.

Table 3.22. Results exceeding screening levels for 2010 radiological monitoring performed in conjunction with PCCR RA and D&D activities

Sampling location	Date sampled	Gross alpha radiation (pCi/L)	Gross beta radiation (pCi/L)	^{233}U/^{234}U (pCi/L)	^{235}U/^{236}U pCi/L)	^{238}U (pCi/L)	Total uranium (μg/L)	^{99}Tc (pCi/L)
Screening Level[a]		15	50	20	24	24	31	4000
Outfall 158	1/2010	104	---	50.8	---	30.8	93.3	---
Outfall 160	1/2010	242	---	136	---	47	143	---
Outfall 170	1/2010	---	---	---	---	---	---	---
K-1420 Pad runoff	1/2010	110	---	77.3	---	---	33.6	---

[a]Screening levels are 15 pCi/L gross alpha radiation, 50 pCi/L gross beta radiation, 20 pCi/L $^{233/234}$U, 24 pCi/L ^{235}U-235 and ^{238}U, and 31 μ/L total uranium.

All runoff and outfall samples collected as part of this effort were taken using the manual grab sampling method. Manual grab samples were collected according to the guidelines specified in Sects. 3.1.2 and 3.3.1 of the EPA's *NPDES Storm Water Sampling Guidance Documen*t (EPA 1992) and applicable procedures that have been developed by the sampling subcontractor. All guidelines stated in the ETTP *SWP3 Sampling and Analysis Plan* (SAP) (BJC 2009b, 2010b) concerning sample documentation, analytical procedures, quality assurance (QA), and quality control (QC) were followed as part of this sampling effort.

Sampling locations were chosen based on the observed runoff characteristics for the building pad. The exact number of sampling locations was also changed in some instances based on runoff flow patterns. Samples were collected when runoff from the pads was sufficient to allow all of the samples for the given analytical parameters to be collected, regardless of the amount or intensity of the rainfall event.

As part of the 2010 SWP3sampling effort, samples were collected at the north side of the K-1420 building footprint in an area near the former calciner room. Samples were also collected from storm water outfalls 158 and 160 in concurrence with the K-1420 pad samples.. Sampling was performed at outfalls 158, 160, 170 and the K-1420 pad for gross alpha/gross beta radiation, transuranics, isotopic uranium, and ^{99}Tc.

All of the runoff samples and outfall samples collected as part of this effort were taken using the manual grab sampling method. Manual grab samples were collected according to the guidelines specified in Sections 3.1.2 and 3.3.1 of the EPA's "NPDES Storm Water Sampling Guidance Document" (EPA 833-B-92-001) and applicable procedures that have been developed by the sampling subcontractor. All guidelines stated in the ETTP SWP3 SAP concerning sample documentation, analytical procedures, Quality Assurance / Quality Control, etc., were followed as part of this sampling effort. Analytical results exceeding screening levels in 2010 are given in Table 3.22.

In 2010, gross alpha radiation was detected in the discharges from storm water outfalls 158 and 160 and the K-1420 pad at levels greater than 15 pCi/L, which is the screening level developed from the maximum contaminant level (MCL) established by the Safe Drinking Water Act. Gross alpha radiation for outfall 170 was below screening level. Compared to historical data (Fig. 3.19 and Tables 3.23–3.26), the results for the 2010 SWP3 sampling are representative of the levels of gross alpha radiation normally found at these locations.

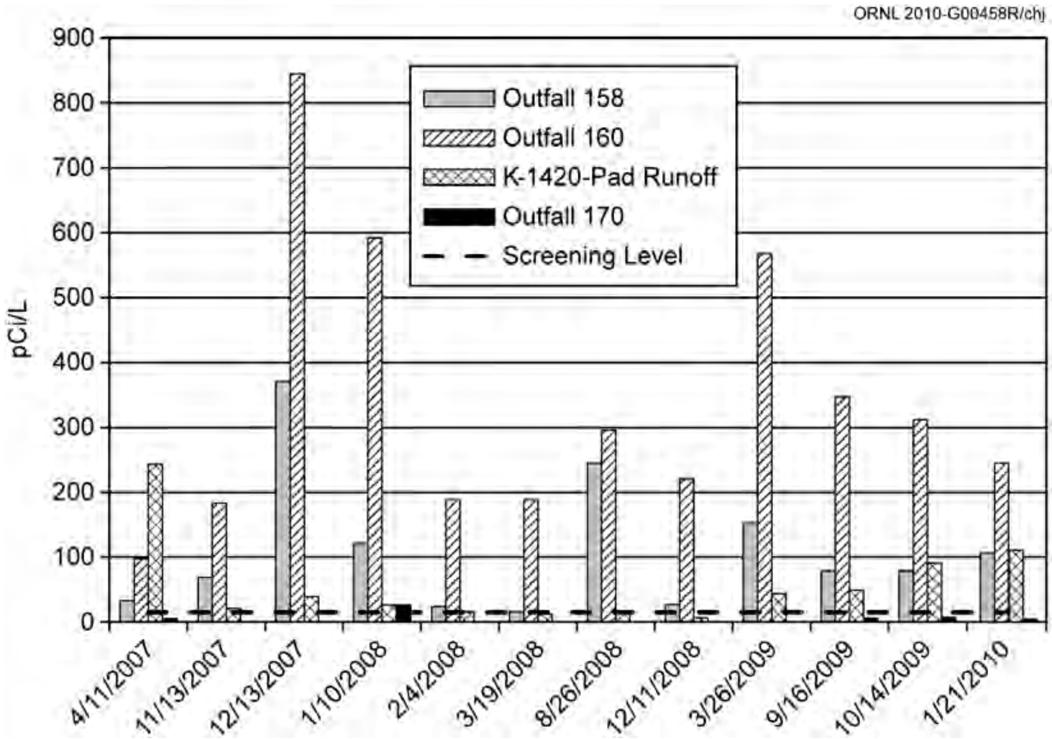


Fig. 3.19. Relative levels of gross alpha radioactivity in discharges from outfalls 158, 160, 170, and the K-1420 pad.

Table 3.23. Analytical results from sampling performed at storm water outfall 158

	Gross alpha (pCi/L)	Gross beta (pCi/L)	$^{233}U/^{234}U$ (pCi/L)	$^{235}U/^{236}U$ (pCi/L)	^{238}U (pCi/L)	^{99}Tc (pCi/L)	Total U (μg/L)
Screening Level	15	50	20	24	24	4000	31
July 2003	98.8	97.5	0.068 U[a]	–0.021	–0.034	No data	No data
May 2004	64.9	44.7	31.87	1.86	18.59	No data	No data
April 2007	33.2	14	19.9	1.94	12.3	No data	37.5
November 2007	69.2	50.1	37.1	1.91	23.1	47.4	69.6
December 2007	370	100	153	12	96.9	69.5	294
January 2008	121	42.3	48.3	3.55	32.4	26.2	98
February 2008	23.8	17.6	11.3	0.994	7.7	14.5	23.4
March 2008	15.8	19.7	8.71	0.041 U	5.44	13.7	16.2
July 2008	89.6	60.7	40.9	3.94	30.9	46.3	93.7
August 2008	245	66	121	7.36	68.2	55.7	206
December 2008	27.3	19.5	63 U	0.72	8.2	14.4	25.2
March 2009	153	58.4	75.6	5.18	47.3	32	145
September 2009	79.2	46.1	47	3.53	32.1	45.1	97.2
October 2009	79	20.8	38.1	2.29	23.8	23	71.8
January 2010	104	22.6	50.8	3.55	30.8	21.9	93.3

[a] U—analyte not detected in sample.

Note: Radiological results are reported after background activity has been subtracted. In cases where background activity exceeds the sample activity, this will result in negative values.

Table 3.24. Analytical results from sampling performed at storm water outfall 160

	Gross alpha (pCi/L)	Gross beta (pCi/L)	$^{233}U/^{234}U$ (pCi/L)	$^{235}U/^{236}U$ (pCi/L)	^{238}U (pCi/L)	^{99}Tc (pCi/L)	Total U (μg/L)
Screening Level	**15**	**50**	**20**	**24**	**24**	**4000**	**31**
March 2001	114	49	66	4.32	38	84	No data
August 2001	48	49	37.38	1.78	7.42	54	No data
January 2002	1020	421	591.9	32.01	108.9	445	No data
February 2004	203	78.2	151.7	10.89	89.68	23.7	65.4
April 2007	98.2	56.3	85.9	5.04	21.2	78	37.5
November 2007	183	72.9	117	8.88	62.7	61.9	191
December 2007	845	152	547	30.3	202	96.2	615
January 2008	592	239	405	18.6	73.8	280	228
February 2008	188	47.5	130	6.31	21.1	54.1	65.7
March 2008	185/191	54.8/90.8	137/150	8.7/10.3	20.7/22.2	58.4/61.4	65.6/70.8
August 2008	296	135	216	10.3	59.7	213	182
December 2008	221	73.9	170	8.1	23.2	74.8	73.4
March 2009	568	131	491	22.7	73	174	230
September 2009	347	68.4	275	13.5	48	73.8	149
October 2009	312	43.9	205	14.9	60.2	41.5	186
January 2010	242	37.7	136	7.63	47	23.9	143

Table 3.25. Analytical results from sampling performed at storm water outfall 170

	Gross alpha (pCi/L)	Gross beta (pCi/L)	$^{233}U/^{234}U$ (pCi/L)	$^{235}U/^{236}U$ (pCi/L)	^{238}U (pCi/L)	^{99}Tc (pCi/L)	Total U (μg/L)
Screening Level	**15**	**50**	**20**	**24**	**24**	**4000**	**31**
January 2002	2.77 U	9.09	1.10	0.03 U	0.44	2.96 U[a]	No data
July 2002	2.46 U	15.2	1.32	0.05 U	0.57	<8.24	No data
September 2005	1.28 U	4.68 J[a]	0.60 J	0.01 U	0.37 J	2.98U	No data
April 2007	5.07	2.46 U	7.17	0.44	2.93	27.2 U	8.92
January 2008	26.3	36.3	98.1	6.14	7.89	13.8	26.3
September 2009	6.11	8.11	2.96	0.19	0.67	10.3	2.09
October 2009	7.16	7.37	3.09	0.29 U	1.01	13.6	3.13
January 2010	2.82 U	9.89	3.62	0.0804 U	0.322 U	7.67 U	0.994U

[a] "U" is a sample result below the detection limit and "J" is a sample result that is above the sample detection limit, but below the sample quantitation limit.

Table 3.26. Analytical results from sampling performed at the K-1420 building pad

	Gross alpha (pCi/L)	Gross beta (pCi/L)	$^{233}U/^{234}U$ (pCi/L)	$^{235}U/^{236}U$ (pCi/L)	^{238}U (pCi/L)	^{99}Tc (pCi/L)	Total U (μg/L)
Screening Level	**15**	**50**	**20**	**24**	**24**	**4000**	**31**
April 2007	243	117	94	12	24.8	22	79.4
November 2007	20.8	9.94	5	0.923	2.95	.04 U[a]	9.2
December 2007	39.1	12.5	28.6	1.66	5.11	4.97 U	16
January 2008	26.7	15.1	17.3	1.03	3.3	1.7	10.3
February 2008	16.1	10.6	11.6	0.426	1.69	2	5.23
March 2008	12.6	23.4	11.2	0.73	1.69	4.7	5.37
August 2008	13.6	2.11 U	11.2	0.766	2.07	09 U	6.51
December 2008	6.9	5.34	63 U	0.23	1.2	.9 U	3.9
March 2009	43.6	19.9	63 U	1.8	6	13.9	19
September 2009	49.1	25.5	35.9	2.13	7.22	8.2	22.5
October 2009	91.4	24.7	69.1	5.02	13.2	7.3	41.5
January 2010	110	25.1	77.3	3.12	10.8	.33	33.6

[a] "U" is a sample result below the detection limit

Gross beta radiation was not detected in the discharges from outfalls 158 and 160 and at the K-1420 pad at levels that exceed the screening level of 50 pCi/L developed from the MCL compared to historical data (Fig. 3.20 and Tables 3.23 through 3.26). Gross beta radiation for outfall 170 was also below screening level.

No ^{99}Tc was detected at levels above the screening level of 4000 pCi/L in samples collected at outfalls 158, 160, and 170 and the K-1420 pad as part of the 2010 SWP3 (Tables 3.23–3.26).

Uranium-233/234 was detected in the discharge from outfalls 158, 160, and the K-1420 Pad in 2010 at levels that exceed the 4% of DCG level of 20 pCi/L for this radionuclide, as seen in Fig. 3.21. Exceedances were not detected for outfall 170. Historical data for ^{233}U/^{234}U collected at this location (Tables 3.23–3.26) indicate that the ^{233}U/^{234}U data for 2010 were near the middle of the range of the historical results.

Uranium-235/236 was not detected at levels above the 4% of DCG level of 24 pCi/g for the 2010 SWP3 sampling (Tables 3.23–3.26).

Uranium-238 was detected in discharges from outfalls 158 and 160 at levels that exceeded 4% of the DCG level of 24 pCi/L. Exceedances were not detected for outfall 170 or the K-1420 pad. Comparing the 2010 results to historical data for ^{238}U collected from these locations (Tables 3.23–3.26) indicate that ^{238}U results collected as part of the 2010 SWP3 sampling are near the middle of the range of the historical results.

Total uranium was detected in the discharge from storm water outfalls 158 and 160 and the K-1420 pad at levels that exceed the screening level of 31 μg/L. Exceedances of the screening level for total uranium were not detected for outfall 170. Total uranium results collected as part of the 2010 SWP3 sampling are several times higher than the screening level at outfalls 158 and 160. However, a comparison to historical results available for total uranium (Tables 3.23–3.26) indicates that total uranium results collected as part of the 2010 SWP3 sampling are within the range of historical results.

The acceptable dose rate in surface water for piscivorous wildlife is 100 millirad (mrad) per day. The total uranium activity on the slab that will result in a 100 mrad per day dose in Mitchell Branch is 2600 pCi/L. Analytical data collected since April 2007 (Table 3.26) indicate that total uranium concentrations are several orders of magnitude below the 2600-pCi/L level. Therefore, it can be concluded that the K-1420 pad is no longer a significant contributor of radioactive contaminants to the storm drain system. In April 2010, approval was granted by TDEC and EPA CERCLA Core Team representatives to discontinue monitoring of the K-1420 pad.

3.5.5.3 Radiological Monitoring of Storm Water Discharges

The ETTP conducts radiological monitoring of storm water discharges to determine compliance with applicable dose standards. It also applies the “as low as reasonably achievable” (ALARA) process to minimize potential exposures to the public. Sampling for gross alpha and gross beta radioactivity, as well as specific radionuclides, is conducted periodically as part of the SWP3. In 2010, new radiological sampling results were obtained for seven storm water outfalls (Table 3.27). These results were used with radiological results for other storm water outfalls from other years, along with calculated flows based on rain events in 2010, to estimate the total discharge of each radionuclide from ETTP via the storm water discharge system (Table 3.28).

Storm water samples were collected from discharges resulting from a storm event greater than 0.1 in. that occurred within a period of 24 hr or less and at least 72 hr after any previous rainfall greater than 0.1 in. in 24 hr. Composite samples were collected at each outfall using Isco automated sampling equipment. The composite samples consisted of at least three aliquots taken during the first 60 min of a storm event discharge. Samples composited by time (equal volume aliquots collected at a constant interval) were used. In situations where the use of an Isco sampler was infeasible or impractical, a series of at least three manual grab samples of equal volume were collected during the first 60 min of a storm event discharge and combined into a composite sample.

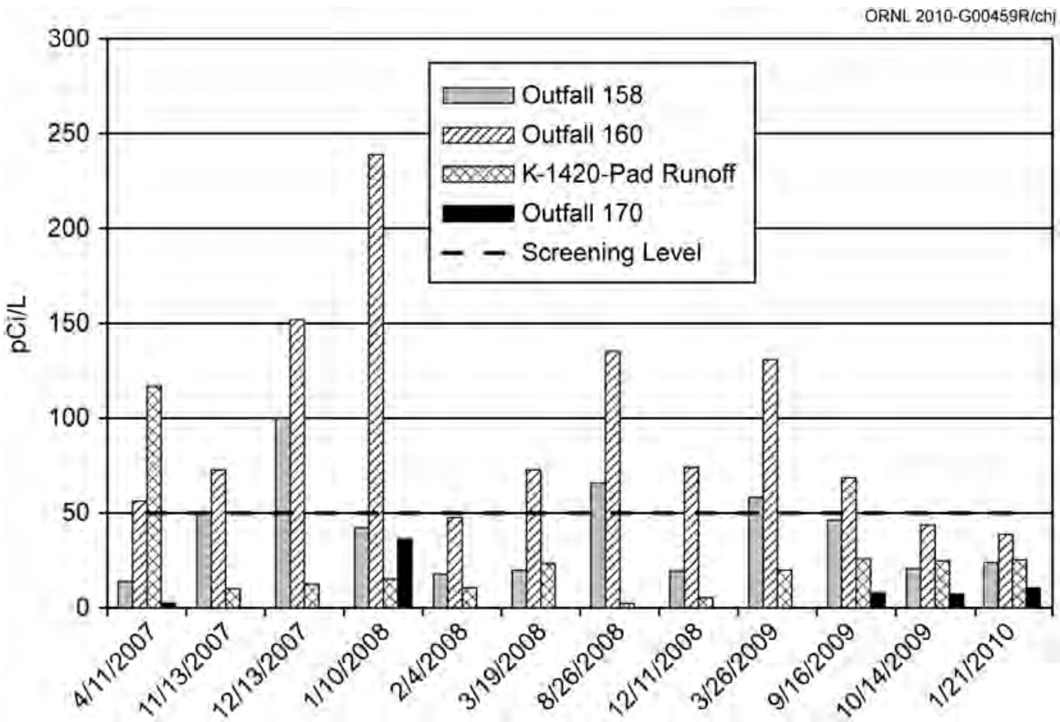


Fig. 3.20. Relative levels of gross beta radioactivity in discharges from outfalls 158, 160, 170, and the K-1420 pad.

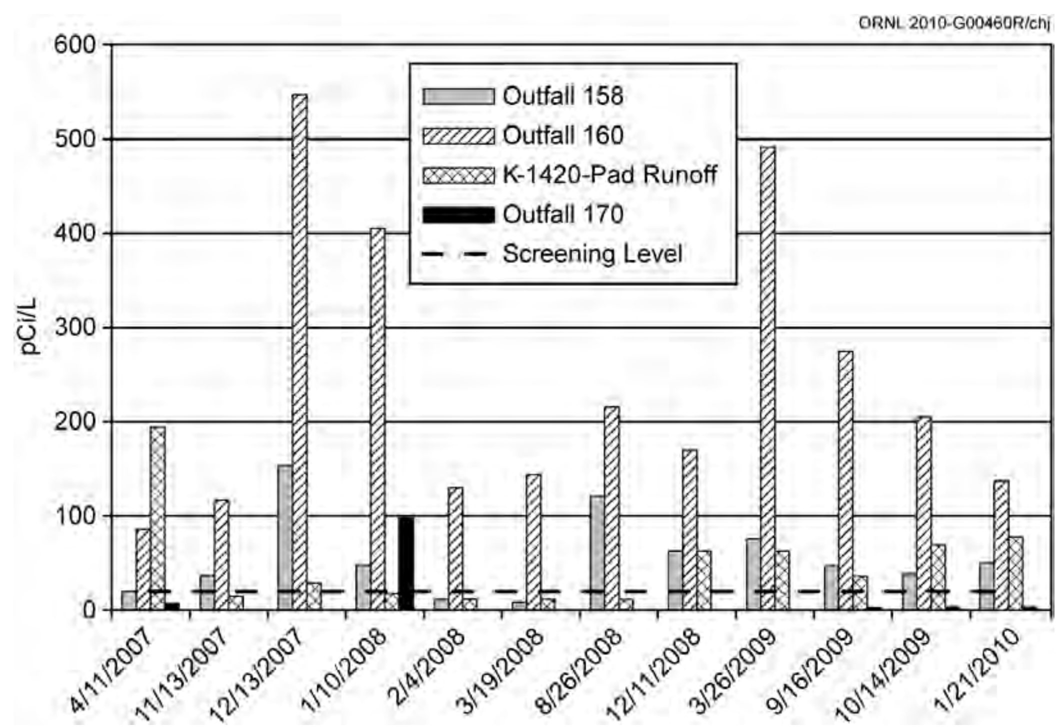


Fig. 3.21. Relative levels of $^{233/234}U$ in discharges from outfalls 158, 160, 170, and the K-1420 pad.

Table 3.27. Storm water sampling for radiological discharges,[a] 2010

Storm water outfall	Date sampled
180	06/10/10
190	09/22/10
230	08/12/10
350	10/25/10
382	03/12/10
430	03/03/10
724	03/12/10

[a] Including gross alpha, gross beta, transuranics (^{237}Np, ^{238}Pu, and $^{239/240}$Pu), isotopic uranium, and ^{99}Tc.

Table 3.28. Radionuclides released to off-site surface waters from the East Tennessee Technology Park storm water system, 2010 (Ci)[a]

Radionuclide	Amount
^{99}Tc	1.7E–2
^{234}U	4.8E–3
^{235}U	3.0E–4
^{238}U	3.1E–3

[a] 1 Ci = 3.7 × 10^{10} Bq

Radiological monitoring was conducted in 2010 as part of the SWP3 for different purposes. Results of all SWP3 radiological monitoring that exceeded screening levels in 2010 are shown in Table 3.29. Comparisons of historical analytical results to those from the 2010 sampling effort are given in Tables 3.30 and 3.31.

Table 3.29. Storm water radiological results exceeding screening levels for radiological discharges, 2010 (pCi/L)[a,b]

Storm water outfall	Gross alpha radiation (pCi/L)	Gross beta radiation (pCi/L)	^{233}U/^{234}U (pCi/L)	^{238}U (pCi/L)	Total uranium (µg/L)
350	57.1	--[c]	34.9	24.8	75.7
724	89.1	--	45.1	37.7	66.2

[a] 1 pCi = 0.037 Bq

[b] Screening levels are 15 pCi/L gross alpha radiation, 50 pCi/L gross beta radiation, 20 pCi/L ^{233}U/^{234}U, 24 pCi/L ^{234}U and ^{238}U, and 31 µ/L total uranium.

[c] Dashed line indicates no exceedances.

Table 3.30. Analytical results from sampling performed at storm water outfall 350

	Gross alpha (pCi/L)	Gross beta (pCi/L)	^{233}U/^{234}U (pCi/L)	^{235}U/^{236}U (pCi/L)	^{238}U (pCi/L)	^{99}Tc (pCi/L)	Total U (µg/L)
Screening level	**15**	**50**	**20**	**24**	**24**	**4000**	**31**
May 2001	162	76.5	70.31	4.36	54.65	26.5	No data
May 2002	25.2	14.8	16.83	1.25	13.3	0.69 U[a]	No data
February 2005	242	76.5	139	7.39	106	4.87 U	No data
December 2006	171	30.4	91.4	6.87	71.8	20.2	217
July 2009	187	62.4	79.1	4.77	63.9	13.7	192
October 2010	57.1	35	34.9	2.66	24.8	6.1	75

[a] U—analyte not detected in sample.

Table 3.31. Analytical results from sampling performed at storm water outfall 724

	Gross alpha (pCi/L)	Gross beta (pCi/L)	$^{233}U/^{234}U$ (pCi/L)	$^{235}U/^{236}U$ (pCi/L)	^{238}U (pCi/L)	^{99}Tc (pCi/L)	Total U (µg/L)
Screening level	**15**	**50**	**20**	**24**	**24**	**4000**	**31**
January 2002	61	441	30.11	1.67	20.3	376	No data
March 2002	119	71.6	44.85/53.61	2.71/4.32	33.55/38.36	54.8	No data
December 2003	70.2	57.3	34.28	2.564	27.08	42.7	81.12
November 2005	99.4	47.4	77.3	5.66	59.8	83.9	No data
March 2007	134	64.5	65	5.78	50.8	82.1/80.4	154
March 2010	89.1	28.7	45.1	2.35	37.7	8.17	113

Gross beta radiation was detected in the discharges from storm water outfalls 350 and 724 at levels that exceed the MCL of 50 pCi/L for this analyte (Tables 3.30 and 3.31). Results for gross beta radiation collected at these locations since 2001 indicate that the gross beta radiation results collected during this portion of the 2010 SWP3 sampling are within the historical range.

Uranium-233/U-234 was detected in the discharges from outfalls 350 and 724 at levels that exceed the 4% of DCG level of 20 pCi/L for these radionuclides (Tables 3.30 and 3.31). Results for $^{233}U/^{234}U$ collected at these locations since 2001 indicate that the $^{233}U/^{234}U$ results collected during this portion of the 2010 SWP3 sampling are within the historical range.

Uranium-238 was detected in the discharges from outfalls 350 and 724 at levels that exceed the 4% of DCG level of 24 pCi/L for these radionuclides (Tables 3.30 and 3.31). Results for ^{238}U collected at these locations since 2001 indicate that the ^{238}U levels in data collected during this portion of the 2010 SWP3 sampling are within the historical range.

Total uranium was detected in the discharges from outfalls 350 and 724 at levels that exceed the screening level of 31 µg/L for these analytes (Tables 3.30 and 3.31). Results for total uranium collected at these location indicate that the total uranium levels in data collected during this portion of the 2010 SWP3 sampling is within the historical range.

3.5.5.4 Monitoring Conducted as Part of the D&D/RA Activities Conducted at Building K-1035

Building K-1035 was built in 1945 as a maintenance general stores warehouse. In the early 1960s it was converted to an instrument maintenance facility. Shop activities have included an instrument shop, metal cabinet fabrication, a photoelectroplating process, printed circuit board fabrication shop, acid cleaning area, line recorder cleaning, and pneumatic repair shop. To the south of the building are the K-1035 pits. Two of these pits, an acid pit and a neutralization pit, received acid and solvent wastes. These wastes came from two dedicated instrument shops within the building—the Printed Circuit Board Fabrication Facility and the Acid Cleaning Area. The third pit, a steam cleaning pit, was used for the removal of oil and dirt from parts and machinery. The contents of all three pits flowed to a single catch basin that discharges to the storm drain 190 network. The Acid Cleaning Area operated from the early 1960s to 1985, and the Printed Circuit Board Fabrication Facility operated from the early 1960s to 1977.

In April 2009, work began on the demolition of Building K-1035 (Fig. 3.22). Siding, pipe insulation, roofing material, etc., were removed prior to general demolition activities. The remainder of the building was demolished using heavy equipment. By June 2009, the building was reduced to rubble. Removal of the building rubble was completed in July 2009. The building footers were removed in early 2010, and the area was backfilled with clean clay and topsoil. The vegetative cover over the area was established in the fall of 2010.

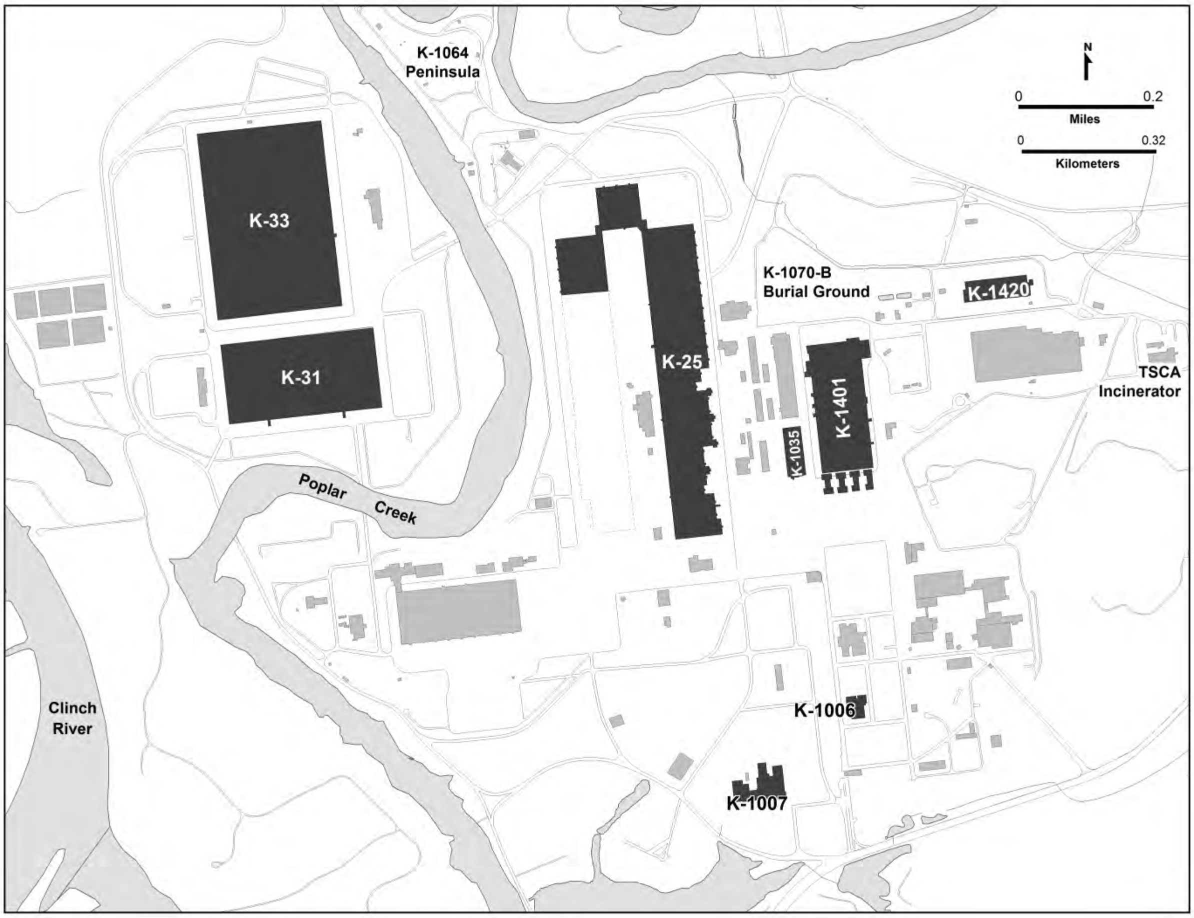


Fig. 3.22. Map of ETTP areas involved in 2010 sampling activities.

In November 2008, before the demolition of Building K-1035 began, the water in nearby storm drain inlets and at storm water outfall 190 was sampled as part of the 2008 SWP3 sampling effort. Samples were collected for analysis for gross alpha/gross beta radiation, isotopic uranium, ^{99}Tc, metals, mercury, VOCs, and PCBs. This provided a baseline for determining if contaminants might be present in the runoff from the K-1035 area. Sampling was also performed in May and August 2009, during the demolition of the building as part of the 2009 SWP3 sampling effort. This was done to determine the efficacy of the protective measures that were installed around storm drain inlets to prevent any demolition materials from entering the storm drain system. Specified manholes and outfalls were also sampled in January 2010 as part of the 2010 SWP3 sampling effort. These samples were collected after most of the demolition activities at Building K-1035 had been completed. Samples were collected for analysis for gross alpha/gross beta radiation, isotopic uranium, ^{99}Tc, metals, mercury, VOCs, and PCBs.

Sampling locations were chosen by EC&P personnel and sampling subcontractor personnel based on their proximity to the area that was remediated, their accessibility, and ease of sampling. Due to fact that many of the storm drains in the area are inaccessible, sampling locations were chosen where flow could be observed and Isco sampling equipment could be installed with minimal complications.

All samples collected as part of this portion of the 2010 SWP3sampling effort were grab samples that were collected manually or by the use of Isco samplers. For the purposes of the ETTP SWP3 sampling, a grab sample is defined as a discrete, individual sample that can be collected manually or by the use of an Isco sampler that is taken within a short period of time, usually 15 min or less. Both manual grab samples and grab samples collected using an Isco sampler were collected within the first 30 min of a discharge. All samples collected in conjunction with the D&D/RA activities conducted at Building K-1035 were collected in accordance with the guidelines presented in the *East Tennessee Technology Park Storm*

Water Pollution Prevention Program Sampling and Analysis Plan (BJC 2009b). All guidelines stated in the ETTP SWP3 SAP concerning sample documentation, analytical procedures, quality assurance/quality control, etc., were followed as part of this sampling effort.

The metals results from the sampling performed in conjunction with the Building K-1035 D&D/RA are presented in Figures 3.23–3.26.

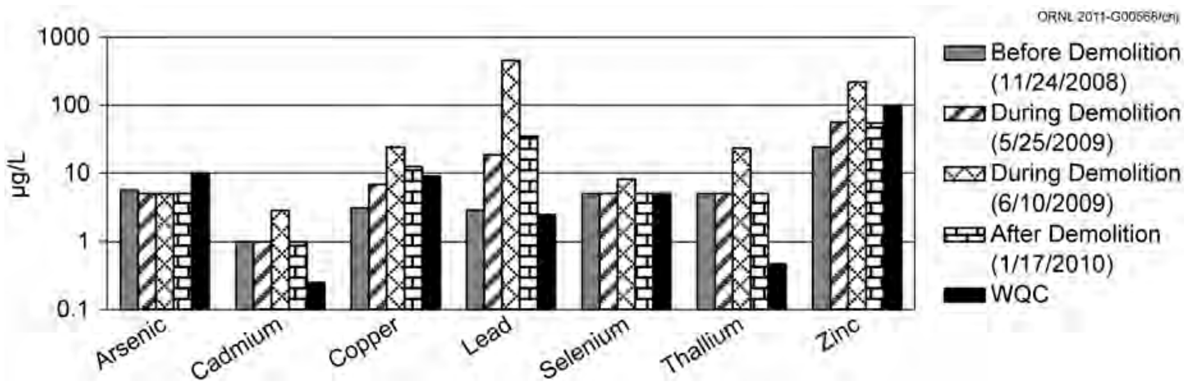


Fig. 3.23. Metals results at manhole 13050.

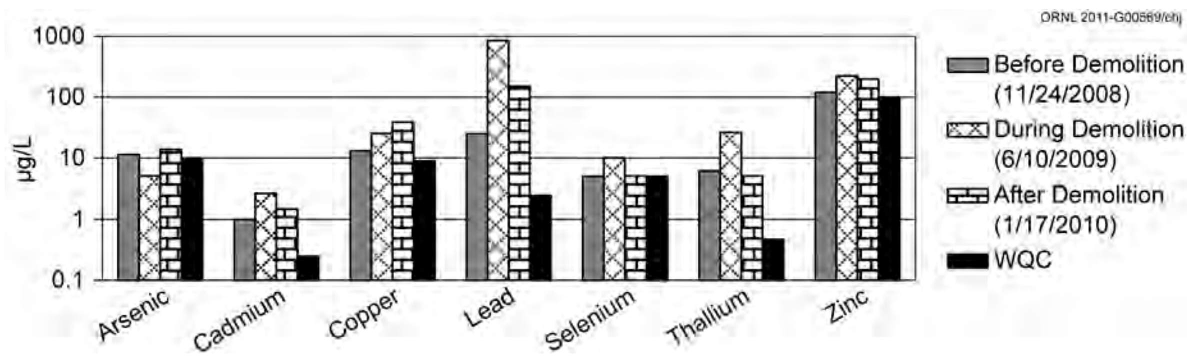


Fig. 3.24. Metals results at manhole 13037A.

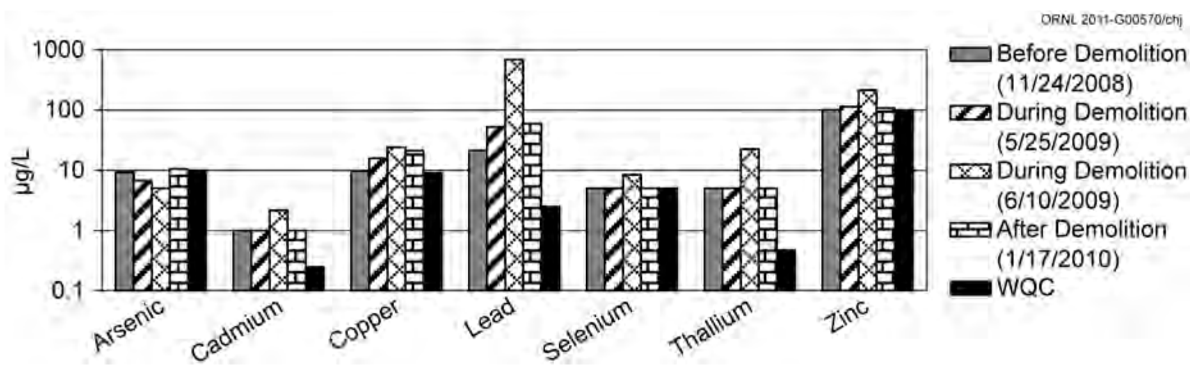


Fig. 3.25. Metals results at manhole 13074A.

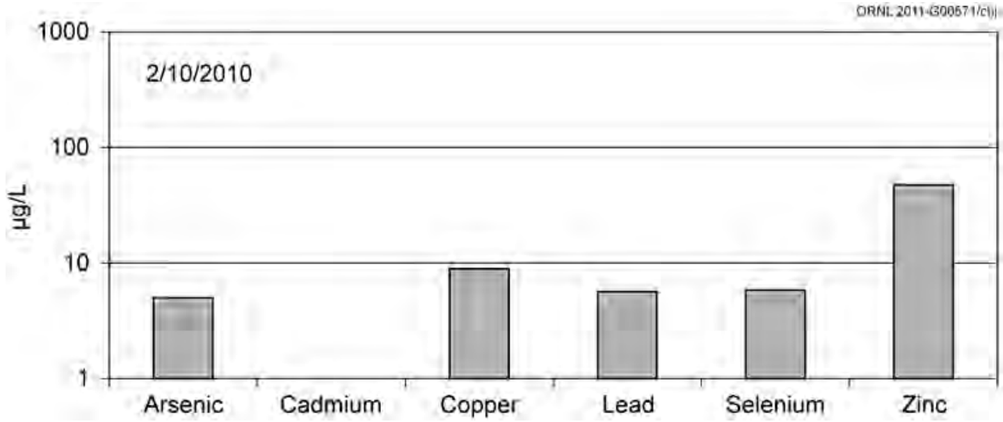


Fig. 3.26. Metals results at manhole 13048.

Metals samples were collected at manhole 13048 in February 2010. This manhole had not been sampled for metals prior to this sampling effort. Levels of Cd, Cu, Pb, and Se in this sample exceeded WQC.

Figures 3.23–3.26 indicate the following.

- In most instances, the levels of metals detected in the samples taken after demolition were completed are below the levels in samples collected during demolition.
- In most instances, metals levels in samples collected after demolition were completed are equal to or higher than the levels detected in samples collected before demolition began.
- Most metals were present at concentrations greater than the WQC in samples collected before, during, and after demolition.
- Metal results were relatively consistent between the manholes that were sampled.
- Improvements in the sediment controls in the Building K-1035 demolition area may have been needed to provide more effective removal of contaminants from the storm water runoff from the area while demolition was under way.
- Discharge of metals presumably by sediment transport appears to have decreased since demolition activities have concluded.

The PCB results from the sampling performed in conjunction with the Building K-1035 D&D are presented below in Figures 3.27–3.29.

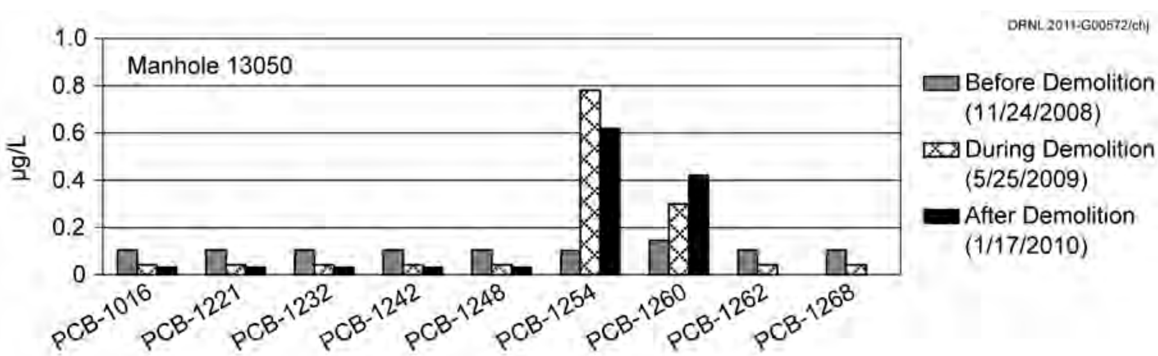


Fig. 3.27. PCB results at manhole 13050.

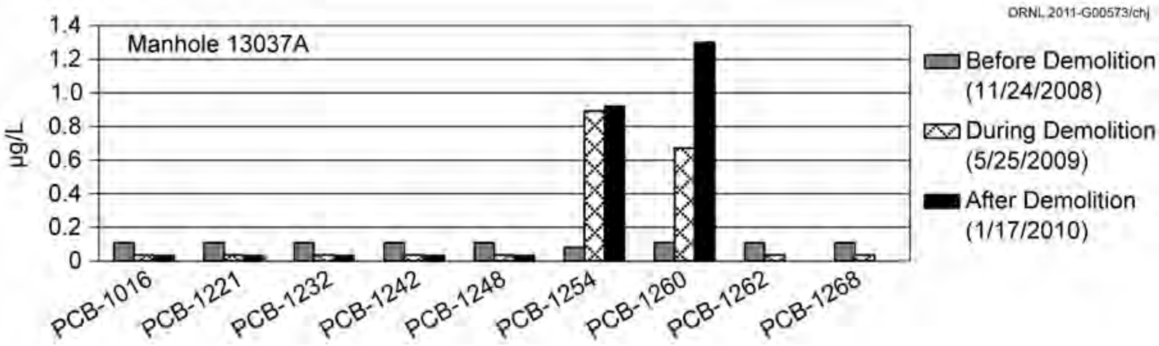


Fig. 3.28. PCB results at manhole 13037A.

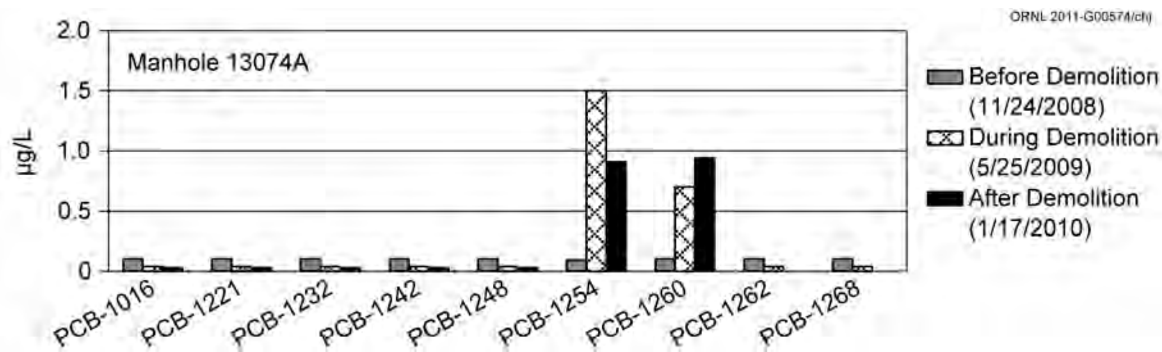


Fig. 3.29. PCB results at manhole 13074A.

Figures 3.27–3.29 indicate the following.

- Concentrations of PCB-1254 and PCB-1260 were higher in samples collected during demolition than levels detected before demolition activities began.
- Concentrations of PCB-1254 decreased after demolition activities were completed but were still above historical levels measured before demolition began.
- Concentrations of PCB-1260 increased in samples collected after demolition activities were completed and are considerably higher than the levels detected before demolition activities began.
- No other concentrations of PCBs appear to have been affected by the demolition of Building K-1035.
- No PCBs were detected in sampling performed at manhole 13048.

In February 2010, samples were collected at manhole 13048 in order to determine whether mercury from the area of the neutralization pits might be present in the storm water runoff from this area. In August 2010, mercury samples were also collected at manholes 13037, 13050, and 13074 to determine if mercury was present in the storm drain system near the K-1035 D&D area.

The mercury results from sampling performed in conjunction with the Building K-1035 D&D are presented in Fig. 3.30.

Mercury was not found to be present above the detection level of 67 ng/L in sampling performed in area manholes sampled in November 2008 (before demolition of Building K-1035 began) or in manholes sampled in May and June 2009 (during demolition of K-1035). However, it should be noted that a less sensitive analytical method was used for mercury analysis for these samples (EPA-245.1). The detection limit of 67 ng/L for this method is above the WQC for mercury, which is 51 ng/L. Therefore, no concrete conclusions about the presence of mercury above WQC at these locations before and during the demolition of K-1035 can be made. In samples collected at manholes in January and February 2010, after demolition of K-1035 was completed, mercury was analyzed using a much more sensitive analytical method (EPA-1631). Mercury was detected in manholes 13037A and 13074A at levels that exceeded the WQC (212 ng/L and 210 ng/L, respectively). Figure 3.30 indicates these analytical results. In addition, samples were collected in February 2010 at manhole 13048 after the demolition of K-1035 had been

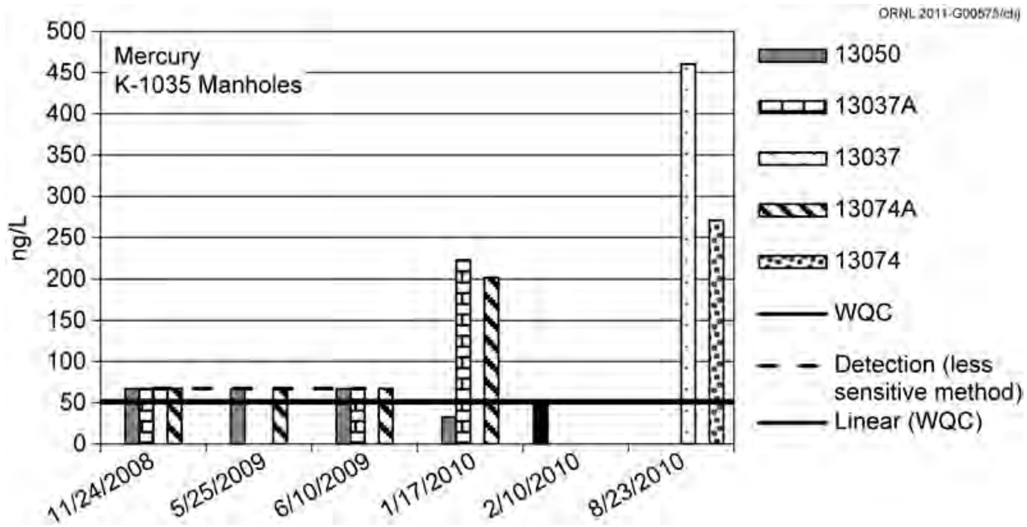


Fig. 3.30. Mercury results for K-1035 manholes.

completed. This manhole is located near the south end of Building K-1035. Mercury was detected at this manhole at a level of 53.6 ng/L, which is above the WQC of 51 ng/L. As part of sampling that was conducted in August 2010, mercury was again found at levels that exceeded WQC at manholes 13037 and 13074A (460.4 ng/L and 270.8, respectively). It is believed that the source of mercury in these manholes may be from the operation and eventual removal of the waste neutralization pits that were located at the south end of the K-1035 Building. When the pits were removed, visible mercury beads were observed at the bottom of drain lines that served the pits. The amount of time the mercury beads may have been present and the amount of mercury that may have been released to the environment as part of the operation of the neutralization pits is unknown.

None of the radiological samples collected in manholes 13048, 13050, 13037A, and 13074A before, during, or after demolition of Building K-1035 had results that were above the applicable screening levels.

All samples collected as part of this portion of the 2010 SWP3 sampling were grab samples collected either manually or with Isco samplers. For the purposes of the ETTP SWP3 sampling, a grab sample is defined as a discrete individual sample that can be collected either manually or with an Isco sampler within a short period, usually 15 min or less. Both manual grab and Isco grab samples were collected within the first 30 min of a discharge. All samples collected in conjunction with the D&D of Building K-1035 were collected in accordance with the guidelines presented in the *East Tennessee Technology Park Storm Water Pollution Prevention Program Sampling and Analysis Plan*. All guidelines stated in the ETTP SWP3 SAP concerning sample documentation, analytical procedures, QA/QC, etc., were followed as part of this sampling effort.

3.5.5.5 Monitoring of Storm Water Runoff from D&D Activities in the K-1131 Area

As part of the D&D activities for Building K-27, waste materials, equipment, and other items currently stored in K-27 will be sorted, segregated, and containerized for shipment. Waste materials, including equipment, machinery, scrap metals, etc., will be moved to the K-1131 building pad area, where the size of the waste materials will be reduced by shearing, cutting, or other physical methods. Other D&D activities to be conducted on the K-1131 pad include the downsizing and repackaging of waste materials from the Building K-25 demolition project and the storage of process tieline piping from the K-413 building area.

As part of the 2010 SWP3 sampling effort, sampling was performed at outfall 380, which receives storm water runoff from the K-1131 pad area. Analytical results from this sampling effort will also be used to complete the EPA 2F forms for outfall 380 as part of the 2013 NPDES permit renewal application. Screening level exceedances for outfall 380 are presented in Table 3.32. Outfall 380 was sampled for all of the parameters listed in Table 3.33. Additional sampling will be conducted as other activities are started or completed on the K-1131 pad.

Table 3.32. Screening level exceedances at outfalls receiving drainage from the K-1131 Pad area

Sampling location	Gross alpha (pCi/L)	Chromium (µg/L)	Copper (µg/L)	Lead (µg/L)	Mercury (µg/L)	Selenium (µg/L)	Total Uranium (µg/L)	Zinc (µg/L)	Arsenic (µg/L)
Screening Level	**15**	**8**	**7**	**2.5**	**Detectable**	**5**	**31**	**75**	**7**
380	58.2	9.8	14.2	21.1	0.0165	6.66 J	34.9	155	---
430	---	---	---	---	---	---	---	---	15.9 J

Table 3.33. Samples collected in 2010 in support of the NPDES permit renewal application

Storm water outfall	Mercury, PCBs, TSS, pesticides, herbicides, anions, BOD, COD, ICP metals,[a] gross alpha/beta, isotopic U, total U, ^{99}Tc, ^{238}Pu, $^{239/240}$Pu, ^{237}Np, sulfide (composite sample)	VOC, SVOC, TOC, oil and grease, acetone/ acetonitrile/ methyl ethyl ketone (Grab sample- manual grab only)	Kjeldahl nitrogen, phenol, total phosphorus, nitrate/nitrite, cyanide, ammonia (as N) (Grab sample – manual grab or grab by compositor)	Temperature, pH, TRC (field readings)
170	X	X	X	X
180	X	X	X	X
230	X	X	X	X
380	X	X	X	X
382	X	X	X	X
410	X	X	X	X
430	X	X	X	X
700	X	X	X	X
710	X	X	X	X
724	X	X	X	X
992	X	X	X	X
05A	X	X	X	X

NOTE: At least two Isco samplers will be required at each outfall in order to obtain sufficient composite sample volumes.
[a] Metals analysis should include Al, Ag, As, Ba, Be, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mo, Mg, Mn, Na, Ni, Pb, Sb, Se, V, Zn, Ti, and Tl.

3.5.5.6 Sampling for CY 2013 NPDES Permit Renewal Application

Even though a new NPDES permit became effective on April 1, 2010, preparations for the NPDES permit that is to be issued in CY 2013 are being made. The permit application for this permit renewal is required to be submitted to TDEC by June 2013, to allow TDEC 180 days to review it. Only about 3 years remain to collect all of the analytical data that is required to complete the EPA 2E and 2F forms that are required to be submitted in the next NPDES permit renewal application. In order for all of the required monitoring to be conducted in time for the permit application to be prepared and submitted, approximately eight to ten outfalls must be sampled each year.

The 2010 SWP3sampling effort focused on the 32 representative outfalls indicated in the ETTP NPDES Permit No. TN0002950 that was issued in April 2010. The outfalls that were selected to be sampled as part of the 2010 SWP3 SAP are listed in Table 3.33. Data collected from sampling conducted as part of the SWP3 SAP will be used in the completion of EPA 2E or 2F forms, as applicable.

The sample collection method for each parameter is specified by the analytical method for that parameter. Parameters that are designated to be collected as composite samples were collected by use of Isco samplers or by manual grab if they cannot be collected by Isco sampler due to location, volume, or time constraints. No parameters designated in Table 3.33 to be collected by manual grab were collected by Isco compositor under any circumstances; however, other parameters that are designated in Table 3.33 as grab samples may have been collected either manually or with Isco samplers.

All samples were collected from discharges resulting from a storm event greater than 0.1 in. that occurs within a time period of 24 hr or less and which occurred at least 72 hr after any previous rainfall greater than 0.1 in. in 24 hr. Some variance in the 72-hr time frame was allowed due to unforeseeable circumstances such as weather conditions and sampling equipment problems.

Table 3.34 contains nonradiological results from this portion of the 2010 SWP3 sampling effort that exceeded screening levels. Table 3.35 contains the radiological results from this effort that exceeded screening levels.

Table 3.34. Screening level exceedances from 2013 permit renewal application sampling for 2010, nonradiological

	Copper (µg/L)	Lead (µg/L)	Mercury (µg/L)	Zinc (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Selenium (µg/L)	PCB-1260 (µg/L)
Screening level	**7**	**2.5**	**Detectable**	**75**	**Detectable**	**8**	**5**	**Detectable**
Outfall 180	4.9	6.9	0.638	76.5	--	--	--	
Outfall 380	4.2	1.1	0.0165	155	--	9.8	6.66 J	
Outfall 230	8.2	3.9	0.0117	158	--	--	--	
Outfall 382	--	--	0.0177	--	4.81J	--	--	
Outfall 410	51 J	--	0.0229	--	--	11.3	--	
Outfall 430	--	--	--	--	--	--	--	
Outfall 700	1	--	0.0426	77.9	--	--	--	
Outfall 724	--	--	0.00213	--	--	--	--	
Outfall 992	--	--	0.0129	--	--	--	--	
Outfall 05A	--	--	1.28/0.232	--	--	--	--	
Outfall 170	--	--	0.014	--	--	--	--	--
Outfall 190	--	0.76	0.249	--	--	--	--	0.479
Outfall 350	0.66	0.5	0.0773	--	15	--	--	
Outfall 694	--	--	0.299	--	--	--	--	--

Table 3.35. Screening level exceedances from 2013 permit renewal application sampling for 2010, radiological

	Total Uranium (µg/L)	Gross Alpha (pCi/L)	U-233/234 (pCi/L)	U-238 (pCi/L)
Screening level	**31**	**15**	**20**	**24**
Outfall 380	34.9	58.2	---	---
Outfall 350	75	---	34.9	24.8
Outfall 724	113	89.1	45.1	37.7

3.5.5.7 Sampling of K-1037 Sumps

Approximately 104 sumps were once located in various building basements, switchyards, and other facilities around ETTP. Many of the sumps no longer discharge because the sump pump has been removed or de-energized, or the building served by the sump has been demolished or abandoned and the sumps have been filled. Water from the sumps that are still active may be discharged to the ETTP storm water drainage system, the ETTP sanitary sewer system, or may be routed to the CNF.

Sumps were sampled as part of the ETTP accumulated water discharge program from 1994 until 1998. During 1998, ETTP Clean Water Act Program personnel analyzed the historical data from the previous year's sampling events and determined that the sump program would be suspended. A few selected sumps were sampled as part of the 2002 SWP3 sampling program, and the sumps located in the K-732 switchyard were sampled in August 2009.

Locations that were sampled in 2010 and analytical parameters are given in Table 3.36.

Table 3.36. Building K-1037 sump sampling parameter

Sampling location	Gross alpha/gross beta	VOCs	ICP metals	Total mercury
Catch basin 9006	X	X	X	X
Catch basin 14015	X	X	X	X

In 1997, building operators were requested to register all sumps located within their buildings. Two sumps were identified and registered for Building K-1037.

1. Sump S-093 is located in the southwest corner of the basement of Building K-1037 adjacent to column T-21. It was stated on the registration for that the sump discharged "behind K-1037 to SD-170." It is believed that the sump may discharge through a pipe that empties into the concrete ditch located south of Building K-1037.
2. Sump S-094 is located near the southwest wall of Building K-1037 adjacent to column L-34. It was stated on the sump registration form that the sump discharged "behind K-1037 to SD-170." As with sump S-093, it is believed that the sump may discharge through a pipe that empties into the concrete ditch located south of K-1037. It is believed that sumps S-093 and S-094 discharge to the concrete drainage ditch through separate pipes. It is believed that both of these sumps remain active.

   The monitoring of these sumps was performed to accomplish several objectives.

   a. The last data available for these sumps were collected in 1998. Therefore, more up-to-date analytical data were needed from the sumps.
   b. As stated in the registration forms, the sumps were believed to discharge to the concrete channel located south of Building K-1037. However, it was also possible that the sumps discharge to an underground storm drain pipe that passes underneath the southwest portion of the building. Sampling the sumps was performed to help verify the actual discharge location.
   c. During past sampling activities in the storm drain network downstream of the sumps, a pulsing of the flow was noted. It was hypothesized that the pulsing could be due to the periodic activation of the sumps. Sampling was performed to determine the possible reason for the pulsing of the flow.

3. Sampling of the sump discharges as they enter the concrete channel south of K-1037 was not considered to be a feasible option. It required that sampling personnel observe the discharge pipes during times when they might flow in order to collect samples from them. The sump pumps may have required several minutes or several hours between discharge cycles. Unless sampling personnel were there at the exact time the pumps are operating and a discharge is occurring, sampling of the sumps would not be possible at the discharge pipes. In addition, accessing the concrete channel by walking down the hill south of K-1037 may have presented a safety hazard. The vegetation (kudzu, etc.) on the side of the hill could have caused tripping and slipping hazards as well as hide potential hazards such as groundhog holes, debris, etc.

Security concerns exist that are related to past operations in Building K-1037. Due to security and logistical concerns, sampling in the storm drain system downstream of the pipes the sumps in the building may be discharging from was preferable to trying to sample the sumps themselves. Therefore, samples were collected from the following locations.

1. Basin 14015 is located downstream of the western end of the concrete channel near the K-1501 steam plant footprint. It receives all of the water that collects in the portion of the concrete channel located southwest of Building K-1037. This includes drainage from the hill south of K-1037 as well as any discharges that may be routed from the southwest corner of Building K-1037. If the sumps located in K-1037 discharge into the concrete channel, samples from this basin will indicate whether there are concerns with the discharge.
2. Manhole 9006 is located in the CNF area near the southwest corner of Building K-1419. Due to access concerns with other manholes further upstream, this is the first manhole that can be sampled that isolates portions of the north, west, and south sides of Building K-1037. In addition to carrying runoff from the concrete channel after it enters basin 14014, basin 9006 also collects runoff and building discharges from the west side of K-1037.

Samples at catch basin 14015 and 9006 were collected for the parameters specified in Table 3.36.

Manual grab samples were collected according to the guidelines specified in Sections 3.1.2 and 3.3.1 of the EPA's *NPDES Storm Water Sampling Guidance Document* (EPA 1992) and applicable procedures that have been developed by the sampling subcontractor.

A pulsing in the flow pattern was observed downstream of Building K-1037 during past sampling events in the outfall 170 drainage system. It was believed that the pulsing of the flow was related to the cycling of the sump pumps in Building K-1037. In an effort to determine if these sump pumps were the reason for the pulsing of the flow downstream, flow observations were made at both basins over a period of approximately 15 min. No noticeable change in the flow at either of these catch basins was observed during the observations. This could be due to any of the following reasons:

- lack of discharge from the sumps during the time the flow was being observed,
- masking of the flow variation due to increased flow in the piping system from storm water runoff, or
- absence of other unknown conditions that caused the flow pulsations during previous observations.

At the time of the flow observations, sampling personnel heard water trickling into the piping system immediately below manhole 14015. There was no way to access this inflow for sampling, so no confirmation of the source of this flow could be made. The flow was discharging at a very low rate, so it was most likely storm water or groundwater entering the piping by moving through the soil to a crack or joint in the piping.

Since no variations in the flow were observed, it appears unlikely that water from the cycling of the sumps is causing any pulsing of the flow. However, it is unknown as to whether the water that was heard entering the piping system could be affecting the flow in some way.

Detectable levels of mercury were identified in both catch basins. Samples from catch basin 9006 had a mercury level of 9.83 ng/L. Samples from catch basin 14015 had a mercury level of 4.31 ng/L. Neither of these results are above the ambient water quality standard for mercury, which is 51 ng/L. Since both of these basins received runoff from the former K-1501 Steam Plant, it is possible that these traces of mercury could be due to the combustion of coal in that facility. No other analytes were detected above screening limits as part of this sampling event.

3.5.5.8 Sampling of Legacy Chromium Groundwater Plume Discharge

The release of hexavalent chromium into Mitchell Branch from the storm drain 170 outfall and from seeps at the headwall of the storm drain 170 discharge point resulted in levels of hexavalent chromium that exceeded state of Tennessee ambient WQC. Immediately below storm drain 170, hexavalent chromium levels were measured at levels as high as 0.78 mg/L, which exceeded the state of Tennessee hexavalent chromium water quality chronic criterion of 0.011 mg/L for the protection of fish and aquatic life. The levels of total chromium were at approximately the same value, indicating that the chromium was almost completely hexavalent chromium at the release point. The fact that the chromium was still in a hexavalent state is surprising since hexavalent chromium has not been used in ETTP operations in over 30 years. On July 20, 2007, TDEC sent a Notice of Violation to DOE for the hexavalent chromium release, and DOE responded on August 3, 2007.

Because chromium has not been used at ETTP for over 30 years, the release of hexavalent chromium into Mitchell Branch was a legacy problem and not an ongoing operations problem. Therefore, DOE determined that the appropriate response to this release was a CERCLA time-critical removal action. On November 5, 2007, DOE notified EPA and TDEC of their intent to conduct a CERCLA time-critical removal action to install a grout barrier wall and groundwater collection system to intercept the chromium-contaminated water currently discharging from the storm drain 170 outfall and headwall seeps into Mitchell Branch.

The purpose of the “Action Memorandum for Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee,” was to abate an immediate potential threat to public health and the environment from hexavalent chromium releases into Mitchell Branch. The potential for a chronic impact on the fish and aquatic life in Mitchell Branch may have increased in the future if the hexavalent chromium release had been allowed to continue.

The biological monitoring results did not indicate that the chromium had a significant, acute impact on fish or aquatic life in Mitchell Branch since the elevated levels of chromium were identified. However, there was a concern that the elevated levels may have begun to have a chronic impact on the fish and aquatic life in Mitchell Branch if the hexavalent chromium releases had not been addressed in a timely manner.

The time-critical removal action was undertaken by DOE, as lead agency, pursuant to CERCLA Section 1049 (a) and the *Federal Facility Agreement for the Oak Ridge Reservation*, Section XIII (DOE 1994). In accordance with 40 *CFR* 300.415(j) and DOE guidance, on-site removal actions conducted under CERCLA are required to meet applicable or relevant and appropriate requirements (ARAR) to the extent practicable considering the exigencies of the situation. The ambient water quality criteria for hexavalent chromium for the designated uses for Mitchell Branch are ARARs for the limited scope of this action and were included in the Action Memorandum.

DOE complied with the ARARs and "to-be-considered" guidance, as set forth in the Action Memorandum, to the extent practicable. The ambient water quality chronic criteria for hexavalent chromium during dry weather base flow periods were not met with the initial action. The action reduced the level of hexavalent chromium in Mitchell Branch by approximately 98% from 0.78 mg/L to levels as low as 0.014 mg/L during worst-case dry weather base flow periods. During wet weather periods, the level of hexavalent chromium in Mitchell Branch was reduced from 0.025 mg/L to current levels that are below method detection thresholds of 0.012 mg/L. The time-critical removal action is documented in the *Removal Action Report for the Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2001a).

Since the Removal Action Report was issued, additional improvements to the collection system have been implemented. The original pneumatic groundwater collection system pumps had a maximum capacity of approximately 8 to 9 gal/min, and the pumps required frequent field maintenance to keep them operating at the maximum rate. In January 2009 electric pumps were installed as replacements for the pneumatic pumps, and the new pumps have a combined maximum pump rate in excess of 20 gal/min. The new pumps have been set at an operational rate of 12 gal/min, which is a rate at which the hexavalent chromium levels in Mitchell Branch consistently have been below the ambient water quality criterion of 0.011 mg/L.

To monitor the continued effectiveness of the collection system, periodic monitoring continued as part of the 2010 SWP3. Samples were collected at piezometer TP-289, K-1407-V hose, outfall 170, and MIK-0.79. Samples collected at TP-289 directly monitor the concentrations of chromium in the contaminated groundwater plume. Samples collected from the K-1407-V hose monitor the chromium in the water recovered by the groundwater collection system. Samples collected at outfall 170 monitor the concentrations of chromium being discharged directly to Mitchell Branch. Samples at MIK-0.79 monitor chromium concentrations in Mitchell Branch after water discharged from outfall 170 has had a chance to mix with other flow in the branch.

Samples at these locations were collected on a monthly basis during either wet weather or dry weather conditions on an alternating basis. Samples were monitored each month for total chromium and on an "as requested basis" for hexavalent chromium at least two times during the year. All of the samples collected as part of this effort were collected using the manual grab sampling method. Manual grab samples were collected according to the guidelines specified in Sects. 3.1.2 and 3.3.1 of the EPA's *NPDES Storm Water Sampling Guidance Document* (EPA 1992), and applicable procedures that have been developed by the sampling subcontractor. All guidelines stated in this sampling and analysis plan (SAP) concerning sample documentation, analytical procedures, quality assurance/quality control, etc., were followed as part of this sampling effort. Figure 3.31 is a graph of the analytical data from this sampling effort.

The analytical data indicate that chromium levels may fluctuate slightly at the TP-289 and K-1407-V hose but are relatively consistent over the long term. Chromium values at outfall 170 and MIK 0.79 have much more variability. This is most likely due to the greater variability in flow rates at these two locations.

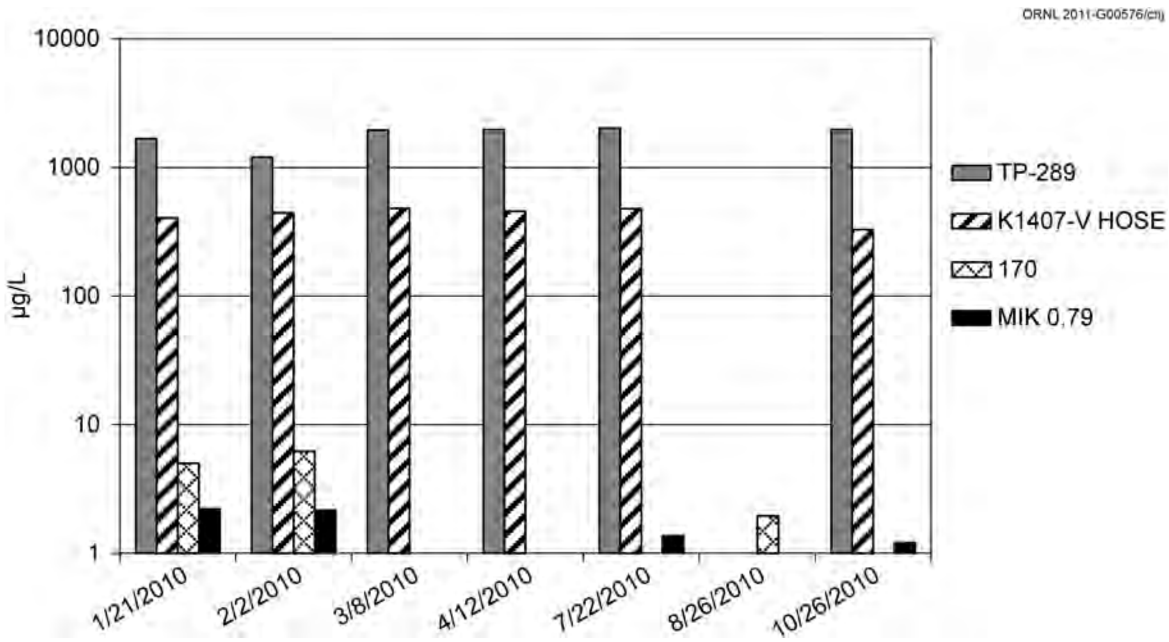


Fig. 3.31. Results from sampling conducted for the chromium collection system.

3.5.5.9 Investigation of Mercury at ETTP

Mercury activities at ETTP included usage, handling, and recovery operations. Mercury usage and handling were common in such equipment as manometers, switches, mass spectrometers, mercury diffusion pumps, mercury traps, and laboratory operations. Process buildings contained many of these manometers, thermometers, and switches. Large quantities of mercury-bearing wastes from the on-site gaseous diffusion plant operations and support buildings, ORNL, and Y-12 were processed and stored at ETTP. Mercury from soils and spill cleanups were processed onsite as well. Mercury recovery operations were conducted in a number of buildings, as shown on Fig 3.32. Many buildings were located in watersheds that discharged primarily to Mitchell Branch.

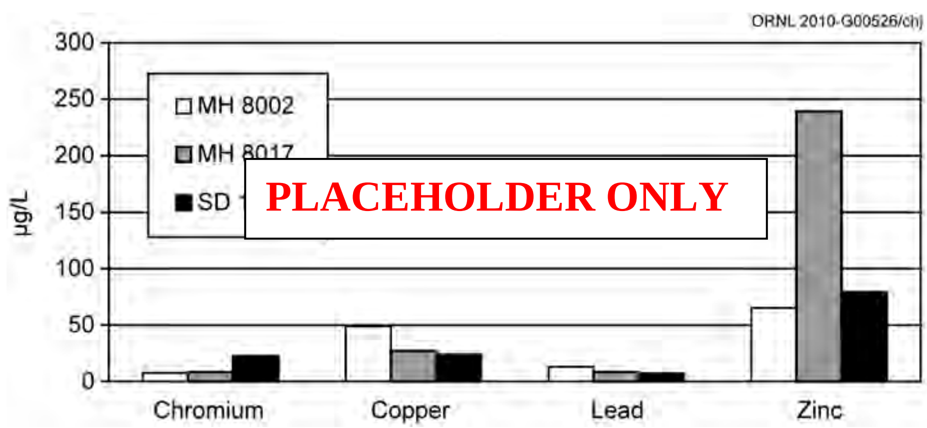


Fig. 3.32. ETTP area plan showing mercury-related facilities and mercury levels in water samples.
[IN DEVELOPMENT - Sherri Cotter has files from BJC Gary Lay- 5/4/11

A new NPDES permit was issued with an effective date of April 1, 2010, that requires quarterly mercury sampling to be performed at storm water outfalls 05A, 170, 180, and 190. These four locations were selected because the permit application information indicated that mercury levels at these outfalls exceeded the ambient water quality criteria (AWQC) level of 51 ng/L. Outfall 05A is the discharge point for the former sewage treatment plant drainage basin. Outfalls 170, 180, and 190 collect storm water from large areas on the north side of ETTP and discharge to Mitchell Branch.

In an effort to obtain analytical data utilizing the more sensitive method and to identify how the discharges from the storm water outfalls may be affecting the water quality of Mitchell Branch and associated waterways, mercury sampling was performed at numerous storm water outfalls with known historical mercury activities as well as surface water and sediment sampling being performed.

As stated above, the applicable water quality criterion for mercury is 0.051 µg/L; therefore, total mercury samples were analyzed by a laboratory with a method detection limit (MDL) for mercury below this criterion. For the storm water and surface water samples, the laboratory methods used for total mercury analysis are the EPA 1631 and 245.7 methods because they are able to detect mercury below the water quality criterion. Depending on the laboratory that runs the analysis, the EPA 1631 method has a detection limit as low as 0.2 ng/L. Surface water samples are collected in dry weather conditions, unless otherwise specified. Storm water samples are collected during both wet and dry weather conditions. Wet weather samples are collected from flows resulting from a storm event greater than 0.1 in. in magnitude in 24 hr and that occurs at least 72 hr after any previous storm event of 0.1 in. or greater in 24 hr. If an intermittent rainfall occurs over a period of 24 hr and did not equal or exceed 0.1 in., it is not considered to be a storm event, and the 72-hr delay until the next rainfall that can potentially be sampled is not in effect. Dry weather samples are collected at least 72 hr after a storm event of 0.5 in. or greater. All dry weather samples are collected by the manual grab sampling technique. Current permit and permit renewal application samples are collected using automated sampling equipment consisting of at least three aliquots taken during the first 60 min of a storm event discharge.

For sediment samples, the laboratory method used for total mercury is the EPA SW846-7471A method. Sediment samples are collected by the manual grab sampling technique.

Results for storm water outfalls 170, 180, and 190 and associated catch basins for each network are shown in Figs. 3.33–3.35. Mercury results for outfall 170 as well as the associated catch basins appear to be well below the WQC since July 2009. For 2010, the results for outfall 170 ranged from 5.49 to 14 ng/L, which are well below the water quality criteria. Outfalls 180 and 190, and associated catch basins, appear to be the primary sources of mercury discharges into Mitchell Branch in relation to the buildings in those drainage areas with historical mercury processes. For 2010, the results for outfall 180 varied significantly in range from 4.23 to 638 ng/L. For 2010, the results for 190 varied in range from 14.8 to 249 ng/L. Outfall 180 appears to have fluctuations in mercury levels that are significantly higher than outfalls 170 and 190. This may be due to infiltration within the drainage system primarily from catch basins 8131 and 8041A in relation to former mercury processes in Buildings K-1303 and K-1401.

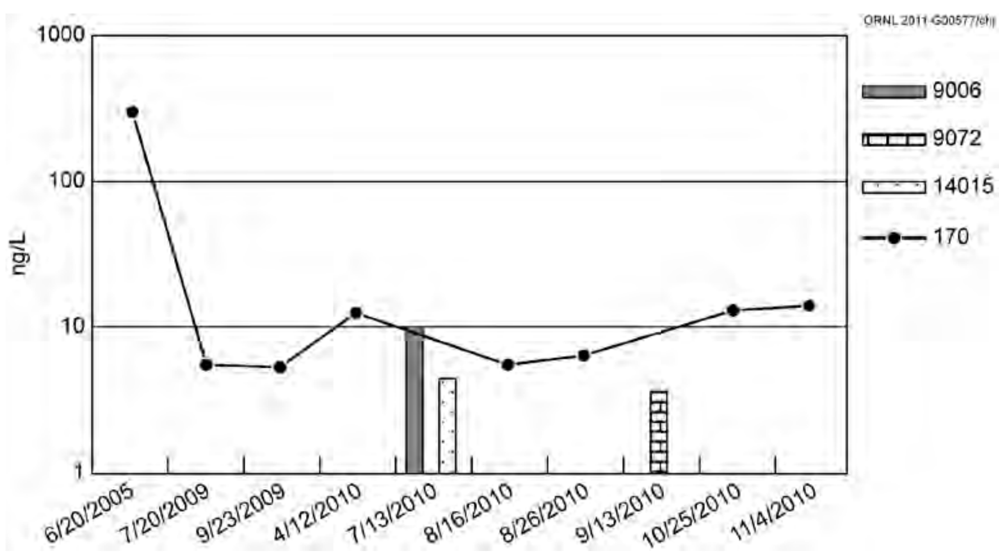


Fig. 3.33. Outfall 170 network water results for mercury.

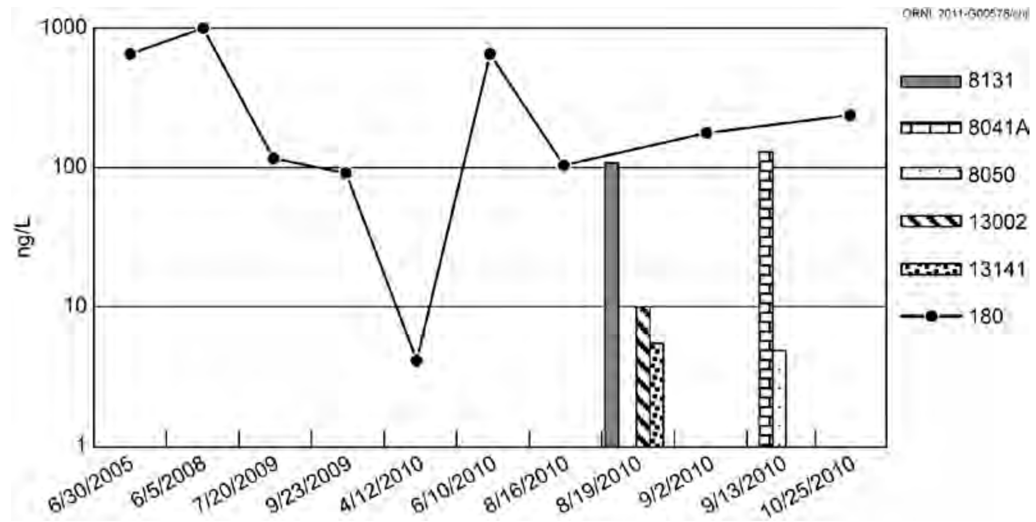


Fig. 3.34. Outfall 180 network water results for mercury.

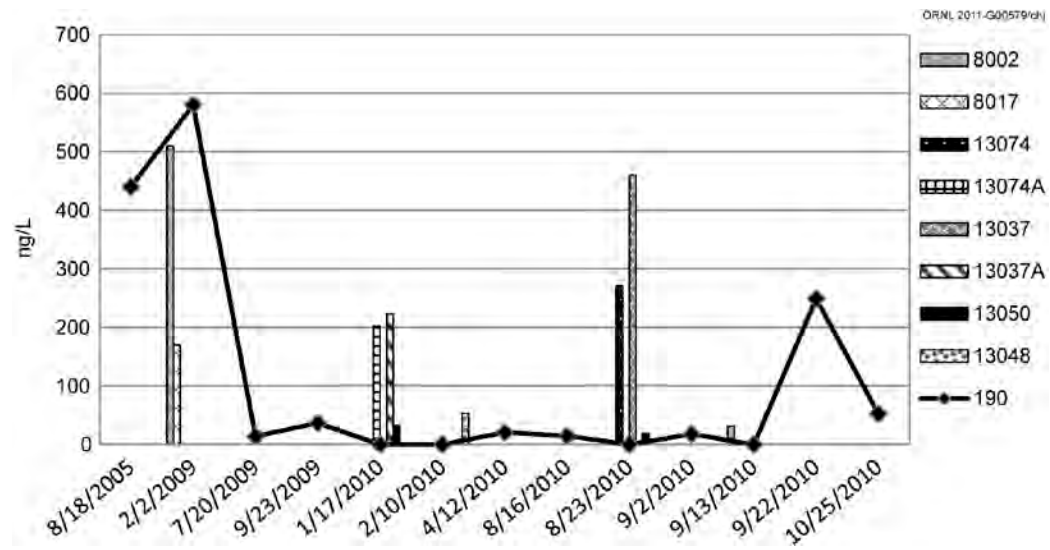


Fig. 3.35. Outfall 190 network water results for mercury.

Likely sources of mercury discharges in the outfall 180 drainage system are from Buildings K-1401, K-1405-7, and K-1407-B pond. The most likely sources of mercury discharges in the outfall 190 drainage system are from operations conducted in Buildings K-1035, K-1218, K-1301, K-1302, K1303, K-1401, and K-1413. By contrast, the mercury discharges in the outfall 170 drainage system would be from K-1420; however, the remediation of this area appears to have resulted in mercury levels below the WQC in comparison to the other two outfalls of Mitchell Branch.

Figure 3.36 shows the location and mercury data ranges for the Mitchell Branch storm water outfalls 170, 180, and 190 networks; however, the elevated result shown for outfall 170 was taken in June 2005, and by comparison, the 2010 results were well below the water quality criteria. Catch basin 13040 in the network for outfall 190 is shown on Fig. 3.36 in relation to Building K-1035, located directly to the west with known mercury processes. This catch basin is shown for future reference and was not sampled in 2010 but will be sampled in 2011.

The Mitchell Branch storm water outfall and in-stream water results for mercury are collectively shown in Fig. 3.37 and indicate the mercury results from in-stream at MIK 1.4 to downstream at the K-1700 weir. Outfall 180 indicates a significantly higher result in October 2010 in comparison to outfalls 170 and 190. As explained previously, this may be due to infiltration within the drainage system.

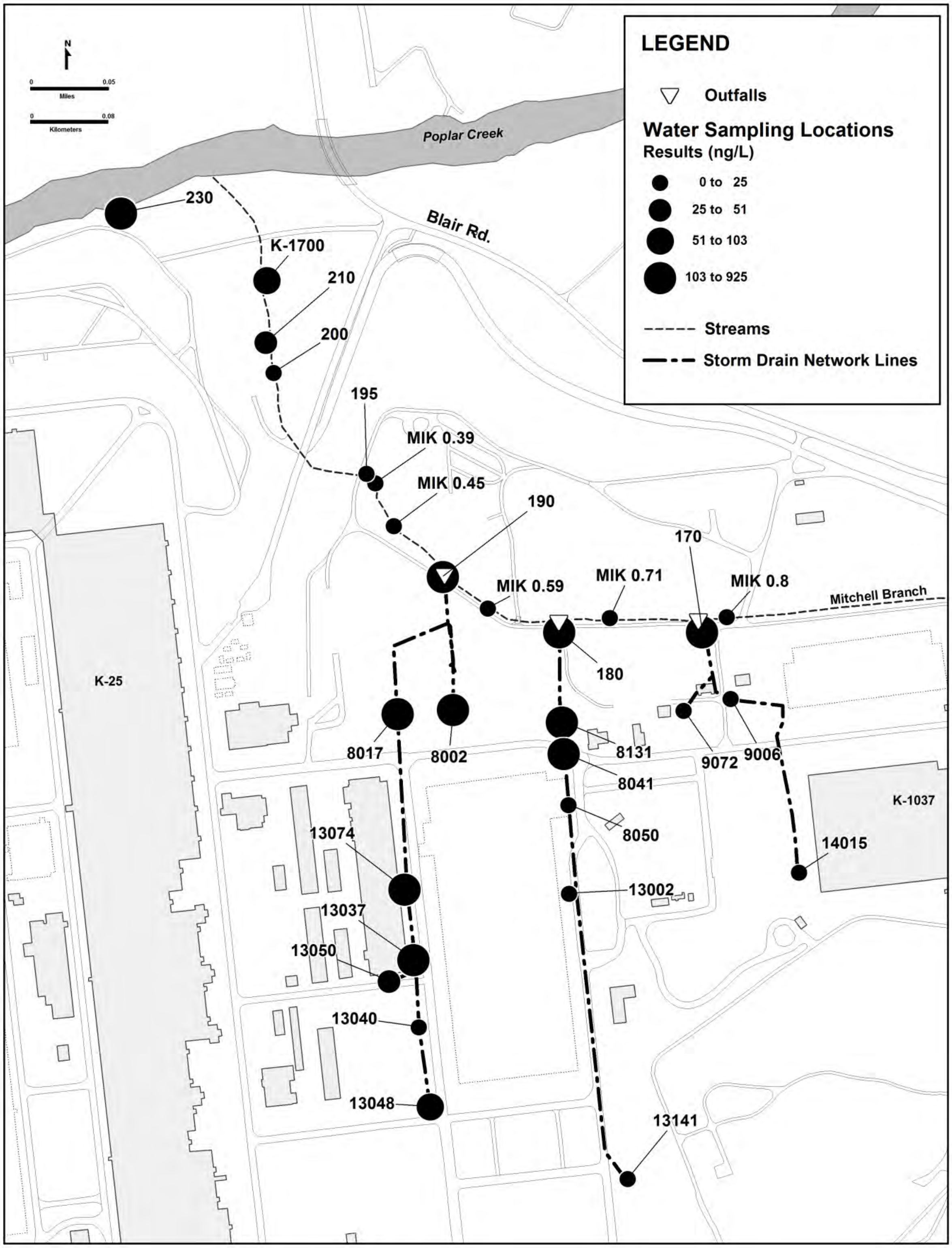


Fig. 3.36. Mitchell Branch water sampling locations and results for mercury.

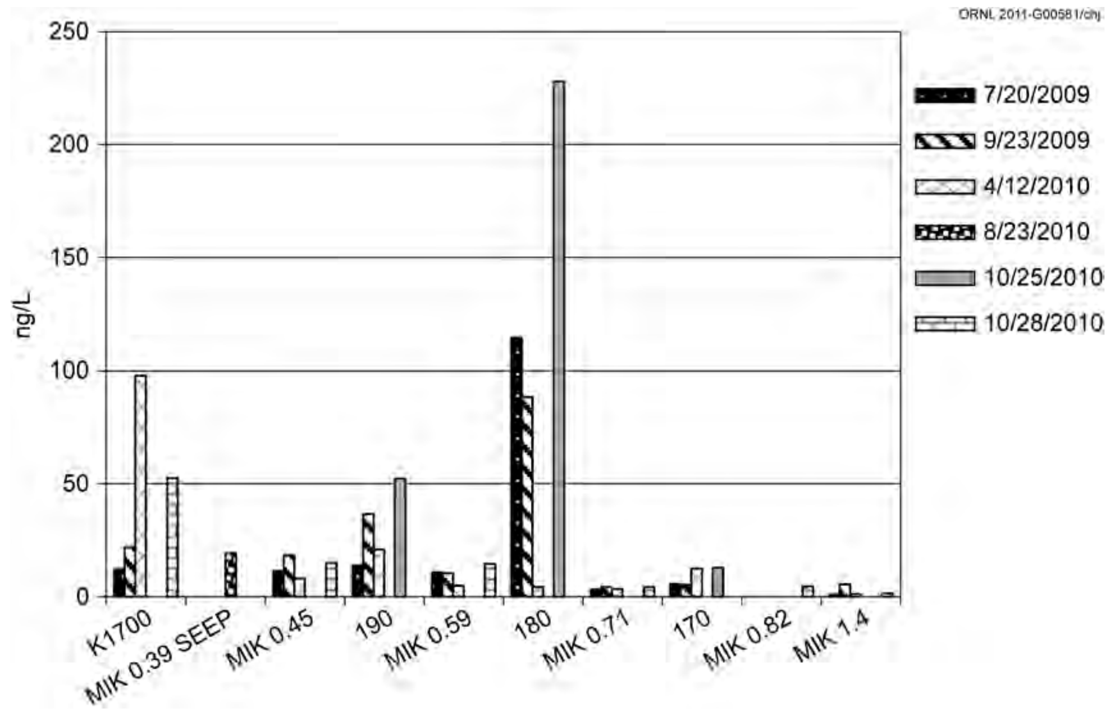


Fig. 3.37. Mitchell Branch storm water outfall and in-stream water results for mercury.

Figure 3.38 is the Mitchell Branch sediment results for mercury. There are noticeably lower mercury levels in the upper areas of Mitchell Branch from the reference location, MIK 1.4, downstream towards outfall 170. There appears to be an apparent seep from the nearby K-1070 burial grounds in the area of MIK 0.39 and MIK 0.45, downstream of outfall 190, to which the elevated levels of mercury may be attributed. Investigations will be conducted to determine if there is a seep in the vicinity of MIK 0.39 to MIK 0.45. Additionally, there appears to be another seep in the area of MIK 0.13 and MIK 0.24, noted by the significant rise in mercury levels at MIK 0.24 as compared to the significantly lower mercury levels at MIK 0.27. Further downstream at the K-1700 weir, there may be the deposition of sediment containing mercury levels noted by the significant rise in mercury levels at this location.

Figures 3.39 and 3.40 indicate the water and sediment results for mercury, respectively, at the K-1700 weir location, specifically. The K-1700 water results for mercury appear to be fairly steady from 2008 through 2009 but become elevated above water quality criteria in March and April of 2010, before decreasing toward water quality criteria levels by the end of October 2010. Water results for mercury taken as part of the K-1700 groundwater program substantiate the elevated mercury levels from early March to mid-August 2010. The K-1700 sediment results for mercury follow a similar trend but for a slightly different time period. Sediment levels for mercury appear steady from March 2001 to July 2003 at lower levels until sampled again in mid-August 2008 when noticeably higher mercury levels are apparent through early July 2010. These higher levels, quite possibly, were due to the accumulation of sediment at this location resulting from storm water discharges and seeps containing mercury that are depositing into Mitchell Branch.

Another area of elevated mercury levels is the site of the former sewage treatment plant and associated storm water outfall 05A. As stated above, storm water outfall 05A requires quarterly mercury sampling because the permit application information indicated that mercury levels at this location exceeded the water quality criteria level of 51 ng/L. Outfall 05A is the discharge point for the former sewage treatment plant drainage basin. Operations at the plant ceased in 2008. Figure 3.41 indicates the locations of the storm water outfall 05A, the K-1203-10 sump, and four groundwater wells that have been monitored for mercury. Table 3.37 shows the comparison of mercury levels between the influent and effluent sources as well as the sediment sample taken from the sump.

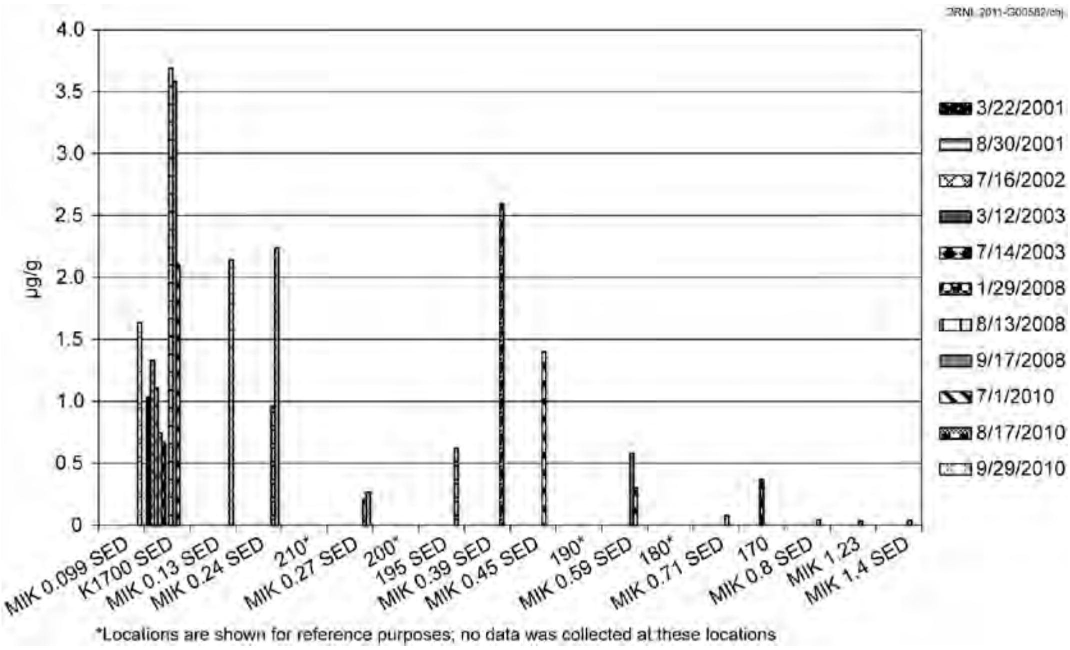


Fig. 3.38. Mitchell Branch storm water outfall and in-stream sediment results for mercury.

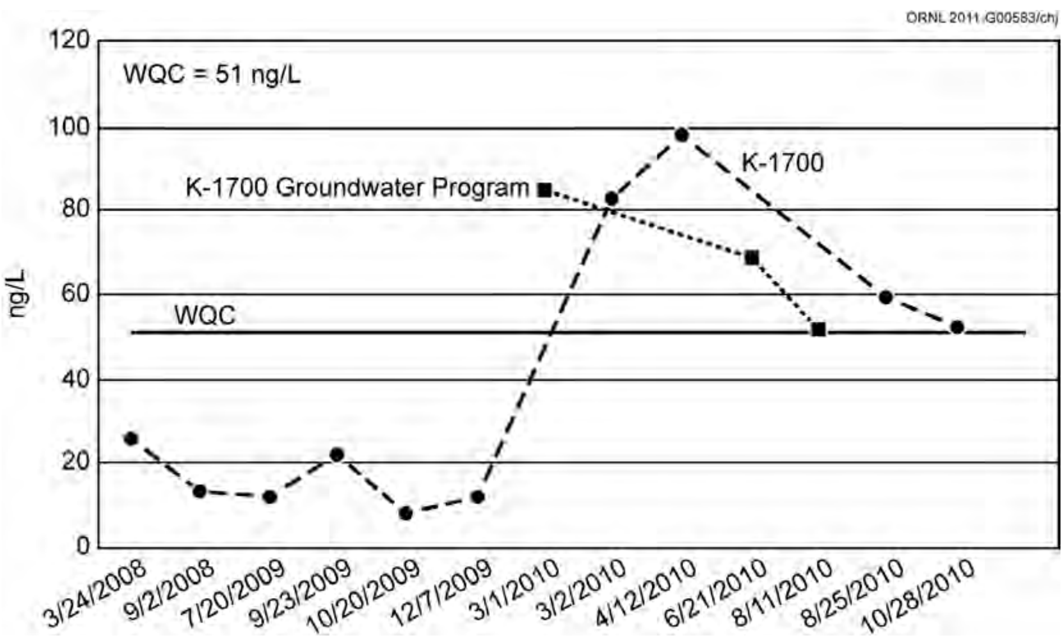


Fig. 3.39. The K-1700 water results for mercury.

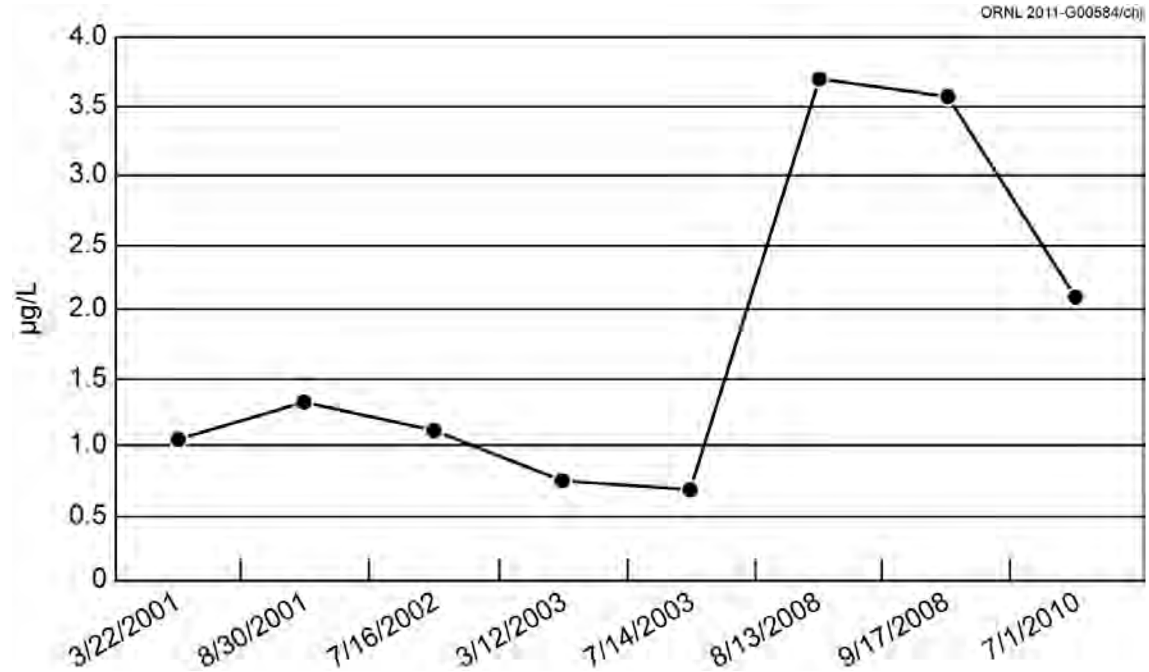


Fig. 3.40. The K-1700 sediment results for mercury.

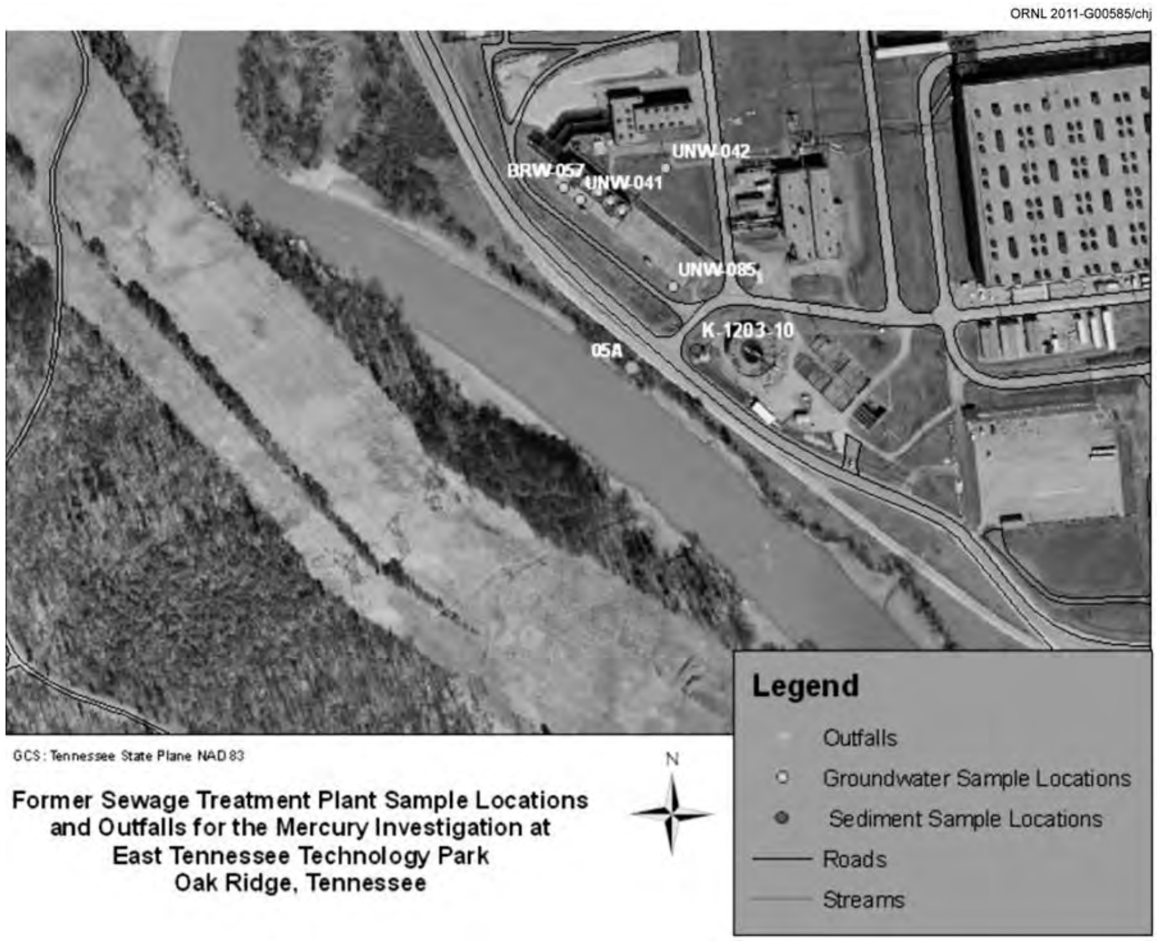


Fig. 3.41. The former sewage treatment plant monitoring locations for mercury.

Table 3.37. Mercury water and sediment results for the former sewage treatment plant

Water influent into K-1203-10 sump (ng/L)			Water effluent at outfall 05A (ng/L)		Sediment from K-1203-10 sump (µg/g)	
11/16/2010	05A-A	82.7	3/21/2006	140	8/17/2010	546.8
11/16/2010	05A-B	37.5	10/22/2007	108		
11/16/2010	05A-C	12.8	6/26/2008	205		
11/16/2010	05A-D	294.8	8/26/2008	135		
			4/12/2010	186		
			8/16/2010	66.4		
			8/26/2010	118		
			10/25/2010	223		

The influent water coming into K-1203-10 sump was monitored from four sources in 2010. Two sources (05A-A and 05A-C) are naturally occurring sheet flows coming into the sump. The other two sources (05A-B and 05A-D) are pipe flow sources. The pipeline for 05A-B is abandoned and runs from the clarifying basin located immediately next to the sump. The pipeline for 05A-D is labeled on historical drawings as being partially abandoned and runs approximately 65–70 ft from the chlorine contact basin (K-1203-8). Two of the influent sources coming into the sump were above WQC (05A-A and 05A-D) in 2010; the highest mercury result was 294.8 ng/L at 05A-D. All four influent sources are to be resampled for mercury in 2011.

Figure 3.42 indicates the mercury results in the effluent water at outfall 05A since 2006. As shown, all results for the past 5 years are above WQC. In 2010, specifically, outfall 05A was monitored four times; the highest mercury result was 223 ng/L on October 25, 2010. Additional monitoring was performed for the former sewage treatment plant area in 2010. Sediment was taken from the sump with a result of 546.8 µg/g, as shown on Table 3.37. Four groundwater wells were also monitored—three unconsolidated wells (UNW-041, UNW-042, UNW-085) and one bedrock well (BRW-057). The results are shown in Table 3.38. One groundwater well had a result above WQC (BRW-057) with a result of 68.7 ng/L; however, the origin of the mercury is not known due to the karst topography of the area.

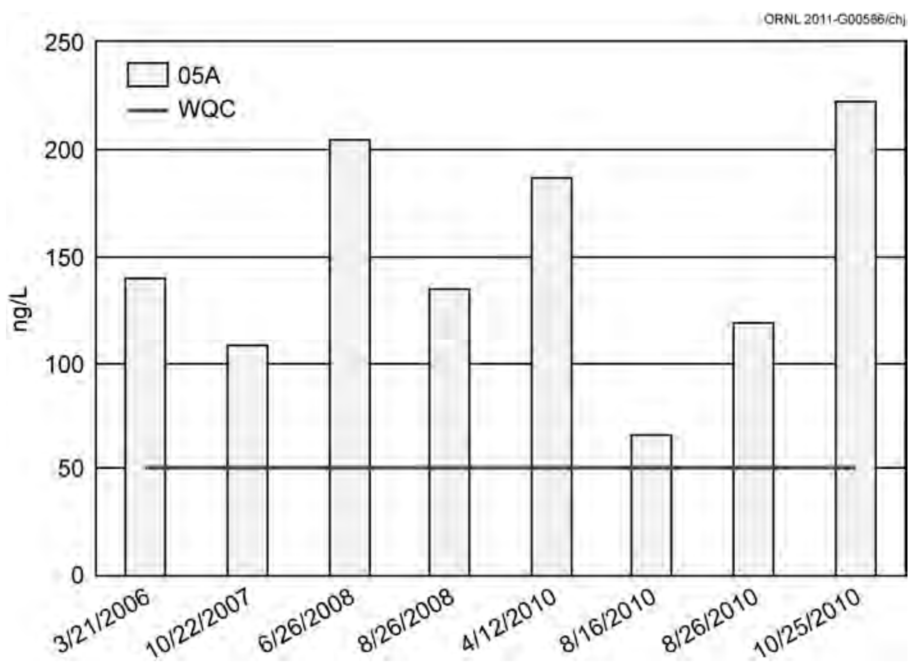


Fig. 3.42. Storm outfall 05A water results for mercury.

Table 3.38. Mercury results of groundwater monitoring performed in 2010 at the former sewage treatment plant area

Groundwater well	Date	Mercury result (ng/L)
UNW-085	11/2/2010	4.6
UNW-042	11/3/2010	5.4
UNW-041	11/4/2010	2.5
BRW-057	11/4/2010	68.7

Other storm water monitoring that was performed at outfalls at ETTP in 2010 with mercury results above WQC are shown in Table 3.39. Storm water outfall 230 is located downstream of Mitchell Branch and the K-1700 weir prior to Poplar Creek and receives storm water discharges from the east side of Building K-25 where it is possible mercury contamination may have occurred from a historically known area described as the K-25 North Trash Slope. Storm water outfall 350 is located on the west side of Building K-25 and receives storm water discharges from a relatively small area. Although historical references do not list mercury specifically as being stored, it may be possible that mercury-contaminated equipment was stored or leaked in this location. Storm water outfall 694 is located in the former powerhouse area and receives storm water discharge from a relatively large area. Several buildings are documented as having mercury processes or operations; therefore, it is likely that the mercury contamination originates from these areas.

Table 3.39. Storm water results of mercury monitoring in 2010 at other ETTP locations above WQC

Storm water outfall	Date	Mercury result (ng/L)
230	8/12/2010	109
350	10/25/2010	77.3
694	11/30/2010	229

Further monitoring for mercury is proposed in 2011 for the Mitchell Branch, former sewage treatment plant, and other locations as part of the NPDES permit program, storm water pollution prevention program, environmental monitoring program, groundwater program, and biological monitoring and abatement program (BMAP). Historical documents continue to be researched, and future monitoring is proposed as part of the ongoing mercury investigation.

3.5.5.10 NPDES Monitoring at the CNF Waste Water Treatment System

Nonradiological monitoring of CNF effluent is conducted according to the requirements of NPDES Permit No. TN0074225. Monitoring requirements, frequencies, and sample types required under the permit changed during 2010 with the reissuance of the permit on December 1, 2010. During the permit renewal process, the CNF was reclassified into the Metal Finishing point source category by the permit writer. This change in point source category largely effected the change in parameters between the previous permit and the renewed permit. The requirements prior to December 1, 2010, are listed in Table 3.40, and the requirements post-December 1, 2010, are listed in Table 3.41. There was also an overall decrease in the sampling frequency between the previous permit and the renewed permit that was based on sampling results from CNF for the previous 3 years. Wastewater from CNF is discharged through outfall 001 into the Clinch River.

Radiological sampling of effluent from the CNF and/or the K-1435 Waste Water Treatment System are conducted weekly. The weekly samples are then composited into a single monthly sample. Table 3.42 lists the total discharges in 2010 by isotope. The radiological results are compared with the DCGs. The sum of the fractions must be kept below 100% of the DCGs; in practice the effluent results from the CNF and/or the K-1435 Waste Water Treatment System were well below 100% of the DCGs until 2007. Figure 3.43 shows a rolling 12-month average for 2010. Monitoring results for 2010 showed a marked decrease in the rolling 12-month average of the sum of the fractions of the DCGs from a high of 1.1 in

Table 3.40. NPDES permit no. TN0074225 outfall 001 monitoring requirements (prior to December 1, 2010)

Parameter	Collection frequency	Sample type
Flow	Continuous	Recorder
pH	Continuous	Recorder
Total suspended solids (TSS)	Weekly	24-hr composite
Chemical oxygen demand (COD)	Weekly	24-hr composite
Benzene	Bimonthly	Grab
Ethylbenzene	Bimonthly	Grab
Toluene	Bimonthly	Grab
Methylene chloride	Bimonthly	Grab
Bromoform	Monthly	Grab
Carbon tetrachloride	Monthly	Grab
Chlorodibromomethane	Monthly	Grab
Chloroform	Monthly	Grab
Dichlorobromomethane	Monthly	Grab
Tetrachloroethylene	Monthly	Grab
1,1,1-Trichloroethane	Monthly	Grab
Trichloroethylene	Monthly	Grab
Vinyl chloride	Monthly	Grab
Naphthalene	Monthly	Grab
Oil and grease	Monthly	Grab
Total petroleum hydrocarbons (TPH)	Monthly	Grab
Chloride, total	Monthly	24-hr composite
Polychlorinated biphenyls (PCBs)	Monthly	24-hr composite
Uranium, total	Monthly	Monthly composite
Gross alpha radioactivity	Monthly	Monthly composite
Gross beta radioactivity	Monthly	Monthly composite
^{234}U	Monthly	Monthly composite
^{235}U	Monthly	Monthly composite
^{236}U	Monthly	Monthly composite
^{238}U	Monthly	Monthly composite
^{99}Tc	Monthly	Monthly composite
^{137}Cs	Monthly	Monthly composite
^{238}Pu	Monthly	Monthly composite
^{239}Pu	Monthly	Monthly composite
^{237}Np	Monthly	Monthly composite
Other radionuclides—determined monthly	Monthly	Monthly composite
Cadmium, total	Quarterly	24-hr composite
Chromium, total	Quarterly	24-hr composite
Copper, total	Quarterly	24-hr composite
Lead, total	Quarterly	24-hr composite
Nickel, total	Quarterly	24-hr composite
Silver, total	Quarterly	24-hr composite
Zinc, total	Quarterly	24-hr composite
Mercury, total	Quarterly	24-hr composite
Acetone	Quarterly	Grab
Acetonitrile	Quarterly	Grab
Methyl ethyl ketone	Quarterly	Grab
Chlordane	Quarterly	Grab
Total toxic organics (TTO)[a]	Quarterly	Grab
Settleable solids[b]	Biannually	Grab
Cyanide, total	Annually	Grab

[a] TTOs include, at a minimum, chloroform, bromoform, dichlorobromomethane, chlorodibromomethane, carbon tetrachloride, tetrachloroethylene, methylene chloride, naphthalene, benzene, ethylbenzene, toluene, and PCB. Other parameters listed in 40 CFR Part 433 are analyzed if their presence is suspected based on process knowledge.

[b] To comply with DOE Order 5400.5, Chap. II, 3.a.(4), the presence of settleable solids greater than 0.1 mg/L must be determined. If settleable solids are present, the sample will be filtered and the solids will be analyzed for total uranium, gross alpha radioactivity, and gross beta radioactivity. Sufficient volume shall be collected and held for radiological analyses. “Settleable solids” is not a NPDES permit parameter, and the result is not reported with the discharge monitoring report.

Table 3.41. NPDES Permit No. TN0074225 Outfall 001 monitoring requirements (since December 1, 2010)

Parameter	Measurement frequency	Sample type
Flow	Continuous	Recorder
pH	Continuous	Recorder
^{137}Cesium	1/month	Monthly composite
^{234}Uranium	1/month	Monthly composite
^{235}Uranium	1/month	Monthly composite
^{236}Uranium	1/month	Monthly composite
^{237}Neptunium	1/month	Monthly composite
^{238}Plutonium	1/month	Monthly composite
^{238}Uranium	1/month	Monthly composite
^{239}Plutonium	1/month	Monthly composite
^{99}Technetium	1/month	Monthly composite
COD	1/month	24-h composite
Gross alpha radioactivity	1/month	Monthly composite
Gross beta radioactivity	1/month	Monthly composite
Oil and grease	1/month	Grab
Other radionuclides contained in wastewater[a]	1/month	Monthly composite
Uranium, total	1/month	Monthly composite
2-4-6-Trichlorophenol	1/quarter	24-h composite
Acetone	1/quarter	Grab
Acetophenone	1/quarter	24-h composite
ICP metals[b]	1/quarter	24-h composite
Methyl ethyl ketone (2-Butanone)	1/quarter	Grab
o-Cresol (2-Methyl Phenol)	1/quarter	24-h composite
p-Cresol (4-Methyl Phenol)	1/quarter	24-h composite
Phenol	1/quarter	24-h composite
Pyridine	1/quarter	24-h composite
Trichloroethylene	1/quarter	Grab
TSS	1/quarter	24-h composite
Biochemical oxygen demand (BOD)	1/year	24-h composite
Chloroform	1/year	Grab
Mercury, Methyl	1/year	Grab
Mercury, total	1/year	24-h composite
PCBs	1/year	24-h composite

[a]Other radionuclides currently being analyzed each month are ^{241}Am, tritium, ^{14}C, ^{230}Th, ^{234}Th, ^{60}Co, and ^{131}I.
[b] ICP metals shall include, at a minimum, Sb, As, Cd, Cr, Co, Cu, Pb, Ni, Ag, Sn, Ti, V, and Zn per the permit and Al, Ba, Be, B, Ca, Fe, Mg, Mn, Mo, K, Se, Si, Na, and Tl.

Table 3.42. Isotopic discharges from the Central Neutralization Facility Waste Water Treatment System, 2010

Isotope	Curies	Isotope	Curies
^{241}Am	3.9E–6	^{239}Pu	2.2E–6
		^{99}Tc	3.3E–2
^{137}Cs	7.1E–5	^{230}Th	7.9E–6
^{60}Co	2.0E–5	^{234}Th	2.5E–3
^{3}H	5.6E–3	^{234}U	2.5E–3
^{131}I	1.7E-5	^{235}U	2.5E–4
^{237}Np	1.1E–5	^{236}U	2.5E–4
^{238}Pu	1.8E–6	^{238}U	2.5E–3

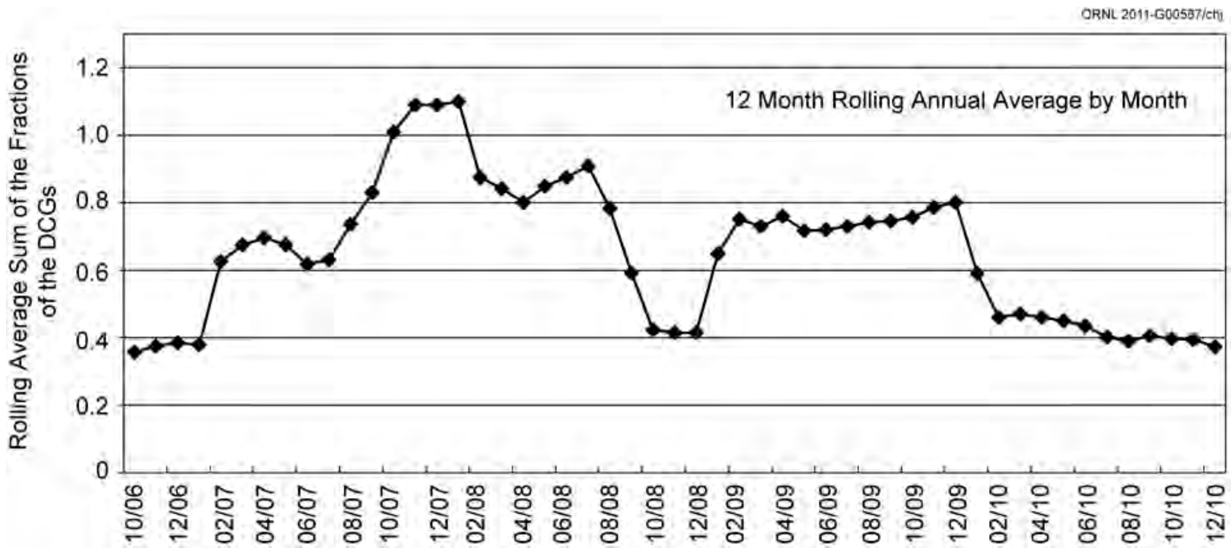


Fig. 3.43. CNF/K-1435 Waste Water Treatment System radionuclide liquid discharges.

January 2008 to 0.4 in December 2010. In most of 2010, the rolling average of the sum of the fractions has remained steady at 0.4 to 0.5. The cessation of waste-burning activities at the TSCA Incinerator may account for much of the decrease. Other factors include changes in operations at the facility to enhance the removal efficiency.

Although uranium isotopes constitute the greatest mass (approximately 7.7 kg) of radionuclides discharged from CNF, ^{99}Tc and tritium account for the greatest activity, due to their much higher specific activities. Transuranic isotopes constitute a small fraction of the total.

3.5.5.10 NPDES Permit Noncompliances

During 2010 ETTP and Bechtel Jacobs operations were conducted in compliance with contractual and regulatory environmental requirements. A single NPDES permit noncompliance attributable to an unpermitted discharge to the storm water drainage system occurred on January 20, 2010. A contractor maintenance worker for an on-site commercial firm poured the contents of two 5-gal paint cans into a storm drain catch basin.

3.5.6 Surface Water Monitoring

The ETTP environmental monitoring program personnel conduct environmental surveillance activities at 13 surface water locations (Fig. 3.44) to monitor groundwater and storm water runoff (K-1700, K-1007-B, and K-901-A) or ambient stream conditions [Clinch River kilometer (CRK) 16; CRK 23; K-1710; K-716; K-700 Slough; and MIK 0.5, 0.6, 0.7, 0.8 and 1.4]. Depending on the location, samples may be collected and analyzed for radionuclides quarterly (K-1700 and MIK 0.5, 0.6, 0.7, 0.8, and 1.4) or semiannually (remainder of locations). Results of radiological monitoring are compared with the DCGs. Radiological data are reported as fractions of DCGs for reported radionuclides. If the sum of DCG fractions for a location exceeds 100% for the year, a source investigation is required. Sources exceeding DCG requirements would need an analysis of the best available technology to reduce the sum of the fractions of the radionuclide concentrations to their respective DCGs to less than 100%. Comparisons with DCGs are updated regularly to maintain an annual average. The monitoring results at all of the surveillance locations generally have remained less than 1% of the allowable DCG (Fig. 3.45). The exceptions are K-1700 and four of locations on Mitchell Branch, as indicated by the sums of the fractions of the DCGs for these locations as follows:

- K-1700: 2.2%,
- MIK 0.5: 2.7%,
- MIK 0.6: 1.9%,
- MIK 0.7: 1.9%, and
- MIK 0.8: 4.2%.

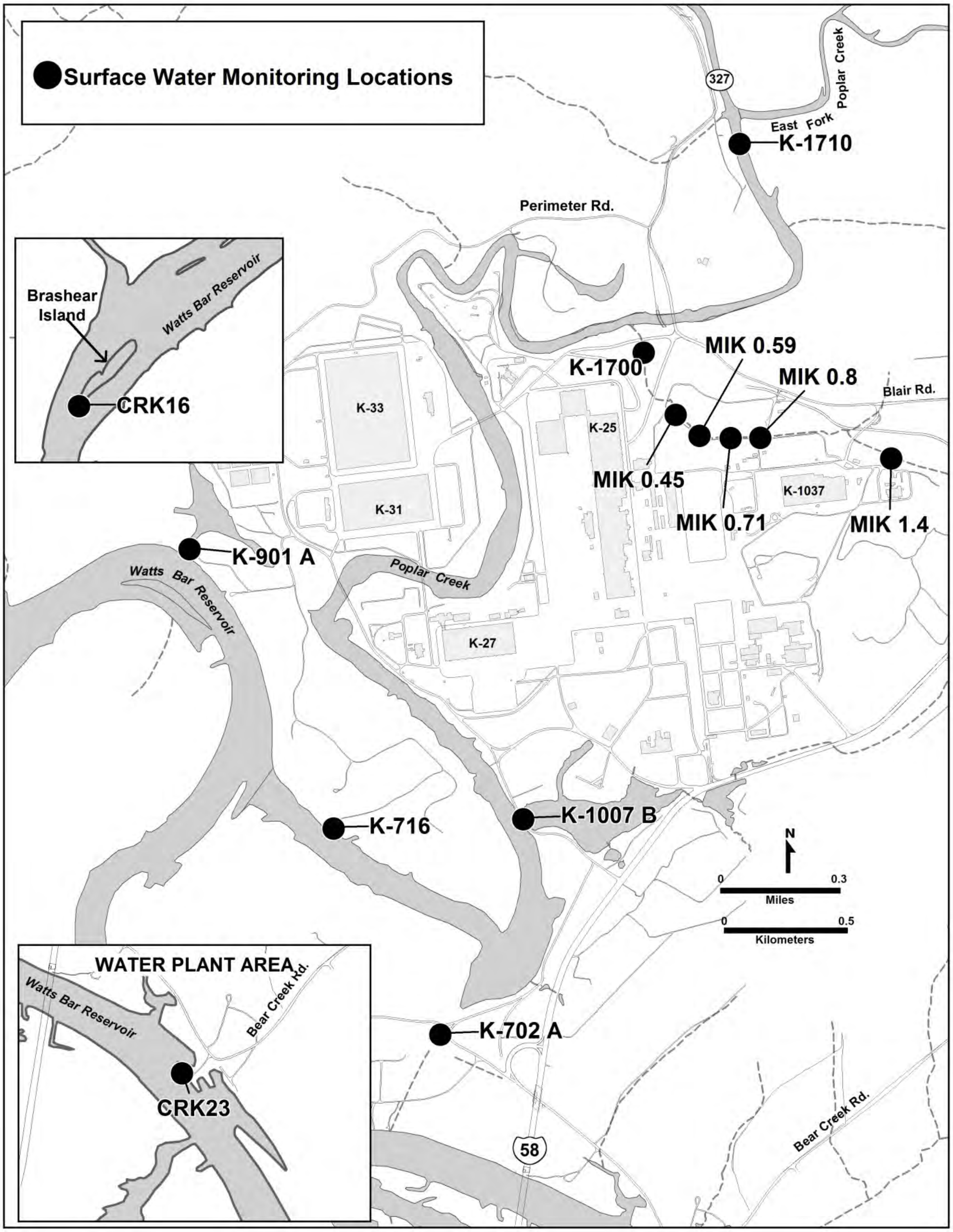


Fig. 3.44. Environmental monitoring program surface water monitoring locations.

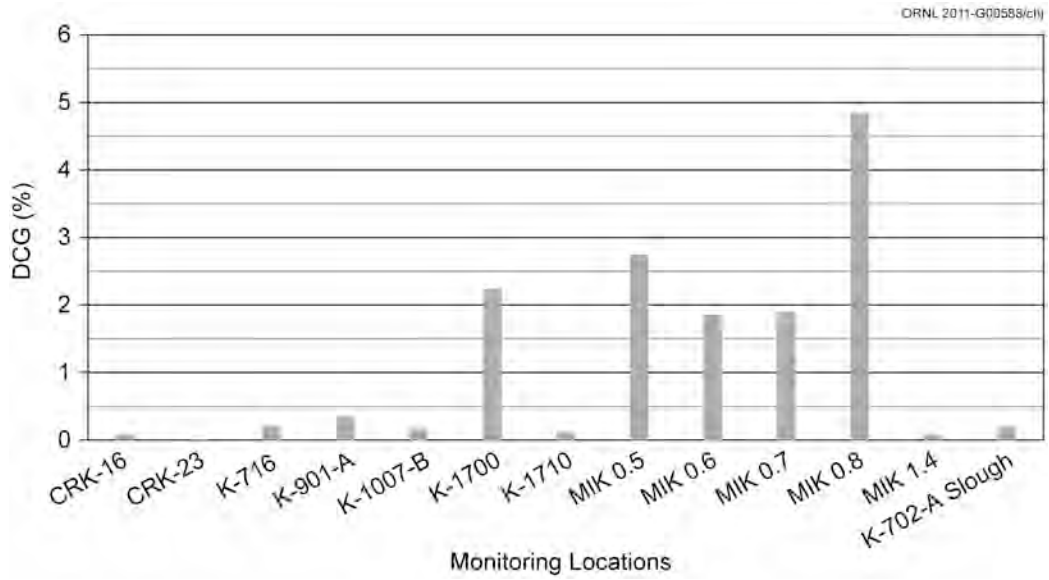


Fig. 3.45. Percentage of derived concentration guides (DCGs) at surface water monitoring locations, 2010.

The percentage of the DCGs at K-1700 (2.2%) was slightly below the percentage of the 2009 monitoring results (2.7%).

Depending on the monitoring location, water samples may be analyzed for pH, selected metals, and VOCs. In 2010, results for most of these parameters were well within the appropriate Tennessee state WQC.

The WQC for dissolved oxygen in stream and ponds is a minimum level of 5 mg/L. In the late summer and fall 2010 monitoring, dissolved oxygen levels at several of the surface water monitoring locations fell below this level. The lowest level (1.7 mg/L) was measured at K-901-A in August. Levels at the K-700 Slough, K-1007-B, K-1700,K-1710, and MIKs 0.5, 0.6, 0.7and 1.4 were also measured at less than 5 mg/L at some point during 2010. Low levels of dissolved oxygen are not uncommon in area streams and are usually associated with higher temperatures (and the associated elevated levels of biological activity) and low rainfall and stream flow. No obvious signs of distress (e.g., dead fish) were observed to be associated with any of these measurements in 2010.

The WQC for mercury is 0.051 µg/L. In 2010, levels of mercury were routinely measured above this level in water collected from K-1700. For details, please see the discussion of the site-wide mercury investigation given in Sect. 3.5.1.

Figures 3.46 and 3.47 illustrate the concentrations of TCE (trichloroethene, trichloroethylene) and total 1,2-DCE (dichloroethene, cis-1,2-dichloroethylene, trans 1,2-dichloroethylene) from K-1700 (which monitors Mitchell Branch), the only surface water monitoring location where VOCs are regularly detected. Concentrations of TCE and total 1,2-DCE are below the Tennessee WQC for recreation, organisms only (300 µg/L for TCE and 10,000 µg/L for trans 1,2-DCE, Appendix D, Table D.2), which are appropriate standards for Mitchell Branch. Moreover, the standards for 1,2-DCE apply only to the "trans" form of 1,2-DCE; almost all of the 1,2-DCE is in the cis-isomer. In addition, vinyl chloride has sometimes been detected in Mitchell Branch water (Fig. 3.48). Volatile organic carbons have been detected in groundwater in the vicinity of Mitchell Branch and in building sumps discharging into storm water outfalls that discharge into the stream; however, storm drain network monitoring generally has not detected these compounds in the storm water discharges. When detected, the concentrations are lower than in the stream. Therefore, it appears that the primary source of these compounds is contaminated groundwater.

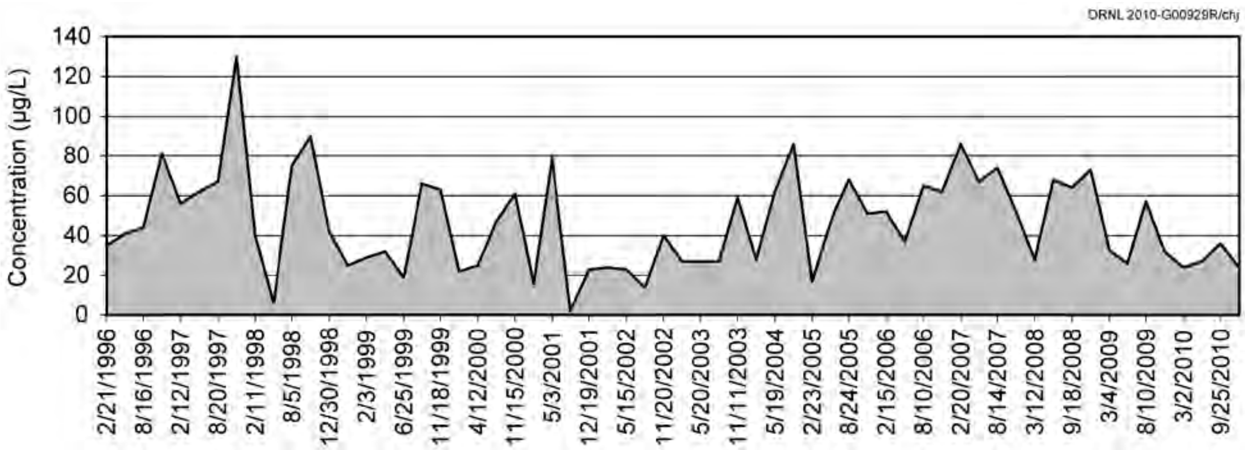


Fig. 3.46. TCE concentrations at K-1700.

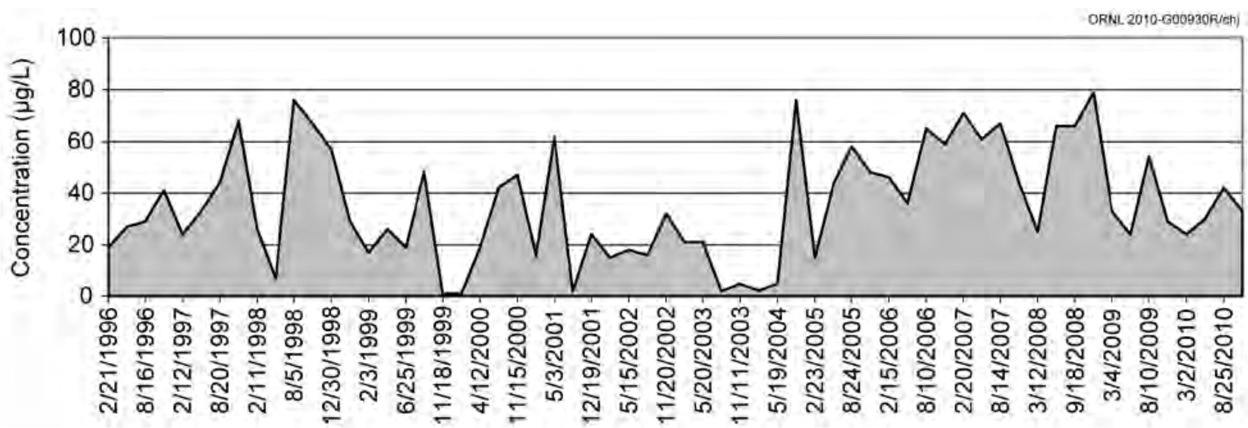


Fig. 3.47. 1,2-DCE concentrations at K-1700.

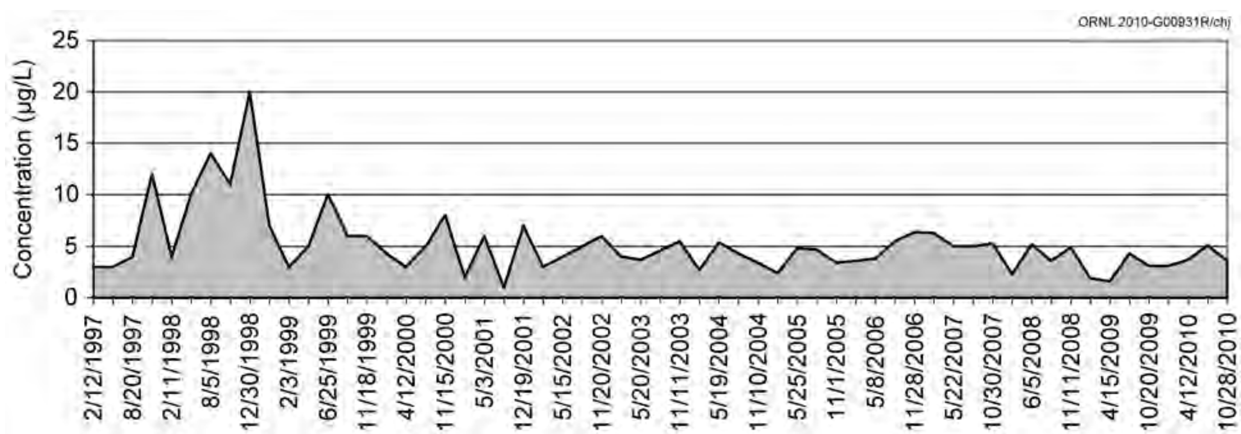


Fig. 3.48. Vinyl chloride concentrations at K-1700.

Surface water has been routinely sampled by DOE contractors and TDEC for several years as part of environmental monitoring programs. The DOE contractor surface water sampling program is conducted in accordance with DOE order surveillance program guidance. In data collected as part of the DOE contractor's sampling effort, dry weather levels of total chromium over the past 10 years (Fig. 3.49) have been shown to be generally less than 0.01 mg/L or, in some instances, at nondetectable levels. Results from routine surface water monitoring conducted in fall 2006 showed a significant increase in the total chromium level in Mitchell Branch but still below the WQC for total chromium. Sampling performed in the spring of 2007 by DOE contractors and TDEC indicated that chromium levels had increased above the levels found in the fall 2006 sampling. A chromium collection system employing two extraction wells and pumps was installed to pump water from the vicinity of storm water outfall 170 for treatment at the CNF. Since this system was installed, chromium levels in Mitchell Branch have dropped dramatically, with levels being routinely measured at less than 3 µg/L. Hexavalent chromium levels in Mitchell Branch were all below the detection limit in 2010.

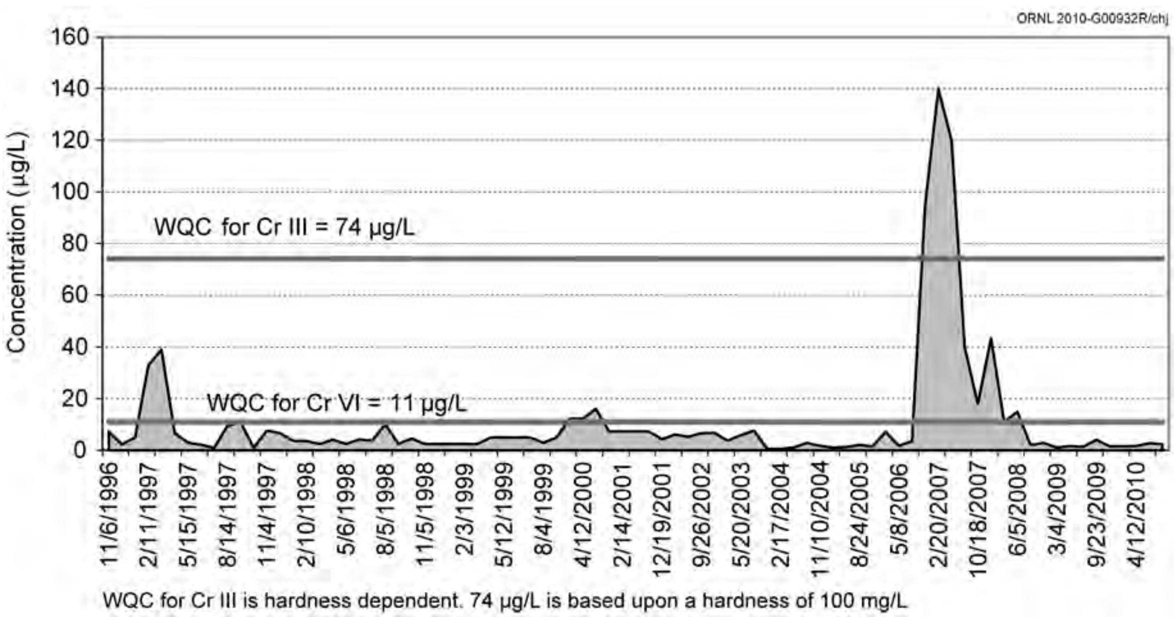


Fig. 3.49. Total chromium concentrations at K-1700.

3.5.7 ETTP Groundwater

3.5.7.1 Introduction

Groundwater at the ETTP site occurs in residual soils, man-made fill, alluvial soils, and bedrock. Because of extensive terrain modification that occurred during site construction, large areas of the main industrial site were subjected to cut and fill activities that modified site hydrology. Most of the ETTP site is underlain by carbonate bedrock of the Chickamauga Group with subordinate areas underlain by carbonates of the Knox Group and clastic dominated sandstones, shales, and siltstones of the Rockwood formation. The geologic structure of bedrock beneath the ETTP site is the most complex of the ORR facilities because of structural rock deformation associated with the White Oak Mountain thrust fault and footwall deformation associated with motion along that fault. The structural complexity coupled with the presence of soluble carbonate bedrock beneath the site led to very complex groundwater flow conditions.

The ETTP groundwater program consists of (1) sitewide groundwater monitoring, primarily the monitoring of major site contaminant plumes and exit pathway contaminant migration, and (2) surface water monitoring for the analysis of ambient water quality criteria (AWQC). Also, an update on conditions as characterized by the biological monitoring in area surface water bodies is included.

3.5.7.2 Background

The groundwater monitoring at the ETTP is focused primarily on investigating and characterizing sites for remediation under CERCLA and groundwater exit pathway monitoring. As a result of the Federal Facility Agreement and certification of closure of the K-1407-B and -C Ponds, the principal driver at the ETTP is CERCLA. ETTP Groundwater Protection Program requirements are incorporated into the Water Resources Restoration Program (WRRP), established to provide a consistent approach to watershed monitoring across the ORR and responsible for groundwater surveillance monitoring at the ETTP, which includes groundwater exit pathway monitoring. This groundwater monitoring is conducted to assess the performance of completed CERCLA actions. Groundwater monitoring wells have been placed downgradient of potential contamination sources. Groundwater discharges into Poplar Creek, the Clinch River, and the three main surface water bodies at ETTP (i.e., the K-901 Pond, K-1007 Pond, and Mitchell Branch). Many of the contaminants at ETTP migrate towards these surface water bodies. Groundwater monitoring wells have been placed near these exit points, and groundwater monitoring is supplemented by the ETTP Environmental Monitoring Plan surface water surveillance program.

At ETTP, surface water and groundwater hydrologic conditions differ from those typical of the ORNL and Y-12 sites because of geologic and site development characteristics. At ETTP the surface water system involves several small, local streams that drain to Poplar Creek or directly to the Clinch River as well as extensive areas with dispersed surface runoff and groundwater seepage to the large water bodies. Groundwater is monitored primarily from constructed monitoring wells; however, sampling is also conducted at several springs or seeps where groundwater emanates to surface water bodies. Groundwater data pertaining to contaminant trends in the vicinity of CERCLA source areas and related to specific remedial actions are discussed in the 2011 RER (DOE 2011). Volatile organic compounds are the main contaminants of concern at most of the groundwater monitoring locations, as discussed in further detail as follows. Very few of the compounds are used currently at ETTP, and the contamination in the plumes is due to legacy materials. The degree of degradation that has occurred over time is highly variable depending on the local groundwater geochemical conditions and the ability of indigenous microbes to degrade the chlorinated compounds. Radionuclides are a minor concern at locations downgradient of the K-1407-B/C Ponds. The 2011 RER (DOE 2011) includes summaries of the groundwater monitoring required for individual cleanup activities at ETTP, as well as recommendations to modify any requirement that would ensure further protection of human health and environment.

3.5.7.3 ETTP Groundwater Monitoring at Major Site Contaminant Plumes

Extensive groundwater monitoring at the ETTP site has identified VOCs as the most significant groundwater contaminant on site. For purposes of analyzing the groundwater contaminant issues at ETTP, the Remedial Investigation/Feasibility Study (RI/FS) subdivided the site into several distinct areas– Mitchell Branch watershed, K-1004 and K-1200 area, the K-27/K-29 area, and the K-901 area (Fig. 3.50). Each of these areas has significant VOC contamination in groundwater. The principal chlorinated hydrocarbon chemicals that were used at ETTP were tetrachloroethene (PCE), trichloroethene (TCE), and 1,1-dichloroethane (1,1-DCA).

Figure 3.50 shows the distribution and concentrations of the primary chlorinated hydrocarbon chemicals and their transformation products, respectively. Several plume source areas are identified within the regions of the highest VOC concentrations. In these areas, the primary chlorinated hydrocarbons have been present for decades and mature contaminant plumes have evolved. The degree of transformation, or degradation, of the primary chlorinated hydrocarbon compounds is highly variable across the ETTP site. In the vicinity of the K-1070-C/D source, a high degree of degradation has occurred, although a strong source of contamination still remains in the vicinity of the "G-Pit," where approximately 9000 gal of chlorinated hydrocarbon liquids were disposed in an unlined pit. Other areas where transformation is significant include the K-1401 Acid Line leak site and the K-1407-B Pond area. Transformation processes are weak or inconsistent at the K-1004 and K-1200 area, K-1035, K-1413, and K-1070-A Burial Ground, and little transformation of TCE is observed in the K-27/K-29 source and plume area.

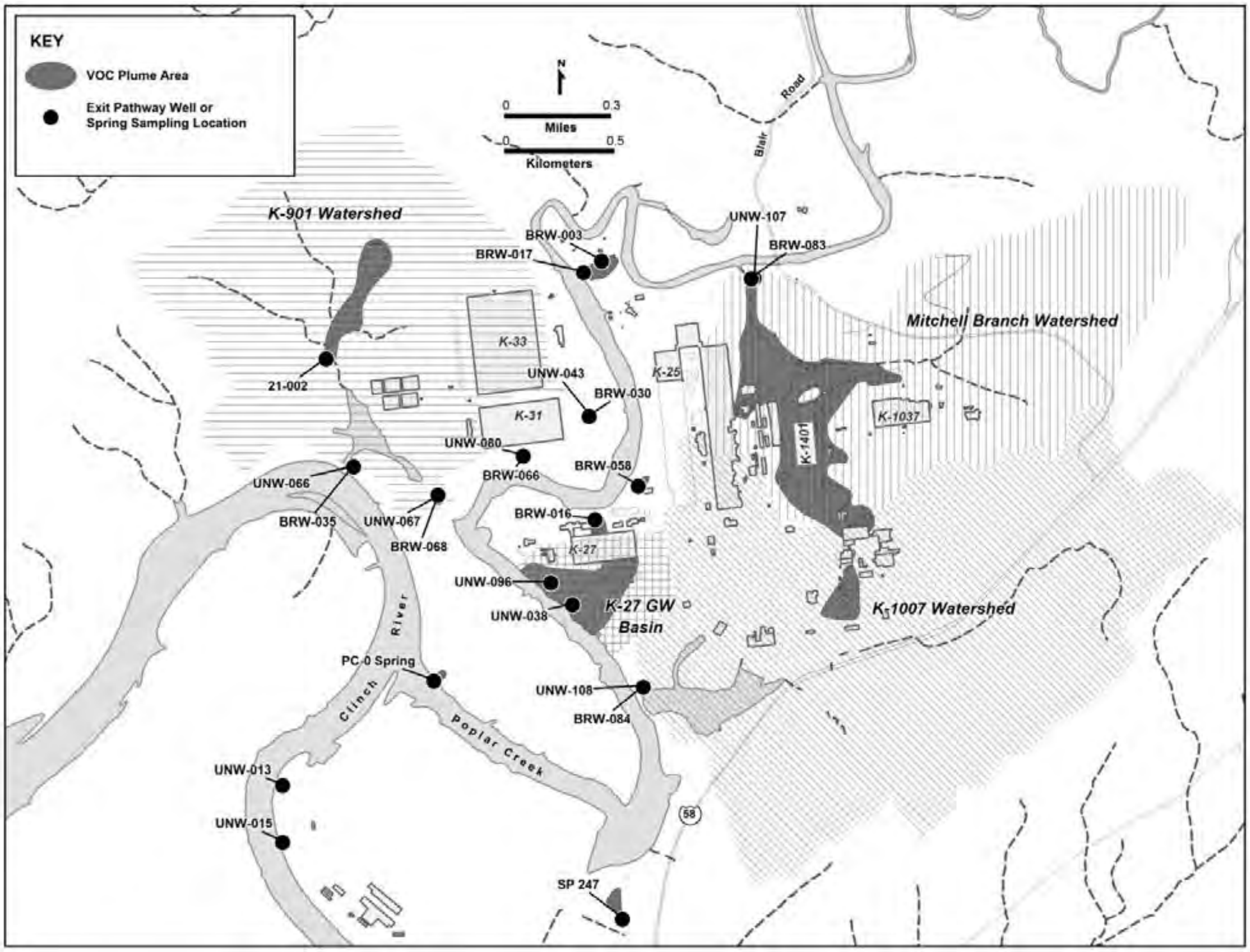


Fig. 3.50. ETTP site exit pathway groundwater monitoring locations.

3.5.7.4 Exit Pathway Monitoring

Groundwater exit pathway monitoring sites are shown in Fig. 3.50. Groundwater monitoring results for the exit pathways are discussed below starting with the Mitchell Branch exit pathway and then progressing in a counterclockwise fashion.

The Mitchell Branch exit pathway is monitored using surface water data from the K-1700 Weir on Mitchell Branch and wells BRW-083 and UNW-107. Figure 3.51 shows the detected concentrations of TCE, 1,2-dichloroethylene (1,2-DCE) (essentially all cis-1, 2-DCE), and vinyl chloride at the K-1700 Weir on Mitchell Branch from FY 1994 through FY 2010. These contaminants are the major contaminants in Mitchell Branch, although low concentrations of carbon tetrachloride, chloroform, and trichloroacetic acid (TCA) are sometimes detected. VOC concentrations measured during FY 2010 were below TDEC recreational organisms only AWQC levels at K-1700.

Wells BRW-083 and UNW-107, located near the mouth of Mitchell Branch (Fig. 3.50), have been monitored since 1994. Table 3.43 shows the history and concentrations of detected VOCs in groundwater. Detection of VOCs in groundwater near the mouth of Mitchell Branch is considered an indication of the migration of the Mitchell Branch VOC plume complex. The intermittent detection of VOCs in this exit pathway is thought to be a reflection of variations in groundwater flow paths that can fluctuate with seasonal hydraulic head conditions, which are strongly affected by rainfall. PCE and TCE were detected at concentrations greater than their respective MCLs in BRW-083 during FY 2010 as a result of the above average rainfall during FY 2009 and 2010.

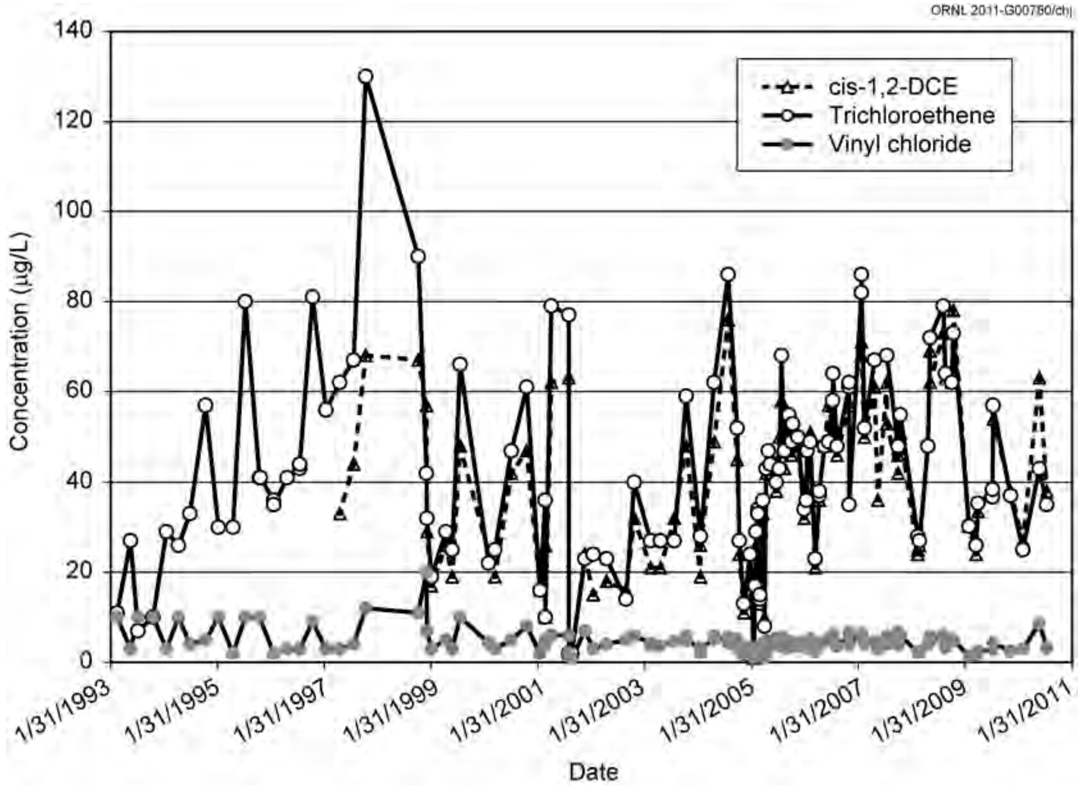


Fig. 3.51. K-1700 Weir VOC concentrations.

Wells BRW-003 and BRW-017 (Fig. 3.50) monitor groundwater at the K-1064 Peninsula burn area. Figure 3.52 shows the history of VOC concentrations in groundwater from FY 1994 through FY 2010. TCE concentrations have declined in both wells, and TCE was detected at concentrations slightly below the MCL in well BRW-017 during FY 2010. Both 1,1,1-TCA and cis-1,2-DCE have declined to undetectable concentrations in both wells.

Groundwater is monitored in four wells (BRW-066, BRW-030, UNW-080, and UNW-043) that lie between buildings K-31/K-33 and Poplar Creek, as shown on Fig. 3.50. VOCs are not contaminants of concern (COCs) in this area; however, leaks of recirculated cooling water in the past have left residual subsurface chromium contamination. Figure 3.53 shows the history of chromium detection in wells at K-31/K-33. Well UNW-043 exhibits the highest residual chromium concentrations of any in the area. Chromium concentrations in well UNW-043 correlate with the turbidity of samples, and acidification of unfiltered samples that contain suspended solids often causes detection of high metals content because the acid preservative dissolves metals that are adsorbed to the solid particles at the normal groundwater pH. During FY 2006, an investigation was conducted to determine if groundwater in the vicinity of the K-31/K-33 buildings contained residual hexavalent chromium from recirculated cooling water leaks. The data indicated the chromium in groundwater near the leak sites was essentially all the less toxic trivalent species. During FY 2008 through FY 2010, field-filtered (i.e., dissolved) and unfiltered samples were collected from UNW-043. As shown on Fig.3.53, the samples filtered in the field prior to acid preservation contained very little chromium, and the dissolved chromium levels did not exceed the MCL. This indicates that most of the chromium in this area is particle bound rather than dissolved in groundwater.

Table 3.43. VOCs detected in groundwater in the Mitchell Branch Exit Pathway (μg/L)[a]

Well	Date	cis-1,2-dichloroethene	Tetrachloroethene	Trichloroethene	Vinyl chloride
BRW-083	8/29/2002	ND	**5**	**28**	ND
	3/16/2004	0.69	2.2	**9.9**	ND
	8/26/2004	2	4.7	**20**	ND
	3/14/2007	5	**9**	**28**	ND
	3/20/2008	ND	ND	ND	ND
	8/21/2008	ND	ND	ND	ND
	3/12/2009	ND	ND	1.31 J	ND
	8/3/2009	ND	2.66	**14.2**	ND
	3/3/2010	ND	ND	ND	ND
	8/30/2010	3.6	**5.1**	**18**	ND
UNW-107	8/3/1998	ND	ND	3	ND
	8/26/2004	4.7	ND	3.6	ND
	8/21/2006	3.4	**14**	2	1.2
	3/13/2007	25	2 J	**23**	2[b]
	8/21/2007	17	ND	**30**	0.3 J
	3/5/2008	ND	ND	ND	ND
	8/18/2008	ND	ND	ND	ND
	3/12/2009	ND	ND	ND	ND
	7/30/2009	ND	ND	ND	ND
	3/4/2010	ND	ND	ND	ND
	7/28/2010	ND	ND	ND	ND

[a] Bold table entries exceed primary drinking water MCL screening values (PCE, TCE = 5 μg/L, cis-1,2-DCE = 70 μg/L, vinyl chloride = 2 μg/L).

Abbreviations: BRW = bedrock wells; J = estimated value; ND = Not Detected; UNW = unconsolidated wells.

[b]Detection occurred in a field replicate. Constituent not detected in regular sample.

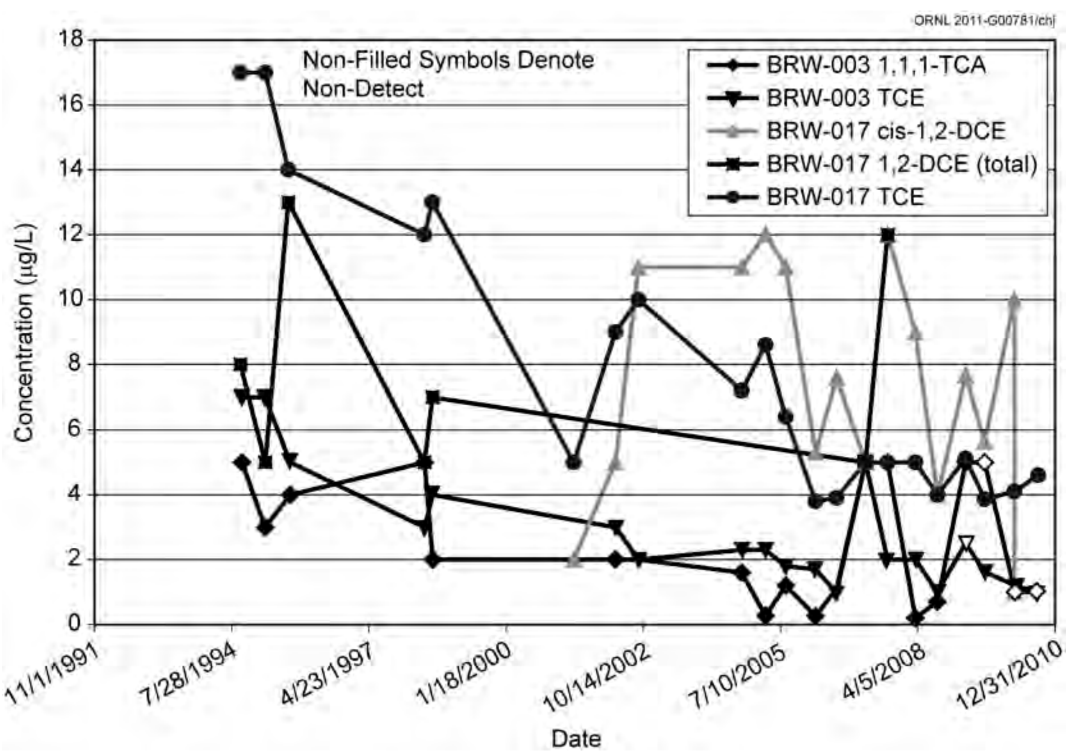


Fig. 3.52. VOC concentrations in groundwater at K-1064 Peninsula area.

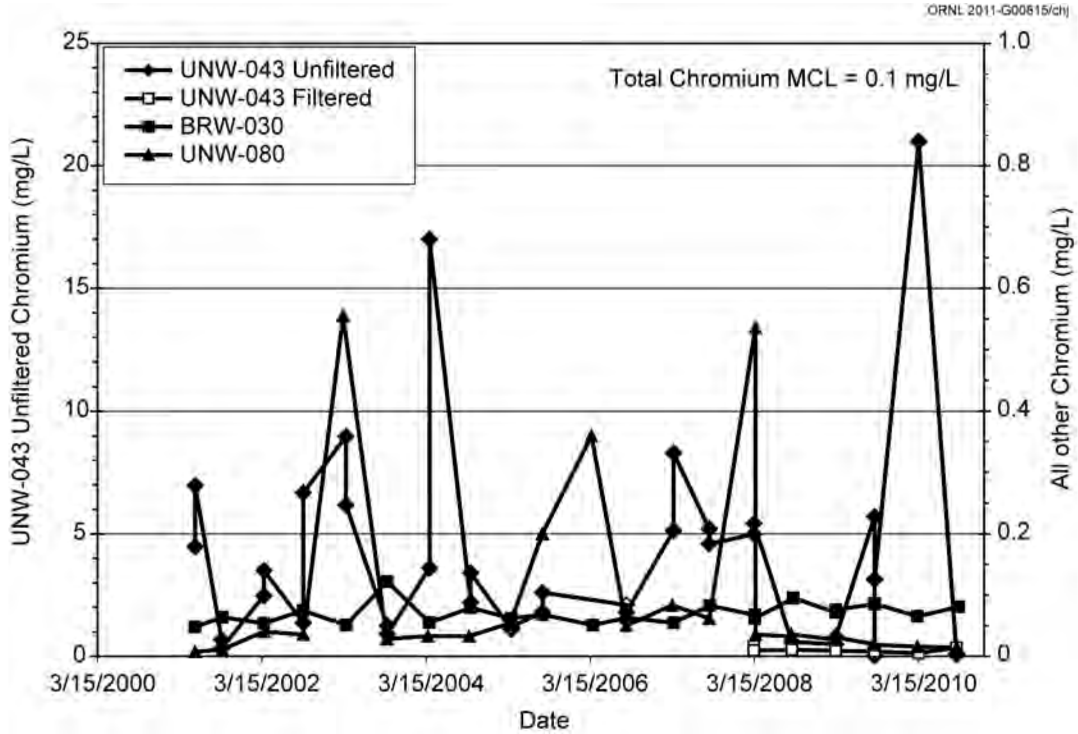


Fig. 3.53. Chromium concentrations in groundwater in the K-31/K-33 area.

Several exit pathway wells are monitored in the K-27/K-29 area, as shown on Fig. 3.50. Figure 3.54 provides concentrations of detected VOCs in wells both north and south of K-27 and K-29 through FY 2010. The source of VOC contamination in well BRW-058 is not suspected to be from K-27/K-29 area operations. VOC concentrations in this area show very slowly declining concentrations.

Wells BRW-084 and UNW-108 are exit pathway monitoring locations at the northern edge of the K-1007-P1 Pond (see Fig. 3.50). These wells have been monitored intermittently from 1994 through 1998 and semiannually from FY 2001 through FY 2010. The first detections of VOCs in these wells occurred during FY 2006 with detection of low (~10 µg/L or less) concentrations of TCE and cis-1,2-DCE. The source area for these VOCs is not known. Volatile organic compounds were not detected in either of these wells during FY 2010. Metals were detected and associated with the presence of high turbidity in the samples. Iron exceeded its secondary drinking water standard in the filtered sample from UNW-108 in the March sampling event. No other primary or secondary MCLs for metals were exceeded in sample aliquots that were field filtered prior to acid preservation during FY 2010.

Exit pathway groundwater in the K-901-A Holding Pond area (Fig. 3.50) is monitored by four wells (BRW-035, BRW-068, UNW-066, and UNW-067) and two springs (21-002 and PC-0). Very low concentrations (<5 µg/L) of VOCs are occasionally detected in wells adjacent to the K-901-A Holding Pond. However, these contaminants are not persistent in groundwater west and south of the pond. No VOCs were detected in the K-901-A Pond exit pathway wells during FY 2010, and alpha and beta activity levels were less than 15 pCi/L and 25 pCi/L, respectively. TCE is the most significant groundwater contaminant detected in the springs, and the historic TCE concentrations are shown in Fig. 3.55. Spring PC-0 was added to the sampling program in 2004. During the spring through autumn seasons, spring PC-0 is submerged beneath the Watts Bar lake level, so this location is accessible for sampling only during winter when the lake level is lowered by TVA. The contaminant source for the PC-0 spring is presumed to be disposed waste at the K-1070-F site. The TCE concentrations are showing a decreasing trend. At spring 21-002, 1,1,1-TCA, 1,2-DCE, carbon tetrachloride, and PCE are sometimes present at concentrations typically less than 5 µg/L. The TCE concentration at spring 21-002 tend to vary between 5 and about 25 µg/L, and this variation appears to be related to variability in rainfall, which affects groundwater discharge from the K-1070-A VOC plume.

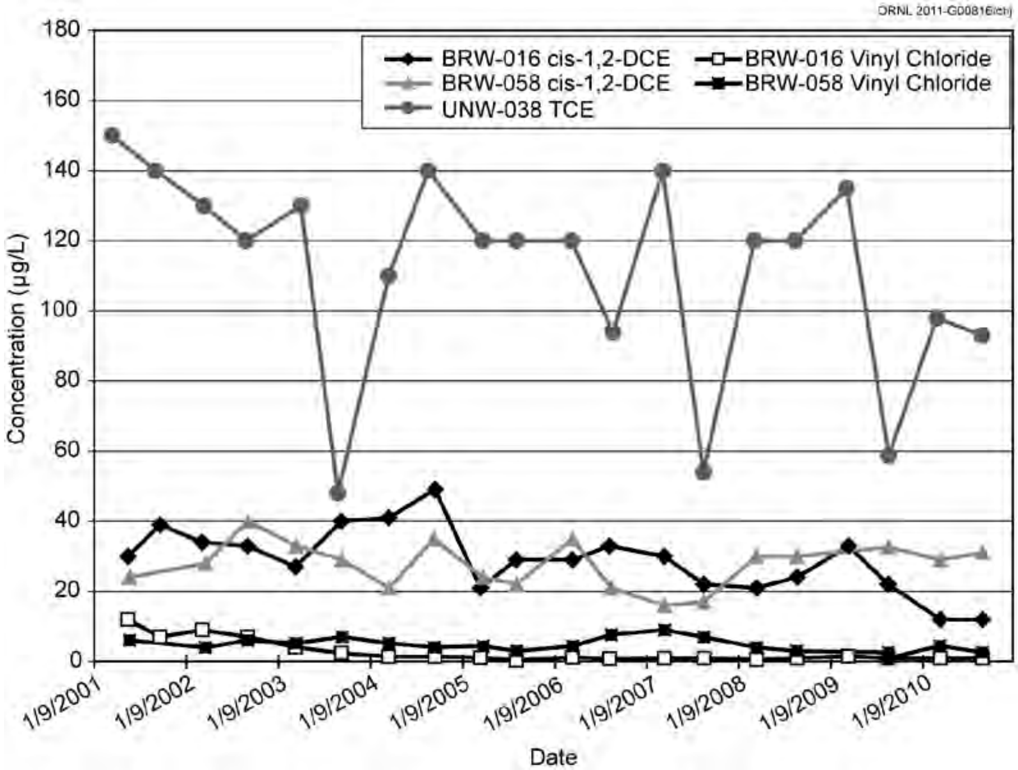


Fig. 3.54. Detected VOC concentrations in groundwater exit pathway wells near K-27 and K-29.

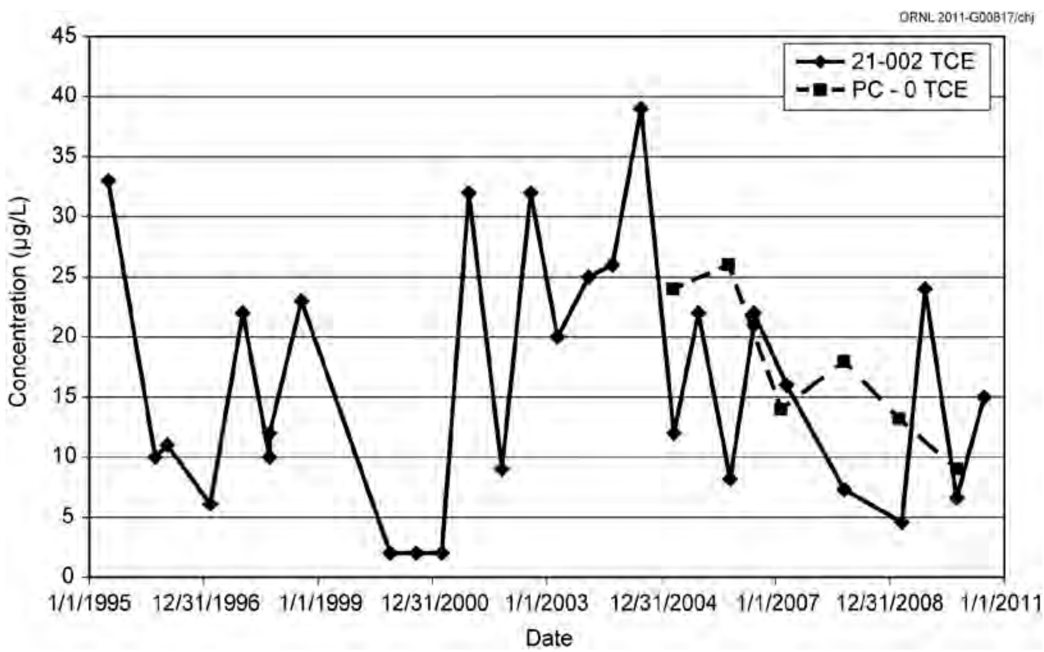


Fig. 3.55. TCE concentrations in K-901 area springs.

Exit pathway groundwater monitoring is also conducted at the K-770 area, where wells UNW-013 and UNW-015 are used to assess radiological groundwater contamination along the Clinch River (Fig. 3.50). Figure 3.56 shows the history of measured alpha and beta activity in this area. Analytical results indicate that the alpha activity is largely attributable to uranium isotopes, and well UNW-013 historically contained ^{99}Tc that is a strong beta-emitting radionuclide responsible for the elevated beta activity in that well. The alpha and beta activity levels in the area groundwater exhibit stable, but variable, conditions.

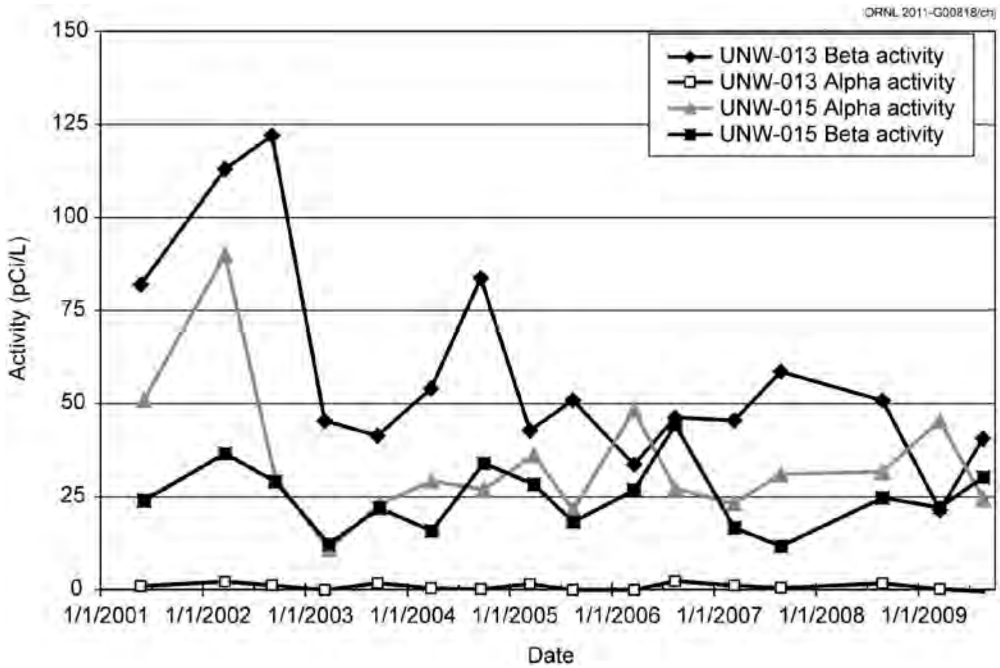


Fig. 3.56. History of measured alpha and beta activity in the K-770 area.

3.5.7.5 Ambient Water Quality Criteria Sampling

During FY 2010 surface water samples were collected at four locations for analysis of AWQC parameters. The sample locations included the three main surface water discharge points—the K-1700 weir on Mitchell Branch, the K-1007-P1 Pond weir, the K-901 Pond weir, and a fourth location. A field replicate sample was collected and analyzed at the K-901 weir during both sampling events. The 21-002 spring was sampled for AWQC parameters to evaluate potential contributions from the K-1070-A groundwater plume. Sample events occurred in late winter (March) and late summer (August). The analytical suite included metals, VOCs, semi-volatile organic compounds (SVOCs), pesticides, PCBs, and dioxins/furans.

The only metals exceedances were for mercury in samples collected at the K-1700 weir on Mitchell Branch. These results were discussed previously in Section 3.5.5.9. Arsenic, cadmium, and selenium were not detected in any of the samples. Although lead was detected in all samples at K-901 and K-1700 weirs, and in one sample at the K-1007 P1 weir, the levels were below the criteria. Copper was detected in one sample from the K-901 weir at a below-criterion level. Chromium was detected in all samples at the K-901 weir and in one sample at the K-1700 weir at levels below criteria, and hexavalent chrome was not detected in any of the samples. Nickel and zinc were detected at the K-1700 and K-901 weirs, but the levels were below criteria.

Although TCE (four samples), vinyl chloride (four samples), and carbon tetrachloride (one sample) exceeded the criteria for water and organisms (implying human consumption of the water) at the K-1700 weir, the criteria for organism-only protection were not exceeded. Similarly, at the 21-002 spring, TCE (two samples) and carbon tetrachloride (one sample) exceeded the water and organisms criteria but did not exceed the organism-only criteria. PCBs were not detected in surface water samples, although they are known to be present in water body sediment columns and are bioaccumulative in fish, as discussed in the following section. Polycyclic aromatic hydrocarbon (PAH) compounds were detected at the K-901 weir at levels below criteria. Several pesticides are detectable in surface water at the three weir locations. Criterion exceedances were measured for heptachlor at the K-901 and K-1700 weirs with measured concentrations of 0.002–0.003 μg/L at K-901 and 0.00085 and 0.00095 μg/L at K-1700 compared to the criterion concentration of 0.00079 μg/L for organism protection. Heptachlor epoxide exceeded its criterion of 0.00039 μg/L at the K-901 weir with measured concentrations of 0.00175 and 0.00185 μg/L.

Traces of dioxin/furan compounds were estimated to be present in the samples; however, no criterion exceedances were measured.

3.6 Biological Monitoring

The ETTP BMAP SAP consists of three tasks designed to evaluate the effects of ETTP operations on the local environment, identify areas where abatement measures would be most effective, and test the efficacy of the measures. These tasks are (1) toxicity monitoring of effluent and ambient waters from several locations within Mitchell Branch, (2) bioaccumulation studies, and (3) in-stream monitoring of biological communities. Figure 3.57 shows the major water bodies at ETTP, and Fig. 3.58 shows the monitoring locations along Mitchell Branch.

In April and October to November of 2010, survival and reproduction toxicity tests using the water flea *Ceriodaphnia dubia* (Fig. 3.59) were conducted at five ambient locations in Mitchell Branch. At the same time, survival and reproduction toxicity tests using *C. dubia* were conducted on effluent from storm water outfalls (SDs)-170 and -190. In both the April tests and October to November tests (Table 3.44), none of the water from the ambient station or from SD-170 or SD-190 exhibited toxicity. While the absence of observable toxicity at the ambient locations is normal, and the absence of observable toxicity at SD-170 is consistent with recent trends, the absence of observable toxicity at SD-190 is a recent development. Until the 2010 tests, full-strength effluent from SD-190 typically reduced reproduction in *Ceriodaphnia dubia,* and prior to the fall 2007 test, survival also was often reduced. While the cause of the reduction in toxicity at SD-170 is not known definitively, the reductions coincide with the efforts to control the chromium seep near SD-170.

In June and July, 2010, caged clams *(Corbicula fluminea)* were placed at several locations around ETTP (Table 3.45). The clams (Fig. 3.60) were allowed to remain in place for 4 weeks and were then analyzed for PCBs and total and methylmercury. The spatial patterns of PCB concentrations in clams were generally consistent with those of previous years, although the concentration of PCBs in clams from storm water outfall 100 was lower than in 2009 and substantially lower than in the past 15 years. The highest PCB concentrations were found in the clams from the K-1007-P1 Pond, with lower concentrations found in the clams from Mitchell Branch. Clams from the K-901-A Pond contained detectable concentrations of PCBs, but the levels were considerably lower than those found in and around the K-1007-P1 Pond. While Arochlors-1248, -1254, and -1260 were detected in the clams from the K-1007-P1 Pond and the K-901-A Pond (in lower concentrations), the primary Aroclor detected in the clams from Mitchell Branch was Aroclor-1254. In general, the concentrations of PCBs at most locations from the 2010 monitoring exhibited similar distributions to those from the 2009 effort. For example, levels at MIK 0.7 averaged 0.17 µg/g in the 2009 samples and 0.14 µg/g in 2010. Levels in clams from MIK 0.8 display a similar pattern. Levels at MIK 0.2 have decreased slightly over the last 3 years (2.76 µg/g in 2008, 2.43 µg/g in 2009, and 2.14 µg/g in 2010). In contrast, PCB concentrations in clams deployed at MIK 0.4 were higher in 2010 (2.0 µg/g) than in 2009 (0.84 µ/g). A new monitoring location in Mitchell Branch was added in 2010 (MIK 0.3). Total PCBs in clams deployed at MIK 0.3 averaged 3.2 µg/g, the highest levels from any site along Mitchell Branch. Among the clams from the K-1007-P1 Pond area, clams from storm water outfall 120 had the highest average concentrations of PCBs in 2010 (2.1 µg/g). Concentrations in clams from the lower storm water outfall 100 were higher in 2009 (1.5 µg/g) than in 2010 (0.76 µg/g), and in clams from the upper storm water outfall 100, levels dropped to an average of 0.255 µg/g in 2010. These concentrations were the lowest that have been recorded in outfall 100. It is too early to tell if these measurements reflect actual decreases in environmental PCB concentrations, or if they are just within the normal range of variations. PCB concentrations in clams from K-901-A Pond were very low, averaging 0.055 µg/g in 2010.

Clams from the Mitchell Branch watershed were analyzed for mercury (both total mercury and methyl mercury) in 2010 (Table 3.45). Although mercury was detected in all clams, the highest mercury concentrations were found in the clams from MIK 0.3 (214.1 ng/g total mercury) and below SD-190 (139.9 ng/g total mercury). Results from the 2010 monitoring were generally similar to those of the 2009 monitoring at the same locations with the exception of MIK 0.2, where mercury concentrations were roughly double those observed in 2009. Methyl mercury concentrations in clams from Mitchell Branch ranged from 20%–40% of the total mercury concentration at all locations.

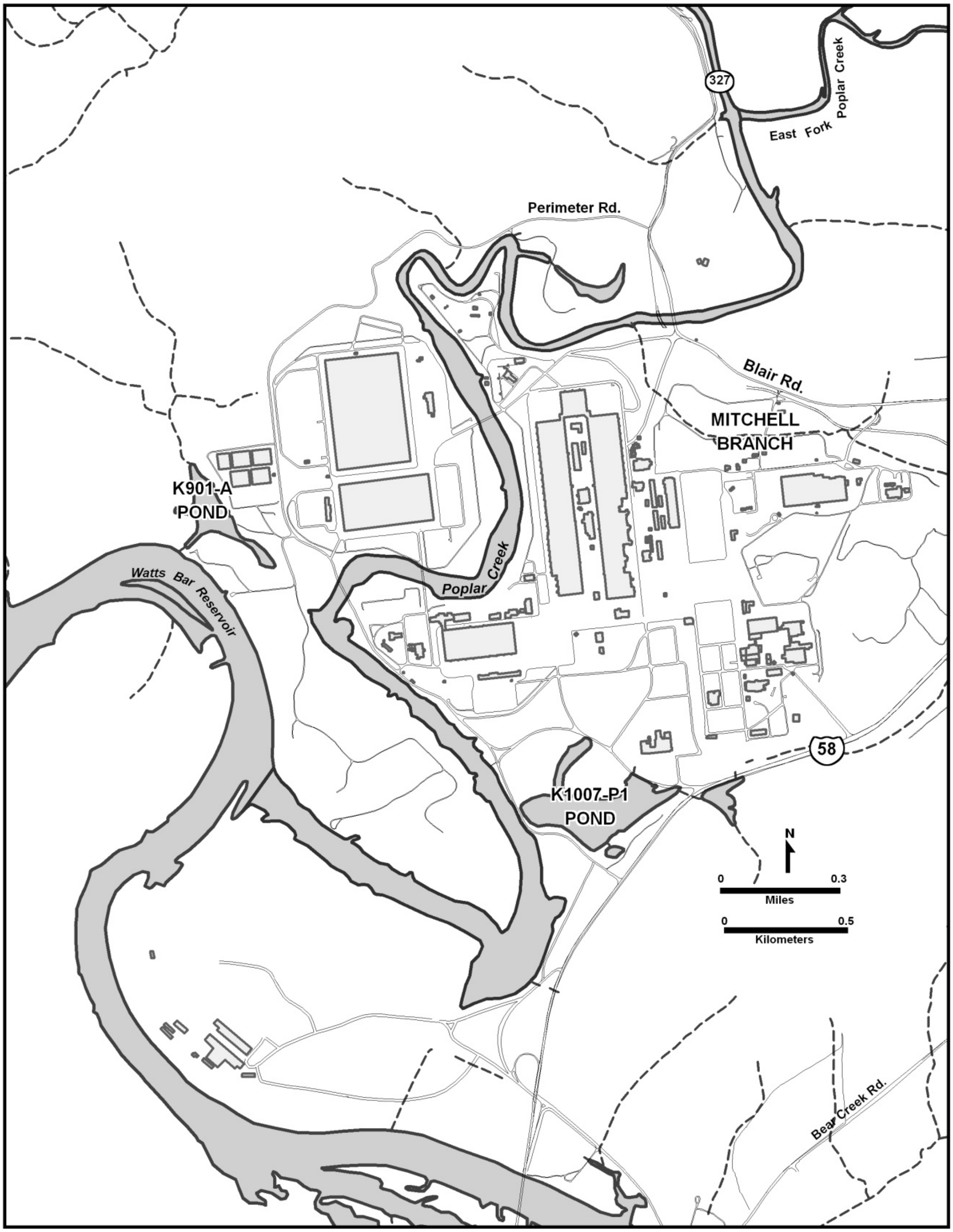


Fig. 3.57. Waterways at ETTP.

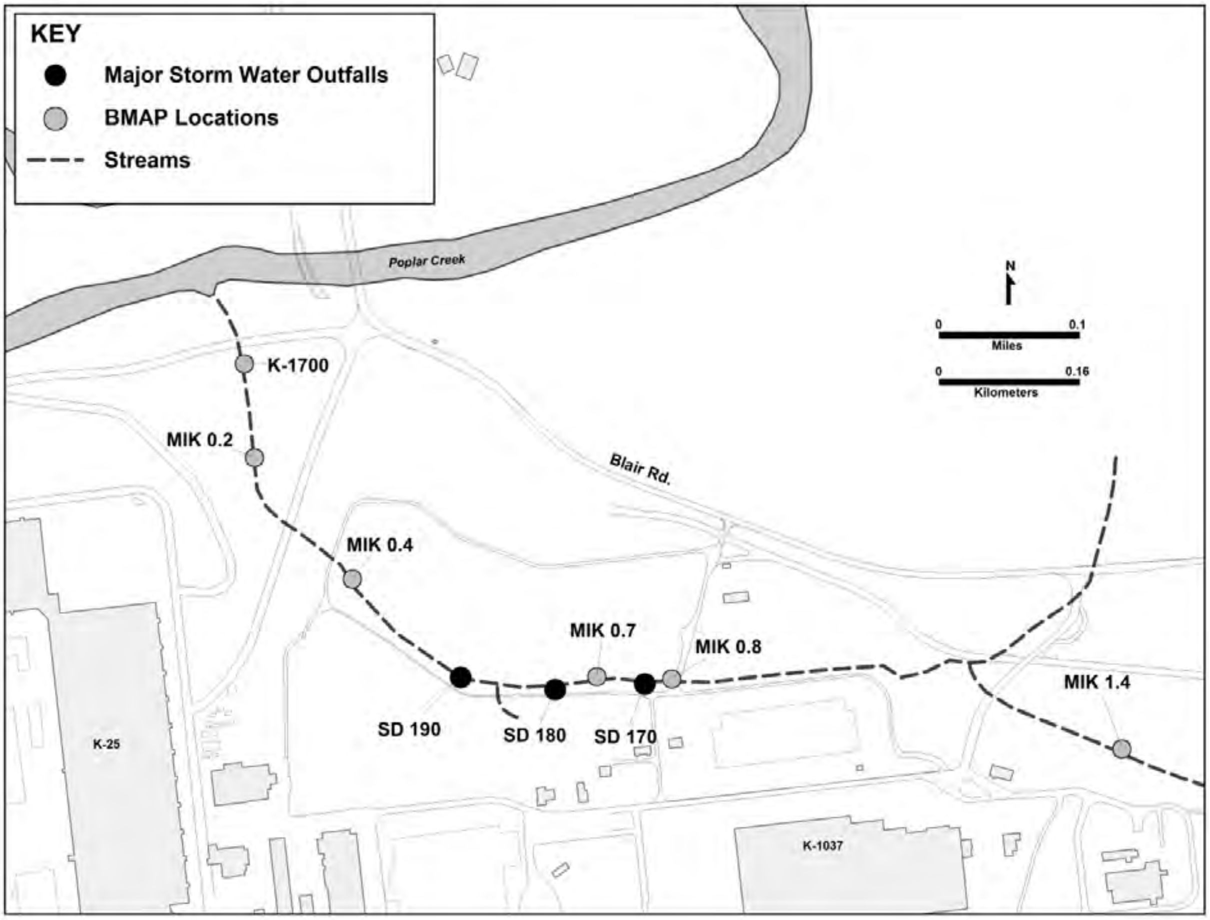


Fig. 3.58. Major storm water outfalls and biological monitoring locations on Mitchell Branch.

ORNL 2010-G00933/chj

Fig. 3.59. Water flea *(Ceriodaphnia dubia)*.

Table 3.44. Mitchell Branch and associated storm water outfall toxicity test results, 2010 (no-observed-effects concentrations)

Test	MIK 1.4	MIK 0.8	SD 170	MIK 0.7	SD 190	MIK 0.4	MIK 0.2
Ceriodaphnia survival (%)	100	100	100	100	100	100	100
Ceriodaphnia reproduction (%)	100	100	100	100	100	100	100

Table 3.45. Analytical results and locations of caged clams in June and July 2010[a]

Site	Sample ID	Aroclor-1248	Aroclor-1254	Aroclor-1260	Total Aroclors	Total Hg	MeHg
Reference Site:	15972A	ND	0 .005	ND	0.01	20.8	9.1
Sewee Creek	15972B	ND	0.011	ND	0.01	36.4	14.9
M itchell Branch: MIK 0.8 (above SD 170)	15982A	ND	0.110	0.008	0.12		
	15982B	ND	0.120	0.011	0.13		
SD170	15983A	ND	0.190	0.022	0.21	41.8	9.3
	15983B	ND	0.250	0.026	0.28	49.5	10.9
M IK 0.7 (below	15984A	ND	0.130	0.017	0.15		
SD170)	15984B	ND	0.120	0.014	0.13		
M IK 0.5 (below SD	15985A	ND	0.130	0.015	0.15	65.7	17.7
180)	15985B	ND	0.150	0.017	0.17	57.6	15.0
SD190	15986A	ND	0.930	0.290	1.22	137.4	85.5
	15986B	ND	0.870	0.220	1.09	142.3	88.2
M IK 0.4 (below	15987A	ND	1.100	0.180	1.28		
SD190)	15987B	ND	2.300	0.390	2.69		
M IK 0.3	15981A	0.910	1.900	0.120	2.93	203.4	17.7
	15981B	1.400	1.900	0.120	3.42	224.8	19.8
M IK 0.2	15980A	0.440	1.600	0.110	2.15	106.3	20.7
	15980B	0.420	1.600	0.110	2.13	117.6	19.1
SD 992	15978A	0.910	1.900	0.120	2.93		
	15978B	1.400	1.900	0.120	3.42		
K1007-P1 Pond:	15974A	0.210	0.078	ND	0.29	24.6	10.2
SD 100 (upper)	15974B	0.160	0.060	ND	0.22	24.9	10.4
SD 100 (lower)	15975A	0.530	0.190	ND	0.72 0.80		
	15975B	0.590	0.210	ND			
SD 120	15976A	ND	2.600	0.460	3.06 1.18		
	15976B	ND	1.000	0.180			
SD 490	15973A	ND	0.270 0.340	0.100	0.37 0.47		
	15973B	ND		0.130			
P1	15977A	0.560 0.520	0.430	ND	0.99 0.91		
	15977B		0.390	ND			
K901A Pond:	15979A	ND ND	0.042	0.017	0.06 0.05		
K901A outfall	15979B		0.037	0.014			

[a]PCBs (shown as Aroclors 1248, 1254, 1260, and total Aroclors; µg/g) and total and methyl mercury (ng/g) in caged Asiatic clams (*Corbicula fluminea*) placed near storm drains and pond outfalls for 4-week periods, June and July 2010. Results are reported on a wet weight basis for composite samples (of 10 clams) from each basket.

Fig. 3.60. Asian clam (*Corbicula fluminea*).

Bioaccumulation monitoring in the K-1007-P1 Pond, K-901-A Pond, K-720 Slough, and Mitchell Branch also involves sampling of fish for PCB concentrations (Table 3.46). Typically, fillets of game fish are used as a monitoring tool to assess human health risks, while whole body composites of forage fish are used to assess ecological risks associated with exposure to PCBs. The target species for bioaccumulation monitoring in 2010 in the K1007-P1 Pond was bluegill sunfish (*Lepomis macrochirus*) (Fig. 3.61). This is a shift from previous efforts that have focused on monitoring largemouth bass (*Micropterus salmoides*). Bass from this pond have historically shown PCB levels well above state and federal guidelines for assessing human health concerns. Among other actions, the remediation of this pond entailed removing predatory, upper trophic level fish such as bass and restocking the pond with smaller fish that are not expected to accumulate PCBs as readily.

While bluegill sunfish were already resident to the K1007-P1 pond, efforts were made to sustain the population by introducing additional bluegill collected from uncontaminated sites. Restocking occurred in February 2010, just 3 months before bioaccumulation sampling (Fig. 3.62). Whole body composites (six composites of 10 bluegill per composite) and fillets from 20 individual bluegill were analyzed for PCBs to assess the ecological and human health risks (respectively) associated with PCB contamination in this pond. Average PCB levels in whole body composites were 5.11 μg/g, as shown in Table 3.46. Fillets averaged 2.13 μg/g total PCBs, significantly lower than levels seen in 2009 (3.11 μg/g). Average PCB concentrations in sunfish collected in Mitchell Branch were 1.2 μg/g, which is significantly higher than the concentrations observed in largemouth bass from the K901A pond (~ 0.3 μg/g). In addition to being analyzed for PCBs, the sunfish collected from Mitchell Branch (MIK 0.2) were analyzed for total mercury. Previous studies have shown that methyl mercury accounts for greater than 95% of the total mercury in fish, so a separate analysis for methyl mercury was not conducted. The EPA's recommended limit for mercury in fish fillets is 0.3 μg/g. Levels of mercury in fish collected at MIK 0.2 were 0.38 μg/g, slightly exceeding this limit.

In April 2010, the benthic macroinvertebrate community at four Mitchell Branch locations (MIKs 0.4, 0.7, 0.8, and 1.4) was sampled by the ORNL Enivronmental Sciences Division using standard quantitative techniques. MIK 1.4 was the reference location. Over the last several years, the condition of the benthic macroinvertebrate community at all locations in Mitchell Branch has generally improved. However in 2010 the metrics at MIK 0.8 showed the greatest change, with metric levels approaching those of the reference site at MIK 1.4. In 2010, total taxa richness and richness of the *Ephemeroptera*, *Plecoptera*, and *Trichoptera* (EPT) species was greatest at MIK 1.4 and decreased at the downstream locations (Fig. 3.63). EPT species are generally pollution intolerant, and lower values generally correlate to some degree of impact to the stream. Total density at MIKs 0.8 and 0.7 was greater than at MIK 1.4, but the density of pollution-intolerant species was generally lower at all of the locations downstream of MIK 1.4 with the exception of MIK 0.8. One possible explanation for the lower number of individuals at MIK 1.4 when compared to MIKs 0.7 and 0.8 may be that Mitchell Branch is shallower at MIK 1.4, and the lower flows may inhibit the population size.

Higher densities downstream of MIK 1.4 may also indicate nutrient enrichment, which commonly leads to increases in density.

Table 3.46. Average PCB concentrations in biota, 2010[a]

Site	Species	Sample type	Sample size (n)	Total PCBs (mean ± SE)	Range of PCB values	No. >1 ppm (PCBs)/N	Total Hg (mean + SE)
1007-P1 Pond	Bluegill	Fillets					
		Resident fish	20	2.13 + 0.16	1.07–3.63	20/20	0.085 + 0.008
		Restocked fish	3	0.99 + 0.34	0.41–1.58	1/3	
		Whole body composites *Resident fish*	6	5.11 + 0.26	4.41–5.90		0.041 + 0.001
		Restocked fish	1	3.39			
K-901-A Pond	Paddlefish[b]	Fillet	1	107		1/1	0.07
	Largemouth bass	Fillet	10	0.30 + 0.05	0.12–0.62	0/10	
	Common carp	Fillet	10	0.71 + 0.20	0.20–2.33	3/10	
	Gizzard shad	Whole body composites	6	2.69 + 0.32	1.81–3.49		0.086 + 0.021
K-720 Slough	Largemouth bass	Fillet	6	0.17 + 0.33	0.06–0.37	0/6	
	Common carp	Fillet	7	0.38 + 0.07	0.20–0.64	0/7	
	Smallmouth buffalo	Fillet	7	0.99 + 0.41	0.20–3.35	2/7	
	Gizzard shad	Whole body composites	6	0.48 + 0.03	0.40–0.54		0.067 + 0.006
Mitchell Branch	Redbreast sunfish	Fillet	6	1.17 + 0.13	0.87–1.55	4/6	0.347 + 0.059
Hinds Creek	Redbreast sunfish	Fillet	5	0.09 + 0.05	0.05–0.28	0/6	0.08 + 0.01

[a]Total PCB (Aroclors 1248, 1254, and 1260) concentrations in fish from the K-1007-P1 Pond, the K-901 Pond, the K-720 Slough, Mitchell Branch, and the reference site, Hinds Creek, 2010. Values are mean concentrations (µg/g) ± 1 S.E. Each whole body composite sample is comprised of 10 individual fish, except restocked fish from the K-1007-P1 Pond, where composite sample was comprised of five individual fish (see discussion of the K-1007-P1 Pond for details on resident vs restocked fish). Where available, data for mean total mercury concentrations (µg/g) are shown.

[b]Paddlefish was collected in June 2009 during fish removal action but was not analyzed until 2010. Data for this fish are presented for comparison and discussion.

Fig. 3.61. Bluegill sunfish (*Lepomis macrochirus).*

ORNL 2010-G00935/chj

Fig. 3.62. Fish bioaccumulation sampling at K-1007-P1 pond.

ORNL 2011-G00819/chj

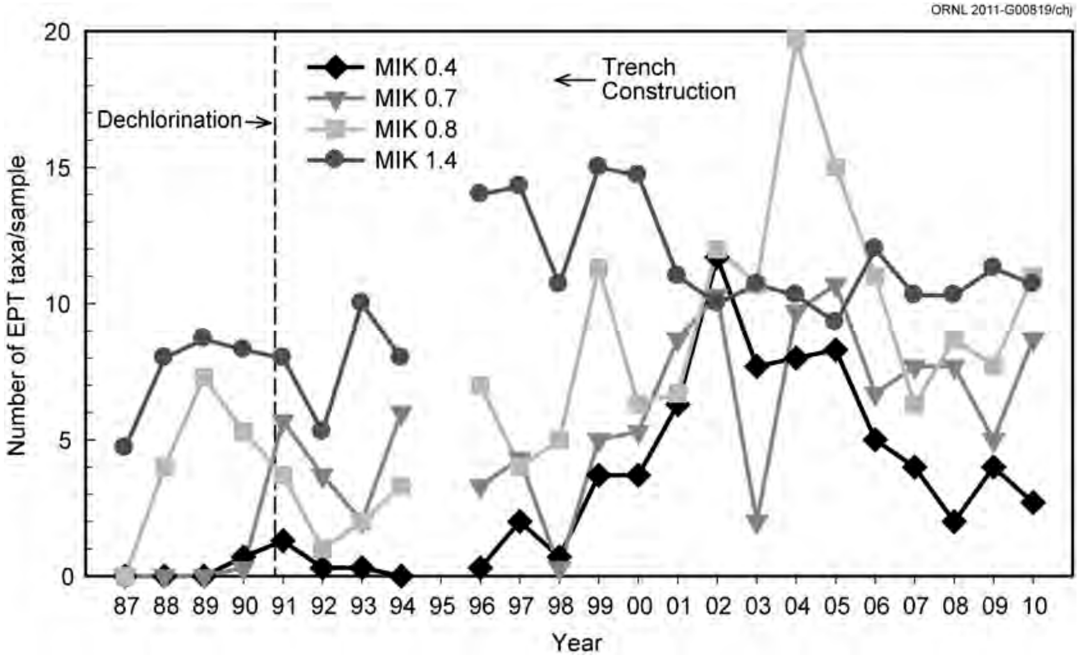


Fig. 3.63. Mean taxonomic richness of the pollution-intolerant *Ephemeroptera*, *Plecoptera*, and *Trichoptera* (mayflies, stoneflies, and caddisflies, or EPT) taxa per sample for the benthic macroinvertebrate community in Mitchell Branch, 1987–2010. Samples were not collected in April 1995, as indicated by the gap in the lines. MIK = Mitchell Branch kilometer.

Since August 2008, TDEC protocols, which assess both community and habitat characteristics, also have been used at monitoring location MIKs 0.4, 0.7, and 0.8. Beginning in August 2009, the use of TDEC protocols was expanded to include MIK 1.4 as well (Fig. 3.64). In the 2010 study, the biotic indices (Fig. 3.65) indicate that the communities at locations MIKs 0.4 and 1.4 were slightly impaired, while the communities at MIKs 0.7 and 0.8 were not impaired. However, the total scores at MIKs 0.7 and 0.8 were only slightly greater than the scores at MIK 1.4, and overall trends indicate that the communities at all three downstream locations (MIKs 0.4, 0.7, and 0.8) are still slightly impaired. The habitat assessment (which primarily considers the physical aspects of the stream to determine its suitability to support invertebrate communities) indicated that not all sampling locations along Mitchell Branch met the habitat goals for this region. In the 2009 study, MIK 0.4 failed to meet the habitat goals. In the 2010 study, MIK 0.8 met the habitat goals. MIKs 0.4, 0.7 and 1.4 were scored as being moderately impaired, although the scores for MIKs 0.7 and 1.4 (124 and 125, respectively) were only slightly less than the TDEC goal of 131. The results of the semiquantitative macroinvertebrate assessment indicated that Mitchell Branch overall is moderately impaired, which is broadly consistent with the results from the studies using the ORNL protocols. Although improvements in the water quality and health of the community may be due to improvement in the stream's quality, it may also be possible that the actual biotic indices (only slightly different) indicate that the changes were within the range of natural annual fluctuations.

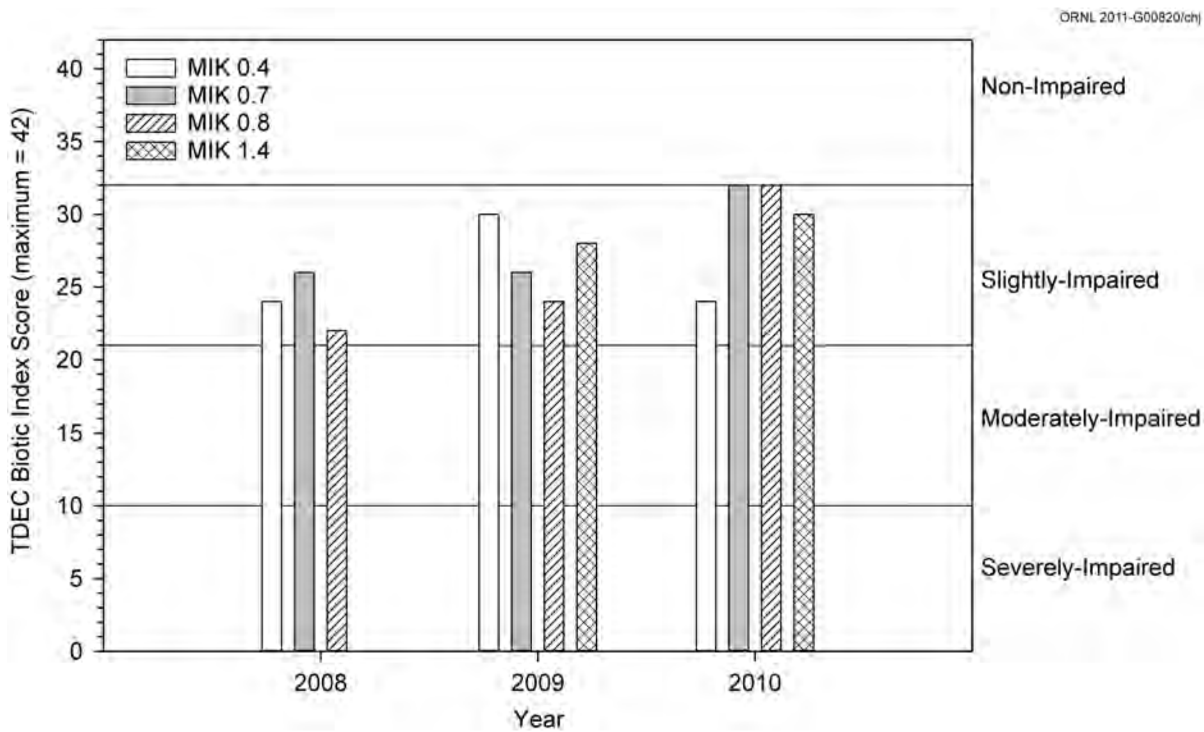


Fig. 3.64. Temporal trends in TDEC Biotic Index scores for Mitchell Branch, August 2008–2010. Horizontal lines show the lower thresholds for biotic condition ratings; respective narrative ratings for each threshold are shown on the right side of each graph.

ORNL 2010-G00938/chj

Fig. 3.65. Benthic macroinvertebrate sampling using Tennessee Department of Environment and Conservation protocols.

Fish communities in Mitchell Branch (MIKs 0.4 and 0.7) and at three reference sites were sampled in March and April of 2010 (Table 3.47). Species richness, density, and biomass were examined. Results for MIK 0.4 indicated a poorer fish community compared to the same location in 2009. Total density and biomass decreased dramatically from 2009. At MIK 0.7 biomass and density showed slight decreases from last year, while species richness remained unchanged. Wide swings in these three parameters are typical of streams that have been severely impacted and are still recovering. While the condition of the fish community has not yet reached a stable condition typical of less impacted streams in the area, the stream is still dominated by more tolerant fish species.

3.7 Quality Assurance Program

BJC is committed to developing, implementing, and maintaining a formal QA program that ensures the highest standards of performance by empowering employees in their respective areas of responsibility through fostering a "no fault" attitude toward the identification and reporting of quality deficiencies. The quality program provides the framework for a results-oriented management system that focuses on performing work safely and meeting mission and customer expectations while allowing BJC and its subcontractors to become more efficient through process improvement.

The BJC QA Program is a management system that addresses three major elements: managing work, performing work (whether self-performed or subcontracted), and assessing the adequacy of work. The management element encompasses management programs, including organizational structure and responsibilities, and management processes, including planning, scheduling, and resource considerations. The management element also includes personnel training and qualifications, continuous improvement, and documents and records. The performance element includes work processes, design, procurement, and inspection and acceptance testing. The assessment element includes external assessments, independent assessments, and management assessments.

The BJC QA Program is based on the Title 10 *Code of Federal Regulations* (CFR) Part 830.120, "Quality Assurance Requirements" and is incorporated within the ISMS. The program identifies the consensus standards used in its development and implementation and describes how the contractor responsible for the facility will implement the requirements contained in those documents. Where equivalent elements do not already exist, additional requirements for radioactive waste packaging are included from 10 CFR 71 Subpart H. DOE reviews changes made to the program annually.

Table 3.47. Fish species richness, density (individuals/m^2), and biomass (g fish/m^2) at Mitchell Branch sites (MIK) and reference sites, Mill Branch (MBK), Scarboro Creek (SCK), and Ish Creek (ISK) for March and April, 2010

Species	MIK 0.7	MIK 0.4	MBK 1.6	SCK 2.2	ISK 1.0
Largescale stoneroller	1.57	0.06	-	0.11	0.44
Campostoma oligolepis	(5.96)	(0.13)		(0.23)	(1.20)
Striped shiner	1.19	0.09	0.03	-	0.85
Luxilus chrysocephalus	(4.15)	(0.38)	(0.31)		(1.54)
Tennessee dace	-	-	-	-	0.01
Phoxinus tennesseensis					(0.01)
Bluntnose minnow	-	-	-	-	0.04
Pimephales notatus					(0.10)
Western blacknose dace	1.65	0.13	0.19	0.56	0.18
Rhinichthys obtusus	(4.64)	(0.32)	(0.60)	(2.38)	(0.37)
Creek chub	0.36	0.06	0.17	-	0.08
Semotilus atromaculatus	(2.18)	(0.39)	(1.91)		(0.32)
White sucker	-	-	0.04	-	-
Catostomus commersoni			(0.91)		
Western mosquitofish	0.01	-	-	-	-
Gambusia affinis	(0.01)				
Banded sculpin	0.09	0.01	-	0.34	0.22
Cottus carolinae	(0.69)	(0.04)		(1.21)	(1.11)
Redbreast sunfish		0.01			0.01
Lepomis auritus	-	(0.28)	-	-	(0.03)
Hybrid sunfish	-	-	-	0.01	0.01
Lepomis sp. x				(0.03)	(0.06)
Green sunfish	0.03	-	-	0.10	0.41
Lepomis cyanellus	(0.29)			(0.92)	(1.64)
Warmouth	-	-	0.04	-	-
Lepomis gulosus			(0.21)		
Bluegill	-	-	0.07	-	0.01
Lepomis macrochirus			(0.36)		(0.02)
Spotted bass	-	-	-	-	0.01
Micropterus punctulatus					(0.01)
Largemouth bass	-	-	<0.01	-	-
Micropterus salmoides			(0.20)		
Blackside snubnose darter	-	-	<0.01	-	-
Etheostoma duryi			(<0.01)		
Stripetail darter			0.02		
Etheostoma kennicotti	-	-	(0.05)	-	-
Snubnose darter					0.16
Etheostoma simoterum					(0.25)
Species richness	7	6	9	4	12
Total density	4.90	0.36	0.56	1.12	2.43
Total biomass	17.92	1.54	4.55	4.77	6.66

The QA Program requirements are reflected in implementing procedures. Subcontractors must meet the same elements when developing and following their own QA plan for each scope of work, or when following the BJC QA Program in executing work scope. Through its BJC Park Worker Annual Training Program, BJC introduces and emphasizes the importance of the QA Program so that it is understood by BJC and subcontract personnel.

New and revised DOE standards (e.g., orders, manuals, technical standards, guides) are screened by BJC QA Organization staff for applicability to BJC work scope and to recommend an approach for developing BJC's position on incorporation into the contract. Applicable standards are routed to functional managers and subject matter experts (SMEs). Necessary actions to address new and/or revised federal, state, and local laws and regulations are considered by the BJC Standards Review Board, whose responsibilities include evaluating issues to determine the need for considering changes to BJC contractual standards due to the following:

- challenges that relate to the appropriateness of safety standards;
- changes to federal, state, and local laws and regulations;
- changes to voluntary consensus standards included as contractual standards;
- changes to approved DOE directives that address safety requirements; and
- new work scope or hazards.

Links to the current set of contractual standards and requirements are maintained on the BJC web site. Additional links are provided for reference to DOE's directives. The BJC organizational structure, functional responsibilities, levels of authority, and interfaces for those planning, managing, performing, and assessing the work are defined in company policies, program plans, program procedures, directives, and subcontracts, as appropriate.

The BJC QA Organization has a key role in implementing continuous improvement and provides direct support to program and project teams throughout the company to facilitate integration of QA requirements into project activities. The BJC QA functional manager is responsible for providing central leadership, direction, and assessment of the BJC QA Program and for assisting BJC project managers and subcontract coordinators in verifying that, when required, subcontractors have an adequate QA plan in place before work is initiated.

BJC senior management is responsible for the leadership and commitment to quality achievement and improvement within a framework of public, worker, and environmental safety. BJC management also has the primary responsibility and accountability for the scope and implementation of the BJC QA Program. BJC personnel are held directly responsible for the quality of their work; line management has final responsibility for the achievement of quality. BJC personnel have the responsibility to immediately stop work if an operation or process seriously jeopardizes safety, health, or the environment or if it possesses imminent life-threatening implications as defined in BJC procedures. These responsibilities are passed down to subcontractors through language contained in each subcontract and through the *Worker Safety and Health Program* (BJC 2009e) and *Environmental Compliance and Protection Program* (BJC 2009f).

The BJC QA Program is implemented through management processes, which include training personnel and verifying their qualifications; identifying opportunities for improvement; controlling documents and records; and planning, scheduling, and identifying resources.

The quality of items, services, and processes is ensured for subcontracts through the procurement process by requiring subcontractors to work under the BJC QA Program or to provide a QA plan that identifies the specific quality requirements applicable to the subcontractor's scope of work.

Environmental management operations include environmental cleanup, waste management, and reindustrialization activities. The ultimate success of BJC's environmental program and projects depends on the quality of the environmental data collected and used in the decision-making process. Environmental data operations include the collection, management, use, assessment, retention, and reporting of such data.

All activities involving the generation, acquisition, and use of environmental data are planned and documented. The type and quality of the data are determined with respect to their intended use. The data quality objective process establishes the objectives for data collection and quality. Determining the type and quality of environmental data needed involves data users as well as personnel responsible for activities affecting data quality.

Environmental monitoring programs at ETTP incorporate data quality objectives and other quality assurance protocols through the sampling and analysis plans and the associated laboratory statements of work. The monitoring program SME and the BJC Sample Management Office (SMO) collaborate in choosing the most appropriate analytic methodology for both radiological and nonradiological monitoring. Sample quantitation levels (the point at which it is possible to quantify the concentration within the appropriate level of confidence), screening levels for notification, analytical methods, and other information necessary to ensure that the data collected are of the appropriate quality and are included in the plans. The SMO and the SME review these criteria with the contracting laboratories to ensure that they are capable of meeting the criteria. If for any reason the laboratory is unable to meet any of the requested criteria, the SME must determine if the laboratory's capabilities are adequate. The appropriate action is then taken to either amend the statement of work or to send the analytical work to a laboratory capable of meeting the monitoring program needs.

Laboratories conducting radiological and nonradiological analyses for ETTP environmental monitoring programs are reviewed periodically by the SMO to ensure that the quality of the analytical work continues to meet the appropriate standards. In 2009, all laboratories used by ETTP environmental monitoring programs performed satisfactorily. Laboratories used by ETTP must be approved by DOE's Analytical Services Program (DOECAP Audit Team), which conducts routine audits (at least once a year, and more frequently if a problem is noted) to ensure that the analyses are of the highest quality.

When data are received from the laboratory, the SMO reviews the data package from the laboratory. Data completeness, quantitation levels, screening levels, holding times, and methodology are examined to ensure that all quality aspects of the analyses meet the criteria set forth in the Sampling and Analysis Plan and the Statement of Work (SOW). Any deficiencies are noted, and the laboratory is contacted for clarification. When the SMO is satisfied that the data are complete and meet all criteria, the data are forwarded to the SME. The SME conducts further reviews and uses the data in the appropriate calculations and reports.

Selected programs or projects impose unique QA requirements on their activities. Such special QA Program requirements are added to and, where possible, integrated with the basic BJC QA Program requirements for the affected facilities and activities. For subcontracted work, the necessary QA requirements are included in subcontract language, or the subcontractor is required to develop a QA plan to be submitted to BJC for review and approval. These special QA requirements are applicable to a specific work scope and are monitored by BJC and/or subcontractor personnel, as appropriate.

3.7.1 Integrated Assessment and Oversight Program

QA Program implementation and procedural and subcontract compliance are verified through the BJC Integrated Assessment and Oversight Program. The program identifies the processes for planning, conducting, and coordinating assessment and oversight of BJC activities, including both self-performed and subcontracted activities, resulting in an integrated assessment and oversight process. The program is composed of three key elements: (1) external assessments conducted by organizations external to BJC, (2) independent assessments conducted by teams independently of the project/function being assessed, and (3) management assessments conducted as self-assessments by the organization or on behalf of the organization manager.

Self-assessments are performed by the organization/function with primary responsibility for the work, process, or system being assessed. Organizations and functions within the company plan and schedule self-assessments. Self-assessments encompass both formal and informal assessments. The formal self-assessments include management assessments and subcontractor oversight. Informal self-assessments include weekly inspections and routine walkthroughs conducted by subcontractor coordinators, ES&H representatives, quality engineers, and line managers.

QA issues identified from internal and external assessments are documented, causal analyses are performed, and corrective actions are developed and tracked to closure. Analyses are conducted periodically to identify trends for management action. Senior management evaluate data from those processes to identify opportunities for improvement.

3.8 Environmental Management and Waste Management Activities

3.8.1 Waste Management Activities

Restoration of the environment, D&D of facilities, and management of the legacy wastes constitute the major operations at ETTP.

The Toxic Substances Control Act (TSCA) Incinerator, located at ETTP, was shut down permanently on December 2, 2009, after treating 35.6 million pounds of liquid and solid waste over a 19-year period.

The TSCA Incinerator was a one-of-a-kind thermal treatment unit. It played a key role in treating radioactive PCB and hazardous wastes (mixed wastes) from the Oak Ridge Reservation, as well as other facilities across the DOE complex, thus facilitating compliance with regulatory and site closure milestones. Closure activities at the incinerator will continue through FY 2011 to remove residual waste such as sludge, ash, and scrubber packing material. Much of the waste generated during 2010 cleanup activities was disposed at facilities on the Oak Ridge Reservation.

EMWMF, located in Bear Creek Valley west of the Y-12 Complex, is an engineered landfill that accepts waste generated from cleanup activities on the Oak Ridge Reservation. It currently consists of four active disposal cells, with a fifth cell awaiting final regulatory approval for use and a sixth cell under construction at the end of FY 2010. EMWMF accepts low-level radioactive and hazardous wastes that meet specific waste acceptance criteria developed in accordance with agreements with state and federal regulators. Waste types that qualify for disposal include soil, dried sludge and sediment, solidified wastes, stabilized waste, building debris, scrap equipment, and personal protective equipment. During FY 2010, EMWMF operations collected, analyzed, and dispositioned approximately 4.8 million gallons of leachate and 1.3 million gallons of contact water at the ORNL Liquid/Gaseous Waste Operations Facility. An additional 10 million gallons of contact water was collected, analyzed, and released to the storm water retention basin after determining that it met the release criteria. EMWMF received approximately 22,700 truckloads of waste accounting for approximately 262,000 tons during FY 2010. Projects that have disposed of waste at EMWMF during the year include the following:

- K-25 Building Demolition Project, including waste generated from the west wing demolition;
- ETTP Decontamination and Decommissioning Project, including K-770 Scrapyard, K-1070-B Burial Ground, and K-1036/K-1058 demolition debris;
- Y-12 Old Salvage Yard Project, Alpha 5 Project, and Biology Project; and
- ORNL Building 3026 and 2000 Complex.

The Central Neutralization Facility, located at ETTP, treated 9.5 million gallons of wastewater in FY 2010. The facility is ETTP's primary wastewater treatment facility and processes both hazardous and nonhazardous waste streams arising from multiple waste treatment facilities and remediation projects. The facility removes heavy metals and suspended solids from the wastewater, adjusts pH, and discharges the treated effluent into the Clinch River. Sludge from the treatment facility is treated, packaged, and disposed of off-site. With the shutdown of the TSCA Incinerator, the Central Neutralization Facility operated at a reduced capacity on day shift only instead of the previous 24/7 operation. The main waste stream is the hexavalent chromium-contaminated groundwater collected from Mitchell Branch. The facility also continued to treat wastewaters generated at the TSCA Incinerator and remediation and investigation projects to support the closure activities. It will be shut down in FY 2011 for decommissioning after establishing a smaller chromated water treatment unit that will sit within the existing Central Neutralization Facility footprint.

At ORNL, approximately 120 million gallons of wastewater were treated and released at the Process Waste Treatment Complex. In addition, the liquid low-level waste evaporator at ORNL treated 120,800 gallons of such waste. A total of 2.2 billion m^3 of gaseous waste was treated at the ORNL 3039 Stack Facility.

These waste treatment activities supported both EM and Office of Science mission activities in a safe and compliant manner during FY 2010. The National Nuclear Security Administration (NNSA) at the Y-12 Complex treated 116.5 million gallons of contaminated ground/sump water at the Groundwater Treatment Facility, the Central Mercury Treatment System, Big Springs Water Treatment System, and the East End Volatile Organic Compounds Treatment System.

The Big Springs Water Treatment System treated 104 million gallons of mercury-contaminated groundwater. The East End Volatile Organic Compound Treatment System treated 11 million gallons of VOC-contaminated groundwater. The West End Treatment Facility and the Central Pollution Control Facility at the Y-12 Complex processed 1.2 million gallons of wastewater primarily in support of NNSA operational activities. The Central Pollution Control Facility also down-blended more than 37,000 gallons of enriched wastewaters using legacy and newly generated uranium oxides from on-site storage and was completed ahead of schedule and under budget in May. EMWMF began operations in 2002 to provide on-site waste disposal capacity from remediation of the Oak Ridge Reservation. Although it is being expanded to its maximum capacity, EMWMF will not be able to handle all of the waste expected to be generated from Reservation cleanup activities.

Further expansion at EMWMF is constrained by physical limitations of the site. Therefore, DOE is considering other locations to build a new disposal facility. DOE began evaluating disposal alternatives in FY 2010 for future Reservation cleanup waste.

Similar to the CERCLA process that was completed for the existing EMWMF, DOE will evaluate the following alternatives detailed in a Focused Feasibility Study:

- No action
- On-site disposal (constructing and operating a new disposal facility on the Reservation)
- Off-site disposal (shipping to an off-site facility)

The on-site disposal alternative includes consideration of options for siting a new facility in the East Bear Creek Valley area or in two other candidate areas (White Wing Scrap Yard and West Bear Creek Valley).

The use of RFIDs was implemented for waste shipments to EMWMF. This innovation allows for faster and more accurate tracking of waste shipments and reduces paperwork, decreases the shipment cycle time, and improves security of the materials being transported along the haul road.

The Oak Ridge Reservation Landfills are located near the Y-12 complex and are designed for the disposal of sanitary, industrial, construction, and demolition wastes that meet the waste acceptance criteria for each landfill. In FY 2010, more than 139,000 cubic yards of waste was disposed of at these facilities, and more than 1.4 million gallons of leachate was collected, monitored, and discharged to the Oak Ridge sewer system. In 2009, planning was initiated to expand Landfill V of the Oak Ridge Reservation Landfills.

3.8.2 Environmental Restoration Activities

The ETTP operated as an enrichment facility for 4 decades, during which time many of the buildings became contaminated to some degree with radionuclides, heavy metals, and toxic organic compounds. In addition, large quantities of wastes were generated, much of which was stored on the site.

ETTP’s Environmental Management Program was created with the goal of demolishing all unnecessary facilities and restoring the site to a usable condition. The safety and health of employees and the public is a constant focus. Cost-effectiveness is also a major consideration in the cleanup operations.

DOE has signed two of three key CERCLA records of decision with the state of Tennessee and EPA authorizing environmental restoration of about 890 ha of land at ETTP. The area encompasses approximately about 567 ha outside the main plant security fence (Zone 1) and about 324 ha inside the fence within the former plant production area (Zone 2). The main objectives of the two decisions are to protect future industrial workers and the underlying groundwater from contamination in soil, slabs, and subsurface structures. The Zone 1 Interim Record of Decision (ROD) was signed in November 2002 and covers the 566-ha area surrounding ETTP outside the main plant perimeter. The Zone 2 ROD was signed in April 2005 and covers the 324-ha in the main plant area. The final site-wide record of decision for groundwater, surface water, sediment, and ecological soil risk is in development.

Final data were collected in FY 2010 to characterize five parcels surrounding ETTP in order to determine if these parcels can be removed from the National Priorities List site boundary, which encompasses the contaminated sites on the Reservation. The entire Reservation was originally placed on the National Priorities List, but EPA has since clarified that listed sites are based on contaminated areas, not property boundaries.

3.8.2.1 K-25 Building Demolition

The K-25 Building, built during the Manhattan Project, occupied approximately 40 acres and contained more than 3,000 stages of gaseous diffusion and associated auxiliary equipment. Each stage consists of a converter, two compressors, two compressor motors, and associated piping. The west wing of the K-25 Building has been demolished, and debris from the demolition has been removed from the site (Fig. 3.66).

ORNL 2011-G00821/chj

Fig. 3.66. The K-25 Building after demolition of the west wing.

Debris from the demolition activities is shipped to the EMWMF, a Reservation disposal facility built near the Y-12 National Security Complex to handle waste from CERCLA cleanup activities. Pre-demolition activities continued in the East Wing, including the removal of high-risk equipment. Workers also continued performing vent, purge, drain, and inspection activities; asbestos removal; and draining of lubrication oil and coolant from the process system in both the east and north wings. Measures were previously taken to improve the safety of workers inside the facility, including the installation of nets and barriers to add protection from falling debris.

3.8.2.2 K-27 and K-33 Buildings Demolition

The K-27 Building is similar to the K-25 Building in terms of process and is approximately 900 ft long, 400 ft wide, and 58 ft in height. Pre-demolition work that has been initiated includes removal of asbestos, hazardous material, loose material, and draining of lubrication oil and coolant. DOE has awarded a contract for the demolition of the K-33 Building. One of the last steps necessary before demolition begins—that is, isolation of the tie line connecting that building to the K-31 Building—was completed.

3.8.2.3 Groundwater Treatability Study

Remediation activities to reduce ETTP groundwater and surface water contamination continued in FY 2010. Work was initiated in FY 2010 to prepare a Zone 1 Final ROD that will address groundwater and ecological protection. Field work on that project will be initiated in FY 2011. A two-phase groundwater treatability study at ETTP began in FY 2009 to support selection of a site-wide groundwater remedy.

The purpose of the study was to determine the feasibility of in situ treatment technologies to restore the groundwater. Two in situ technologies have been identified as possibilities, and one or both may be suitable: thermal conductive heating and biological treatment.The purpose of the first phase of the study was to characterize and delineate suspected areas of solvent contamination. Seven boreholes were installed to depths of 110 to 160 ft below ground surface in FY 2009 (Fig. 3.67).

In FY 2010, Dense Non-Aqueous Phase Liquid (DNAPL) was detected in one of the boreholes in the vicinity of the former K-1401 Vapor Degreasing Tank. DNAPLs are a group of organic substances that are relatively insoluble in water and more dense than water. Seven additional boreholes were installed to further delineate the lateral extent of DNAPL contamination.

ORNL 2011-G00822/chj

Fig. 3.67. Drilling exploratory boreholes near the K-1401 area.

A workshop was held in September 2010 to review the data and select a technology for a Phase II Pilot Field Study. The workshop concluded that in situ thermal treatment may be appropriate for DNAPL treatment in the weathered bedrock zone, that in situ thermal or biological treatment may be appropriate for treatment of the unconsolidated zone, and that a waiver may be appropriate for the deep bedrock zone. The objective of the study is to determine if these technologies would be effective in reducing the mass of contamination in the groundwater and reducing the risk of exposure to human health and the environment.

3.8.2.4 Soil, Burial Ground, and Exposure Unit Remediation Activities

The soil at ETTP is to be remediated to a level that protects a future industrial workforce and the underlying groundwater. Records of Decision (RODs), which detail the selected cleanup methods, are in place that address soil, slabs, subsurface structures, and burial grounds for both zones.

Remediation of contaminated soil continued at the K-770 Scrapyard, and approximately 97,000 yd^3 of soil has been shipped to EMWMF for disposal. Remediation of the K-770 Scrapyard was 99% complete at the end of FY 2010.

Work was initiated in FY 2010 to prepare a Zone 1 Final ROD that will address groundwater and ecological protection. Field work on that project will be initiated in FY 2011.

In Zone 2, work in Exposure Units (EUs) 31 and 32 was completed, and remediation of the K-1070-B Burial Ground continued. EU 31 is in the center of ETTP and spans approximately 8.5 ha. A Phased Construction Completion Report (PCCR) was completed that documented the characterization of the EU, the remediation of the K-1035 slab and underlying soil, the removal of the K-1401 slab, and the backfilling of the K-1401 basement.

EU 32 also is in the center of ETTP and spans approximately 7.4 ha. A PCCR was prepared that documented the characterization of the EU and the remediation of the K-1066-G Yard, which consisted of the removal of equipment and material that was stored there.

Through the end of FY 2010, approximately 93,000 yd^3 were excavated from the K-1070-B Burial Ground. Excavation of the trenches was initiated, and the groundwater collection, filtering, and transfer system to the Central Neutralization Facility was installed.

3.8.2.5 Mitchell Branch Chromium Collection System

In 2007, surveillance data indicated that the chromium levels in Mitchell Branch had markedly increased. Subsequent analyses showed that the chromium was almost entirely in the hexavalent state. Since hexavalent chromium has not been used at ETTP for many years, it is believed that the source is groundwater contaminated with legacy material, and not a result of current operational issues. The chromium collection system consists of a grout layer to impede the flow of the groundwater and two extraction wells and pumps to pump the groundwater from the vicinity of storm water outfall 170 for treatment at the CNF and discharge through the CNF NPDES outfall. Since the installation of this system and subsequent modifications to increase pumping rates, chromium levels in Mitchell Branch have been reduced to well below the WQC of 11 µg/L, and near or below the detection levels of 1 to 3 µg/L. In FY 2010, DOE approved a non-time-critical Removal Action for a long-term solution to the release of hexavalent chromium into Mitchell Branch. The Removal Action Work Plan and conceptual design were completed in FY 2010. DOE had previously approved a time-critical Action Memorandum to address releases of hexavalent chromium from an unknown source to Mitchell Branch in FY 2007.

3.8.2.6 K-1007 Ponds Remediation

Largemouth bass from the K-1007-P1 Pond were known to accumulate high concentrations of PCBs in their muscle tissue. As a result of multiple studies of the pond, the major source of PCB contamination was thought to be in the sediments, which are easily suspended by bottom-feeding fish like carp and shad, especially in this system where grass carp totally decimated pond plants that historically served to stabilize the sediments. High nutrient loads in the pond from a large goose population were thought to contribute high suspended algal biomass. Lipid-rich gizzard shad, which forage on sediment and suspended algae and therefore accumulate very high PCBs, served as a major vector of PCB transfer to largemouth bass and wildlife. In 2009, a non-time-critical removal action was implemented that used fish, wildlife, and plant management principles to minimize the risks associated with PCBs in the pond. The problem fish were removed from the pond, geese were discouraged from the area, and extensive pond recontouring and planting was conducted. The goal was to create in the pond a population of relatively low bioaccumulator fish (i.e., primarily small sunfish), plus dense areas of rooted aquatic vegetation to stabilize the sediment to prevent resuspension. This innovative approach was deemed more cost-effective than traditional dredging operations and served to preserve the pond as an ecological and aesthetic asset for the area.

Fish removal, recontouring, and revegetation were completed at the ETTP P1 Pond located next to Building K-1007 (Fig. 3.68). Fish removal was also conducted in two additional ETTP ponds located adjacent to Highway 58, with approximately 8.5 tons of fish recovered from all three. Removal of the fish was necessary because the species that were in the ponds would stir the contaminated sediment at the bottom of the ponds. The pond was restocked with fish species that are less likely to disturb the pond sediment. Barriers were placed to prevent fish from migrating into the pond from Poplar Creek. The fish barrier was damaged during FY 2010 after a severe weather event. Undesirable fish that reentered the pond were removed, and the fish barrier was repaired.

ORNL 2011-G00823/chj

Fig. 3.68. Revegetating the K-1007-P1 Pond.

Miscellaneous Remediation Efforts

ETTP has designated certain facilities with a low risk for radiological and chemical contamination as "Low-Risk/Low-Complexity" D&D facilities. All waste from these facilities is expected to contain a low level of expectation risk and contamination. In FY 2010, six low-risk/low-complexity facilities were demolished.

3.8.3 Reindustrialization

The Reindustrialization Program was developed to accelerate cleanup of the site and to allow for beneficial reuse of underutilized facilities and land. Facilities determined appropriate for reuse are leased or transferred to non-DOE entities such as the Community Reuse Organization of East Tennessee (CROET) or the city of Oak Ridge. CROET is a not-for-profit corporation established to foster diversification of the regional economy by reutilizing excess DOE property for private-sector investment and job creation.

With the property and infrastructure transfers and upgrades in FY 2010, the DOE Oak Ridge Office Reindustrialization Program marked a turning point in realizing DOE's vision to transform ETTP into a private sector business/industrial park. In FY 2010, the Reindustrialization Program transferred Land Parcel ED-8 and the K-792 Switchyard Complex (including Buildings K-796-A and K-791-B) to CROET. Approximately 145 contiguous acres, with supporting infrastructure located along Highway 58 at the front portion of ETTP, are now available for economic development. Additional land areas at ETTP are in various stages of the transfer process, and utility infrastructure improvements continue to support expansion of ETTP. In addition to land, DOE transferred the Phase I Electrical Distribution System in February 2010 and several site roadways to the city of Oak Ridge in May and June 2010. The Phase I portion of the electrical system included all direct off-site main plant power lines. The roadway transition included 1.3 miles of roads at the main site entry and arterial roadways to provide public access to privately owned buildings at ETTP.

In FY 2010, CROET completed construction of two speculative buildings and upgraded the fire protection systems in the privately owned buildings at ETTP, while the city constructed a new power line from their substation to serve the speculative buildings and the Land Parcels ED-5 East and West.

DOE has now transferred ownership of approximately 176 acres of land (Fig. 3.69) and 332,000 ft^2 in building space at ETTP. These transfers have been made via a provision in CERCLA that allows for the transfer of property for economic development purposes. These activities are all part of DOE's plan to transform ETTP into a private-sector business and industrial park.

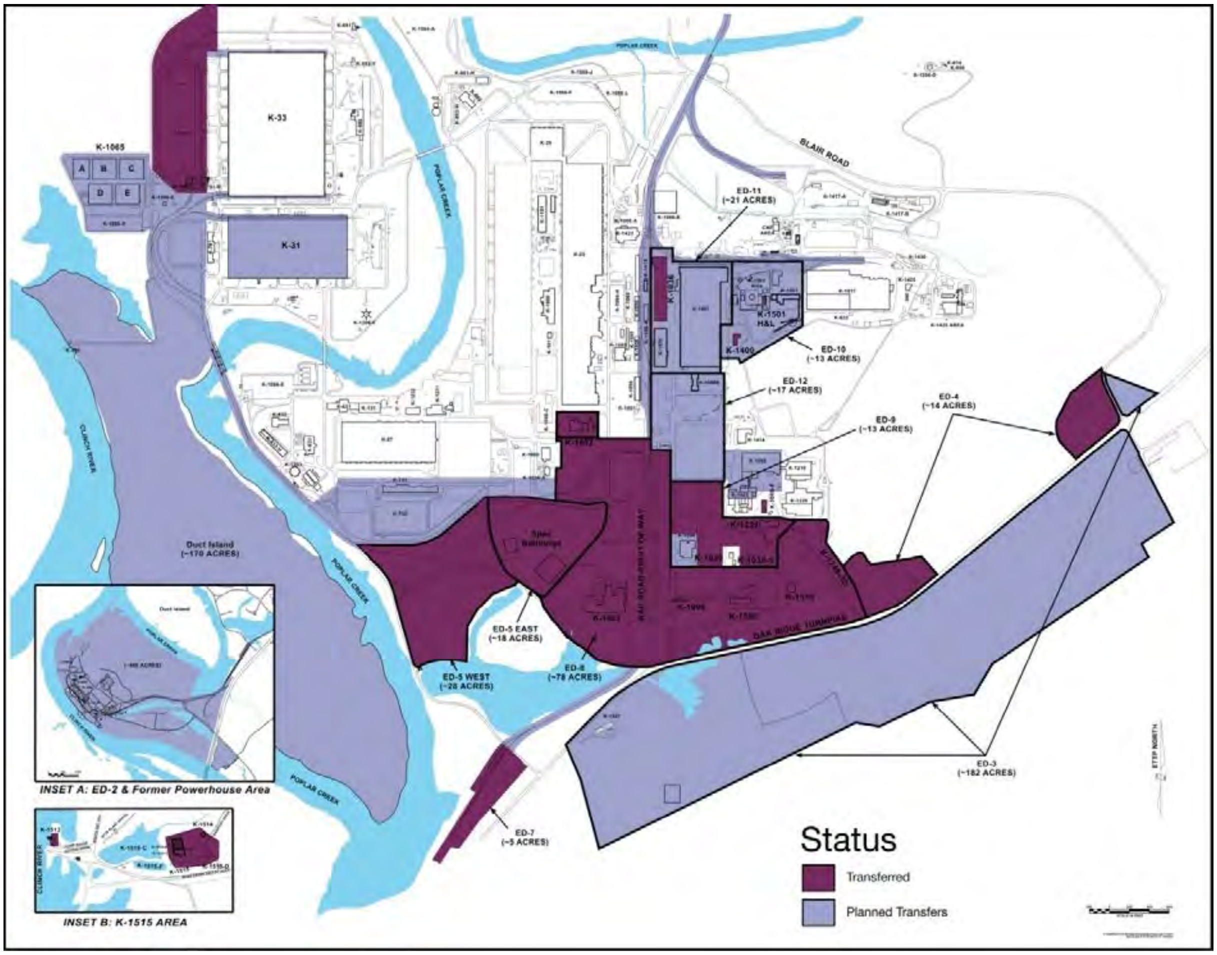


Fig. 3.69. Reindustrialization Status (new) [In development - Sherri Cotter & Louie Finley (BJC)/Phil Brooks (SAIC)]

3.8.4 Biosolids Program

Under the Biosolids Program, treated municipal sludge (biosolids) from the city of Oak Ridge publicly owned treatment works (POTW), is applied to six approved sites (Fig 3.70) on the Oak Ridge Reservation (ORR) as a soil conditioner and fertilizer. The Bechtel Jacobs Company, LLC (BJC) provides oversight for the program (*Application of Sanitary Biosolids on the Oak Ridge Reservation, Program Oversight Plan,* BJC/OR-1217), which operates under a land license agreement between the DOE and the city. The city has applied biosolids on the ORR since 1983.

Land application is included in the EPA policy on municipal biosolids, which was formally articulated in June 1984 (49 CFR 24358), as an example of beneficial use. Municipal biosolids are regulated by the EPA under the provisions of Title 40, *Code of Federal Regulations* (CFR), Part 503 of the Clean Water Act (CWA). These regulations establish standards for biosolids use and disposal, including risk-based, metal-loading criteria and agronomic (nitrogen) loading limits for the receiving soil. Additional requirements are imposed by the Environmental Assessments (DOE/EA-1042, DOE/EA-1356, and draft DOE/EA-1779) written for the program and by the Tennessee Department of Environment and Conservation (TDEC) through the land application approval process.

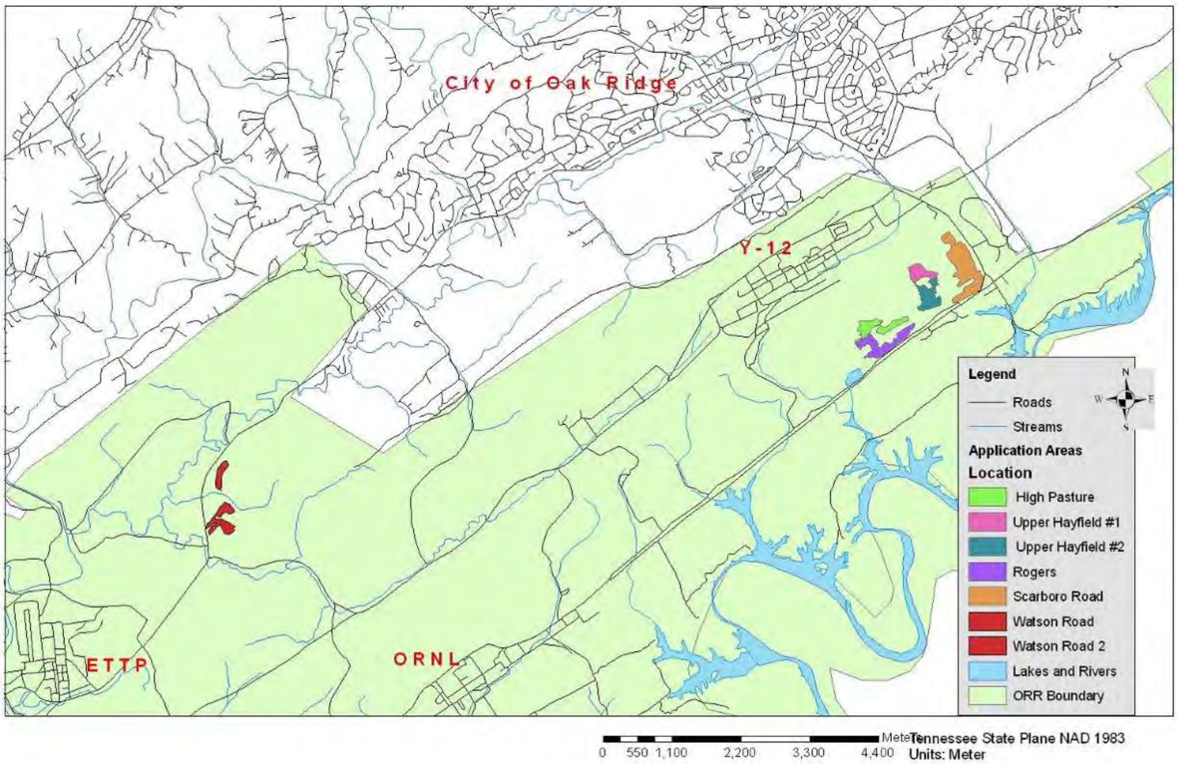


Fig.3.70. Location of the biosolids application sites with respect to the ETTP, Y-12, and ORNL facilities within the region. [In development – Sherri Cotter from Eileen Shea (CDM)]

In addition to metals, POTW biosolids typically contain both natural and anthropogenic radionuclides. In particular, the Oak Ridge POTW biosolids contain trace quantities (parts per million) of slightly enriched uranium from the Y-12 Plant. Radionuclides in biosolids are not currently regulated by the EPA. With the consent of TDEC, the city, and DOE, the Biosolids Program has established specific radionuclide limits for the biosolids and receiving soil using radiation dose limit calculations. Currently, the biosolids and soil limits are calculated using the RESRAD model assuming conservative pathway scenarios (DOE/EA-1042, DOE/EA-1356).

The NRC regulations prohibit an unlicensed entity from receiving, possessing, or handling special nuclear material (SNM). The state of Tennessee, however, is authorized by the NRC to exempt certain classes or quantities of SNM from the requirements of a potential license when it makes a finding that the exemption of such quantities of SNM would not constitute an unreasonable risk to the health and safety of the public. On April 29, 1993, the city requested a waiver from the SNM licensing requirement from TDEC Division of Radiological Health (DRH). This waiver was granted by DRH on September 27, 1993. Accordingly, the SNM aspects of the biosolids application program are in compliance with requirements of NRC and TDEC.

3.8.4.1 Biosolids Fields at the ORR

The biosolids land application sites are located on the ORR in Oak Ridge, Tennessee (Fig 3.70). Five of the active sites are in the vicinity of Bethel Valley Road, while the remaining active site, Watson Road, is located on Highway 95, near the Horizon Center. Table 3.48 presents the six application sites and their gross acreage values.

Table 3.48. ORR biosolids active land application sites gross acreage

Site	Acres (Ac)	Hectares (ha)
Upper Hayfield #1	30	12.15
Upper Hayfield #2	27	10.93
High Pasture	46	18.62
Watson Road	117	47.37
Scarboro	77	31.17
Rogers	32	12.96

3.8.4.2 Current Program

The city POTW near Turtle Park in Oak Ridge, Tennessee, processes approximately 30 million gallons per day (gpd) of wastewater. The plant receives wastewater from a variety of industrial, commercial, and residential generators in the Anderson/Roane County area. The DOE contributes approximately 20% of the influent to the POTW directly from the Y-12 site, with lesser amounts from the ETTP through the Rarity Ridge treatment plant, and from ORNL through tanker delivery of sludge. All industrial generators are required by Oak Ridge Ordinance Number 9-91 to obtain an industrial discharge permit (IDP) from the city, which prescribes discharge limits and monitoring/reporting requirements. The POTW uses a standard activated-sludge process in which biosolids from both the primary and secondary sedimentation basins are fed into two aerobic holding tanks. From there, the liquid biosolids are pumped to a belt press system for drying.

The city is working toward production of Class B biosolids with 20% to 25% solids content, which will then be transported to one of the six active application sites using a standard-size discharge manure spreader. All of the tanks formerly used for anaerobic treatment have now been converted to aerobic digesters. It is estimated that up to 2600 lb of dry solids could be land applied on an average day.

3.8.4.3 Current Status

The city has accumulated approximately 750,000 gal of liquid (approximately 97–98% liquid) biosolids in digesters that resulted from attempts to produce a class B product. Under a land application approval from TDEC, the city began application of the liquid biosolids in November 2010 at the ORR using a sprayer truck. Currently, the environmental assessment DOE/EA-1356 governs restrictions for biosolids application at the ORR. These restrictions include protective boundaries, setbacks for surface water features, and areas with potential channels to groundwater of 500 ft, and 50 ft around waters of the state. In accordance with industry best-management practices, application is not permitted under conditions of saturated site soil, precipitation, or excessive wind. Additionally, in accordance with TDEC land application guidance, application is only permitted on slopes of 8% or less.

From November 10, 2010, through December 31, 2010, the city made nine trips to the High Pasture site and applied 3.61 dry tons of product. Current loading calculations indicate that a maximum of 16.5 tons of dry material may be applied to the High Pasture southern tabletop without exceeding nitrogen requirements for vegetation present on the fields. Table 3.49 presents data on biosolids applied during 2010 at the ORR.

Table 3.49. Biosolids applied during 2010 at the ORR

Date	Dry amount applied (lb)	lb	tons	% used	Loads
11/10/2010	528	528	0.26	1.60	1
11/11/2010	2,358	2,886	1.44	8.75	2
11/12/2010	1,560	4,446	2.22	13.47	2
11/22/2010	1,284	5,730	2.87	17.36	2
11/29/2010	757	6,487	3.24	19.66	1
12/10/2010	729	7,216	3.61	21.87	1

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4. The Y-12 National Security Complex

The Y-12 National Security Complex, a premier manufacturing facility operated by Babcock & Wilcox Technical Services Y-12 L.L.C. (B&W Y-12) for the National Nuclear Security Administration, plays a vital role in DOE's Nuclear Security Enterprise. While drawing on more than 60 years of manufacturing excellence, Y-12 helps ensure a safe and reliable U.S. nuclear weapons deterrent.

The Complex also retrieves and stores nuclear materials, fuels the nation's naval reactors, and performs complementary work for other government and private-sector entities.

Today's environment requires a Y-12 that has a new level of flexibility and versatility. So while continuing its key role, Y-12 has evolved to become the complex that the nation looks to for support in protecting America's future by developing innovative solutions in manufacturing technologies, prototyping, safeguards and security, technical computing, and environmental stewardship.

Due to differing permit reporting requirements and instrument capabilities, various units of measurement are used in this report. The list of units of measure and conversion factors provided on page xxvii is intended to help readers convert numeric values presented herein as needed for specific calculations and comparisons.

4.1 Description of Site and Operations

4.1.1 Mission

The Y-12 Complex is a one-of-a-kind manufacturing facility that plays an important role in U.S. national security. The roles of the Y-12 Complex include the following:

- receipt, storage, and protection of special nuclear materials;
- quality evaluation/enhanced surveillance of the nation's nuclear weapon stockpile;
- safe and secure storage of nuclear materials;
- dismantlement of weapon secondaries and disposition of weapon components;
- provision of technical support to the National Nuclear Security Administration (NNSA) Defense Nuclear Nonproliferation Program;
- provision of fuel for the nation's naval reactors program;
- transfer of technology to private industry;
- maintenance of DOE capabilities; and
- provision of support to DOE, other federal agencies, and other national priorities.

Babcock & Wilcox Technical Services Y-12, LLC (B&W Y-12) is the NNSA's management and operating contractor responsible for operation the Y-12 National Security Complex. Located within the town limits of Oak Ridge, Y-12 covers more than 328 ha (810 acres) in the Bear Creek Valley, stretching 4.0 km (2.5 miles) down the valley and nearly 2.4 km (1.5 miles) wide. Approximately 6,000 people work on site, including employees of B&W Y-12, NNSA, Wackenhut Services (NNSA's security services contractor), other DOE contractors, and subcontractors.

NNSA-related facilities located off the Y-12 Complex site but in Oak Ridge include the Office of Secure Transportation (OST) Agent Operations Eastern Command (AOEC) Secure Transportation Center and Training Facility and an analytical laboratory. The laboratory is a leased facility providing a wide range of routine and nonroutine analytical services for environmental and hazardous waste programs of NNSA, DOE, and other customers.

4.1.2 Transformation

Complex Transformation is NNSA's vision for a smaller, safer, more secure, and less expensive nuclear weapons complex that leverages the scientific and technical capabilities of its workforce and meets national security requirements.

The complex is old; many of the facilities were required for the Cold War security environment but are no longer necessary to use or affordable to maintain. The Y-12 Complex's infrastructure reduction effort focuses on removing excess buildings and infrastructure to support reduction in maintenance and operating cost and to provide real estate for future modernization needs. The country's need to construct smarter, more environmentally friendly buildings is a focus of the new construction projects.

4.1.2.1 Infrastructure Reduction

At Y-12, the Facilities and Infrastructure Recapitalization Program (FIRP) executed more than 125 major repair, utility upgrade, and demolition projects with a combined value of almost $450 million since 2002. Under this program site personnel have removed 284 excess buildings totaling 1.2 million gross square feet. Through FIRP, Y-12 has also executed more than $30 million of roofing projects, resulting in the replacement of more than 20 acres of deteriorated roofs with modern, energy-efficient roof systems. There were no funded activities under the FIRP during FY 2010, and this program has been completed.

The Infrastructure Reduction project team had completed planning in the previous fiscal year for demolition projects for Buildings 9709 and 9766. Both buildings were key demolitions needed to support the overall transformation efforts. Building 9766, a 36,800 square feet facility, was demolished in 2010. The 9766 building slab will be developed into a parking area. Building 9709 demolition was funded and authorized in late 2010. The project includes the Buildings 9709, 9409-30, and 9416-21. In December, the project completed the utility isolation planning and held the pre-bid meeting for the demolition of the associated structures.

Building 9720-38 was demolished during October and November of 2010. Its 7,700 square footage had been used to store material since its construction in 1981. Additional demolitions were funded via the American Recovery and Reinvestment Act.

4.1.2.2 American Recovery and Reinvestment Act

Funding from the American Recovery and Reinvestment Act of 2009 (ARRA) has allowed more cleanup work to be performed at the Y-12 Complex. Y-12 received ARRA funding in May 2009 for these seven "shovel-ready" projects, which as a group will be completed by the end of FY 2011:

- Alpha 5 Legacy Material Disposition,
- Beta 4 Legacy Material Disposition,
- Building 9206 Filter House deactivation & demolition (D&D),
- Old Salvage Yard Scrap Removal,
- West End Mercury Area Storm Sewer Remediation,
- Biology Complex D&D (Buildings 9769, 9211, 9220, and 9224), Phase I , and
- Building 9735 D&D.

ARRA projects are also regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and are authorized by a time-critical removal action memorandum. The Y-12 Recovery Act projects are scheduled to meet or exceed existing regulatory milestones. Progress on each of these projects is detailed in Section 4.8, Environmental Management and Waste Management Activities.

4.1.2.3 New Construction

The transformation of Y-12 from a Cold War nuclear weapons complex into a 21st century Nuclear Security Enterprise took major steps forward in 2010 with completion of critical infrastructure projects while continuing to plan for others.

Potable Water Project Completed. A critical improvement to the operations of the Y-12 National Security Complex came online with the 2010 summer start-up of a new potable water system that includes two prominent, 220-foot-tall water towers and more than 1.5 miles of newly installed water lines. The site uses potable water for operations, as well as drinking water.

The $62.5 million Potable Water System Upgrades Project provides a more reliable long-term water supply. In addition to 8,360 linear feet of newly installed piping, 3,800 linear feet were replaced, and another 2,115 feet were cleaned and lined.

Original cast-iron water mains and laterals that had deteriorated were either repaired or replaced, according to a news release. Sprinkler systems that contain antifreeze were modified to include a backflow preventer, to ensure no cross-connections with potable water. Fourteen antifreeze loops were severed from the water supply, and the antifreeze was drained to eliminate the possibility of cross-contamination; 52 backflow preventers were installed.

The most visible features of the project are the two water towers, each holding two million gallons (Fig. 4.1). They are similar to those many cities across the country use to supply drinking water.

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Fig. 4.1. New tanks for the potable water system can be seen in the background, while in the foreground is Y-12's new, natural-gas-fired steam plant.

Steam Plan Life Extension Project. A new, more efficient steam plant (Fig 4.1) at the Y-12 National Security Complex that will significantly reduce emissions opened in April 2010. The new plant replaced a coal-burning facility built in 1954 and was built as part of the NNSA's Facilities and Infrastructure Recapitalization Program. The $59 million facility generates steam in four boilers that burn natural gas, and the steam is used for heating and other processes, including fire protection systems.

The new plant, which can run on fuel oil if needed, is expected to significantly reduce emissions of greenhouse gases, such as carbon dioxide and nitrous oxide, as well as toxic substances, like particulate matter and sulfur dioxide, by up to 99%.

Complex Command Center (CCC) —The proposed Complex Command Center will house the fire department, the plant shift superintendent's office, the technical support/emergency operations center, and emergency management support. These functions are now scattered throughout the site in aging, outmoded facilities. Third-party financing was determined not to be a viable acquisition strategy at this time for the CCC project and various acquisition strategies, including the use of more traditional line-item funding, are being evaluated.

Uranium Process Facility (UPF)—The UPF (Fig. 4.2), cornerstone of Y-12's modernization strategy, is proposed to replace current enriched uranium and other processing operations. This involves a new, fully modernized manufacturing facility optimized for safety, security, and efficiency. It would be the only facility of its type in the United States.

ORNL 2010-G00474/chj

Fig. 4.2. Uranium Process Facility conceptual image.

4.2 Environmental Management System

As part of B&W Y-12's commitment to environmentally responsible operations, Y-12 has implemented an environmental management system (EMS) based on the rigorous requirements of the globally recognized International Organization for Standardization (ISO) 14001-2004 (ISO 2004).

4.2.1 Integration with Integrated Safety Management System

The Integrated Safety Management System (ISMS) is the DOE's umbrella of environment, safety, and health (ES&H) programs and systems that provides the necessary structure for any work activity that could potentially affect the public, a worker, or the environment. B&W Y-12's ISMS has incorporated the elements of the ISO 14001 EMS in the overall umbrella of ISMS for environmental compliance, pollution prevention, waste minimization, and resource conservation. The DOE Office of Health, Safety and Security (HSS) annual environmental progress reports on implementation of EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* (Executive Order 2007) and Office of Management and Budget's Environmental Stewardship Scorecard gave Y-12 an EMS scorecard rating for FY 2010 of green, indicating full implementation of EO 13423 requirements.

4.2.2 Policy

The environmental policy of B&W Y-12 and its commitment to providing sound environmental stewardship practices through the implementation of an EMS have been defined and are endorsed by top management and have been made available to the public via company-sponsored forums and public documents such as this one. The B&W Y-12 ES&H policy is presented in Fig. 4.3.

This policy has been communicated to all employees; has been incorporated into General Employee Training (GET) for every employee, guest, and contractor; and made available for viewing on the internal Y-12 Web Site. Y-12 personnel are made aware of the commitments stated in the policies and how the commitments relate to Y-12 work activities.

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Y-12 Environment, Safety, and Health Policy

Policy: As we work to achieve the Y-12 mission and our vision of a modernized Y-12 Complex, we will do so by ensuring the safety and health of every worker, the public, and the environment. Every employee, contractor, and visitor is expected to take personal responsibility for their actions.

- Environmental Policy: We protect the environment, prevent pollution, comply with applicable requirements, and continually improve our environment.
- Safety and Health Policy: The safety and health of our workers and the protection of public health and safety are paramount in all that we do. We maintain a safe work place and plan and conduct our work to ensure hazard prevention and control methods are in place and effective.

In support of this policy, we are committed to:

- Integration of Environment, Safety and Health (ES&H) into our business processes for w ork planning, budgeting, authorization, execution, and change control in accordance with our Integrated Safety Management System.
- Continuously improving our processes and systems by establishing, tracking, and achieving goals that drive performance excellence.
- Direct, open, and truthful communication of this policy and our ES&H performance to our employees, contractors, customers, and stakeholders.
- Strive to minimize the impact of our operations on the environment in a safe, compliant, and cost-effective manner using sustainable practices for energy efficiency, fleet management, water consumption, pollution prevention, recycling/reuse, source reduction, resource conservation, and environmentally preferable purchasing.
- Incorporate sustainable design principles into the design and construction of facility upgrades, new facilities, and infrastructure considering life-cycle costs and savings.
- Incorporate the use of engineering controls to reduce or eliminate hazards whenever possible into the design and construction of facility upgrades, new facilities, and infrastructure.
- Strive to provide a clean and efficient workplace free of occupational injuries and illnesses (Target Zero).
- Foster and maintain a work environment of mutual respect and teamwork that encourages free and open expression of ES&H concerns.

Fig. 4.3. B&W Y-12 environment, safety, and health policy.

4.2.3 Planning

4.2.3.1 Environmental Aspects

Environmental aspects may be thought of as potential environmental hazards associated with a facility operation, maintenance job, or work activity. Aspects and impacts are evaluated to ensure that the significant aspects and potential impacts continue to reflect stakeholder concerns and changes in regulatory requirements. The following aspects have been identified as potentially having significant environmental impact:

- waste generation,
- air emissions,
- liquid discharges,
- storage/use of chemicals and radioactive materials,
- legacy contamination,
- excess/surplus materials,
- historical and cultural resources,
- natural resource consumption (energy and water), and
- natural resource conservation (positive impacts).

The EMS provides the system to ensure that environmental aspects are systematically identified, monitored, and controlled in order to mitigate or eliminate potential impacts to the environment.

4.2.3.2 Legal and Other Requirements

To implement the compliance commitments of the ES&H policy and to meet legal requirements, systems are in place to review changes in federal, state, or local environmental regulations and to communicate those changes to affected staff. The environmental compliance status is documented each year in this report (see Sect. 4.3).

4.2.3.3 Objectives, Targets, and Environmental Action Plans

B&W Y-12 continues to respond to change and pursue sustainability initiatives by establishing and maintaining environmental objectives, targets (goals), and action plans. Goals and commitments are established annually and are agreed to by the Y-12 NNSA Site Office (YSO) and B&W Y-12 and are consistent with mission, budget guidance, ES&H work scope, site incentive plans, and continuous improvement. Targets and action plans are established for broad objectives to pursue improvement in environmental performance in five areas: clean air, energy efficiency, hazardous materials, stewardship of land and water resources, and waste reduction/recycling/buy green. Highlights of the 2010 B&W Y-12 environmental targets achieved are presented in Sect. 4.2.6.1.

4.2.3.4 Programs

NNSA has developed and funded several important programs to integrate environmental stewardship into all facets of Y-12's missions. The programs also address the DOE order requirements for protecting various environmental media, reducing pollution, conserving resources, and helping to promote compliance with all applicable environmental regulatory requirements and permits.

4.2.3.4.1 Environmental Compliance

The B&W Y-12 Environmental Compliance Department (ECD) provides environmental technical support services and oversight for Y-12 Complex line organizations to ensure that site operations are conducted in a manner that is protective of workers, the public, and the environment; in compliance with applicable standards, DOE orders, environmental laws, and regulations; and consistent with B&W Y-12's environmental policy and site procedures. The ECD serves as the B&W Y-12 interpretive authority for environmental compliance requirements and as the primary point of contact between B&W Y-12 and external environmental compliance regulatory agencies such as the city of Oak Ridge, the Tennessee Department of Environment and Conservation (TDEC), and the U.S. Environmental Protection Agency (EPA). The ECD administers compliance programs aligned with the major environmental legislation that affects Y-12 Complex activities. Compliance status and results of monitoring and measurements conducted by these compliance programs are presented in this document.

The ECD also maintains and ensures implementation of the Y-12 EMS and spearheads initiatives to proactively address environmental concerns in order to continually improve environmental performance and go "beyond compliance."

4.2.3.4.2 Waste Management

The B&W Y-12 Waste Management Department manages and supports the full life cycle of all waste streams within the Y-12 Complex. While ensuring compliance with federal and state regulations, DOE orders, waste acceptance criteria, and Y-12 procedures and policies, the Waste Management Department provides

- technical support to generators on waste management, pollution prevention, and recycling issues and
- waste certification in accordance with DOE orders and the Nevada Test Site (NTS) Waste Acceptance Criteria for waste to be shipped to NTS for disposition.

4.2.3.4.3 Sustainability and Stewardship

The Sustainability and Stewardship Program has two major missions. The first is to establish and maintain company-wide programs and services to support sustainable waste management operations. These sustainable operations include Pollution Prevention and Recycling Programs, Excess Materials, Waste Sampling, Waste Generator Services, and Y-12 PrYde. The Y-12 PrYde program incorporates an inspection and rating system related to the cleanliness of facilities, materials, and hazardous/unsafe conditions to help personnel maintain work areas in a clean, safe, environmentally sound, and professional manner.

The second mission is the stewardship practices, the programs that manage the legacy issues and assist in the prevention of additional problematic areas being formed. Stewardship Programs include Clean Sweep, Unneeded Materials and Chemicals (UMC).

The synergistic effects of combining these programs under a single umbrella improves overall compliance with Executive Orders, DOE Orders, state and federal regulations, and NNSA expectations and also eliminates duplication of efforts while providing an overall improved appearance of the Y-12 Complex to enhance modernization efforts.

Additionally, the implementation of these programs directly supports EMS objectives and targets to disposition unneeded materials and chemicals, continually improve recycle programs by adding new recycle streams as applicable, improve environmentally preferable purchasing (i.e., promoting the purchase of products made with recycled content and bio-based products, including alternative fuels such as E-85 and biodiesel), meet sustainable design requirements, complete the pollution prevention reporting requirements, and various other related activities.

4.2.3.4.4 Energy Management

Energy management is an ongoing and comprehensive effort containing key strategies to reduce consumption of energy, water, and fuel (electricity, coal, natural gas, and gasoline/diesel). As part of Facility Management and Programs in Facilities, Infrastructure, and Services, Energy Management tracks federally mandated conservation initiatives at Y-12 and informs personnel about sustainability issues, particularly in relation to energy, water, and fuel conservation and efficiency.

Among other duties, the Energy Manager directs the site toward meeting energy management sustainability goals as defined in the Site Sustainability Plan (B&W 2010) issued in December 2010.

4.2.4 Implementation and Operation

4.2.4.1 Roles, Responsibility, and Authority

The safe, secure, efficient, and environmentally responsible operation of Y-12 requires the commitment of all personnel. All personnel share the responsibility for successful day-to-day accomplishment of work and the environmentally responsible operation of Y-12. Environmental and Waste Management technical support personnel assist the line organizations with identifying and carrying out their environmental responsibilities. Additionally, an Environmental Officer Program is in place to facilitate communication of environmental regulatory requirements and to promote the EMS as a tool to drive continual environmental improvement at Y-12. Environmental Officers coordinate their organization’s efforts to maintain environmental regulatory compliance and promote other proactive improvement activities.

4.2.4.2 Communication and Community Involvement

Y-12 is committed to keeping the community informed in areas of operations, environmental concerns, safety, and emergency preparedness. The Community Relations Council, composed of 20 members from a cross section of the community, including environmental advocates, neighborhood residents, Y-12 retirees, and business and government leaders, serves to facilitate communication between Y-12 and the community. The council provides feedback to B&W regarding its operations and ways to enhance community and public communications. A few examples of Y-12's community outreach activities are described in the following paragraphs.

B&W Y-12 sponsored and participated in community events in 2010 including WaterFest at the Ijams Nature Center in Knoxville and Oak Ridge Earth Day (Fig 4.4) to provide highlights of Y-12's environmental management, sustainability and stewardship, pollution prevention activities, and information about the Tennessee Pollution Prevention Partnership (TP3) to more than 2,000 members of the public. B&W also sponsored Oak Ridge Associated Universities Science Bowl, East Tennessee Fuels Coalition Run for Clean Air, and the Foothills Land Conservancy in 2010. In addition B&W Y-12 has promoted the history of Oak Ridge by partnering with The Oak Ridge Secret City Festival (Fig. 4.5) and the American Museum of Science and Energy to provide guided tours of the Y-12 Complex.

As part of Y-12 America Recycles Day (Fig 4.6) activities, staff from the Y-12 Pollution Prevention Program visited four local charities to distribute $200 checks raised by Y-12 employee aluminum beverage can (ABC) recycling efforts. Since the ABC recycling program began in 1994, more than $78,000 has been donated to various charities.

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Fig. 4.4. Y-12 celebrates the 40th anniversary of Earth Day in 2010.

ORNL 2011-G00643/ch_

Fig. 4.5. Visitors board a bus for a tour of Y-12, held in conjunction with the Secret City Festival.

ORNL 2011-G00644/chj

Fig. 4.6. An aluminum beverage can (ABC) recycling reminder as part of America Recycles Day.

B&W Y-12 actively promoted the TP3 program by mentoring and sharing information with interested organizations to encourage pollution prevention and involvement in TP3. In 2010, B&W Y-12 shared information concerning the TP3 program with the city of Farragut, Tennessee America Recycles, Y-12 employees, and members of the local community.

4.2.4.3 Emergency Preparedness and Response

Local, state, and federal emergency response organizations (EROs) are fully involved in the Y-12 emergency drill and exercise program. The annual drill and exercise schedule is coordinated with all organizations to ensure maximum possible participation. At a minimum, the Tennessee Emergency Management Agency (TEMA) Duty Office and the DOE Headquarters (HQ) Watch Office participate in all Y-12 emergency response exercises.

Y-12 conducted two full-participation exercises (FPEs) with the state of Tennessee in FY 2010. The focus of these FPEs were (1) conduct an integrated response to a chemical release at Y-12; (2) conduct integrated field monitoring operations for a chemical release; (3) conduct integrated emergency public information operations; (4) triage, treat, decontaminate and transport injured, chemically injured, and contaminated persons; and (5) allow local hospitals to manage an influx of "worried well" patients claiming contamination from the event. Three additional full-scale exercises were conducted involving a criticality event and security events.

Y-12's expertise in emergency management continues to be recognized within the Department of Energy. Y-12 Emergency Management Program Office (EMPO) staff performed an evaluation of the Nevada National Security Site in January 2010, Los Alamos National Laboratory in August 2010, and Lawrence Livermore National Laboratory in September 2010. EMPO staff also participated in the DOE Emergency Management Issues Special Interest Group Conference held in Las Vegas, Nevada. Y-12 made presentations, participated in steering committee meetings, and distributed Y-12 Emergency Management Program information to other DOE facility emergency management professionals.

4.2.5 Checking

4.2.5.1 Monitoring and Measurement

Y-12 maintains procedures to monitor and measure key characteristics of its operations and activities that can have a significant environmental impact and to monitor overall environmental performance. Environmental effluent and surveillance monitoring programs are well established, and the results of the

2010 program activities are reported elsewhere in this document. Progress achieving environmental goals is reported as a monthly metric on the senior management web portal, Performance Track, that consolidates and maintains Y-12 site-level performance measures. Progress is reviewed in periodic meetings with senior management and NNSA-YSO.

4.2.5.2 EMS Assessments

To periodically verify that the EMS is operating as intended, assessments are conducted as part of Y-12's assessment program. The assessments are designed to ensure that nonconformities with the ISO 14001 standard are identified and addressed. Y-12's EMS assessment program consists of a three-prong approach that includes focused EMS assessments, routine surveillances, inspections and data reviews, and environmental multi-media assessments integrated with regularly scheduled facility evaluations lead by the Independent Assessment Organization.

Four EMS assessments and four facility evaluations employing an environmental multi-media approach were conducted in 2010. As a result of the EMS assessments a new internal web tool, EC ConDocs, is being developed which provides improved access and management of controlled documents owned by the Environmental Compliance Department, including procedures and technical reports. The facility evaluations confirmed the EMS is being adequately implemented across the site.

4.2.6 EMS Performance

The EMS objectives and targets and other plans, initiatives, and successes that work together to accomplish DOE goals and reduce environmental impacts are discussed in this section. Y-12 reported performance via DOE's Pollution Prevention Tracking and Reporting System (PPTRS) and to Energy Management to support development of Y-12's initial Site Sustainability Plan required by Executive Order 13514, Federal Leadership in Environmental, Energy and Economic Performance.

4.2.6.1 EMS Objectives and Targets

B&W Y-12 achieved nine of nine targets scheduled for completion by end of FY 2010. Overall 51 actions were completed versus 50 planned for completion through September. Five additional targets scheduled for completion by end of FY 2011 are on schedule. Highlights included the following with additional detail and success presented in other sections of this report.

- Clean Air—A project to replace the coal-fired boiler steam plant with an new plant fired by natural gas was completed. (see Sect. 4.1.2.3). In addition, completed and revised Greenhouse Gas (GHG) FY 2008 Base Year presentation and GHG inventory calculation (see Sect. 4.2.6.7).
- Energy Efficiency— A Phase 1 of Energy Savings Performance Contract (ESPC) projects was implemented. Planned for FY 2013 completion, these projects will reduce energy intensity by 4% and potable water use by 5%. To promote energy awareness, a new web-based energy awareness training video was completed for delivery in FY 2011 to Y-12 site employees. Additional accomplishments are presented in Sect. 4.2.6.3.
- Hazardous Materials— ARRA funding is being used to expedite removal of legacy wastes and building demolition at the Y-12 National Security Complex (see Sect. 4.8).
- Land/Water Conservation—A Y-12 water assessment was completed to develop a comprehensive understanding of the current water-consuming applications and equipment at Y-12 and to identify key areas for water efficiency improvements. Additional water conservation successes are presented in Sect. 4.2.6.4.
- Reduce/Reuse/Recycle/Buy Green—the Y-12 Pollution Prevention Program spearheads the evaluation of bio-based products for usage at Y-12 and efficiency and data quality improvements for reporting sustainable acquisition goals. Section 4.2.6.2 presents additional successes that support this EMS target area.

4.2.6.2 Sustainability and Stewardship

Numerous efforts at Y-12 have reduced its impact on the environment. Efforts include increased use of environmentally friendly products and processes and reductions in waste and emissions. During the past few years, these efforts have been recognized by our customers, our community, and other stakeholders (see Sect. 4.2.7). Not only have the pollution prevention efforts at Y-12 benefited the environment, they have also resulted in avoided costs (Fig. 4.7).

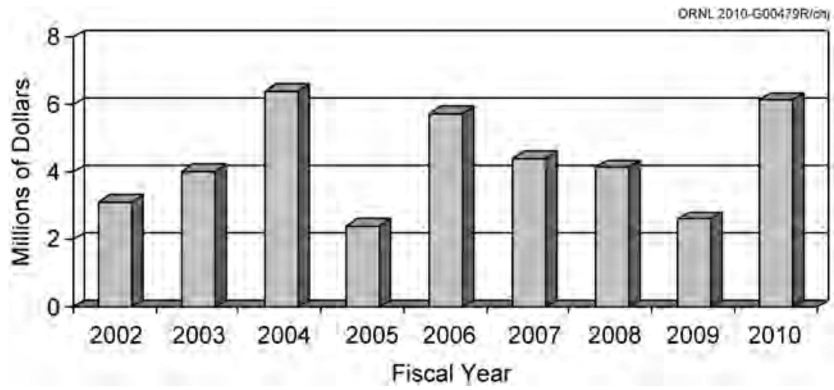

Fig. 4.7. Cost avoidance from Y-12 pollution prevention activities.

In FY 2010, Y-12 implemented 110 pollution prevention initiatives (Fig. 4.8), with a reduction of more than 50.68 million kilograms (111 million pounds) of waste and a cost savings/avoidance of more than $6.1 million. The completed projects include the activities presented below.

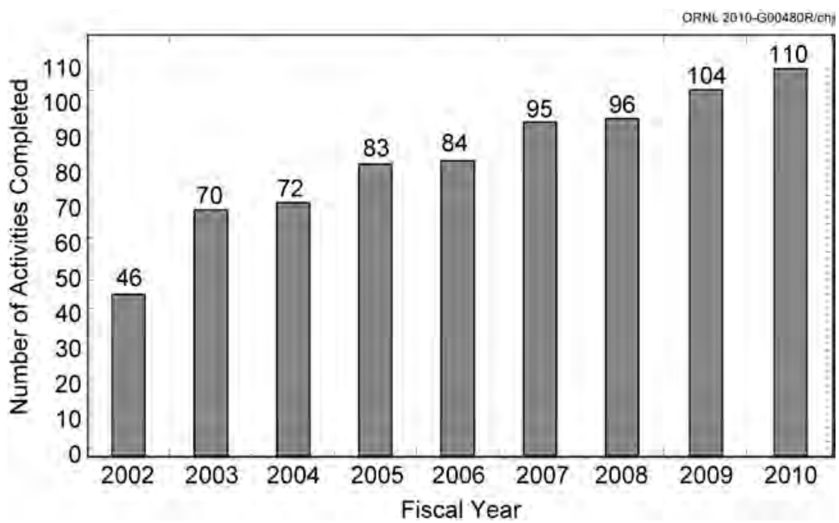

Fig. 4.8. Y-12 pollution prevention initiatives.

Initiatives with Pollution Prevention Benefits and Source Reduction. Sustainable initiatives have been embraced across the Y-12 Complex to reduce the impact of pollution on the environment and to increase operational efficiency. Many of Y-12's sustainable initiatives have pollution prevention benefits or targets eliminating the source of pollution, including the 2010 activities highlighted in this section.

Product Exchange. Product Exchange provides a mechanism for employees to post unneeded surplus consumable items available for reuse by other groups. Y-12 enhanced the Product Exchange system in 2010 to include additional consumable items such as office products. Product Exchange now includes the following categories of consumable materials and chemicals: Office, Lab, and Maintenance. Product Exchange exemplifies Y-12's sustainability practices and provides an efficient and environmentally friendly way to make recycling and reusing unneeded or surplus materials and chemicals easy and accessible.

Sustainable Acquisition/Environmentally Preferable Purchasing. Sustainable products, including recycled-content materials, are procured for use across the Y-12 Complex. In 2010, B&W Y-12 procured recycled-content materials valued at more than $3.53 million for use at the site.

Unneeded Materials and Chemicals. The Unneeded Materials and Chemicals (UMC) initiative was implemented to assist in the potential utilization and ultimate disposition of resources that were not being used. The overall goal of the UMC initiative is reuse of existing resources while providing a cleaner/safer facility and improved compliance. The UMC disposition process (Fig 4.9) does not simply manage all UMC as waste but first tries to find another outlet using a systematic process. The steps of this process are to first try to identify another use (1) within Y-12, (2) within DOE, (3) within the government, (4) through sale to the public, (5) through recycle, and finally (6) through disposal as waste. Since 2006, the UMC program at Y-12 has dispositioned more than 8,100 items.

Y-12 Analytical Chemistry. For over 30 years, the Analytical Chemistry Organization (ACO) has used the inductively coupled plasma (ICP) method for beryllium analysis. While the ICP method produced sound results, other issues began to emerge such as the generation of Resource Conservation Recovery Act (RCRA) regulated hazardous waste acidic rinsates, high equipment costs, and repetitive motion problems. A new method was needed in order to address the above issues and to process the increased number of beryllium samples that would be generated by Y-12's American Recovery and Reinvestment Act (ARRA) project activities. Through collaboration with other DOE facilities and technology transfer companies, Y-12 has implemented a new method, automated fluorescence, to analyze beryllium that prevents the generation of hazardous waste and improves workplace safety both in the laboratory and in the field.

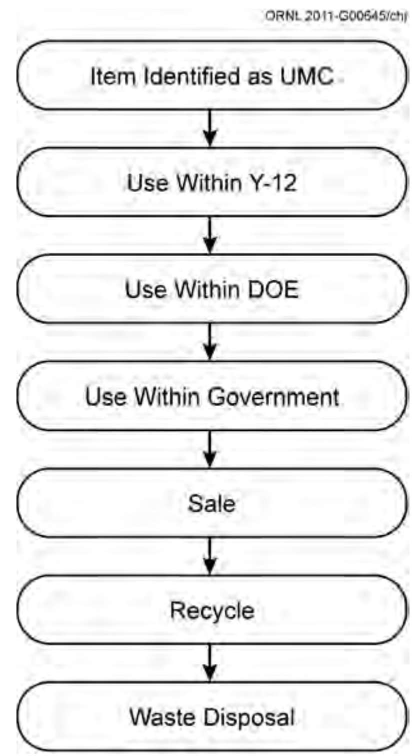

Fig. 4.9. Unneeded Materials and Chemicals Disposition Process at Y-12.

Recycling Initiatives. B&W Y-12 has a well-established recycling program and continues to identify new material streams and to expand the types of materials that can be recycled by finding new markets and outlets for the materials. As shown in Fig. 4.10, over 1.36 million kilograms (2.99 million pounds) of materials was diverted from landfills and into viable recycle processes. Currently, recycled materials range from office-related materials to operations-related materials such as scrap metal, tires, and batteries. The recycling program was expanded in 2010 to include light-emitting diode (LED) lamps and empty sodium hydroxide bottles. Many recycling activities have been implemented, including the 2010 activities highlighted in this section.

ARRA Activities. ARRA funds are being used to prepare large contaminated excess facilities for demolition, demolish five excess buildings, and clean up sources of environmental contamination. Y-12's ARRA projects have focused on completing activities in a sustainable, timely, and safe manner. Y-12's ARRA projects have recycled or reused over 1 million pounds of materials. Y-12 has completed all ARRA project milestones on or ahead of schedule while achieving a milestone of 1 million safe work hours without a lost time injury. Project teams have focused on exploring and implementing waste minimization practices for legacy materials. This focus has resulted in the transfer of excess materials from Y-12 to other organizations for reuse. Personnel have taken steps to preserve historical items discovered as a part of the cleanup efforts.

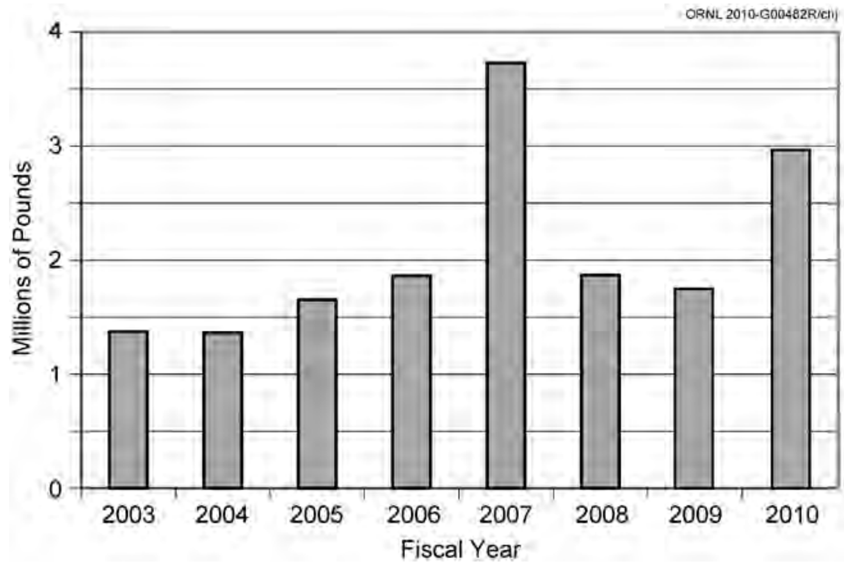

Fig. 4.10. Y-12 recycling results.

Waste Management Plan Reviews. The underlying principle behind this initiative is to review all of the Waste Management Plans prior to implementation, which supports the goals to increase the longevity of landfill space, save energy and natural resources, reduce costs to Y-12, and to comply with Federal regulations. The team ensures that all wastes that are planned to be generated have been reviewed to ensure that source reduction techniques have been incorporated and that all recyclable materials have been identified. Finally, review of the plans provides an opportunity to suggest pollution prevention considerations including any optimizations/source reduction techniques, and recycling/reuse opportunities.

Greenhouse Gas Reductions. An initiative was started to develop a more effective logistics process for managing shipments to the Nevada Nuclear Security Site (NNSS). The goals were to better utilize trailer capacity and reduce the corresponding transportation cost per project without jeopardizing project or shipping time lines. The newly developed combination loading process has led to a 50% reduction in the number of shipments to NNSS. In addition, personnel coordinated the removal of the Poe-style sanitary dumpsters and replaced them with standard compactor-style dumpsters. Each Poe-style dumpster had to be transported to the landfill to be emptied and then returned to its normal location, while compactor dumpsters can be emptied into the compactor truck prior to transporting the combined loads to the landfill in a single trip.

The completion of these activities has reduced manpower requirements and resulted in a reduction of greenhouse gas emissions related to transportation of materials. These activities resulted in a combined cost avoidance of more than $281,000 in transportation costs related to eliminating more than 113,000 vehicle miles traveled.

4.2.6.3 Energy Management

In 2010 the Department of Energy sites' "executable plans," previously developed annually to update and report energy use, were renamed "site sustainability plans" and expanded to cover the requirements of Executive Orders 13423 and 13514 and DOE's Strategic Sustainability Performance Plan (SSPP), Discovering Sustainable Solutions to Power and Secure America's Future (DOE 2010).

Y/IA-437, Y-12 Site Sustainability Plan (SSP) (B&W Y-12 2010), published in December 2010, serves as a deliverable to fulfill the planning and reporting requirements of these requirements. The DOE sustainability goals and Y-12 status and plans for these goals are summarized in Table 4.1.

Table 4.1. Y-12 Site Sustainability Plan Goal Performance and Review for 2010

DOE Goal	Y-12 Performance Status	Planned Actions and Key Issues
28% Scope 1 & 2 GHG reduction by FY 2020 from a FY 2008 baseline	Currently on track to meet this goal with 9.4% estimated reduction in Scope 1 & 2 GHG	Y-12 and Federal Energy Management Program (FEMP) Scope 1 & 2 GHG baseline calculations are not consistent and will be further evaluated for future reporting
30% energy intensity reduction by FY 2015 from a FY 2003 baseline	Y-12 has achieved a 16.8% reduction in energy intensity from the 2003 baseline. ESPC implementation is projected to provide an additional 11.6% reduction.	Energy- and water-efficiency projects will continue to be implemented as funding allows.
7.5% of a site's annual electricity consumption from renewable sources by FY 2010 (2× credit if the energy is produced on-site)	Y-12 purchased Green-e–certified Renewable Energy Certificates (RECs) in the amount of 21,000 MWh per year. This meets the goal for FY 2010–FY 2012.	The purchase and installation of renewable energy sources were evaluated in a FEMP study and deemed economically infeasible for Y-12. On the basis of the study, a waiver will probably be submitted to NNSA.
Every site to have at least one on-site renewable energy generating system by FY 2010	The Y-12 site has implemented various small-scale photovoltaic systems to power lights, battery-charging stations, and remote analytical equipment.	Renewable electricity systems will be continually reevaluated according to application and cost benefit.
10% annual increase in fleet alternative fuel consumption by FY 2015 relative to a FY 2005 baseline	Y-12 has exceeded the alternative fuel goal with a 837% increase in alternative fuel vehicle (AFV) consumption versus the FY 2005 baseline.	Additional measures will be evaluated for continued improvement beyond the initial goals
2% annual reduction in fleet petroleum consumption by FY 2015 relative to a FY 2005 baseline	Y-12 has achieved the petroleum reduction goal with a 42% reduction versus the FY 2005 baseline	Additional measures will be evaluated for continued improvement beyond the initial goals.
75% of light-duty vehicle purchases must consist of AFVs by FY 2015	Y-12 has met this goal in 2010, attaining 100% of AFV vehicles of the 17 purchased.	Plans are for 100% of future light-duty vehicle purchases to be AFVs.
To the maximum extent practicable: advanced metering for electricity by October 2012; steam and natural gas by October 2016; standard meters for water	Based on current funding levels, it will be difficult for Y-12 to meet the 2012 goal.	Metering has been prioritized and is being upgraded as building improvements are made with High-Performance Sustainable Building (HPSB) priorities as funding allows.
Cool roofs for roof replacements unless project already has Critical Decision 2 (CD-2) approval. New roofs must have thermal resistance of at least R-30.	Y-12 is meeting this goal. Investments in roofing have resulted in more than 20 acres of new roofing since FY 2002. Full implementation of cool roof technology in new roofing applications was achieved in 2008.	Future roofing projects will continue to use cool roofs where practical, with 10,055 ft^2 planned installation in FY 2011.

Table 4.1. (continued)

DOE Goal	Y-12 Performance Status	Planned Actions and Key Issues
Training and outreach: DOE facility energy managers to be Certified Energy Managers by September 2012	Y-12 is meeting this requirement.	The Y-12 energy manager will attain Certified Energy Manager status in FY 2011. Energy Awareness training has been added as a baseline training requirement for all employees.
Sulfur hexafluoride (SF_6) capture program by September 2012	The SF_6 gas is contained and is only used in specific applications. The neutron generator will be evaluated to see if additional capture and recovery devices could be installed.	Future applications will not use SF_6 coolant.
13% Scope 3 GHG reduction by FY 2020 from a FY 2008 baseline	Y-12 is not currently meeting this goal. Y-12's Scope 3 GHG emissions have increased by 6.0% from the FY 2008 baseline, primarily due to increased workforce resulting from ARRA initiatives	The increase in Scope 3 emissions is proportional to the increase in plant population due to additional mission activities including ARRA projects. The site will investigate additional opportunities for reducing commuter emissions and business travel.
All new construction and major renovations greater than $5 million to be LEED® Gold certified (Leadership in Energy and Environmental Design). Meet HPSB guiding principles if less than or equal to $5 million.	Existing plans for any new construction or leased facilities are being developed with the LEED certification criteria.	The Uranium Processing Facility (UPF) project has a LEED professional on the design team and is evaluating the impact of LEED certification.
15% of existing buildings larger than 5,000 gross square feet to be compliant with the five guiding principles of HPSB by FY 2015.	Y-12 is at risk for meeting this goal. One building is LEED certified, and HPSB assessments have determined the appropriate cadre of buildings to prioritize. The site will make incremental progress within existing funding until additional funding is identified. Two buildings will bring Y-12 into compliance if tracking based on square footage; 13 buildings are required if tracking is based on building count.	The EPA Portfolio Manager will be used to track progress toward the guiding principles. Future funding availability will have a significant influence on progress made in this area.
16% water intensity reduction by FY 2015 from a FY 2007 baseline, 26% by FY 2020	Y-12 has met this goal with a 29.3% potable water intensity reduction from the confirmed FY 2007 baseline. ESPC implementation will further assist with water conservation at Y-12.	Water conservation measures (WCMs) will continue to be incorporated on a building-by-building basis.

Table 4.1. (continued)

DOE Goal	Y-12 Performance Status	Planned Actions and Key Issues
20% water consumption reduction of industrial, landscaping, and agricultural (ILA) water by FY 2020 from a FY 2010 baseline	Y-12 does not consume ILA water; water is purchased to supplement creek flow as required by the State of Tennessee National Pollutant Discharge Elimination System (NPDES) permit. A recent negotiation with Tennessee Department of Environmental Conservation (TDEC) reduced the supplement from 7 million gal/d to 5 million gal/d, a reduction of 29%, once implemented.	The City of Oak Ridge has been requested to install a constant pressure-regulated source to control the augmentation flow to maintain the 2M gal/d reduction
Divert at least 50% of nonhazardous solid waste from landfill by FY 2015, excluding construction and demolition materials and debris	Y-12 has had an industrial recycling/diversion rate of more than 70% since 2006.	At least one new recycle material stream is added to the recycling program each fiscal year to further increase the diversion rate.
Divert at least 50% of construction and demolition materials and debris from landfill by FY 2015	Y-12 has had an industrial recycling/diversion rate of more than 70% since 2006.	At least one new recycle material stream is added to the recycling program each fiscal year to further increase the diversion rate.

Energy Performance. Comprising 57% of the Y-12 greenhouse gas (GHG) emissions, purchased electricity is by far the major contributor to energy intensity. During FY 2010, reductions in energy intensity (Fig. 4.11) were a result of the conversion from coal to natural gas steam generation, an increase of energy efficient square footage at the Y-12 site, and energy-efficient measures in select facilities. A new gas-fired (fuel oil backup) steam plant was constructed and placed into service. This change in operation completely eliminated the consumption of coal and the associated environmental aspects of the process. Heating, ventilation, and air-conditioning (HVAC) setbacks were put in place in two leased facilities. Additionally, HVAC equipment and monitoring controls in several buildings were repaired and reconnected, providing more efficient functionality. Several production facilities are undergoing lighting upgrades to replace outdated incandescent and fluorescent fixtures with new energy efficient lighting.

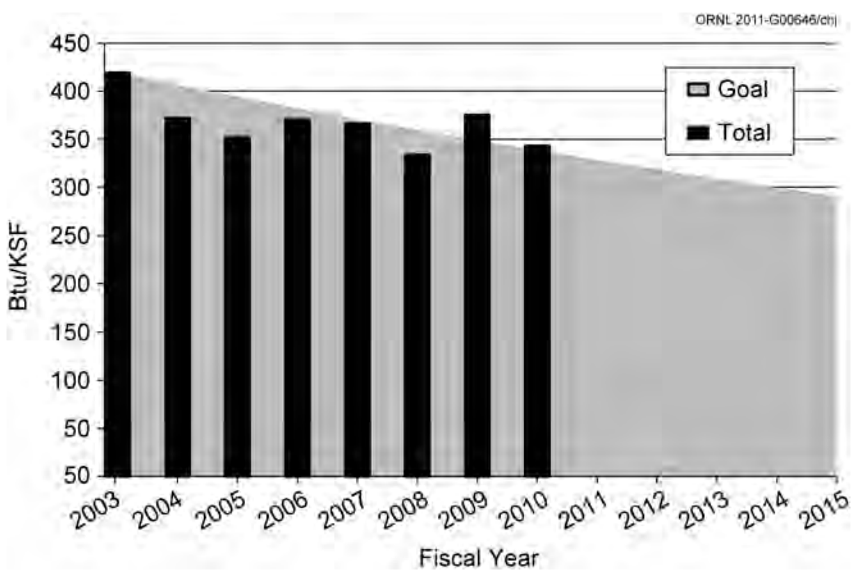

Fig. 4.11. Y-12 Energy Intensity vs Goal: FY2007 vs FY 2010.

4.2.6.4 Water Conservation

Based upon the FY 2007 baseline, in FY 2010 Y-12 reduced annual potable water consumption by 298,944,000 gal, or 21.8%. This equates to a potable water intensity reduction of 29.3%, almost double the water intensity reduction goal of 16% (Fig. 4.12). This also exceeds the FY 2026 goal of 26% reduction. Continued reductions in water usage are attributable to the upgrades in water-consuming systems, such as the steam plant, demineralization plant, cooling tower, and process water.

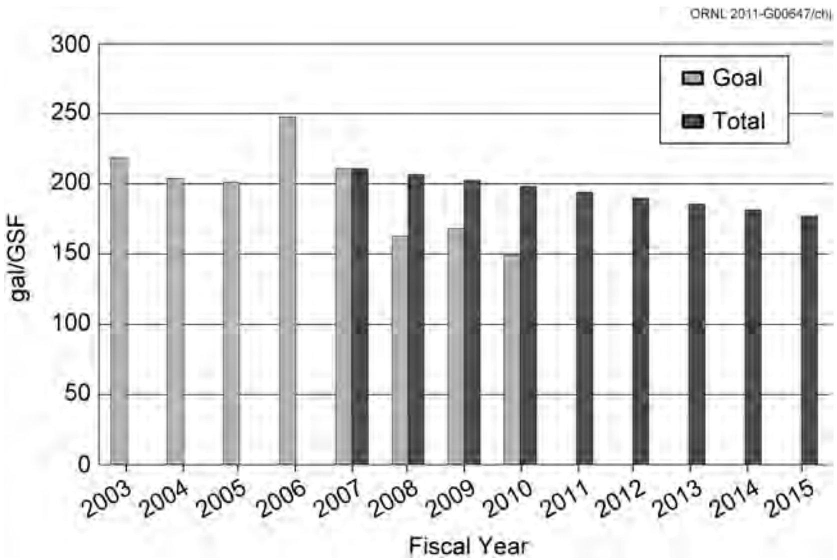

Fig. 4.12. Y-12 Site Water Intensity vs Goal: FY2007 vs FY 2010.

The DOE Federal Energy Management Program (FEMP) Water Program, led by Pacific Northwest National Laboratory and Water Savers, Inc., a water efficiency company, conducted a site-wide water assessment at Y-12 during April through August 2010. The water assessment resulted in recommended water conservation measures (WCMs) that could save 228,154 kgal annually (16.5%) and reduce energy by 40,307 million BTUs. If all WCMs are implemented, the annual cost savings is $714,201. The water-assessment team identified 18 unique water and energy conservation measures designed to improve the water efficiency of Y-12. Many of the domestic upgrades are identified for future implementation on a building-by-building basis as funding allows. Similarly, many of the cooling tower upgrades are prioritized and will be evaluated accordingly for implementation as funding permits.

4.2.6.5 Fleet Management

The Y-12 site has already surpassed the petroleum reduction goal with respect to the 2005 baseline. The site achieved a 53 % reduction within 5 years, which surpasses the requirement for the reduction of 2% per year. These four initiatives have helped spur that significant reduction.

- Vehicle pools were established at facilities with large concentrations of workers.
- Car pooling is encouraged in areas where it is feasible.
- Shuttle buses are provided throughout areas of the plant site.
- Vehicles not meeting site-use goals have been removed or reassigned on the basis of site needs.

Furthermore, the site has been very successful in achieving the goals for alternative fuel usage, as summarized in Table 4.2. A 837% increase in alternative fuels has been achieved from the 2005 baseline (surpassing the goal of 100%), with 20% of the current Y-12 fleet being alternative fuel vehicles. Of Y-12’s 538 vehicles (includes government owned, GSA leased, and commercially leased), 108 are now flexible fuel vehicles and 77 were converted to ultra-low sulfur diesel fuel. All flexible fuel–capable vehicles have been operated on E85 ethanol alternative fuel since 2008.

Table 4.2. Summary of petroleum and alternative fuel usage over a 5-year period

	2005 Baseline	2010 Data	% Increase/ decrease	EO 13423 goal	Actual
Petroleum (Non-fleet)	54,426 L (14,378 gal)	24,181 L (6,388 gal)	55.6% decrease	2% per year decrease	14% per year decrease
Petroleum (Fleet)	606,141 L (160,126 gal)	348,802 L (75,262 gal)	53% decrease	2% per year decrease	10% per year decrease
E-85 fuel + biodiesel	18,174 L (4,801 gal)	53,132 L (62,483 gal)	837% increase	10% per year increase	167.4% per year increase

In order to track the continued success of the fuel-saving measures, the fleet manager monitors gasoline, E-85 ethanol, and B20 biodiesel fuel consumption by both Y-12 and General Services Administration vehicles and maintains monthly reporting metrics. Future fleet management energy savings will be achieved by continued strict monitoring of vehicle use. Increasing the use of alternative fuels and replacing gasoline-fueled vehicles with E-85-fueled vehicles will occur as funding permits. Goals in support of alternative fuel use have been achieved such as procuring a hybrid bus and pickup truck for the Y-12 fleet in addition to the E-85 replacements (Fig 4.13).

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Fig. 4.13. Y-12 fleet receives newer, greener vehicles.

4.2.6.6 Electronic Stewardship

The Y-12 Complex committed to the Federal Electronics Challenge (FEC) pledge in 2008 to improve the management of electronic assets during all life-cycle phases: acquisition and procurement, operation and maintenance, and end-of-life management. In 2010, as an FEC Partner, B&W Y-12 completed all FEC annual reporting to account for efficient operation and maintenance of electronics and implementation of other practices to maximize Y-12 energy efficiency, reduce electronic-related wastes, and improve end-of-life management. B&W Y-12 received a 2010 FEC Silver Level Award in April 2010 (see Sect. 4.2.7).

4.2.6.7 Greenhouse Gas (GHG)

Y-12 developed a preliminary GHG inventory in August 2009. The inventory was developed for FY 2008, with an initial FY 2003 baseline year. Based on the requirements of Executive Order 13514, Y-12's baseline year was changed to FY 2008.

Table 4.3 provides Scope 1 and 2 GHG emissions for FY 2008 and FY 2010. Y-12 is currently not meeting the Scope 3 GHG emissions goal against the 2008 baseline. Y-12's Scope 3 GHG emissions have increased by 6.1% since FY 2008. This increase is proportional to the increase in site population due to additional mission activities including ARRA projects. Scope 3 emissions are reduced through employee workweek schedules, carpool programs, enhanced off-site computing, and waste management improvements. Implementation of those existing initiatives occurred before the 2008 baseline.

Table 4.3. Y-12 comprehensive GHG emissions comparison

Comparison of Y-12 greenhouse gas emissions (mt CO_2)	Data source[a]	FY 2008 baseline	FY2010 PPTRS and EMS-4/FAST estimates
Scope 2			
Electricity	EMS-4	185,089	186,492
Scope 1			
Fuel Consumption – Coal[b]	EMS-4	115,090	53,388
Fuel Consumption – Natural Gas[b]	EMS-4	7,952	51,697
Non-Fleet Fuel Consumption – Gasoline	EMS-4	265	no data
Non-Fleet Fuel Consumption – DSL	EMS-4	103	no data
Fleet Vehicle Consumption – B20	B&W FAST	181	0
Fleet Vehicle Consumption – DSL	B&W FAST	73	296
Fleet Vehicle Consumption – E85	B&W FAST	40	60
Fleet Vehicle Consumption – Gas	B&W FAST	1,384	667
Industrial Fugitive Emissions	PPTRS	16,233	3,096.2
On-Site Landfill	PPTRS	ETTP[c]	ETTP
On-Site Wastewater	PPTRS	6.9	7.3
Total Scope 1 & 2		**326,417**	**295,704**
Scope 3			
T&D Losses	FEMP	12,194	12,286
Off-site Municipal Wastewater Treatment	FEMP	266	280
Employee Commute	PPTRS	17,447	18,747
Air Travel	PPTRS	1,920	2,377
Rental Car (Ground Travel)	PPTRS	331	411
Total Scope 3		**32,158**	**34,101**
TOTAL GHG Emissions		**358,575**	**329,805**

[a]EMS-4 – Energy Management System 4
B&W FAST – Y-12 fleet reported data via Federal Automotive Statistical Tool
PPTRS – Pollution Prevention Tracking and Reporting System
FEMP – Federal Energy Management Program
[b]Emissions were estimated using AP42 engineering emission factors for the specific steam boiler equipment in use at the Y-12 Complex. FEMP estimates are based on emission factors designated for bituminous coal and natural gas as defined in the EPA Mandatory GHG reporting rules, which are based on national average combustion efficiency rather than the specific combustion equipment in use at the Y-12 site.
[c]ETTP – Reported as part of ETTP site report.

Y-12 is on track to meet the comprehensive GHG inventory through the successful implementation of numerous energy initiatives outlined in this document and in Y-12's Environmental Management System. Y-12 is on track to meet the reduction goal for Scope 1 and 2 GHG emissions through the successful implementation of numerous energy initiatives outlined in this document and in Y-12's Environmental Management System. Fleet baselines reported via Federal Automotive Statistical Tool (FAST) include existing data for all on-site subcontractors. Portions of the FY 2010 data are not available for all contractors; therefore, the value generated by FEMP will be greater than reflected below.

Results indicate that the majority (57%) of Y-12's FY 2010 GHG emissions were from indirect (Scope 2) emission from purchased electricity. The largest direct (Scope 1) emission during the baseline year was from combustion of coal to produce steam (32.1%). This contribution was significantly reduced by 50% due to the start-up of the natural gas–fired steam plant during FY 2010. As previously mentioned, this project also diminishes the estimated GHG emissions from industrial fugitive emissions by a factor of 10 to account for approximately 0.5% of the site-wide Scope 1 and 2 GHG emissions in FY 2010. In light of current estimates, overall Y-12 has achieved a 9% reduction in Scope 1 and 2 emissions compared with the FY 2008 baseline. Data for all GHG emissions will be refined during the FY 2011 time frame.

4.2.7 Awards and Recognition

The Y-12 commitment to environmentally responsible operations has been recognized by more than 65 external environmental awards since November 2000 from local, state, and national agencies. The awards received in 2010 are summarized below.

DOE E-Star Award. “Y-12's Sustainability and Stewardship Program Transforms Y-12 into a Greener and Leaner Complex” was selected to receive an E-Star Award from DOE Headquarters (Fig. 4.14). The E-Star Award recognizes innovation and/or excellence in pollution prevention and environmental sustainability stewardship efforts within the Department of Energy and is selected by an independent panel. This award was selected from approximately 127 nominations by pollution prevention representatives from the U.S. Department of Health and Human Services, U.S. Department of Homeland Security, and U.S. Army Corps of Engineers.

ORNL 2011-G00649/chj

Fig 4.14. “Y-12's Sustainability and Stewardship Program Transforms Y-12 into a Greener and Leaner Complex” was selected to receive an E-Star Award from DOE Headquarters.

Tennessee Chamber of Commerce and Industry (TCC&I). B&W Y-12 was recognized in three areas at the 28th Annual Tennessee Chamber of Commerce and Industry Environmental Conference in awards ceremonies on October 2010. Award winners were selected by a panel of state officials who reviewed the nomination, accomplishments, and compliance records of the respective environmental programs. B&W Y-12 received the following two awards:

- Environmental Excellence Award for “Y-12's Sustainability and Stewardship Program Transforms Y-12 into a Greener and Leaner Complex”
- Air Quality Award for “Y-12's New Steam Plant”

Additionally, B&W Y-12 received achievement certificates for the following activities:

- Solid Waste Management Certificate for "Y-12 Unneeded Materials and Chemicals Initiative"
- Solid Waste Management Certificate for "Y-12 Initiatives Make DOE-wide Electronics Recycling Securely Sustainable"

NNSA Awards. In 2010 the Y-12 Complex received one NNSA Pollution Prevention Best in Class Award and two NNSA Environmental Stewardship Awards. This is the seventh consecutive year that the Y-12 Complex has been recognized by NNSA for award-winning activities. These awards recognize innovation and/or excellence in pollution prevention and environmental sustainability stewardship efforts within the NNSA and DOE and are selected by an independent panel.

Tennessee Pollution Prevention Partnership. In 2010**,** Y-12 was awarded Performer Level status in the TP3 Program for another year. In order to maintain Performer Level status in the TP3 Program, Y-12 must illustrate ongoing commitment to pollution prevention through the completion of a success story and mentoring and outreach activities. Y-12's activities are reviewed annually by the members of the Tennessee Department of Environment and Conservation (TDEC) TP3 Program Review Panel.

Federal Electronics Challenge (FEC). B&W Y-12 received a 2010 FEC Silver Level Award in April 2010 which recognizes the achievements of FEC partners and their leadership in federal electronics stewardship. Y-12 was one of 14 Silver Level Award winners (Fig. 4.15). This FEC Silver Award was specifically received for Y-12's accomplishments in operations and maintenance and end-of-life management activities of electronics.

ORNL 2011-G00650/chj

Fig. 4.15. Y-12 was presented a 2010 Federal Electronics Challenge Silver Award.

4.3 Compliance Status

4.3.1 Environmental Permits

Table 4.4 notes environmental permits in force at Y-12 during 2010. More detailed information can be found within the following sections.

4.3.2 NEPA/NHPA Assessments

NNSA adheres to the National Environmental Policy Act (NEPA) regulations, which require federal agencies to evaluate the effects of proposed major federal activities on the environment. The prescribed evaluation process ensures that the proper level of environmental review is performed before an irreversible commitment of resources is made.

During 2010, environmental evaluations were completed for 34 proposed actions, all of which were determined to be covered by a categorical exclusion (CX).

4.3.2.1 Site-Wide Environmental Impact Statement (SWEIS) for Y-12 Complex

The NEPA implementing procedures, 10 CFR 1021 (DOE 1996), require a 5-year evaluation of the current Y-12 Complex site-wide environmental impact statement (SWEIS). A new SWEIS is being prepared to evaluate the new modernization proposals and to update the analyses presented in the original Y-12 SWEIS (issued in November 2001). The notice of intent was published in the *Federal Register* on November 28, 2006, and a public scoping meeting was held December 15, 2006, in Oak Ridge.

The draft SWEIS was issued in October 2009 (NNSA 2009), and a notice of availability was published in the *Federal Register* on October 30, 2009. Two public hearings for the draft SWEIS were held on November 17 and 18, 2009. These hearings allowed members of the public to provide comments on the draft SWEIS. The meetings were attended by approximately 350 members of the public. The public comment period for the draft SWEIS ended on January 29, 2010. The final SWEIS was issued February 2011, and the Notice of Availability was published March 4, 2011.

4.3.2.2 Preserving Y-12's History for Future Generations

In accordance with the National Historic Preservation Act (NHPA), NNSA is committed to identifying, preserving, enhancing, and protecting its cultural resources. The compliance activities in 2010 included completing an NHPA Section 106 review on 34 proposed projects, and participating in various outreach projects with local organizations and schools.

Thirty-four proposed projects were evaluated to determine whether any historic properties eligible for inclusion in the *National Register of Historic Places* would be adversely impacted. Of the 34 proposed projects, it was determined that there were no adverse effects on historic properties eligible for listing in the *National Register* and that no further Section 106 documentation was required.

The Y-12 Oral History Program continues with ongoing efforts to conduct oral interviews of current and former employees to document the knowledge and experience of those who worked at the Y-12 Complex during World War II and the Cold War era. The interviews provided information on day-to-day operations of the Y-12 Complex, the use and operation of significant components and machinery, and how technological innovations occurred over time. Some of the information collected from the interviews may be used in various media to include DVDs shown in the Y-12 History Center.

Table 4.4. Y-12 Complex environmental permits

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	New Steam Plant Package Boilers (Construction)	960947	9/06/2007	2/01/2009[a]	DOE	DOE	B&W Y-12
CAA	Chip Oxidizer Operating Permit	554594	10/21/2004	10/21/2009[b]	DOE	DOE	B&W Y-12
CAA	Operating Permit (Title V)	554701	10/21/2004	10/21/2009[b]	DOE	DOE	B&W Y-12
CAA	Steam Plant (existing) Clean Air Interstate Rule NO_x Permit	861316	6/9/2008	Upon renewal of Title V permit (554701)	DOE	DOE	B&W Y-12
CAA	Disassembly and Storage Operation (Construction)	963891P	9/29/2010	10/01/2011	DOE	DOE	B&W Y-12
CWA	Industrial & Commercial User Wastewater Discharge (Sanitary Sewer Permit)	No. 1-91	4/1/2010	3/31/2015	DOE	DOE	B&W Y-12
CWA	National Pollutant Discharge Elimination System Permit	TN0002968	3/13/2006	12/31/2008 Application for reissuance submitted 7/1/2008	DOE	DOE	B&W Y-12
CWA	Construction General Permit for Bear Creek Road Bypass	TNR 133700	5/26/2010	On Notice of Termination of May 30, 2010 (covered until new general permit issued)	Stein Construction	Stein Construction	B&W Y-12
CWA	401 Water Quality Certification / ARAP Access / Haul Road	NRS10.083	6/10/2010	6/09/2015	B&W Y-12	B&W Y-12	B&W Y-12
CWA	Department of Army Permit	2010-00366	9/02/2010	9/02/2015	DOE, B&W Y-12	B&W Y-12	B&W Y-12
CWA	General Stormwater Permit Potable Water System Upgrade (area F&P)	TNR 132628	6/29/2007	5/30/2010 (project completed 2010)	B&W Y-12	B&W Y-12	B&W Y-12

Table 4.4. (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CWA	General Stormwater Permit Potable Water System Upgrade (area O)	TNR 132975	6/29/2007	5/30/2010 (project completed 2010)	DOE	Washington Group	Washington Group
CWA	General Stormwater Permit Steam Plant Replacement Project	TNR 133198	7/2/2008	5/30/2010 (project completed 2010)	DOE	G&S Construction	G&S Construction
RCRA	Hazardous Waste Transporter Permit	TN3890090001	1/19/2011	1/31/2012	DOE	DOE	B&W Y-12
RCRA	Hazardous Waste Corrective Action Permit	TNHW-121	9/28/2004	9/28/2014	DOE	DOE, NNSA, and all ORR co-operators of hazardous waste permits	BJC
RCRA	Container Storage Units	TNHW-122	8/31/2005	8/31/2015	DOE	DOE/B&W Y-12	B&W Y-12/ Navarro-GEM JV, co-operator
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-127	10/06/2005	10/06/2015	DOE	DOE/B&W Y-12	B&W Y-12 co-operator
RCRA	RCRA Post-Closure Permit for the Chestnut Ridge Hydrogeologic Regime	TNHW-128	9/29/2006	9/29/2016	DOE	DOE/BJC	BJC
RCRA	RCRA Post-Closure Permit for the Bear Creek Hydrogeologic Regime	TNHW-116	12/10/2003	12/10/2013	DOE	DOE/BJC	BJC
RCRA	RCRA Post-Closure Permit for The Upper East Fork Poplar Creek Hydrogeologic Regime	TNHW-113	9/23/2003	9/23/2013	DOE	DOE/BJC	BJC
Solid Waste	Industrial Landfill IV (Operating, Class II)	IDL-01-103-0075	Permitted in 1988—most recent modification approved 1/13/1994	N/A	DOE	DOE/BJC	BJC

Table 4.4. (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
Solid Waste	Industrial Landfill V (Operating, Class II)	IDL-01-103-0083	Initial permit 4/26/1993	N/A	DOE	DOE/BJC	BJC
Solid Waste	Construction and Demolition Landfill [Overfilled, Class IV Subject to CERCLA Record of Decision (ROD)]	DML-01-103-0012	Initial permit 1/15/1986	N/A	DOE	DOE/BJC	BJC
Solid Waste	Construction and Demolition Landfill VI (Postclosure care and maintenance)	DML-01-103-0036	Permit terminated by TDEC 3/15/2007	N/A	DOE	DOE/BJC	BJC
Solid Waste	Construction and Demolition Landfill VII (Operating, Class IV)	DML-01-103-0045	Initial permit 12/13/1993	N/A	DOE	DOE/BJC	BJC
Solid Waste	Centralized Industrial Landfill II (Postclosure care and maintenance)	IDL-01-103-0189	Most recent modification approved 5/8/1992	N/A	DOE	DOE/BJC	BJC

[a] A request for extension was submitted to TDEC on January 7, 2009. This permit is addressed in the Title V renewal application.

[b] The Y-12 Title V Operating Air Permit Renewal Application was submitted to TDEC on April, 23, 2009. As part of the permit application renewal, it was requested that TDEC combine Air Permit 554594 into Air Permit 554701 followed by cancellation of Air Permit 554594.

Abbreviations

BJC Bechtel Jacobs Company
CAA Clean Air Act
CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
CWA Clean Water Act
DOE U.S. Department of Energy
GEM-JV GEM Technologies, Inc. Joint venture
NNSA National Nuclear Security Administration
NOT Notice of termination
ORR Oak Ridge Reservation
RCRA Resource Conservation and Recovery Act
ROD record of decision
TDECTennessee Department of Environment and Conservation

The Y-12 History Center, located in The New Hope Center, continues to be a work in progress featuring new artifacts, photographs, and pop-up signs. The Y-12 History Center displays exhibits, photographs, artifacts, brochures, DVDs, and other information associated with the history of Y-12 and the New Hope Community. The Center is open to the public Monday through Thursday from 8:00 a.m. to 5:00 p.m. and on Fridays by special request. A selection of materials, including DVDs, books, pamphlets, postcards and fact sheets, is available free to the public. Tours of the center were conducted for various organizations, local schools, and VIP visitors.

Outreach activities in 2010 consisted of B&W Y-12 partnering with the city of Oak Ridge, the Convention and Visitor's Bureau, and the Arts Council of Oak Ridge who sponsors the annual Secret City Festival. The Secret City Festival promoted the history of the Manhattan Project by providing guided tours of the Y-12 Complex in June. The American Museum of Science and Energy ran shuttles continuously to Y-12's New Hope Visitor Center. The Y-12 Complex conducted a total of 46 tours. About 1,377 people from 29 states visited the Y-12 History Center and toured the Y-12's historic facility, Building 9731, known as the "Pilot Plant" (Fig 4.16). Tour participants had an opportunity to tour the east end of Y-12 with an off-stop at Building 9731, an off-stop at the overlook on Chestnut Ridge to get a view of the Y-12 Plant, and a windshield tour of the Highly Enriched Uranium Materials Facility (HEUMF) as they returned to the New Hope Center. The tour participants were greeted at Building 9731 by two "Pilot Plant" retirees, Mrs. Jane Greer Puckett and Mr. Martin Skinner (Fig 4.17). Mrs. Puckett was the first female graduate from the statistics program at the University of Tennessee. From 1943 – 1947, she worked as a statistician in Building 9731. She was responsible for verifying the production data for the uranium-235. Martin Skinner was an electrical engineer when he worked at Y-12. From 1946–1950, he worked in Building 9731 with a crew of people that conducted testing of the calutrons. He also helped design a display on how to operate the calutrons.

B&W Y-12 also partnered with the American Museum of Science and Energy by providing guided public tours from June through September. Other outreach activities include visiting local schools and conducting presentations on the history of Y-12 and Oak Ridge.

ORNL 2011-G00651/chj

Fig. 4.16. Y-12's Building 9731 between two images of calutrons.

ORNL 2011-G00652/chj

Fig. 4.17. "Calutron Girls" Betty Whitehead, left, and Dorothy Spoon, right, join Jane Greer Puckett, in center, as they share memories of earlier times working at Y-12.

4.3.3 Clean Air Act

This section contains a review of the major elements of the Clean Air Program at the Y-12 Complex Including program highlights for 2010.

The DOE was issued the Title V Major Source Operating Permits 554701 and 554594 in 2004 for the Y-12 Complex and required compliance implementation began April 1, 2005. More than 3,000 data points are obtained and reported under the Title V operating permit every 6 months, and there are five continuous monitors for criteria pollutants as well as numerous continuous samplers for radiological emissions.

There was no noncompliance as a result of monitoring activities during 2010.

In 2010, two construction air permits were in effect at the Y-12 Complex. Under a permit issued in 2007, construction began in 2008 on the replacement steam plant. The new steam plant was transitioned to management and the operating contractor on April 30, 2010. Since the new steam plant is in operation, the old steam plant is shut down and there is no plan to operate it again in the future.

A construction air permit was issued was for an operation for the machining of beryllium and/or beryllium compounds on September 29, 2010. The current operation is permitted under Y-12 Major Source (Title V) Operating Permit.

More than 90% of the Y-12 Complex pollutant emissions to the atmosphere are attributed to the operation of the old coal-fired and natural gas–fired steam plant. Emissions from the new steam plant will be significantly lower than those from the old steam plant, resulting in an overall air quality improvement. The new steam plant burns primarily natural gas and will have a Number 2 fuel oil backup. The Clean Air construction permit for this project included a Best Available Control Technology analysis for certain criteria pollutants and a case-by-case Maximum Achievable Control Technology (MACT) analysis for hazardous air pollutants.

Prior 2-year efforts to increase usage of E-85 (i.e., a mixture of 85% ethanol and 15% gasoline) in flexible fuel vehicles continued to reap motor vehicle emission reductions in 2010.

In 2010, TDEC personnel performed an inspection of the Y-12 Complex on July 28 and 29 to verify compliance with applicable regulations and permit conditions. No compliance issues were identified.

4.3.4 Clean Water Act and Aquatic Resources Protection

The Y-12 NPDES permit (TN0002968) was issued on March 13, 2006, and became effective on May 1, 2006. An application for reissuance of the NPDES permit was submitted to TDEC, Division of Water Pollution Control, on July 1, 2008.

The permit expired December 31, 2008, and Y-12 Complex discharges are continuing under the requirements of this permit pending TDEC action on the renewal application submitted on July 1, 2008. The effluent limitations contained in the permit are based on the protection of water quality in the receiving streams. The permit emphasizes storm water runoff and biological, toxicological, and radiological monitoring.

During 2010 the Y-12 Complex continued its excellent record for compliance with the National Pollutant Discharge Elimination System (NPDES) water discharge permit. More than 5,000 data points were obtained from sampling required by the NPDES permit; only one noncompliance was reported. Some of the key requirements in the permit are summarized below (additional details are provided in Sect. 4.5, Surface Water Program):

- chlorine limitations based on water quality criteria at three outfalls located near the headwaters of East Fork Poplar Creek which are controlled by dechlorination systems;
- reduction of the measurement frequency for pH and chlorine at East Fork Poplar Creek outfalls with the additional requirement for measurements in stream at two locations (Station 17 and monitoring location C11);
- a radiological monitoring plan requiring monitoring and reporting of uranium and other isotopes at pertinent locations (see Sect. 4.5.2);
- implementation of a storm water pollution prevention plan requiring sampling and characterization of storm water (see Sect. 4.5.3);
- storm water sampling of stream baseload sediment at four instream East Fork Poplar Creek locations (see Sect. 4.5.3);
- a requirement for an annual storm water monitoring report, an annual report of the Biological Monitoring and Abatement Plan (BMAP) data;
- a requirement to manage the flow of East Fork Poplar Creek such that a minimum flow of 19 million L/day (5 million gal/day) is guaranteed by adding raw water from the Clinch River to the headwaters of East Fork Poplar Creek; and
- whole effluent toxicity testing limitation for the three outfalls of East Fork Poplar Creek (see Sect. 4.5.8).

A notice of appeal of certain permit terms and limits for legacy constituents of mercury and PCBs was filed by NNSA in April 2006. The permit limits for toxicity at three outfalls were appealed because legacy contamination may adversely affect toxicity and their cleanup is addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Chlorine limits at the headwaters of the creek were also appealed, and a compliance schedule was requested so that a dechlorination unit could be put in place to handle a more stringent chlorine limit at outfall 109. The dechlorination unit has since been installed in accordance with the compliance schedule. Issues associated with the appeal were not resolved prior to expiration of the permit.

An application for renewal of the NPDES permit was completed in June 2008 and was submitted to TDEC on July 1, 2008. This work effort included special sampling needed to fully characterize effluents and to properly complete permit application forms. During 2010 permits for storm water associated with construction activity were in effect for three projects located in the Y-12 Complex. The projects are the Potable Water System (storage tanks and waterlines), the Steam Plant Life Extension, and The Bear Creek Road Bypass. Y-12 Environmental Compliance staff continue to keep TDEC apprised of site developments, and as of January 2011 TDEC had not yet issued a draft of the new permit.

The Industrial and Commercial User Wastewater Discharge Permit (1-91) was issued by the city of Oak Ridge to Y-12 on April 1, 2010. The permit, which expires on March 31, 2015, provides requirements for the discharge of wastewaters to the sanitary sewer system as well as prohibitions for certain types of wastewaters. There were 11 permit exceedances of the permit in 2010. Three were for exceeding the discharge limit (monthly average) for total recoverable phenols, two were for exceeding the discharge limit (daily maximum) for total recoverable phenols, one was for exceeding the discharge limit (monthly average) for total oil and grease, one was for exceeding the discharge limit (daily maximum) for oil and grease, and four were for exceeding the maximum daily allowable flow limit. During the year, the city of Oak Ridge conducted two inspections under the Industrial Pretreatment Program (February 8, 2010, and August 25, 2010). The city of Oak Ridge requested, and Y-12 has delivered, an action plan to address inflow/infiltration into the sanitary sewer system. Members of the Clean Water Program continued to work on surface water programs such as the Storm Water Pollution Prevention, including storm water sampling and site inspections, BMAP, and development of best management practices plans for projects and site activities. Work continued on streamlining data management for compliance reporting, review, approval, and tracking of water discharges and connections to the storm and sanitary sewer systems.

4.3.5 Safe Drinking Water Act

The City of Oak Ridge supplies potable water to the Y-12 Complex that meets all federal, state, and local standards for drinking water. The water treatment plant, located north of the Y-12 Complex, is owned and operated by the city of Oak Ridge.

The Tennessee Regulations for Public Water Systems and Drinking Water Quality, Chap.1200-5-1, sets limits for biological contaminants and for chemical activities and chemical contaminants. Sampling for the following is conducted by the Y-12 Utilities Management Organization:

- Total coliform
- Chlorine residuals
- Lead
- Copper
- Disinfectant by-product
- Propylene glycol

In 2010, the Y-12 potable water system retained its approved status for potable water with the TDEC. A 3-year sanitary survey was conducted by the state of Tennessee during 2010. The score for the survey was 98 out of a possible 100. Y-12 continued sampling the potable water system for propylene glycol. TDEC instituted a requirement for sampling the site potable water system for propylene glycol in 2007 after learning that an unapproved cross connection exists between the Y-12 potable water system and the antifreeze fire sprinkler systems containing propylene glycol. All of the samples collected during 2010 resulted in laboratory results below the detection limits. There are future plans to eliminate these cross connections.

All total coliform samples collected during 2010 were analyzed by the state of Tennessee lab, and the results were negative. Analytical results for disinfectant by-products (total trihalomethanes and haloacetic acids) for the Y-12 water systems were below the TDEC and Safe Drinking Water Act (SDWA) limits. The Y-12 potable water system is currently sampled triennially for lead and copper, and the system sampling was last completed in August 2008. These results were below the TDEC and SDWA limits and met the established requirements.

Major improvements to the potable water system were performed during 2009–2010 including the following:

- Construction of two 7.5 million liters (2 million gal) elevated water tanks
- Replacement of 702 m (2,300 ft) of potable water lines
- Cleaned and lined 645 m (2,115 ft) of potable water lines
- Excavated and inspected 317 m (1,040 ft) of existing potable water lines
- Installed 52 new backflow assemblies
- Isolation and conversion of 152 antifreeze loop fire sprinkler systems

4.3.6 The Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) regulates hazardous wastes that, if mismanaged, could present risks to human health or the environment. The regulations are designed to ensure that hazardous wastes are managed from the point of generation to final disposal. In Tennessee, EPA delegates the RCRA program to TDEC; EPA retains an oversight role. Y-12 is considered a "large-quantity generator" because it may generate more than 1,000 kg (2,205 lb) of hazardous waste in a month and because it has RCRA permits to store hazardous wastes for up to 1 year before shipping off site to licensed treatment and disposal facilities. Y-12 also has a number of satellite accumulation areas and 90-day waste storage areas.

Mixed wastes are materials that are both hazardous (under RCRA guidelines) and radioactive. The Federal Facilities Compliance Act (1992) requires that DOE work with local regulators to develop a site treatment plan to manage mixed waste. Development of the plan has two purposes: to identify available treatment technologies and disposal facilities (federal or commercial) that are able to manage mixed waste produced at federal facilities and to develop a schedule for treating and disposing of the waste streams.

The ORR Site Treatment Plan (TDEC 2008) is updated annually and submitted to TDEC for review. The updated plan documents the current mixed-waste inventory and describes efforts undertaken to seek new commercial treatment and disposal outlets for various waste streams. NNSA has developed a disposition schedule for the mixed waste in storage and will continue to maintain and update the plan as a reporting mechanism, as progress is made. Y-12 is reducing inventory of legacy mixed waste as part of the plan (Fig. 4.18).

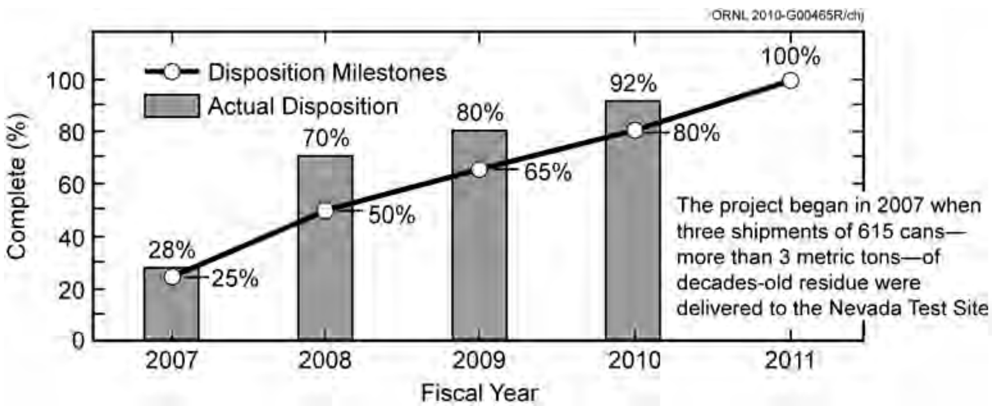

Fig. 4.18. Reducing inventory of legacy mixed waste as part of the ORR Site Treatment Plan.

The quantity of hazardous and mixed wastes generated by Y-12 decreased in 2010 (Fig. 4.19). The decrease was attributed to a reduction of contaminated groundwater treated this year, which directly correlates to 25 cm (10 in.) less rainfall in 2010 than in 2009. Waste resulting from repackaging and disposal of legacy mixed waste also increased. Legacy mixed wastes are being repackaged and disposed of in accordance with milestones in the ORR Site Treatment Plan. Progress on disposition of legacy mixed wastes exceeded established milestones for FY 2010. Ninety-five percent of the total hazardous and mixed waste generated in 2010 was generated as contaminated leachate from legacy operations. The Y-12 Complex currently reports waste on 105 active waste streams. Y-12 is a state-permitted treatment, storage, and disposal facility. Under its permits, Y-12 received 2,028 kg (4,472 lb) of hazardous and mixed waste from the off-site Union Valley analytical chemistry laboratory in 2010. In addition, 492,074 kg (1,085,023 lb) of hazardous and mixed waste was shipped to DOE-owned and commercial treatment, storage, and disposal facilities. More than 8 million kg (18 million lb) of hazardous and mixed wastewater was treated at on-site wastewater treatment facilities.

TDEC conducted a comprehensive inspection of Y-12's hazardous waste program in November 2010, including permitted storage facilities, satellite accumulation areas, and 90-day accumulation areas. No violations were noted during the inspection.

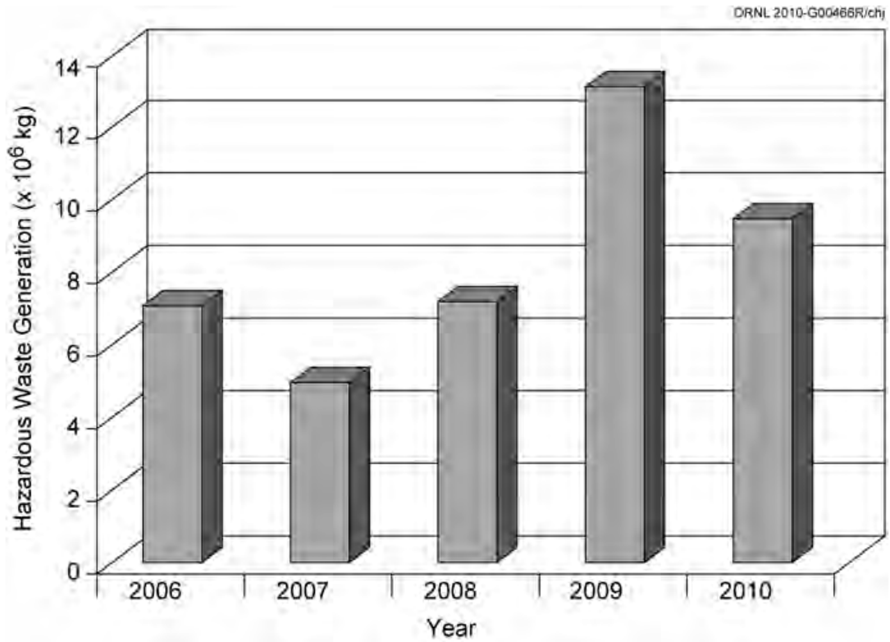

Fig. 4.19. Hazardous waste generation, 2006–2010.

4.3.6.1 RCRA Underground Storage Tanks

TDEC regulates the active petroleum underground storage tanks (USTs) at Y-12. Existing UST systems that are to remain in service at the Y-12 Complex must comply with performance requirements described in TDEC underground storage tank regulations (TN 1200-1-15). Three specific requirements are considered:

- release detection for both the tank and piping,
- corrosion protection for both the tank and piping, and
- spill/overfill prevention equipment.

The Y-12 UST Program includes two active petroleum USTs that meet all current regulatory compliance requirements. The UST registration fees for the tanks are current, enabling fuel delivery until March 31, 2012. All legacy petroleum UST sites at Y-12 have either been granted final closure by TDEC or have been deferred to the CERCLA process for further investigation and remediation. TDEC conducted a comprehensive inspection of Y-12's petroleum USTs in August 2009. No violations were found during that inspection.

4.3.6.2 RCRA Subtitle D Solid Waste

Located within the boundary of the Y-12 Complex are the Oak Ridge Reservation landfills operated by the DOE-EM (Office of Environmental Management) program. The facilities include two Class II operating industrial solid waste disposal landfills and one operating Class IV construction demolition landfill. The facilities are permitted by TDEC and accept solid waste from DOE operations on the ORR. In addition, one Class IV facility (Spoil Area 1) is overfilled by 8,945 m^3 (11,700 yd^3) and has been the subject of a CERCLA remedial investigation/feasibility study. A CERCLA Record of Decision (ROD) for Spoil Area 1 was signed in 1997. One Class II facility (Landfill II) has been closed and is subject to postclosure care and maintenance. Associated TDEC permit numbers are noted in Table 4.4.

Landfill V, a Class II landfill, is used for disposal of sanitary, industrial, construction, and demolition waste. Expansion of this landfill was initiated in April 2010 with ARRA funding. Expansion of the landfill will increase capacity by 294,354 m^3 (385,000 yd^3) to provide more capacity for the increased cleanup work on the Reservation. The expansion also includes upgrading and refurbishing support facilities.

4.3.7 RCRA/CERCLA Coordination

The ORR Federal Facility Agreement is intended to coordinate the corrective action processes of RCRA required under the Hazardous Waste Corrective Action permit (formerly known as the Hazardous and Solid Waste Amendments permit), with CERCLA response actions.

Three RCRA postclosure permits, one for each of the three hydrogeologic regimes at Y-12, have been issued to address the eight major closed waste disposal areas at Y-12. Because it falls under the jurisdiction of two postclosure permits, the S-3 Pond Site is described as having two parts, eastern and former S-3 (Table 4.5). Postclosure care and monitoring of East Chestnut Ridge Waste Pile was incorporated into permit TNHW-128. Groundwater corrective actions required under the postclosure permits have been deferred to CERCLA. RCRA groundwater monitoring data were reported yearly to TDEC and EPA in the Groundwater Monitoring Report for Y-12 (BJC 2011).

Periodic updates of proposed construction and demolition activities at the Y-12 Complex (including alternative financing projects) have been provided to managers and project personnel from the TDEC DOE Oversight Division and EPA Region 4. A CERCLA screening process is used to identify proposed construction and demolition projects that warrant CERCLA oversight. The goal is to ensure that modernization efforts do not impact the effectiveness of previously completed CERCLA environmental remedial actions and that they do not adversely impact future CERCLA environmental remedial actions.

4.3.8 Toxic Substances Control Act

The storage, handling, and use of PCBs are regulated under the Toxic Substances Control Act (TSCA). Capacitors manufactured before 1970 that are believed to be oil filled are handled as if they contain PCBs, even when that cannot be verified from the manufacturer’s records. Certain equipment containing PCBs and PCB waste containers must be inventoried and labeled. The inventory is updated by July 1of each year. The 2010 (PCB) annual inventory was submitted June 16, 2010.

Given the widespread historical uses of PCBs at Y-12, along with fissionable material requirements that must be maintained, an agreement between EPA and DOE was negotiated to assist the ORR facilities in becoming compliant with TSCA regulations. This agreement, known as the Oak Ridge Reservation Polychlorinated Biphenyl Federal Facilities Compliance Agreement (ORR PCB FFCA), which came into effect in 1996, provides a forum with which to address PCB compliance issues that are truly unique to these facilities. Y-12 operations involving TSCA-regulated materials were conducted in accordance with TSCA regulations and the ORR-PCB-FFCA.

Table 4.5. RCRA postclosure status for former treatment, storage, and disposal units on the ORR

Unit	Major components of closure	Major postclosure requirements
Upper East Fork Poplar Creek Hydrogeologic Regime (RCRA Postclosure Permit No. TNHW-113)		
New Hope Pond	Engineered cap, Upper East Fork Poplar Creek distribution channel	Cap inspection and maintenance. No current groundwater monitoring requirements in lieu of ongoing CERCLA actions in the eastern portion of Y-12
Eastern S-3 Ponds Groundwater Plume	None for groundwater plume, see former S-3 Ponds (S-3 Site) for source area closure	Postclosure corrective action monitoring. Inspection and maintenance of monitoring network
Chestnut Ridge Hydrogeologic Regime (RCRA Postclosure Permit No. TNHW-128)		
Chestnut Ridge Security Pits	Engineered cap	Cap inspection and maintenance. Postclosure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks
Kerr Hollow Quarry	Waste removal, access controls	Access controls inspection and maintenance. Postclosure detection monitoring. Inspection and maintenance of monitoring network and survey benchmarks
Chestnut Ridge Sediment Disposal Basin	Engineered cap	Cap inspection and maintenance. Postclosure detection monitoring. Inspection and maintenance of monitoring network and survey benchmarks
East Chestnut Ridge Waste Pile	Engineered cap	Cap inspection and maintenance. Postclosure detection monitoring. Inspection and maintenance of monitoring network, leachate collection sump and survey benchmarks. Management of leachate
Bear Creek Hydrogeologic Regime (RCRA Postclosure Permit No. TNHW-116)		
Former S-3 Ponds (S-3 Site)	Neutralization and stabilization of wastes, engineered cap, asphalt cover	Cap inspection and maintenance. Postclosure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks
Oil Landfarm	Engineered cap	Cap inspection and maintenance. Postclosure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks
Bear Creek Burial Grounds A-North, A-South and C-West, and the Walk-In Pits	Engineered cap, leachate collection system specific to the burial grounds	Cap inspection and maintenance. Post-closure corrective action monitoring. Inspection and maintenance of monitoring network and survey benchmarks

Abbreviations

RCRA Resource Conservation and Recovery Act

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act

4.3.9 Preventing Spills and Reporting Spills/Releases

4.3.9.1 Preventing Oil Pollution and Spills

Y-12 maintains its *Spill Prevention, Control, and Countermeasures Plan* (SPCC Plan) to prevent spills of oil and hazardous constituents as well as the countermeasures to be invoked should a spill occur. A revision to the SPCC Plan was released in 2010. This revision updated general Y-12 Complex spill prevention techniques and, in particular, reflected the addition of a fuel oil storage tank and dike system built and operated as part of the new Y-12 Complex Steam Plant.

In general, the first response of an individual discovering a spill is to call the plant shift superintendent. Spill response materials and equipment are stored near tanks and drum storage areas and other strategic areas of the Y-12 Complex to facilitate spill response. All Y-12 personnel and subcontractors are required to have initial spill and emergency response training before they can work on site. This training is received as part of the GET Program.

4.3.9.2 Emergency Reporting Requirements

The Emergency Planning and Community Right-to-Know Act (EPCRA) and Title III of the Superfund Amendments and Reauthorization Act (SARA) require that facilities report inventories (i.e., Tier II Report sent to the local emergency planning committees and the state emergency response commission) and releases (i.e., Toxic Release Inventory Report submitted to state and federal environmental agencies) of certain chemicals that exceed specific release thresholds. Y-12 complied with those requirements in 2010 through the submittal of reports under EPCRA Sections 302, 303, 311, 312, and 313. Y-12 had no releases of extremely hazardous substances as defined by EPCRA in 2010.

One Section 311 notification was made in 2010 because of the significant increase in the amount of one material in inventory. This material was not new to the reporting process, but the increased amount warranted notification to emergency responders. There were no newly identified hazardous or extremely hazardous chemicals over threshold during 2010. Inventories, locations, and associated hazards of hazardous and extremely hazardous chemicals were submitted in an annual report to state and local emergency responders as required by the Section 312 requirements. Y-12 reported 64 chemicals that were in inventory over threshold during the 2010 reporting year.

Each ORR facility evaluates its respective operations to determine applicability for submittal of annual toxic release inventory reports (Section 313) to EPA and TDEC on or before July 1 of each year. The reports cover the previous calendar year and address releases of certain toxic chemicals to air, water, and land as well as waste management, recycling, and pollution-prevention activities. Threshold determinations and reports for each of the ORR facilities are made separately. Operations involving these chemicals are evaluated to determine which chemicals exceeded the reporting thresholds based on amounts manufactured, processed, or otherwise used at each facility. After threshold determinations are made, releases and off-site transfers are calculated for each chemical that exceeded one or more of the thresholds.

Total 2010 reportable toxic releases to air, water, and land, and waste transferred off site for treatment, disposal, and recycling were 59,148 kg (130,399 lb). Table 4.6 lists the reported chemicals for the Y-12 Complex and summarizes releases and off-site transfers for those chemicals exceeding reporting thresholds.

Table 4.6. Emergency Planning and Community Right-to-Know Act Section 313 toxic chemical release and off-site transfer summary for the Y-12 Complex, 2009 and 2010

Chemical	Year	Quantity[a] (lb)[b]
Chromium	2009	6,106
	2010	*c*
Cobalt	2009	*d*
	2010	*c*
Copper	2009	*c*
	2010	4,265
Lead Compounds	2009	12,859
	2010	73,412
Manganese	2009	*d*
	2010	*c*
Mercury Compounds	2009	125
	2010	13
Methanol	2009	92,020
	2010	52709
Nickel	2009	*c*
	2010	*c*
Nitric Acid	2009	3,320
	2010	*d*
Ozone	2009	*c*
	2010	*d*
Silver	2009	*d*
	2010	*c*
Sulfuric Acid	2009	46,000
	2010	*d*
Total	2009	161,180
	2010	130,399

[a] Represents total releases to air, land, and water and includes off-site waste transfers. Also includes quantities released to the environment as a result of remedial actions, catastrophic events, or one-time events not associated with production processes.

[b] 1 lb = 0.45359237 kg.

[c] Not applicable because releases were less than 500 lb; hence, a Form A was submitted.

[d] Not reported for the year (i.e., below threshold).

4.3.9.3 Spills and Releases

Y-12 has procedures for notifying off-site authorities for categorized events at the Y-12 National Security Complex. Off-site notifications are required for specified events according to federal statutes, DOE orders, and the Tennessee Oversight Agreement. As an example, any observable oil sheen on East Fork Poplar Creek and any release impacting surface water must be reported to the EPA National Response Center in addition to other reporting requirements. Spills of CERCLA reportable quantity (RQ) limits must be reported to the EPA National Response Center, DOE, the Tennessee Emergency Management Agency, and the Anderson County Local Emergency Planning Committee.

There were no releases of hazardous substances exceeding an RQ. There was one release of waste water into upper East Fork Poplar Creek (see Sect. 4.3.9.4) that resulted in a fish kill.

4.3.9.4 Environmental Occurrences

The Y-12 Occurrence Reporting program provides timely notification to the DOE Complex of Y-12 events and site conditions that could adversely affect the public or worker health and safety, the environment, national security, DOE’s safeguards and security interests, functioning of DOE facilities, or the department’s reputation.

Y-12 occurrences are categorized and reported through the Occurrence Reporting and Processing System (ORPS). ORPS provides NNSA and the DOE community with a readily accessible database of information about occurrences at DOE facilities, causes of those occurrences, and corrective actions to prevent recurrence of the events. DOE analyzes aggregate occurrence information for generic implications and operational improvements.

On August 29, 2010, approximately 300 gallons of lime slurry overflowed a neutralization process tank located at the Y-12 Steam Plant Wastewater Treatment Facility [Occurrence Report Number**:** NA--YSO-BWXT-Y12SITE-2010-0030]. A portion of the overflow entered the storm drain system and reached East Fork Poplar Creek (EFPC) at NPDES Outfall 200. Surveys of the stream inside Y-12 revealed 33 dead minnows in the area of Outfall 200. Many other live, active fish were also observed in the area. The condition was determined to be an isolated acute event, and no additional impact to fish in EFPC was observed. Water samples were taken and the relative pH (acid/base scale) measurements were 7.85, which are within the normal range of 6.0–9.0 (a pH of 7.0 is neutral).

4.3.9.5 Mercury Removal from Storm Drain Catch Basins

In May 2003, metallic mercury was observed in two storm drain catch basins located in the west end of the Y-12 Complex. The storm drain line on which the catch basins are located flows into East Fork Poplar Creek at Outfall 200. Mercury tends to collect at those low spots in the drain system following heavy rains. During 2010, spill response and waste services personnel conducted two removals and recovered an estimated 2.6 kg (7.0 lb) of mercury. Approximately 32.6 kg (73 lb) have been recovered since 2003.

4.3.10 Audits and Oversight

A number of federal, state, and local agencies oversee Y-12 activities. In 2010, Y-12 was inspected by federal, state, or local regulators on five occasions. The TDEC Department of Energy Oversight Division maintained a part-time regulator on site who provided periodic oversight of Y-12 activities. Except for work completed under the Federal Facilities Agreement (FFA), TDEC DOE Oversight work is nonregulatory. This clarification should be made to avoid a misunderstanding of TDEC DOE Oversight’s role at Y-12. Most other matters such as CAA, CWA, and RCRA are regulated by TDEC’s Knoxville Basin Office, not TDEC DOE Oversight. The Environmental Restoration Section at TDEC DOE-O handles CERCLA matters at Y-12. In addition to external audits and oversight, Y-12 has a comprehensive self-assessment program.

TDEC inspectors completed their annual compliance inspection of Y-12’s hazardous waste management practices November 18. The five-member audit team inspected more than 40 RCRA-permitted storage and accumulation areas, examined RCRA annual reports, training records, spill control equipment, waste characterization records, hazardous waste manifests, and waste reduction reports. This year is the third consecutive year that no noncompliance findings were identified. A summary of external regulatory audits and reviews for 2010 is provided in Table 4.7.

Table 4.7. Summary of external regulatory audits and reviews, 2010

Date	Reviewer	Subject	Issues
February 8	City of Oak Ridge	Semi-Annual Industrial Pretreatment Compliance Inspection	0
July 28–29	TDEC	Annual Clean Air Compliance Inspection	0
August 25	City of Oak Ridge	Semi-Annual Industrial Pretreatment Compliance Inspection	0
November 16–17	TDEC	Clean Water Act Compliance Evaluation Inspection	0
November 16–18	TDEC	Annual Resource Conservation and Recovery Act (RCRA) Inspections	0

4.3.10.1 Enforcement Actions and Memos

There was no consent orders issued to Y-12 in 2010.

4.4 Air Quality Program

Permits issued by the state of Tennessee are the primary vehicle used to convey the clean air requirements that are applicable to the Y-12 Complex. New projects are governed by construction permits, and eventually, the requirements are incorporated into the site-wide Title V operating permit. Sections of the Title V permit contain requirements that are generally applicable to most industrial sites. Examples include requirements associated with asbestos controls, control of stratospheric ozone-depleting chemicals, and control of fugitive emissions as well as the general administration of the permit. The Title V permit also contains a section of specific requirements directly applicable to individual sources of air emissions at Y-12. Major requirements included in that section include the National Emission Standards for Hazardous Air Pollutants for Radionuclides (Rad NESHAP, 40 CFR 61) requirements and the numerous requirements associated with emissions of criteria pollutants and other hazardous air pollutants (nonradiological). In addition, a number of sources that are exempt from permitting requirements under state rules but subject to listing on Title V permit application are documented, and information about them is available upon request from the state.

Ambient air monitoring, while not specifically required by any permit condition, is conducted at Y-12 to satisfy DOE order requirements, as a best management practice and/or to provide evidence of sufficient programmatic control of certain emissions. Ambient air monitoring conducted specifically for Y-12 (i.e., mercury monitoring) is supplemented by additional monitoring conducted for the ORR and by both on-site and off-site monitoring conducted by TDEC. In addition, the overall effectiveness of the Clean Air Act compliance program is ensured by internal audits and external audits, such as the annual inspection conducted by state of Tennessee personnel.

4.4.1 Construction and Operating Permits

In 2010, Y-12 Complex had two construction air permits. One construction permit was for the replacement steam plant continued in 2010. The other construction permit was for an operation for the machining beryllium and/or beryllium compounds.

The DOE/NNSA and Y-12 Title V permits, currently two permits with an outstanding request to combine them into one permit, include 32 air emission sources and more than 100 air emission points. All remaining emission sources are categorized as insignificant and exempt from permitting. The Tennessee Air Pollution Control Board issued a minor modification to the Title V Major Source Operating Permit 554701 on April 5, 2009. The minor modification was to align permit conditions with site transformation activities. Permit change requests still pending at the end of 2010 include

- a request to convert one construction permit to an operating permit;
- a request to combine permit 554594 (which only has one emission source) into the existing Y-12 site-wide permit;

- a request to add the new steam plant to the operating permit;
- a request to add Fuel Station Stage 1 emission control requirements to the permit;
- a request to change condition on construction air permit to included beryllium to the process;
- a request to convert the machining operation for adding beryllium to an operating permit; and
- a request for operational flexibility change for the metal working operation.

The Y-12 Complex major source (Title V) operating air permit renewal application was prepared and hand delivered to the TDEC personnel in April 2009. As part of the permit application renewal, it was requested that TDEC combine Air Permit 554594 into Air Permit 554701 followed by cancellation of Air Permit 554594. The complete permit application consists of four volumes. The complete, unedited application consists of Volumes 1, 2, 3.2, and 4.3. Volumes 3.1, 4.1, and 4.2, which are edited for classification reasons, were provided to the TDEC for their review and approval. Any classified information is held on site at the Y-12 National Security Complex for the appropriately Q-cleared TDEC personnel to review as needed. The Title V renewal operating air permit from the TDEC is still pending at end of 2010.

Permit administration fees in excess of $70,000 per year are paid to TDEC in support of the Title V program. Y-12 has chosen to pay the fees based on a combination of actual emissions [steam plant, methanol, solvent 140 volatile organic compound (VOC)] and allowable emissions (balance of plant). In years when a detailed air emission inventory is not required to be compiled for Y-12 operations, the emissions ledger compiled to support the annual fee payment is the most comprehensive presentation of total site emissions. In 2010, emissions categorized as actual emissions totaled 1,533,795 kg (1,690.72 tons), and emissions calculated by the allowable methodology totaled 647,884 kg (714.17 tons). The total emissions fee paid was $79,072.27.

Demonstrating compliance with the conditions of air permits is a significant effort at the Y-12 Complex. Key elements of maintaining compliance are maintenance and operation of control devices, monitoring, record-keeping, and reporting. High-efficiency particulate air (HEPA) filters, baghouses, and scrubbers are control devices used at the Y-12 Complex. HEPA filters are found throughout the complex, and in-place testing of HEPA filters to verify the integrity of the filters is routinely performed. Baghouses and scrubbers are operated and maintained in accordance with source-specific procedures. Monitoring consists of tasks such as continuous stack sampling, one-time stack sampling, and monitoring the operation of control devices. Examples of continuous stack sampling are the radiological stack monitoring systems on numerous sources throughout the complex, continuous NO_x monitors and continuous opacity monitors on the old steam plant. However, continuous NO_x and opacity monitoring were ceased on April 30, 2010 when the old steam plant went off-line.

The Y-12 Complex site-wide permit requires quarterly and semiannual reports. In addition, two major annual reports are required. One report is the overall ORR radiological NESHAP report (CFR 2009a), which includes specific information regarding Y-12 Complex emissions; the second is an annual Title V compliance certification report indicating compliance status with all conditions of the permit.

4.4.1.1 Generally Applicable Permit Requirements

The Y-12 Complex, like many industrial sites, has a number of generally applicable requirements that require management and control. Asbestos, ozone-depleting substances, and fugitive particulate emissions are notable examples.

4.4.1.1.1 Control of Asbestos

The Y-12 Complex has numerous buildings and equipment that contain asbestos-containing materials. The compliance program for management of removal and disposal of asbestos-containing materials includes demolition and renovation notifications to TDEC and inspections, monitoring, and prescribed work practices for abatement and disposal of asbestos materials. There was no reportable release of asbestos in 2010.

4.4.1.1.2 Stratospheric Ozone Protection

Y/TS-1880, *Y-12 Complex Ozone Depleting Substances (ODS) Phase-Out and Management Plan* (B&W Y-12 2009a), provides a complete discussion of requirements and compliance activities at the Y-12 Complex. ODS reductions are based on the DOE Order 450.1A (DOE 2008) objective to phase out as equipment reaches life expectance, equipment repairs are no longer cost-effective, or viable solvent replacements are identified. Past ODS reduction initiatives began in the early 1980s and focused on Class I ODS usage in refrigerants and solvent cleaning operations. Only one small chiller remains at the Y-12 Complex which contains Class I ODS. This system has a 181-kg (400-lb) charge of refrigerant and was manufactured in 1992. If it is determined to be economically practicable, this system will be retrofitted in accordance with the DOE 2010 implementation goal.

Y-12 Complex initiatives in support of the DOE objectives have also involved elimination of solvents in cleaning processes. Operations personnel developed and implemented changes in one process which reduced the amount of ODS solvent emissions by up to 8,891 kg (19,600 lb) each year. Evaluation of ODS reduction opportunities continue for another solvent cleaning operation. Future actions related to this process will be dependent on ongoing efforts to identify a safe and viable replacement chemical or to identify practical and cost-effective modifications to process equipment.

Any Class I and Class II substitutions are made in accordance with EPA's Significant New Alternatives Program (SNAP). Y-12 Complex personnel are notified as EPA issues regulations detailing SNAP replacement chemicals which may be applicable to plant operations. In order to prevent ODS from coming on-site, procurement documents are written to ensure that no additional equipment or processes using Class I ODS are brought onsite, and Class II ODS usage is limited wherever possible.

Infrastructure reduction activities also led to the reduction of ODS materials on site. All refrigerants and solvents must be removed from equipment prior to disposal. Recovered ODS are typically recycled/reused in other equipment in the Y-12 Complex. However, Class I ODS deemed excess must be transferred to Defense Logistics Agency as needed. Remaining ODS are offered to other DOE sites or government agencies, sold, or properly disposed if not useable.

4.4.1.1.3 Fugitive Particulate Emissions

As Modernization and Infrastructure Reduction efforts increase at the Y-12 Complex, the need also increases for good work practices and controls to minimize fugitive dust emissions from construction and demolition activities. Y-12 Complex personnel continue to use a mature project planning process to review, recommend, and implement appropriate work practices and controls to minimize fugitive dust emissions.

4.4.1.2 Radiological National Emission Standard for Hazardous Air Pollutants

The release of radiological contaminants, primarily uranium, into the atmosphere at the Y-12 Complex occurs almost exclusively as a result of plant production, maintenance, and waste management activities. The major radionuclide emissions contributing to the dose from the Y-12 Complex are the nuclides ^{234}U, ^{235}U, ^{236}U, and ^{238}U, which are emitted as particulates. The particle size and solubility class of the emissions are determined based on review of the operations and processes served by the exhaust systems to determine the quantity of uranium handled in the operation or process, the physical form of the uranium, and the nature of the operation or process. The four categories of processes or operations that are considered in the total of uranium emissions are

- those that exhaust through monitored stacks,
- unmonitored processes for which calculations are performed per Appendix D of 40 CFR 61 (CFR 2009b),
- processes or operations exhausting through laboratory hoods also involving Appendix D calculations, and
- emissions from room ventilation exhausts using radiological control monitoring data from the work area.

Continuous sampling systems are used to monitor emissions from a number of process exhaust stacks at the Y-12 Complex. In addition, a probe-cleaning program is in place, and the results from the probe cleaning at each source are incorporated into the respective emission point source term. In 2010, 40 process exhaust stacks were continuously monitored, 34 of which were major sources; the remaining 6 were minor sources. The sampling systems on these stacks have been approved by EPA Region 4.

During 2010, unmonitored uranium emissions at the Y-12 Complex occurred from 37 emission points associated with on-site, unmonitored processes and laboratories operated by B&W Y-12. Emission estimates for the unmonitored process and laboratory stacks were made using inventory data with emission factors provided in 40 CFR Part 61, Appendix D (CFR 2009b). The Y-12 Complex source term includes an estimate of those unmonitored emissions.

The Analytical Chemistry Organization laboratory, operated by B&W Y-12, is located in a leased facility on Union Valley Road, approximately 0.3 miles east of the Y-12 Complex, and is not within the ORR boundary. In 2010 there were no emission points (or sources) in the laboratory facility.

Additionally, estimates from room ventilation systems are considered using radiological control data on airborne radioactivity concentrations in the work areas. Where applicable, exhausts from any area where the monthly concentration average exceeds 10% of the derived air concentration (DAC), as defined in the Compliance Plan (DOE 2005), are included in the annual source term. Annual average concentrations and design ventilation rates are used to arrive at the annual emission estimate for those areas. Five emission points from room ventilation exhausts were identified in 2010 where emissions exceeded 10% of the DAC. These emission points feed to monitored stacks, and any radionuclide emissions are accounted for as noted for monitored emission points.

The Y-12 Complex Title V Major Source Operating Permits contain a site-wide, streamlined alternate emission limit for enriched and depleted uranium process emission units. A limit of 907 kg (2,000 lb) per year of particulate was set for the sources for the purposes of paying fees. The compliance method defined for Permit 554701, Condition E3, and Permit 554594, Condition E4, requires the annual actual mass emission particulate emissions to be generated using the same monitoring methodologies required for Rad NESHAP compliance. An estimated 0.014 Ci (0.7 kg) of uranium was released into the atmosphere in 2010 as a result of Y-12 activities (Figs. 4.20 and 4.21).

The calculated radiation dose to the maximally exposed off-site individual from airborne radiological release points at Y-12 during 2010 was 0.2 mrem. This dose is well below the NESHAP standard of 10 mrem and is less than 0.07% of the 300 mrem that the average individual receives from natural sources of radiation. (See Sect. 7.1.2. for an explanation of how the airborne radionuclide dose was determined.)

4.4.1.3 Quality Assurance

Quality assurance activities for the Rad NESHAP program are documented in *Y-12 National Security Complex Quality Assurance Project Plan for National Emission Standards for Hazardous Air Pollutants (NESHAP) for Radionuclide Emission Measurements* (Y-12 2010a). The plan satisfies the quality assurance (QA) requirements in 40 CFR Part 61, Method 114 (CFR 2007), for ensuring that the radionuclide air emission measurements from the Y-12 Complex are representative to known levels of precision and accuracy and that administrative controls are in place to ensure prompt response when emission measurements indicate an increase over normal radionuclide emissions. The requirements are also referenced in TDEC regulation 1200-3-11-.08. The plan ensures the quality of the Y-12 radionuclide emission measurements data from the continuous samplers, breakthrough monitors, and minor radionuclide release points. It specifies the procedures for the management of the activities affecting the quality of the data. The QA objectives for completeness, sensitivity, accuracy, and precision are discussed. Major programmatic elements addressed in the QA plan are the sampling and monitoring program, emission characterization, the analytical program, and minor source emission estimates.

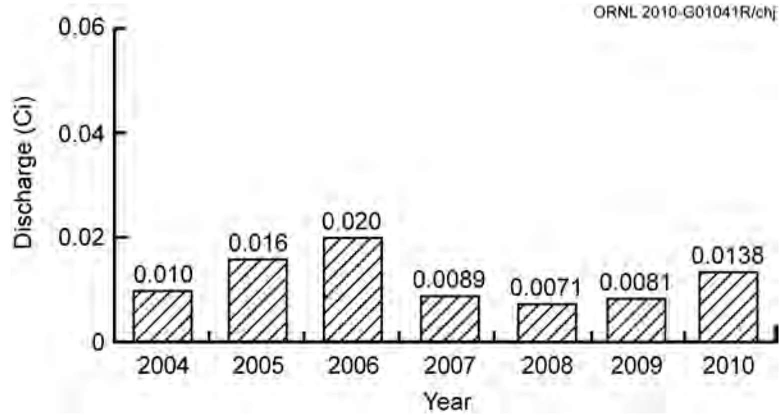

Fig. 4.20. Total curies of uranium discharged from the Y-12 Complex to the atmosphere, 2004–2010.

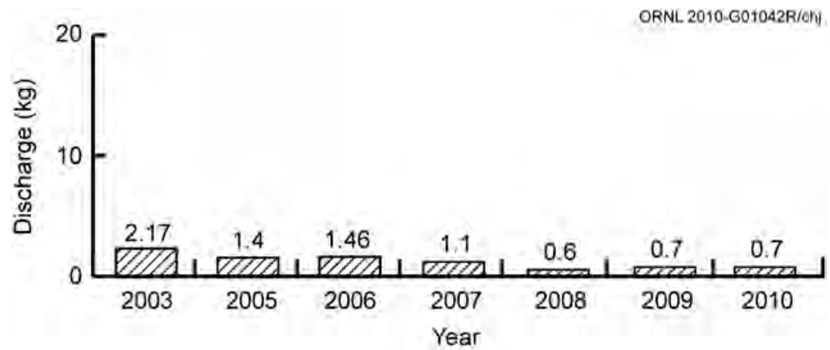

Fig. 4.21. Total kilograms of uranium discharged from the Y-12 Complex to the atmosphere, 2004–2010.

4.4.1.4 Source-Specific Criteria Pollutants

Proper maintenance and operation of a number of control devices (e.g., HEPA filters, baghouses, and scrubbers) are key to controlling emissions of criteria pollutants. The primary source of criteria pollutants at the Y-12 Complex is the steam plant, where coal and natural gas were burned in 2010. Information regarding actual vs. allowable emissions from the steam plant is provided in Tables 4.8 and 4.9. The Y-12 Title V operating air permit for the old Steam Plant required the opacity monitoring systems to be fully operational 95% of the operational time of the monitored units during each month of the calendar quarter. During 2010, the opacity monitoring systems were operational for more than 95% of the operational time of the monitored units during each month. During 2010, five 6-minute periods of excess emissions occurred. Quarterly reports of the status of the old Steam Plant opacity monitors were submitted to TDEC personnel.

Table 4.10 is a record of excess emissions and inoperative conditions for the east and west stack opacity monitors for 2010. Visible emission evaluations were also conducted at the steam plant semiannually to demonstrate compliance. The Y-12 Title V operating air permit also required continuous monitoring of NO_x mass emissions during the ozone season (May 1 through September 30). Since the old steam plant did not operate during the ozone season in 2010, the cumulative NO_x mass emissions measured from the steam plant was 0 kg (0 tons) of NO_x, the limit being 157,850 kg (174 tons), as shown in Fig. 4.22. Boiler 3 was shutdown, and its tonnage was removed from the total NO_x limit for the steam plant.

Particulate emissions from point sources result from many operations throughout Y-12. Compliance demonstration is achieved via several activities, including monitoring the operations of control devices, limiting process input materials, and using certified readers to conduct stack-visible emission evaluations.

Table 4.8. Actual vs. allowable air emissions from the Old Oak Ridge Y-12 Steam Plant, 2010

Pollutant	Emissions (tons/year)[a]		Percentage of allowable
	Actual	Allowable	
Particulate	6	945	0.6
Sulfur dioxide	337	20,803	1.6
Nitrogen oxides[b]	167	5,905	2.8
Nitrogen oxides (ozone season only)	0[c]	174	0
Volatile organic compounds[b]	1.3	41	3.2
Carbon monoxide[b]	17	543	3.1

NOTE: The old steam plant boilers were permanently turned off on April 30, 2010. The emissions are based on fuel usage data for January through April 2010.

[a] 1 ton = 907.2 kg.

[b] When there is no applicable standard or enforceable permit condition for some pollutants, the allowable emissions are based on the maximum actual emissions calculation as defined in Tennessee Department of Environment and Conservation Rule 1200-3-26-.02(2)(d)3 (maximum design capacity for 8760 h/year). The emissions for both the actual and allowable emissions were calculated based on the latest EPA compilation of air pollutant emission factors. (EPA 1995 and 1998. *Compilation of Air Pollutant Emission Factors AP-42, Fifth Edition, Volume 1: Stationary Point and Area Sources*. Environmental Protection Agency, Research Triangle Park, N.C. January 1995 and September 1998.)

[c] The NO_x monitors did not operated in 2010.

Table 4.9. Actual vs. allowable air emissions from the New Oak Ridge Y-12 Steam Plant, 2010

Pollutant	Emissions (tons/year)[a]		Percentage of allowable
	Actual	Allowable	
Particulate	4	41	9.8
Sulfur dioxide	0.3	39	0.8
Nitrogen oxides[b]	14	81	17.3
Nitrogen oxides (ozone season only)	0[c]	0	0
Volatile organic compounds[b]	2	9.4	21.3
Carbon monoxide[b]	28.5	139	20.5

NOTE: The emissions are based on fuel usage data for May through December 2010. The emissions also included the fuel used during testing.

[a] 1 ton = 907.2 kg.

[b] When there is no applicable standard or enforceable permit condition for some pollutants, the allowable emissions are based on the maximum actual emissions calculation as defined in Tennessee Department of Environment and Conservation Rule 1200-3-26-.02(2)(d)3 (maximum design capacity for 8760 h/year). The emissions for both the actual and allowable emissions were calculated based on the latest EPA compilation of air pollutant emission factors. (EPA 1995 and 1998. *Compilation of Air Pollutant Emission Factors AP-42, Fifth Edition, Volume 1: Stationary Point and Area Sources*. Environmental Protection Agency, Research Triangle Park, N.C. January 1995 and September 1998.)

[c] The new steam plant does not contain NO_x monitors.

Table 4.10. Periods of excess emissions and out-of-service conditions for old Y-12 Steam Plant east and west opacity monitors, 2010

Date	Stack	Condition	Comments
January 13	East	Two 6-min periods of excess emissions	Due to torn filter bags in Compartment 7 of Baghouse 4.
January 18	East	One 6-min period of excess emissions	Due to torn filter bags in Compartment 8 of Baghouse 4.
January 28	West	One 6-min period of excess emissions	Due to start-up of the fans on Boiler 2.
February 27	East	One 6-min period of excess emissions	Due to start-up of the fans on Boiler 4.

NOTE: The old steam plant boilers were permanently turned off on April 30, 2010.

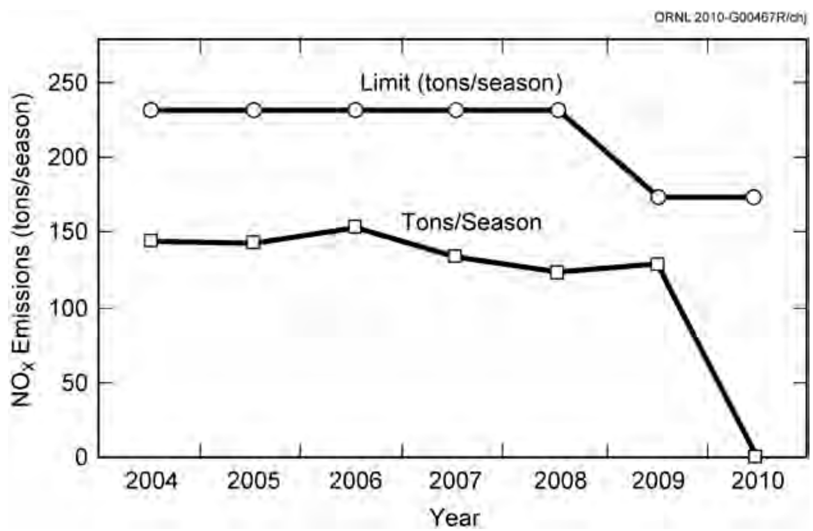

Fig. 4.22. Y-12 Steam Plant NO_x emissions per ozone season.

Emissions of SO_2 were primarily from the combustion of coal at the old steam plant. Sulfur in coal is analyzed, and calculations are performed to ensure that emissions remain below permit limits.

Use of Solvent 140 and methanol throughout the complex along with use of acetonitrile at a single source are primary sources of VOC emissions. Material mass balances and engineering calculations are used to determine annual emissions.

The results of monitoring a number of process parameters along with stack-monitoring results are provided in reports to TDEC quarterly, semiannually, and annually. All monitored results, including stack-monitoring results, were provided in reports in 2010 and were in compliance with the Title V permit.

4.4.1.5 Quality Control

Calibration error tests of the opacity monitoring systems at the old steam plant were historically performed on a semiannual basis as required by the permit. Since the old steam plant was permanently shut down on April 30, 2010, no calibration error tests were required for the opacity monitors in 2010.

The NO_x continuous emissions monitoring systems were operated in conformance with the requirements of 40 CFR 75 (CFR 2010). Requirements included a periodic relative accuracy test audit (RATA) for continuous nitrogen oxides emissions monitoring systems as part of the NO_x Budget Trading Program. Since the NO_x monitors did not operate during 2010 ozone season, a periodic RATA was not required.

4.4.1.6 Hazardous Air Pollutants (Nonradiological)

Beryllium emissions from machine shops are regulated under a state-issued permit and are subject to a limit of 10 g per 24 h. Compliance is demonstrated through a one-time stack test and through monitoring of control device operations. Hydrogen fluoride is used at one emission source, and emissions are controlled through the use of scrubber systems. The beryllium control devices and the scrubber systems were monitored during 2010 and found to be operating properly.

Methanol is released as fugitive emissions (e.g., pump and valve leaks) as part of the brine/methanol system. Methanol is subject to state air permit requirements; however, due to the nature of its release (fugitive emissions only), there are no specific emission limits or mandated controls. Mercury is a significant legacy contaminant at the Y-12 Complex, and cleanup is being addressed under the environmental remediation program. Like methanol emissions, mercury air emissions from legacy sources are fugitive in nature and therefore are not subject to specific air emission limits or controls. On-site monitoring of mercury is conducted and is discussed under Sect. 4.4.2, Ambient Air.

The old Y-12 Steam Plant emissions, due to the combustion of coal, contain hazardous air pollutants such as mercury, hydrogen chloride, and other metals and gaseous hazardous air pollutants. In 2007 the EPA vacated a proposed MACT, which was intended to minimize hazardous air pollution emissions. The old Y-12 Steam Plant would have become subject to certain elements of the new rule effective in 2007 had the rule not been vacated. The new natural-gas-fired steam plant came on-line on April 20, 2010, and coal is no longer combusted, prior to the rule becoming effective in 2011. In 2007, a case-by-case MACT review was conducted as part of the construction permitting process for the Y-12 replacement steam plant. Specific conditions aimed at minimizing hazardous air pollutant emission from the new steam plant will be incorporated into the operating permit for the new source.

Unplanned releases of hazardous air pollutants are regulated through the Risk Management Planning regulations. Y-12 Complex personnel have determined that there are no processes or facilities containing inventories of chemicals in quantities exceeding thresholds specified in rules pursuant to Clean Air Act, Title III, Sect.112(r), “Prevention of Accidental Releases.” Therefore, the Y-12 Complex is not subject to that rule. Procedures are in place to continually review new processes and/or process changes against the rule thresholds.

4.4.2 Ambient Air

To understand the complete picture of ambient air monitoring in and around the Y-12 Complex, data from monitoring conducted on and off site specifically for Y-12, DOE reservation-wide monitoring, and on-site and off-site monitoring conducted by TDEC personnel must be considered. There are no federal regulations, state regulations, or DOE orders that require ambient air monitoring within the Y-12 Complex boundary; however, on-site ambient air monitoring for mercury and radionuclides is conducted as a best management practice. With the reduction of plant operations and improved emission and administrative controls, levels of measured pollutants have decreased significantly during the past several years. In addition, major processes that result in emission of enriched and depleted uranium are equipped with stack samplers that have been reviewed and approved by EPA to meet requirements of the NESHAP regulations.

4.4.2.1 Mercury

The Y-12 Complex ambient air monitoring program for mercury was established in 1986 as a best management practice. The objectives of the program have been to maintain a database of mercury concentrations in ambient air, to track long-term spatial and temporal trends in ambient mercury vapor, and to demonstrate protection of the environment and human health from releases of mercury to the atmosphere at Y-12. Originally, four monitoring stations were operated at Y-12, including two within the former mercury-use area near the west end of Y-12. The two atmospheric mercury monitoring stations currently operating at Y-12, Ambient Air Station No. 2 (AAS2) and Ambient Air Station No. 8 (AAS8), are located near the east and west boundaries of Y-12, respectively (Fig. 4.23). Since their establishment in 1986, AAS2 and AAS8 have monitored mercury in ambient air continuously with the exception of short intervals of downtime because of electrical or equipment outages. In addition to the monitoring stations located at Y-12, a control or reference site (Rain Gauge No. 2) was operated on Chestnut Ridge in the Walker Branch Watershed for a 20-month period in 1988 and 1989 to establish a reference concentration.

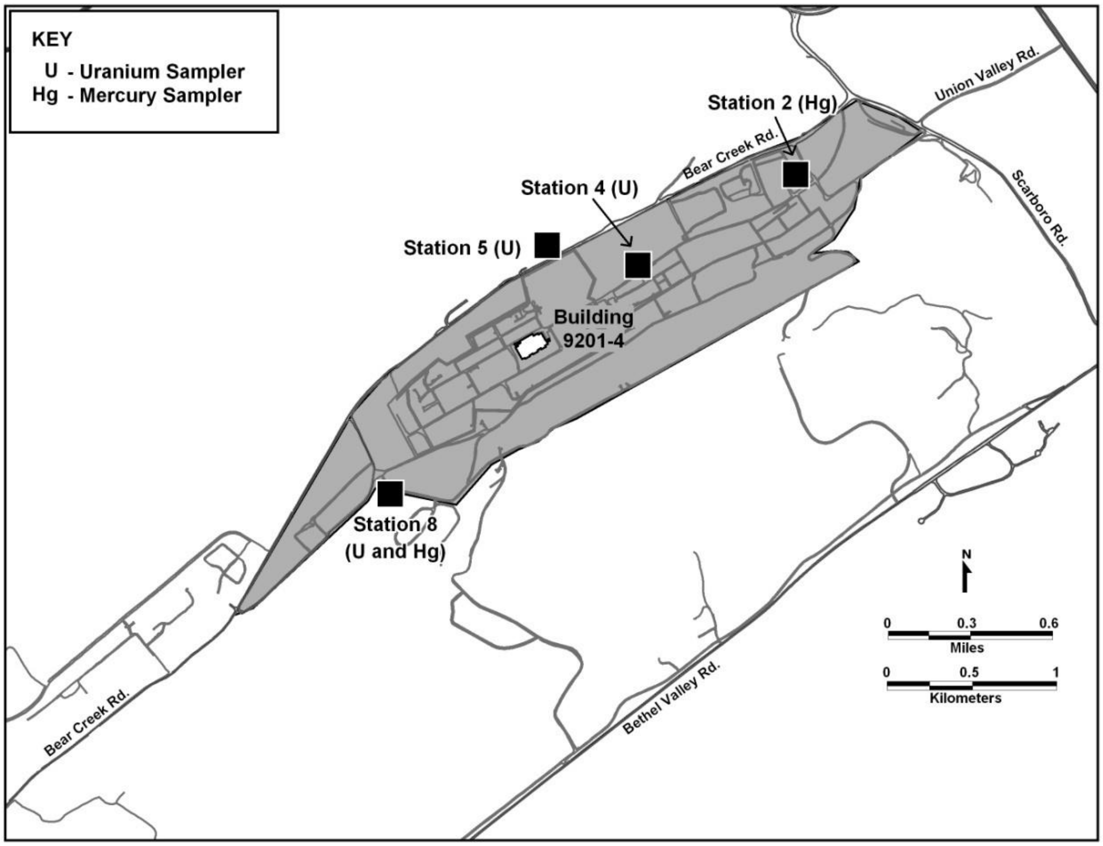

Fig. 4.23. Locations of ambient air monitoring stations at the Y-12 Complex.

In order to determine mercury concentrations in ambient air, airborne mercury vapor is collected by pulling ambient air through a sampling train consisting of a Teflon filter and an iodated-charcoal sampling trap. A flow-limiting orifice upstream of the sampling trap restricts airflow through the sampling train to ~1 L/min. Actual flows are measured weekly with a calibrated Gilmont flowmeter in conjunction with the weekly change-out of the sampling trap. The charcoal in each trap is analyzed for total mercury using cold vapor atomic fluorescence spectrometry after acid digestion. The average concentration of mercury vapor in ambient air for each 7-day sampling period is calculated by dividing the total mercury per trap by the volume of air pulled through the charcoal trap during the corresponding sampling period.

As reported previously, the average mercury concentration at the ambient air monitoring sites has declined significantly since the late 1980s. Recent average annual concentrations at the two boundary stations are comparable to concentrations measured in 1988 and 1989 at the Chestnut Ridge reference site (Table 4.11). The average mercury concentration at the AAS2 site for 2010 was 0.0035 $\mu g/m^3$ (N = 49), comparable to averages measured since 2003 though higher than reported for 2009 (i.e., 0.0030 $\mu g/m^3$).

Table 4.11. Summary of data for the Oak Ridge Y-12 National Security Complex ambient air monitoring program for mercury for CY2010. The averages for 1986 through 1988, a period of elevated mercury concentration, are also shown for comparison

Ambient air monitoring stations	Mercury vapor concentration (μg/m³)			
	2010 Minimum	2010 Maximum	2010 Average	1986–1988[a] Average
AAS2 (east end of the Y-12 Complex)	0.0007	0.012	0.0035	0.010
AAS8 (west end of the Y-12 Complex)	0.0011	0.013	0.0050	0.033
Reference Site, Rain Gauge No.2 (1988[b])	N/A	N/A	N/A	0.006
Reference Site, Rain Gauge No.2 (1989[c])	N/A	N/A	N/A	0.005

[a]Period in late-80s with elevated ambient air mercury levels.
[b]Data for period from February 9 through December 31, 1988.
[c]Data for period from January 1 through October 31, 1989.

After noting a gradual increase in average annual concentration at AAS8 for the period 2005 through 2007 (thought to be perhaps due to increased excavation and decontamination and decommissioning work on the west end during this period), the average concentration at AAS8 for 2010 was 0.0050 μg/m³ (N = 49) or similar to levels recorded in 2008 and the early 2000s.

Table 4.11 summarizes the 2010 mercury results and results from the 1986 through 1988 period for comparison. Figure 4.24 illustrates temporal trends in mercury concentration for the two active mercury monitoring sites since the inception of the program in 1986 through 2010 (plots 1, 2) and seasonal trends at AAS8 from 1993 through 2010 (plot 3). The dashed line superimposed on plots 1 and 2 is the EPA reference concentration (RfC) of 0.3 μg/m³ for chronic inhalation exposure. The large increase in Hg concentration at AAS8 observed in the late 1980s (plot 2) was thought to be related to disturbances of Hg-contaminated soils and sediments during the Perimeter Intrusion Detection Assessment System and utility restoration projects under way then in West End Mercury Area. In plot 3, a monthly moving average has been superimposed over the AAS8 data to highlight seasonal trends in mercury at AAS8 from January 1993 through 2010.

In conclusion, 2010 average mercury concentrations at the two mercury monitoring sites are comparable to reference levels measured for the Chestnut Ridge reference site in 1988 and 1989. Measured concentrations continue to be well below current environmental and occupational health standards for inhalation exposure to mercury vapor, that is, the National Institute for Occupational Safety and Health recommended exposure limit of 50 μg/m³ (time-weighted average or TWA for up to a 10-h workday, 40-h workweek), the American Conference of Governmental Industrial Hygienists workplace threshold limit value of 25 μg/m³ as a TWA for a normal 8-h workday and 40-h workweek, and the current EPA reference concentration (RfC = 0.3 μg/m³) for elemental mercury for daily inhalation exposure without appreciable risk of harmful effects during a lifetime.

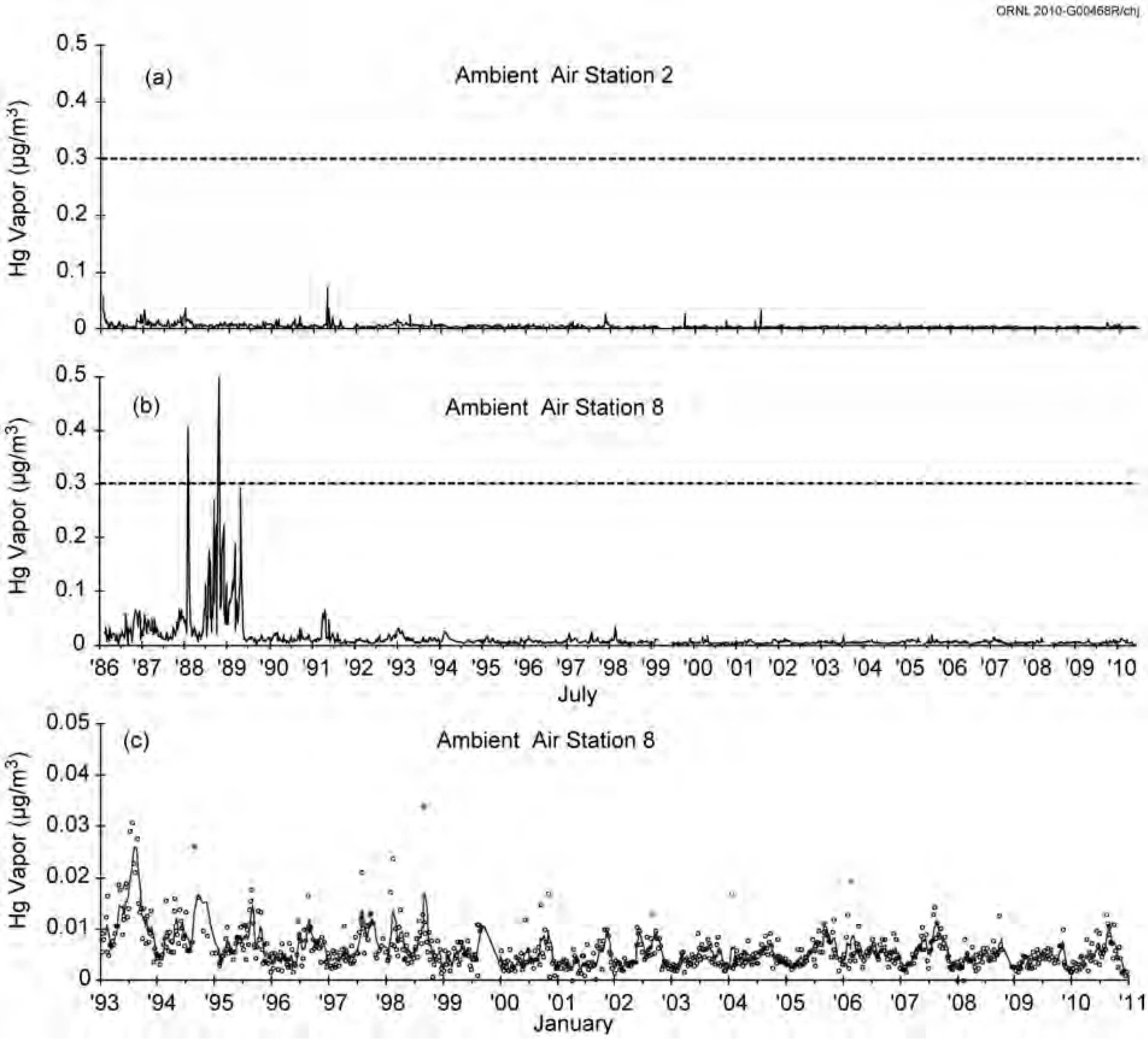

Fig. 4.24. Temporal trends in mercury vapor concentration for the boundary monitoring stations at the Y-12 National Security Complex, July 1986 to January 2011 (plots 1 and 2) and January 1993 to January 2011 for AAS8 (plot 3).

4.4.2.2 Quality Control

A number of QA/QC steps are taken to ensure the quality of the data for the Y-12 mercury in ambient air monitoring program.

An hour meter records the actual operating hours between sample changes. This allows for correction of total flow in the event of power outages during the weekly sampling interval.

The Gilmont correlated flowmeter used for measuring flows through the sampling train is purchased new each year or, if not new, is shipped back to the manufacturer annually for calibration traceable to the National Institute of Standards and Technology.

A minimum of 5% of the samples in each batch submitted to the analytical laboratory are blank samples. The blank sample traps are submitted “blind” to verify trap blank values and to serve as a field blank for diffusion of mercury vapor into used sample traps during storage prior to analysis.

In order to verify the absence of mercury breakthrough, 5 to 10% of the field samples have the front (upstream) and back segments of the charcoal sample trap analyzed separately. The absence of mercury above blank values on the back segment confirms the absence of breakthrough.

Chain-of-custody forms track the transfer of sample traps from the field technicians all the way to the analytical laboratory.

A field performance evaluation is conducted annually by the project manager to ensure that proper procedures are followed by the sampling technicians. No issues were identified in the last evaluation conducted March 25, 2009.

Analytical QA/QC requirements include

- use of prescreened and/or laboratory purified reagents,
- analysis of at least two method blanks per batch,
- analysis of standard reference materials,
- analysis of laboratory duplicates (one per 10 samples; any laboratory duplicates differing by more than 10% at five or more times the detection limit are to be rerun [third duplicate] to resolve the discrepancy), and
- archival of all primary laboratory records for at least 1 year.

4.4.2.3 Ambient Air Monitoring Complementary to the Y-12 Ambient Air Monitoring

Ambient air monitoring is conducted at multiple locations near the ORR to measure radiological and other selected parameters directly in the ambient air. These monitors are operated in accordance with DOE orders. Their locations were selected so that areas of potentially high exposure to the public are monitored continuously for parameters of concern. This monitoring provides direct measurement of airborne concentrations of radionuclides and other hazardous air pollutants, allows facility personnel to determine the relative level of contaminants at the monitoring locations during an emergency, verifies that the contributions of fugitive and diffuse sources are insignificant, and serves as a check on dose-modeling calculations. As part of the ORR network, an ambient air monitoring station located in the Scarboro Community of Oak Ridge (Station 46) measures off-site impacts of the Y-12 operations. This station is located near the theoretical area of maximum public pollutant concentrations as calculated by air-quality modeling. ORR network stations are also located at the east end of the Y-12 Complex (Station 40) and just south of the Country Club Estates neighborhood (Station 37).

The state of Tennessee is primarily responsible for ambient air monitoring to characterize the region in general and to characterize and monitor DOE operations specifically. This is accomplished in numerous ways. Specific to Y-12 operations, there are three uranium ambient air monitors within the Y-12 Complex boundary that, since 1999, have been utilized by TDEC personnel in their environmental monitoring program. Each of the monitors uses 47-mm borosilicate glass-fiber filters to collect particulates as air is pulled through the units. The monitors control airflow with a pump and rotometer set to average approximately 2 standard cubic feet per minute.

In addition, TDEC DOE Oversight Division air quality monitoring includes several other types of monitoring on the ORR, for example,

- RADNet air monitoring,
- fugitive radioactive air emission monitoring,
- ambient VOC air monitoring,
- perimeter air monitoring,
- real-time monitoring of gamma radiation,
- ambient gamma radiation monitoring using external dosimetry, and
- program-specific monitoring associated with infrastructure-reduction activities.

Results of these activities are summarized in annual status reports, which are issued by the TDEC DOE Oversight Division.

The state of Tennessee also operates a number of regional monitors to assess ambient concentrations of criteria pollutants such as sulfur dioxide, particulate (various forms), and ozone, for comparison against ambient standards. The results are summarized and available through EPA and state reporting mechanisms.

4.5 Water Quality Program

4.5.1 NPDES Permit and Compliance Monitoring

The current Y-12 NPDES permit (TN0002968) requires sampling, analysis, and reporting for approximately 65 outfalls. Major outfalls are noted in Fig. 4.25. The number is subject to change as outfalls are eliminated or consolidated or if permitted discharges are added. Currently, the Y-12 Complex has outfalls and monitoring points in the following water drainage areas: East Fork Poplar Creek, Bear Creek, and several tributaries on the south side of Chestnut Ridge, all of which eventually drain to the Clinch River.

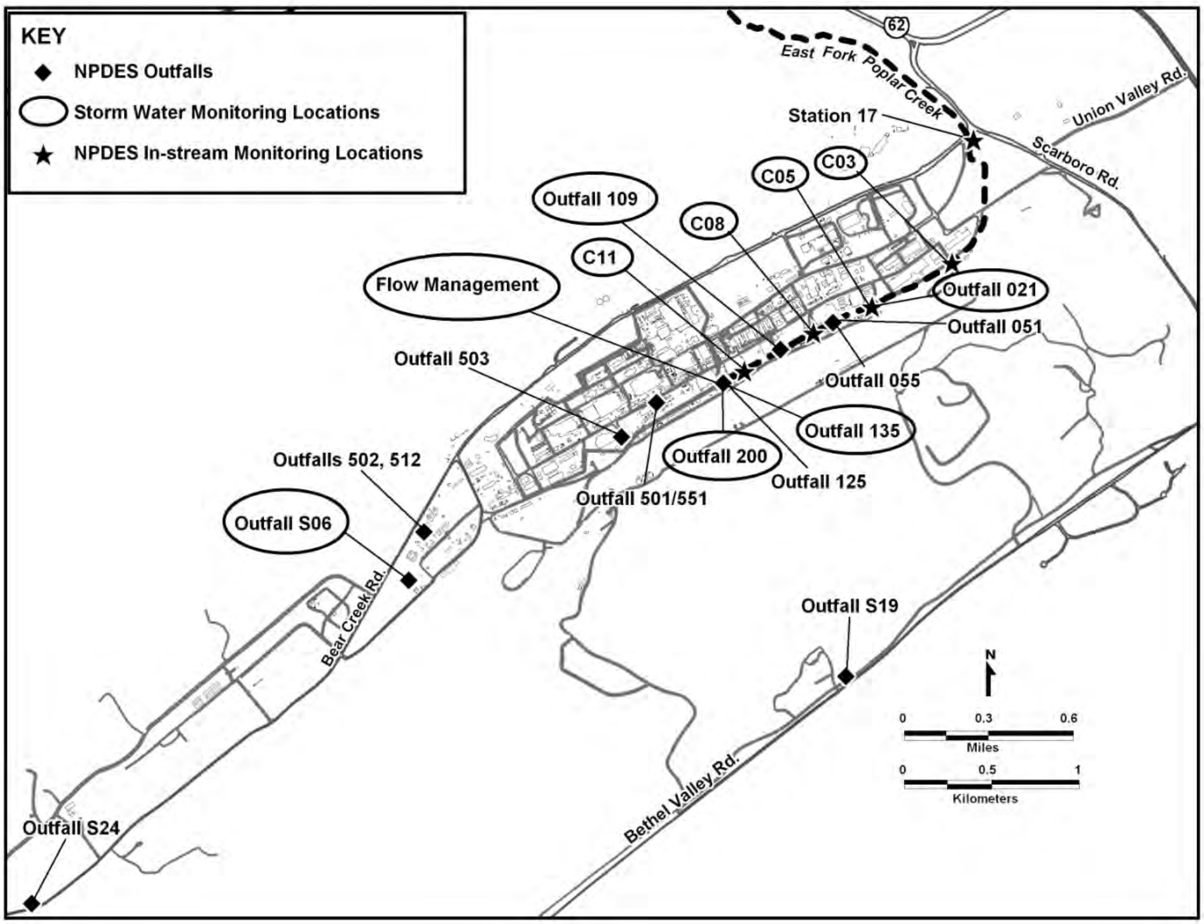

Fig. 4.25. Major Y-12 Complex National Pollutant Discharge Elimination System (NPDES) outfalls and storm water monitoring locations.

Discharges to surface water allowed under the permit include storm drainage, cooling water, cooling tower blowdown, steam condensate, and treated process wastewaters, including effluents from wastewater treatment facilities. Groundwater inflow into sumps in building basements and infiltration to the storm drain system are also permitted for discharge to the creek. The monitoring data collected by the sampling and analysis of permitted discharges are compared with NPDES limits where applicable for each parameter. Some parameters, defined as "monitor only," have no specified limits.

The water quality of surface streams in the vicinity of the Y-12 Complex is affected by current and legacy operations. Discharges from the Y-12 Complex processes flow into East Fork Poplar Creek before the water exits the Y-12 Complex. East Fork Poplar Creek eventually flows through the city of Oak Ridge to Poplar Creek and into the Clinch River. Bear Creek water quality is affected by area source runoff and groundwater discharges. The NPDES permit requires regular monitoring and storm water characterization in Bear Creek and several of its tributaries.

Requirements of the NPDES permit for 2010 were satisfied, and monitoring of outfalls and instream locations indicated excellent compliance. Data obtained as part of the NPDES program are provided in a monthly report to the TDEC. The percentage of compliance to the permit for 2010 was >99.9%. The only 2010 NPDES permit limit excursion occurred when the measured cadmium value at Outfall 200, 0.00118 mg/L, exceeded the permit limit of 0.001 mg/L on December 8, 2010. At the time of the reading, there were no observed adverse effects on the receiving stream. An accidental discharge of 300 gallons of lime slurry which overflowed a process tank at the Steam Plant Wastewater Treatment Facility on August 29, 2010, resulted in a second NPDES noncompliance. A portion of the discharge reached East Fork Polar Creek through Outfall 200. Thirty-three dead minnows were found in the upper portion of the creek following this incident.

Dechlorination treatment in the upper reach of EFPC provided excellent control of chlorinated discharges, and toxicity testing results of three outfalls in the upper reach have shown no toxicity. Table 4.12 lists the NPDES compliance monitoring requirements and the 2010 compliance record.

4.5.2 Radiological Monitoring Plan and Results

A radiological monitoring plan is in place at the Y-12 Complex to address compliance with DOE orders and NPDES Permit TN002968. The permit requires the Y-12 Complex to submit results from the radiological monitoring plan quarterly as an addendum to the NPDES discharge monitoring report. There were no discharge limits set by the NPDES permit for radionuclides; the requirement is to monitor and report. The radiological monitoring plan was developed based on an analysis of operational history, expected chemical and physical relationships, and historical monitoring results. Under the existing plan, effluent monitoring is conducted at three types of locations: (1) treatment facilities, (2) other point-source and area-source discharges, and (3) instream locations. Operational history and past monitoring results provide a basis for parameters routinely monitored under the plan (Table 4.13). The current *Radiological Monitoring Plan for Y-12 Complex* (Y-12 2010b) was last revised and reissued in June 2010.

Radiological monitoring during storm water events is accomplished as part of the storm water monitoring program. Uranium is monitored at three major East Fork Poplar Creek storm water outfalls, four instream monitoring locations as well as raw water flow, and at an instream outfall on Bear Creek. Results of storm event monitoring during 2010 were reported in *Annual Storm Water Report for the Y-12 National Security Complex, Oak Ridge, Tennessee* (B&W Y-12 2011), which was issued in January 2011. In addition, the monthly 7-day composite sample for radiological parameters taken at Station 17 on East Fork Poplar Creek likely includes rain events.

Radiological monitoring plan locations sampled in 2010 are noted in Fig. 4.26. Table 4.14 identifies the monitored locations, the frequency of monitoring, and the sum of the percentages of the derived concentration guidelines (DCGs) for radionuclides measured in 2010. Radiological data were well below the allowable DCGs.

Table 4.12. NPDES compliance monitoring requirements and record for the Y-12 Complex, January through December 2010

Discharge point	Effluent parameter	Daily avg (lb/d)	Daily max (lb/d)	Daily avg (mg/L)	Daily max (mg/L)	Percentage of compliance	Number of samples
Outfall 501 (Central Pollution Control)	pH, standard units			*a*	9.0	*b*	0
	Total suspended solids			31.0	40.0	*b*	0
	Total toxic organic				2.13	*b*	0
	Hexane extractables			10	15	*b*	0
	Cadmium	0.16	0.4	0.075	0.15	*b*	0
	Chromium	1.0	1.7	0.5	1.0	*b*	0
	Copper	1.2	2.0	0.5	1.0	*b*	0
	Lead	0.26	0.4	0.1	0.2	*b*	0
	Nickel	1.4	2.4	2.38	3.98	*b*	0
	Nitrate/Nitrite				100	*b*	0
	Silver	0.14	0.26	0.05	0.05	*b*	0
	Zinc	0.9	1.6	1.48	2.0	*b*	0
	Cyanide	0.4	0.72	0.65	1.20	*b*	0
	PCB				0.001	*b*	0
Outfall 502 (West End Treatment Facility)	pH, standard units			*a*	9.0	100	6
	Total suspended solids	19	36.0	31.0	40.0	100	6
	Total toxic organic				2.13	100	1
	Hexane extractables			10	15	100	6
	Cadmium	0.16	0.4	0.075	0.15	100	6
	Chromium	1.0	1.7	0.5	1.0	100	6
	Copper	1.2	2.0	0.5	1.0	100	6
	Lead	0.26	0.4	0.10	0.20	100	6
	Nickel	1.4	2.4	2.38	3.98	100	6
	Nitrate/Nitrite				100	100	6
	Silver	0.14	0.26	0.05	0.05	100	6
	Zinc	0.9	1.6	1.48	2.0	100	6
	Cyanide	0.4	0.72	0.65	1.20	100	6
	PCB				0.001	100	3
Outfall 503 (West End Treatment Facility)	pH, standard units			*a*	9.0	*b*	0
	Total suspended solids	125	417	30.0	40.0	*b*	0
	Hexane extractables	63	83.4	10	15	*b*	0
	Iron	20.8	20.8	5.0	5.0	*b*	0
	Cadmium	0.16		0.075	0.15	*b*	0
	Chromium	0.8	0.8	0.20	0.20	*b*	0
	Copper	4.17	4.17	0.20	0.40	*b*	0
	Lead			0.10	0.20	*b*	0
	Zinc	4.17	4.17	1.0	1.0	*b*	0

Table 4.12. (continued)

Discharge point	Effluent parameter	Daily avg (lb/d)	Daily max (lb/d)	Daily avg (mg/L)	Daily max (mg/L)	Percentage of compliance	Number of samples
Outfall 512 (Groundwater Treatment Facility)	pH, standard units			*a*	9.0	100	12
	PCB				0.001	100	4
Outfall 520	pH, standard units			*a*	9.0	100	19
Outfall 200 (North/South pipes)	pH, standard units			*a*	9.0	100	54
	Hexane extractables			10	15	100	53
	Cadmium			0.001	0.025	92	12
	Lead			0.041	1.190	100	12
	PCB			0.002	0.002	100	4
Outfall 550	pH, standard units			*a*	9.0	*b*	0
	Mercury			0.002	0.004	*b*	0
Outfall 551	pH, standard units			*a*	9.0	100	52
	Mercury			0.002	0.004	100	52
Outfall 051	pH, standard units			*a*	9.0	100	13
Outfall 135	pH, standard units			*a*	9.0	100	12
	Lead			0.04	1.190	100	12
	PCB			0.002	0.002	100	4
Outfall 125	pH, standard units			*a*	9.0	100	12
	Cadmium			0.001	0.025	100	12
	Lead			0.04	1.190	100	12
	PCB			0.002	0.002	100	4
Outfall 055	pH, standard units			*a*	9.0	100	13
	Mercury				0.004	100	46
	Total Residual Chlorine				0.5	100	3
Outfall 109	pH, standard units			*a*	9.0	100	5
	Total Residual Chlorine				0.5	100	4
Outfall 021	pH, standard units			*a*	9.0	100	5
	Total Residual Chlorine				0.188	100	4
Outfall 077	pH, standard units			*a*	9.0	b	0
Outfall EFP	pH, standard units			*a*	9.0	100	209

Table 4.12. (continued)

Discharge point	Effluent parameter	Daily avg (lb/d)	Daily max (lb/d)	Daily avg (mg/L)	Daily max (mg/L)	Percentage of compliance	Number of samples
Outfall C11	pH, standard units			*a*	9.0	100	26
	Total residual chlorine				0.019	100	24
	Temperature (°C)				30.5	100	25
Outfall S06	pH, standard units			*a*	9.0	100	2
Outfall S19	pH, standard units			*a*	9.0	100	1
Outfall S24	pH, standard units			*a*	9.0	100	4
Category I outfalls	pH, standard units			*a*	9.0	100	20
Category II outfalls	pH, standard units			*a*	9.0	100	30
	Total Residual Chlorine				0.5	100	31
Category III outfalls	pH, standard units			*a*	9.0	100	11
	Total residual chlorine				0.5	100	10

[a] Not applicable.
[b] No discharge.

Table 4.13. Radiological parameters monitored at the Y-12 Complex, 2010

Parameters	Specific isotopes	Rationale for monitoring
Uranium isotopes	^{238}U, ^{235}U, ^{234}U, total U, weight % ^{235}U	These parameters reflect the major activity, uranium processing, throughout the history of Y-12 and are the dominant detectable radiological parameters in surface water
Fission and activation products	^{90}Sr, ^{3}H, ^{99}Tc, ^{137}Cs	These parameters reflect a minor activity at Y-12, processing recycled uranium from reactor fuel elements, from the early 1960s to the late 1980s, and will continue to be monitored as tracers for beta and gamma radionuclides, although their concentrations in surface water are low
Transuranium isotopes	^{241}Am, ^{237}Np, ^{238}Pu, $^{239/240}Pu$	These parameters are related to recycle uranium processing. Monitoring has continued because of their half-lives and presence in groundwater
Other isotopes of interest	^{232}Th, ^{230}Th, ^{228}Th, ^{226}Ra, ^{228}Ra	These parameters reflect historical thorium processing and natural radionuclides necessary to characterize background radioisotopes

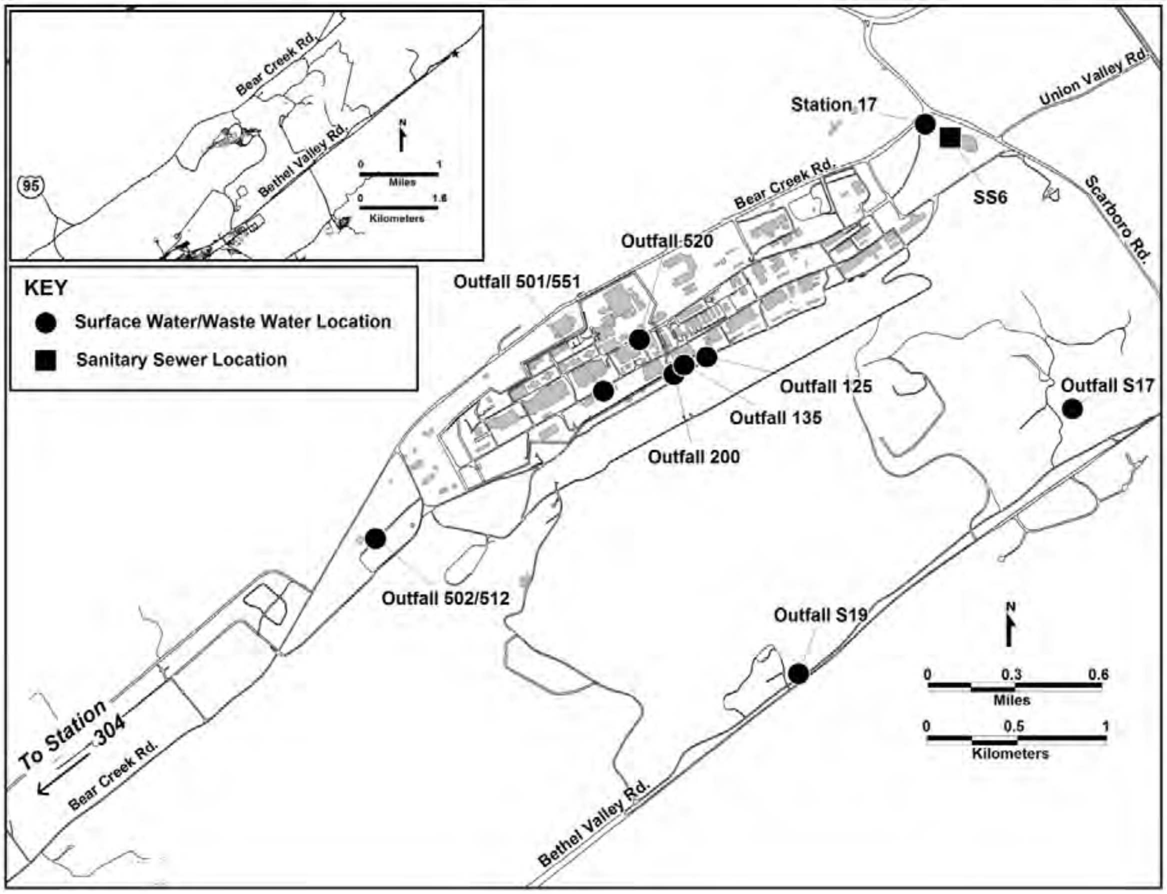

Fig. 4.26. Surface water and sanitary sewer radiological sampling locations at the Y-12 Complex.

Table 4.14. Summary of Y-12 Complex Radiological Monitoring Plan sample requirements and 2010 results

Outfall no.	Location	Sample frequency	Sample type	Sum of DCG percentage
	Y-12 Complex wastewater treatment facilities			
501	Central Pollution Control Facility	1/month	Composite during batch operation	No flow
502	West End Treatment Facility	1/batch	24-h composite	3.8
512	Groundwater Treatment Facility	4/year	24-h composite	2.5
520	Steam condensate	1/year	Grab	0.2
551	Central Mercury Treatment Facility	4/year	24-h composite	1.1
	Other Y-12 Complex point and area source discharges			
125	Outfall 125	4/year	24-h composite	5.2
135	Outfall 135	4/year	24-h composite	2.5
S17	Kerr Hollow Quarry	1/year	24-h composite	3.5
S19	Rogers Quarry	1/year	24-h composite	0
	Y-12 Complex instream locations			
S24	Outfall S24	4/year	7-day composite	5.7
Station 17	East Fork Poplar Creek, complex exit (east)	1/month	7-day composite	1.2
200	North/south pipes	1/month	24-h composite	4.3
	Y-12 Complex Sanitary Sewer			
SS6	East End Sanitary Sewer Monitoring Station	1/week	7-day composite	5.6

In 2010, the total mass of uranium and associated curies released from the Y-12 Complex at the easternmost monitoring station, Station 17 on Upper East Fork Poplar Creek, was 326 kg or 0.075 Ci (Table 4.15). Figure 4.27 illustrates a 5-year trend of these releases. The total release is calculated by multiplying the average concentration (grams per liter) by the average flow (million gallons per day). Converting units and multiplying by 365 days per year yields the calculated discharge. The increase in uranium quantity in 2010 may be the result of higher rainfall and subsequent movement of sediment and runoff from surfaces such as rooftops.

Table 4.15. Release of uranium from the Y-12 Complex to the off-site environment as a liquid effluent, 2006–2010

Year	Quantity released	
	Ci[a]	kg
	Station 17	
2006	0.050	131
2007	0.036	70
2008	0.046	75
2009	0.067	187
2010	0.075	326

[a]1 Ci = 3.7E+10 Bq.

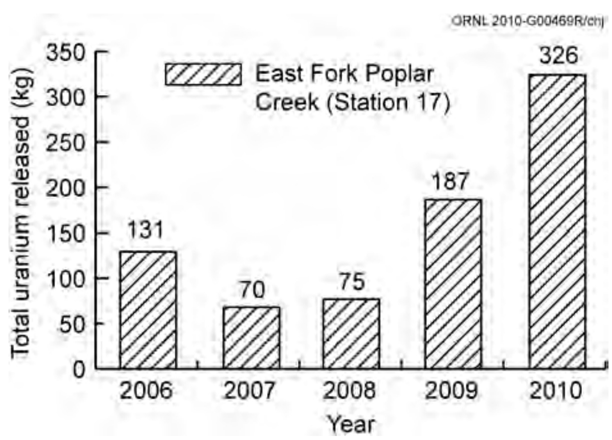

Fig. 4.27. Five-year trend of Y-12 Complex release of uranium to East Fork Poplar Creek.

The Y-12 Complex is permitted to discharge domestic wastewater to the city of Oak Ridge's publicly owned treatment works. Radiological monitoring of the sanitary sewer system discharge is conducted and reported to the city of Oak Ridge, although there are no city-established radiological limits. Potential sources of radionuclides discharging to the sanitary sewer have been identified in previous studies at the Y-12 Complex as part of an initiative to meet the "as low as reasonably achievable" goals. Results of radiological monitoring are reported to the city of Oak Ridge in a quarterly monitoring report.

4.5.3 Storm Water Pollution Prevention

The development and implementation of a storm water pollution prevention plan at the Y-12 Complex is designed to minimize the discharge of pollutants in storm water runoff. The plan identifies areas that can reasonably be expected to contribute contaminants to surface water bodies via storm water runoff and describes the development and implementation of storm water management controls to reduce or eliminate the discharge of such pollutants. This plan requires (1) characterization of storm water by sampling during storm events, (2) implementation of measures to reduce storm water pollution, (3) facility inspections, and (4) employee training.

The NPDES permit defines the primary function of the Y-12 Complex to be a fabricated metal products industry. However, it also requires that storm water monitoring be conducted for three additional sectors: scrap/waste recycling activities; landfill and land application activities; and discharges associated with treatment, storage, and disposal facilities as they are defined in the Tennessee Storm Water Multi Sector General Permit for Industrial Activities (TNR050000). Each sector has prescribed cut-off concentration values and some have defined sector mean values. The "rationale" portion of the NPDES permit for the Y-12 Complex states "cut-off concentrations were developed by the EPA and the state of Tennessee and are based on data submitted by similar industries for the development of the multi-sector general storm water permit. The cut-off concentrations are target values and should not be construed to represent permit limits." Similarly, sector mean values are defined as "a pollutant concentration calculated from all sampling results provided from facilities classified in this sector during the previous term limit."

Storm water sampling was conducted for 2010 during rain events that occurred in August, September, and October. Results were published in the *Annual Storm Water Report for the Y-12 National Security Complex, Oak Ridge, Tennessee* (B&W Y-12 2011), which was submitted to the Division of Water Pollution Control in January 2011. Per the NPDES permit, storm water monitoring is performed each year for sector outfalls, three major outfalls that drain large areas of the Y-12 Complex, raw water flow, and four instream monitoring locations on East Fork Poplar Creek (Fig. 4.25). The permit also calls for sampling of stream baseload sediment that is being transported due to the heavy flow. Sediment sampling is performed at the four instream locations.

In general, the quality of storm water exiting the Y-12 Complex via EFPC indicated some decline in 2010. However, this decline is attributable to construction, demolition, and remediation projects which have been or are scheduled to be completed in 2011. Increased emphasis will be placed on site inspections and the timely implementation of improved storm water control measures. As a proactive measure, additional storm water sampling of the suspect areas will be conducted in early 2011 (instead of waiting until late summer as noted in the NPDES permit).

4.5.4 Flow Management (or Raw Water)

Because of concern about maintaining water quality and stable flow in the upper reaches of East Fork Poplar Creek, the NPDES permit requires the addition of Clinch River water to the headwaters of East Fork Poplar Creek (North/South Pipe–Outfall 200 area) so that a minimum flow of 26 million liters (7 million gal) per day is maintained at the point where East Fork Poplar Creek leaves the reservation (Station 17). With the completion of the project, instream water temperatures decreased by approximately 5°C (from approximately 26°C at the headwaters).

A request to modify the NPDES permit to allow the minimum flow, measured at Station 17, to be reduced to 19 million liters (5 million gal) per day was made, and on December 30, 2008, TDEC modified the permit. The modified permit requires 19 million liters (5 million gal) rather than 26 million liters (7 million gal) minimum daily flow as measured at the Station 17 location. In addition to water conservation, this action offers the potential benefit of reducing the transport of mercury from a contaminated section of the streambed.

Discussions with city of Oak Ridge water system management regarding modification of the raw water supply system for EFPC have been conducted. During 2010 the raw water flow input to EFPC was reduced by approximately 1.5 million gal per day.

4.5.5 Y-12 Complex Ambient Surface Water Quality

To monitor key indicators of water quality, a network of real-time monitors located at three instream locations along Upper East Fork Poplar Creek is used. The Surface Water Hydrological Information Support System (SWHISS) is available for real-time water quality measurements, such as pH, temperature, dissolved oxygen, conductivity, and chlorine. The locations are noted in Fig. 4.28. The primary function of the SWHISS is to provide an indication of potential adverse conditions that could be causing an impact on the quality of water in Upper East Fork Poplar Creek. It is operated as a best management practice.

Additional sampling of springs and tributaries is conducted in accordance with the Y-12 Groundwater Protection Program to monitor trends throughout the three hydrogeologic regimes (see Sect. 4.6).

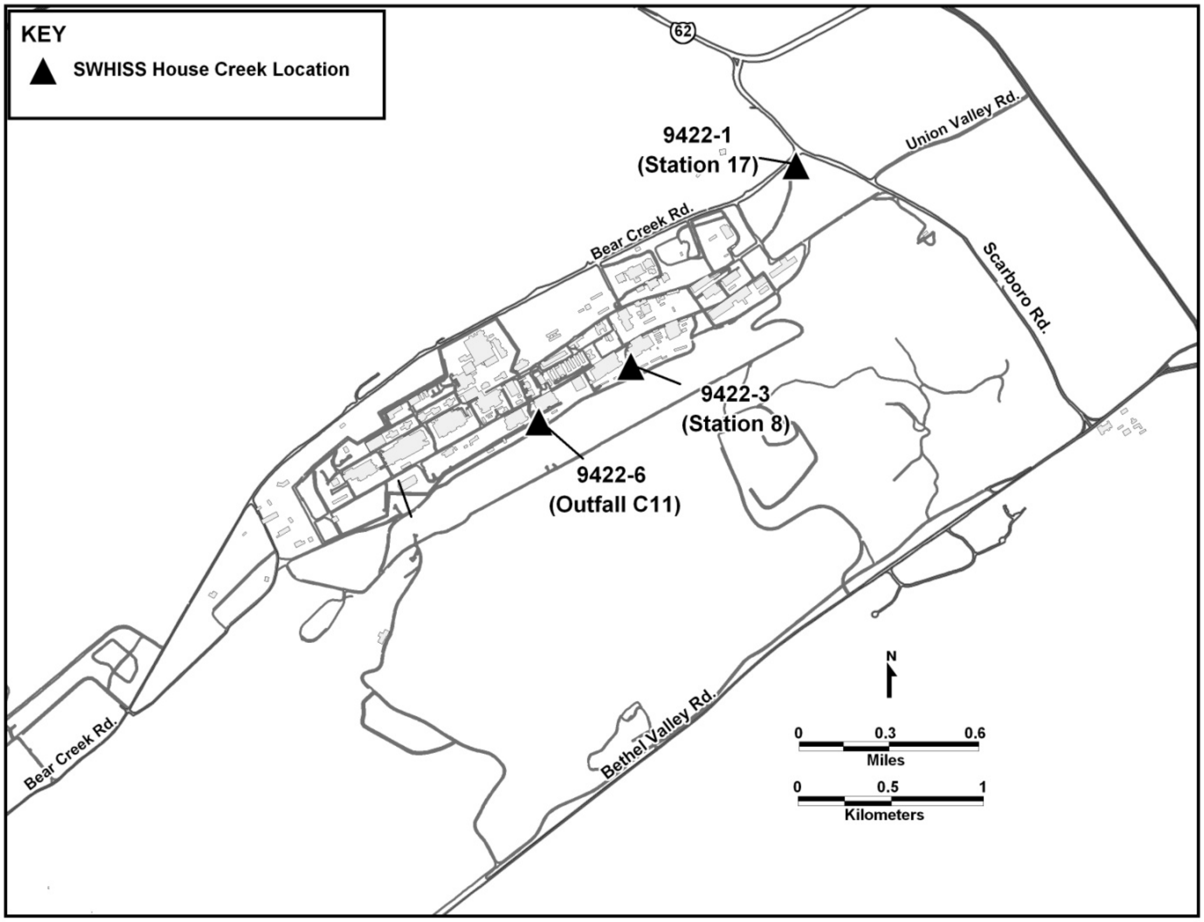

Fig. 4.28. Surface Water Hydrological Information Support System (SWHISS) monitoring locations.

4.5.6 Industrial Wastewater Discharge Permit

The Industrial and Commercial User Wastewater Discharge Permit No. 1-91 provides requirements for the discharge of wastewaters to the sanitary sewer system as well as prohibitions for certain types of wastewaters. It prescribes requirements for monitoring certain parameters at the East End Sanitary Sewer Monitoring Station. Limitations are set in the permit for most parameters. Samples for gross alpha, gross beta, and uranium are taken by a weekly 24-h composite sample. The sample is analyzed for uranium if the alpha and beta values exceed certain levels. Other parameters (including metals, oil and grease, solids, and biological oxygen demand) are monitored on a monthly basis. Organic parameters are monitored once per quarter. Results of compliance sampling are reported quarterly. Flow is measured 24 h per day at the monitoring station.

As part of the city of Oak Ridge's pretreatment program, city personnel use the monitoring station to conduct compliance monitoring as required by the pretreatment regulations. City personnel also conduct twice yearly compliance inspections. Monitoring results during 2010 (Table 4.16) indicate 11 exceedances of the permit in 2010. Three were for exceeding the discharge limit (monthly average) for total recoverable phenols, two were for exceeding the discharge limit (daily maximum) for total recoverable phenols, one was for exceeding the discharge limit (monthly average) for total oil and grease, one was for exceeding the discharge limit (daily maximum) for oil and grease, and four were for exceeding the maximum daily allowable flow limit.

Over the last several years, Y-12 personnel have conducted flow monitoring at key locations of the sanitary sewer system during wet and dry weather conditions. This effort has enabled a determination to be made of the general areas of the system most likely to contribute the greatest volume of infiltration or inflow of extraneous water into the lines. Examination of the data in 2009 led to the conclusion that inflow of surface water was the major contributor, and in November 2009, a plan was developed to conduct smoke tests of the lines to locate specific inflow problems. The testing effort was initiated in 2010 and is expected to be completed in 2011. During 2010 several minor inflow source corrections were made.

Table 4.16. Y-12 Complex Discharge Point SS6, Sanitary Sewer Station 6
(January through December 2010)

Effluent parameter	Number of samples	Daily average value (effluent limit)[a]	Daily maximum value (effluent limit)[b]	Percentage of compliance
Flow, mgd	365	*c*	1.4	99
pH, standard units	15	*c*	9/6[d]	100
Silver	15	0.05	0.1	100
Arsenic	15	0.01	0.015	100
Biochemical oxygen demand	15	200	300	100
Cadmium	15	0.0033	0.005	100
Chromium	15	0.05	0.075	100
Copper	15	0.14	0.21	100
Cyanide	15	0.041	0.062	100
Iron	15	10	15	100
Mercury	15	0.023	0.035	100
Kjeldahl nitrogen	15	45	90	100
Nickel	15	0.021	0.032	100
Oil and grease	16	25	50	94
Lead	15	0.049	0.074	100
Phenols—total recoverable	20	0.3	0.5	75
Suspended solids	15	200	300	100
Zinc	15	0.35	0.75	100

[a]Units in milligrams per liter unless otherwise indicated.
[b]Industrial and Commercial Users Wastewater Permit limits.
[c]Not applicable.
[d]Maximum value/minimum value.

4.5.7 Quality Assurance/Quality Control

The Environmental Monitoring Management Information System (EMMIS) is used to manage surface water monitoring data. EMMIS uses standard sample definitions to ensure that samples are taken at the correct location at a specified frequency using the correct sampling protocol.

Field sampling QA encompasses many practices that minimize error and evaluate sampling performance. Some key quality practices include the following:

- use of standard operating procedures for sample collection and analysis;
- use of chain-of-custody and sample identification, customized chain-of-custody documents, and sample labels provided by EMMIS;
- instrument standardization, calibration, and verification;
- sample technician training;
- sample preservation, handling, and decontamination; and
- use of QC samples, such as field and trip blanks, duplicates, and equipment rinses.

Surface water data are entered directly by the analytical laboratory into the Laboratory Information Management System (LIMS) on the day of approval. EMMIS routinely accesses LIMS electronically to capture pertinent data. Generally, the system will store the data in the form of concentrations.

A number of electronic data management tools enable automatic flagging of data points and allow for monitoring and trending data over time. Field information on all routine samples taken for surface water monitoring is entered in EMMIS, which also retrieves data nightly from the analytical laboratory. The system then performs numerous checks on the data, including comparisons of the individual results against any applicable screening criteria, regulatory thresholds, compliance limits, best management standards, or other water quality indicators, and produces required reports.

4.5.8 Biomonitoring Program

In accordance with the requirements of the 2006 NPDES permit (Part III-E, p. 9), a biomonitoring program is in place that evaluates three outfalls that discharge to the headwaters of East Fork Poplar Creek (Outfalls 200, 135, and 125). Water from each outfall was tested once in 2010 using fathead minnow larvae and *Ceriodaphnia dubia*. Table 4.17 summarizes the inhibition concentration (IC_{25}) results of biomonitoring tests conducted during 2010 at Outfalls 200, 135, and 125. The IC_{25} is the concentration of effluent that causes a 25% reduction in *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth. Thus, the lower the value, the more toxic the effluent. The IC_{25} was greater than the highest tested concentration of each effluent (100% for outfall 200, 20% for outfall 135, and 36% for outfall 125) for each test conducted, indicating that no toxicity was detected during 2010.

Table 4.17. Y-12 Complex Biomonitoring Program summary information[a] for Outfalls 200, 135, and 125 in 2010

Site	Test date	Species	IC_{25}[b] (%)
Outfall 200	12/7/10	*Ceriodaphnia*	>100
Outfall 200	12/7/10	Fathead minnow	>100
Outfall 135	12/9/10	*Ceriodaphnia*	>20
Outfall 135	12/9/10	Fathead minnow	>20
Outfall 125	12/9/10	*Ceriodaphnia*	>36
Outfall 125	12/9/10	Fathead minnow	>36

[a] The inhibition concentrations (IC_{25}) are summarized for the discharge monitoring locations, Outfalls 200, 135, and 125.

[b] IC_{25} as a percentage of full-strength effluent from outfalls 200, 135, and 125 diluted with laboratory control water. The IC_{25} is the concentration that causes a 25% reduction in *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth.

4.5.9 Biological Monitoring and Abatement Programs

The NPDES permit issued for the Y-12 Complex in 2006 mandates a Biological Monitoring and Abatement Program (BMAP) with the objective of demonstrating that the effluent limitations established for the facility protect the classified uses of the receiving stream, East Fork Poplar Creek. The BMAP, which has been monitoring the ecological health of East Fork Poplar Creek since 1985, currently consists of three major tasks that reflect complementary approaches to evaluating the effects of the Y-12 Complex discharges on the aquatic integrity of East Fork Poplar Creek. These tasks include (1) bioaccumulation monitoring, (2) benthic macroinvertebrate community monitoring, and (3) fish community monitoring. Data collected on contaminant bioaccumulation and the composition and abundance of communities of aquatic organisms provide a direct evaluation of the effectiveness of abatement and remedial measures in improving ecological conditions in the stream.

Monitoring is presently being conducted at five primary East Fork Poplar Creek sites, although sites may be excluded or added, depending upon the specific objectives of the various tasks. The primary sampling sites include upper East Fork Poplar Creek at East Fork Poplar Creek kilometer (EFK) 24.4 and 23.4 (upstream and downstream of Lake Reality, respectively); EFK 18.7 (also EFK 18.2), located off the ORR and below an area of intensive commercial and light industrial development; EFK 13.8, located upstream from the Oak Ridge Wastewater Treatment Facility; and EFK 6.3, located approximately 1.4 km below the ORR boundary (Fig. 4.29). Brushy Fork at Brushy Fork kilometer (BFK) 7.6 is used as a reference stream in two tasks of the BMAP. Additional sites off the ORR are also occasionally used for reference, including Beaver Creek, Bull Run, Cox Creek, Hinds Creek, Paint Rock Creek, and the Emory River in Watts Bar Reservoir (Fig. 4.30).

Significant increases in species richness and diversity in East Fork Poplar Creek over the last 2 decades demonstrate that the overall ecological health of the stream continues to improve. However, the pace of improvement in the upper reaches of East Fork Poplar Creek near the Y-12 Complex has slowed in recent years, and fish and invertebrate communities continue to be less diverse than the corresponding communities in reference streams.

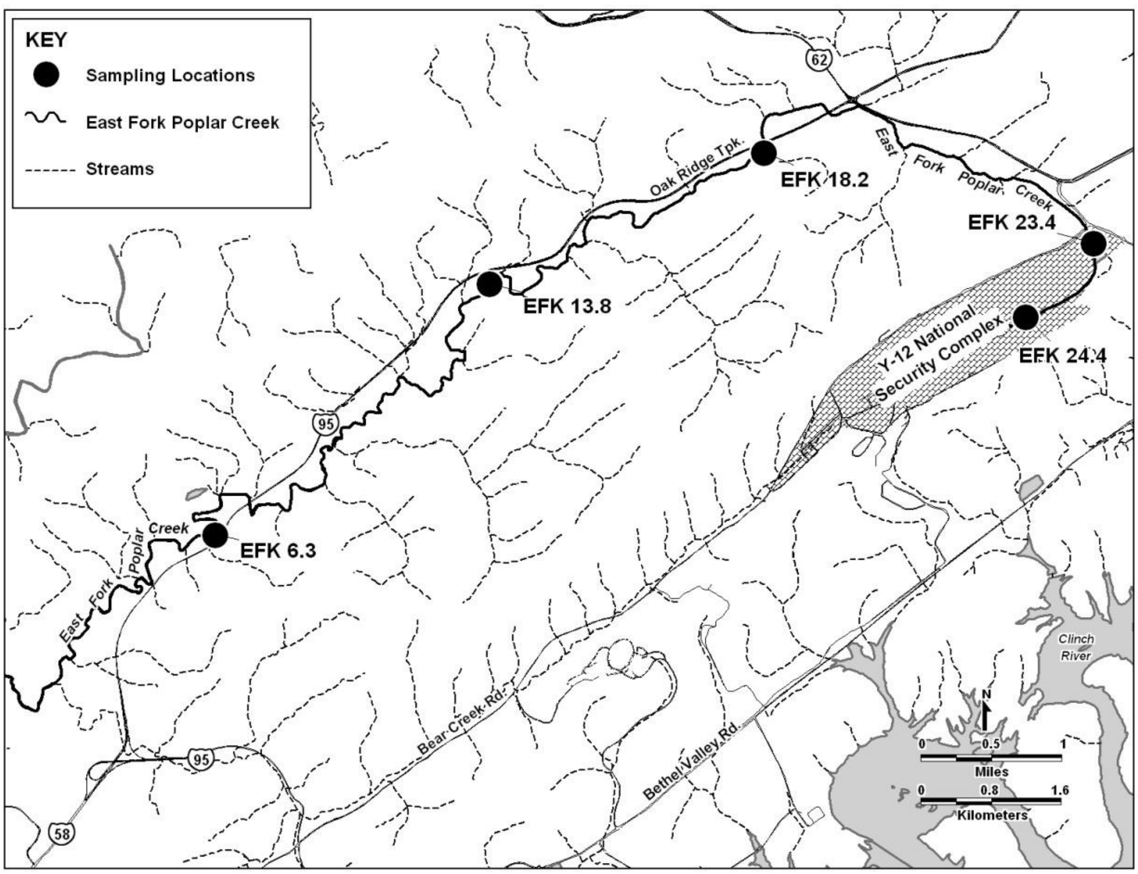

Fig. 4.29. Locations of biological monitoring sites on East Fork Poplar Creek in relation to the Oak Ridge Y-12 National Security Complex.

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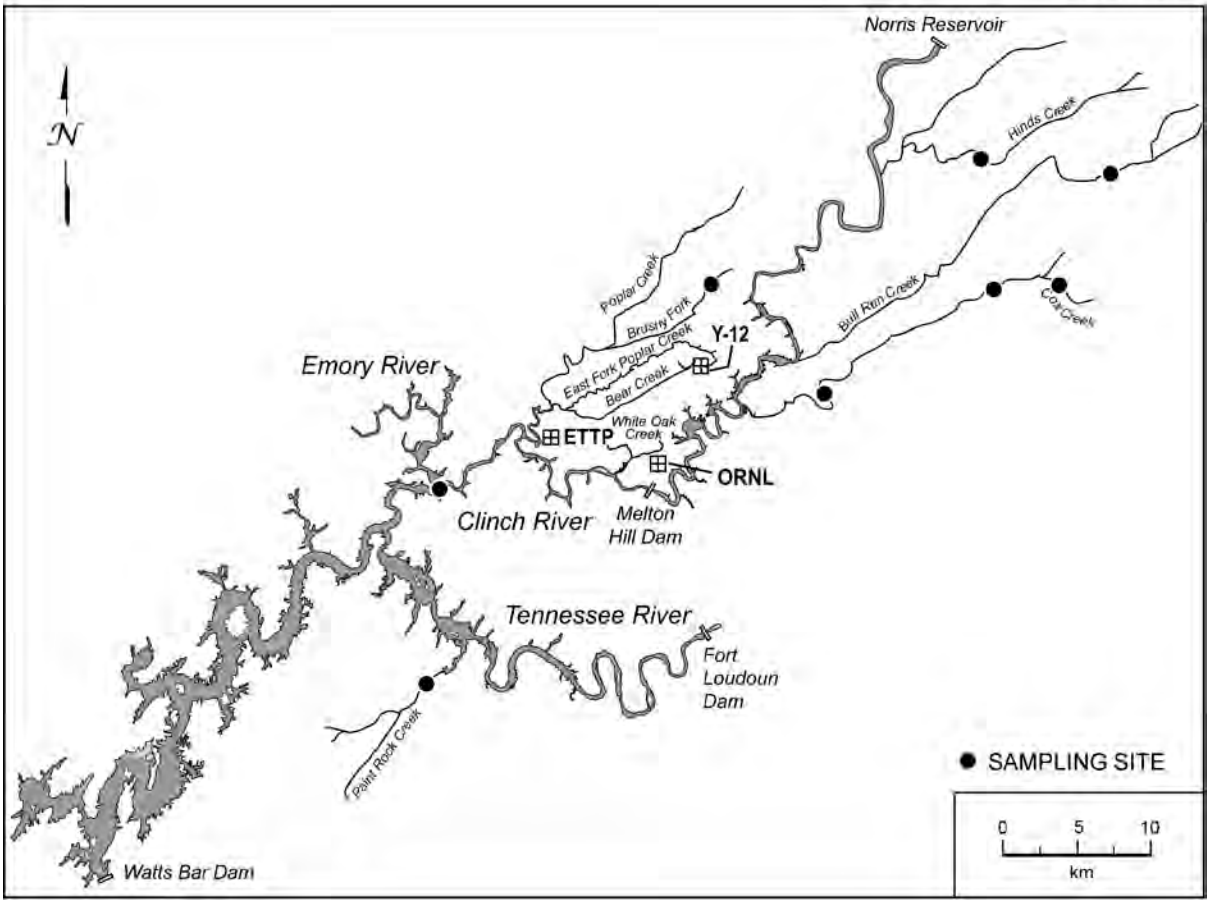

Fig. 4.30. Locations of biological monitoring reference sites in relation to the Oak Ridge Y-12 National Security Complex.

4.5.9.1 Bioaccumulation Studies

Mercury and PCB levels in fish from East Fork Poplar Creek (EFPC) have been historically elevated relative to fish in uncontaminated reference streams. Fish in EFPC are monitored regularly for mercury and PCBs to assess spatial and temporal trends in bioaccumulation associated with ongoing remedial activities and Y-12 Complex operations.

As part of this monitoring effort, redbreast sunfish (*Lepomis auritus*) and rock bass (*Ambloplites rupestris*) are collected twice a year from five sites throughout the length of EFPC and are analyzed for tissue concentrations of mercury (twice yearly) and PCBs (annually). Mercury concentrations remained higher in fish from East Fork Poplar Creek in 2010 than in fish from reference streams. Elevated mercury concentrations in fish from the upper reaches of EFPC indicate that the Y-12 Complex remains a continuing source of mercury to fish in the stream. Although waterborne mercury concentrations in the upper reaches of EFPC decreased substantially following the 2005 start-up of a treatment system on a mercury-contaminated spring (Fig. 4.31), mercury concentrations in fish have not yet decreased in response. Mean mercury concentrations in fish collected from this site were lower than in 2009 but comparable to the concentrations seen in recent years. In contrast, average aqueous mercury concentrations increased from 2009–2010, with mean concentrations in 2010 exceeding those observed prior to the implementation of the Big Spring Water Treatment System in 2005. Because the bioaccumulation of mercury in fish occurs predominantly through the food chain rather than aqueous exposure, there may be a time lag before the effects of this increase in aqueous mercury concentrations are seen in fish tissue concentrations. Continued monitoring is necessary to see whether aqueous mercury concentrations continue to increase, and whether this affects fish tissue mercury concentrations. Mean concentrations of PCBs in fish at EFK 23.4 (the site where PCBs in fish are highest) have been increasing since 2008 but continued to be much lower than peak concentrations observed in the mid-1990s (Fig. 4.32).

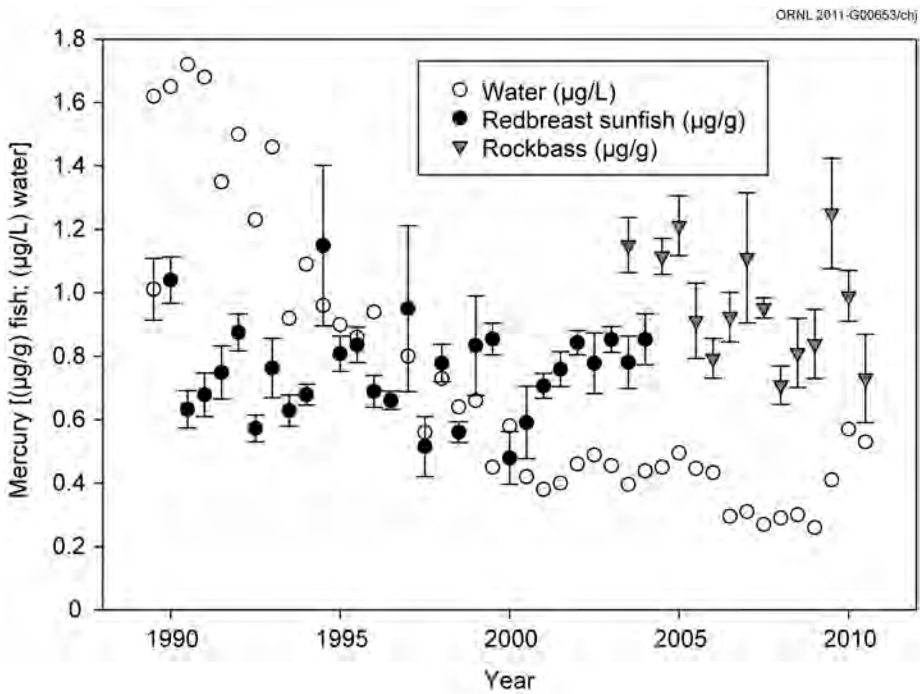

Fig 4.31. Semiannual average mercury concentration in water and muscle fillets of redbreast sunfish and rock bass in East Fork Poplar Creek at EFK 23.4 through spring 2010.

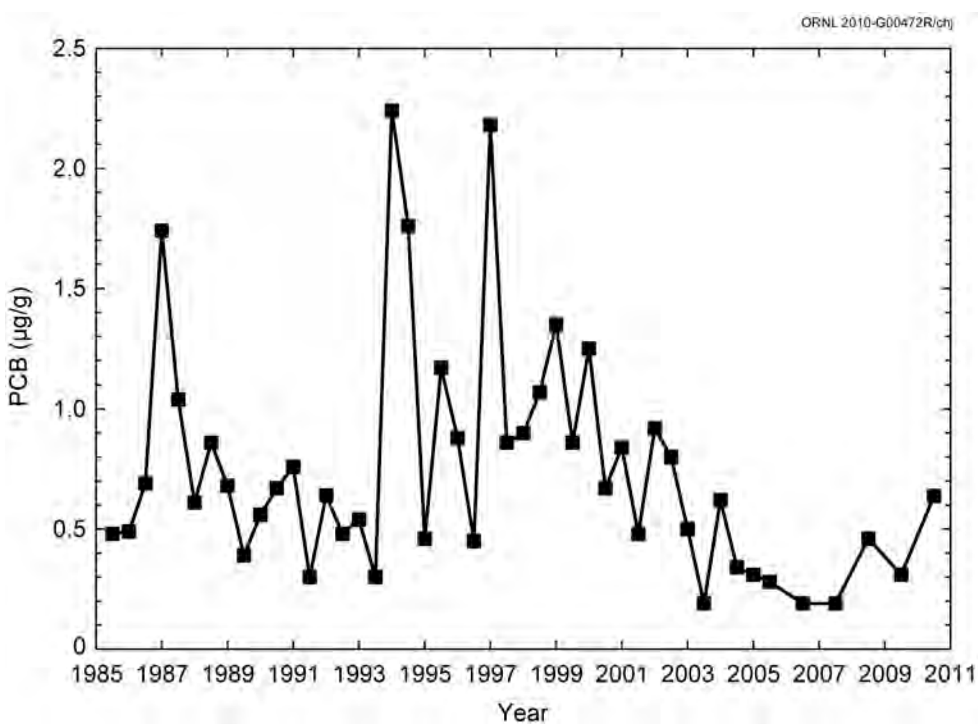

Fig. 4.32. Mean concentrations of PCBs in redbreast sunfish and rock bass muscle fillets in East Fork Poplar Creek at EFK 23.4 through Spring 2010 (EFK = East Fork Poplar Creek kilometer).

4.5.9.2 Benthic Invertebrate Surveys

Monitoring of benthic macroinvertebrate communities continued at three sites in East Fork Poplar Creek and at two reference streams in the spring of 2010. The macroinvertebrate community at EFK 23.4 and EFK 24.4 remained degraded as compared with reference communities, although recent trends at EFK 23.4 suggest improvement has occurred at that site since 2004. Trends at EFK 24.4, on the other hand, suggest that no substantial change has occurred at that site since 1999 (Fig. 4.33). Results from 2010 for EFK 13.8 continue to suggest that no substantial change has occurred at that site, and that mildly degraded conditions remain.

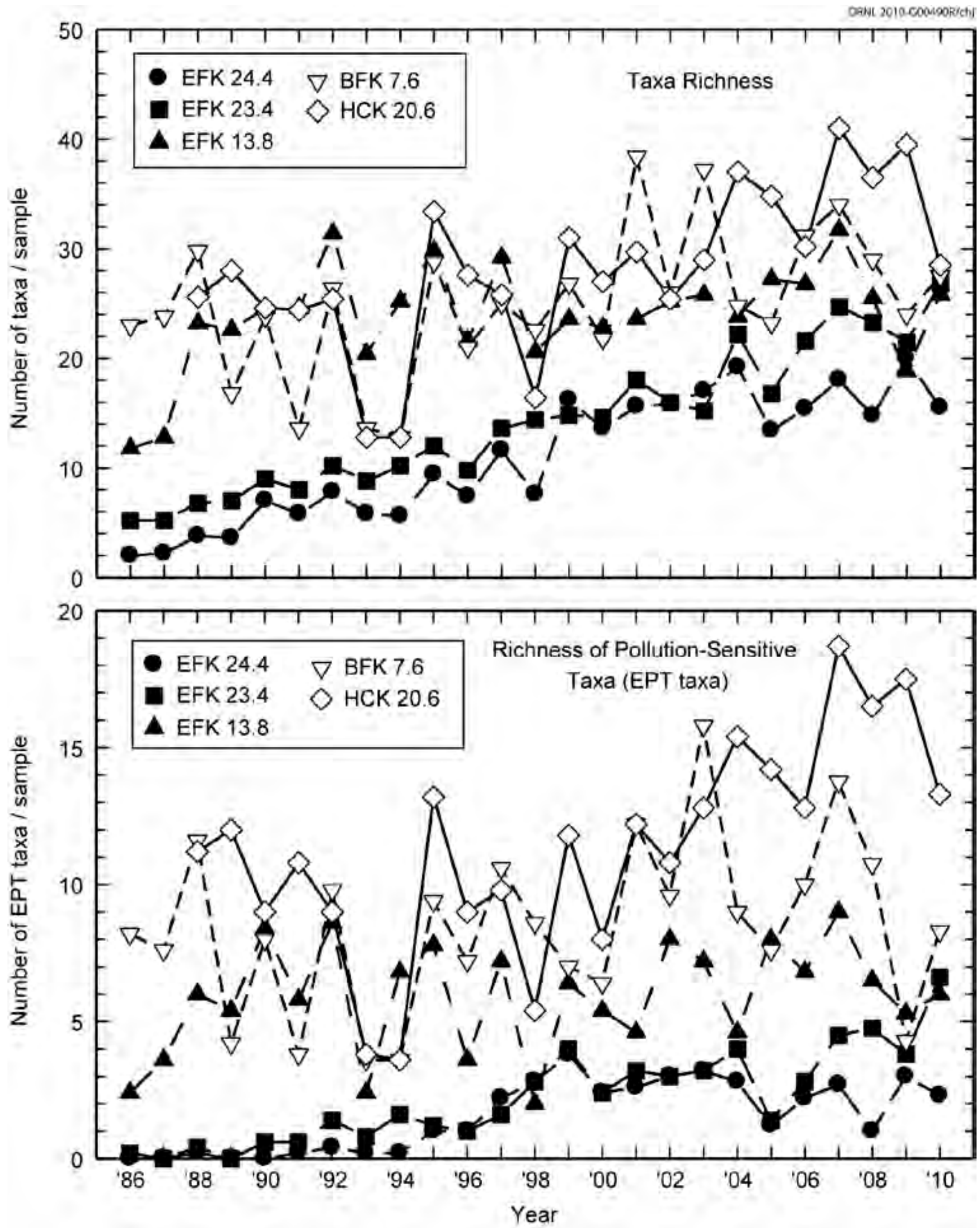

Fig. 4.33. Total taxonomic richness (mean number of taxa/sample) and total taxonomic richness of the Ephemeroptera, Plecoptera, and Trichoptera (EPT) (mean number of EPT taxa/sample) of the benthic macroinvertebrate communities sampled in spring from East Fork Poplar Creek and references sites on nearby Brushy Fork (BFK 7.6) and Hinds Creek (HCK 20.6).

4.5.9.3 Fish Community Monitoring

Fish communities were monitored in the spring and fall of 2010 at five sites along East Fork Poplar Creek and at a reference stream. Over the past two decades, overall species richness, density, biomass, and the number of pollution-sensitive fish species (Fig. 4.34) have increased at all sampling locations below Lake Reality. However, the East Fork Poplar Creek fish community continues to lag behind the reference stream community in most important metrics of fish diversity and community structure. This is especially true at the monitoring sites closest to the Y-12 Complex where the sensitive species richness is only 25% of the reference value (EFK 23.4) or sensitive species are absent altogether (EFK 24.4).

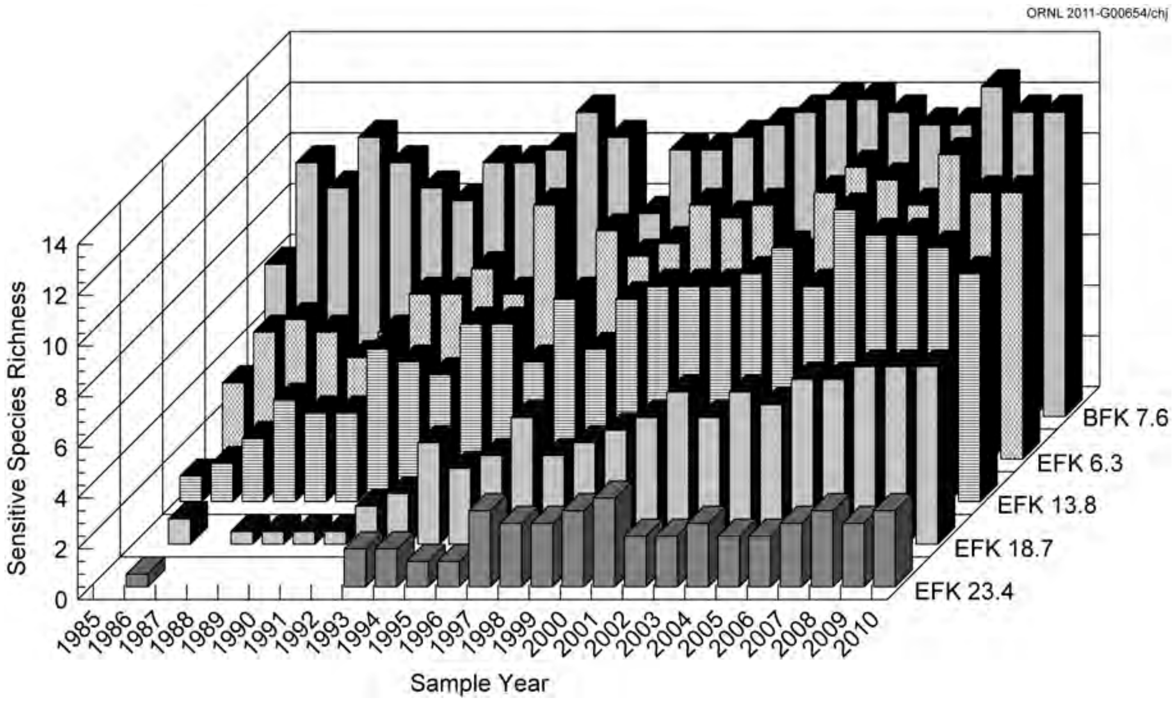

Fig. 4.34. Comparison of mean sensitive species richness (number of species) collected each year from 1985 through 2010 from four sites in East Fork Poplar Creek and a reference site (Brushy Fork).

4.6 Groundwater at the Y-12 Complex

Groundwater monitoring at Y-12 is performed to determine what impacts to the environment from legacy and current operations are occurring. More than 200 sites have been identified at the Y-12 Complex that represent known or potential sources of contamination to the environment as a result of past operational and waste management practices. Monitoring provides information on the nature and extent of contamination of groundwater, which is then used to determine what actions must be taken to protect the worker, public, and the environment in compliance with regulations and DOE orders. Figure 4.35 depicts the major facilities or areas for which groundwater monitoring was performed during CY 2010.

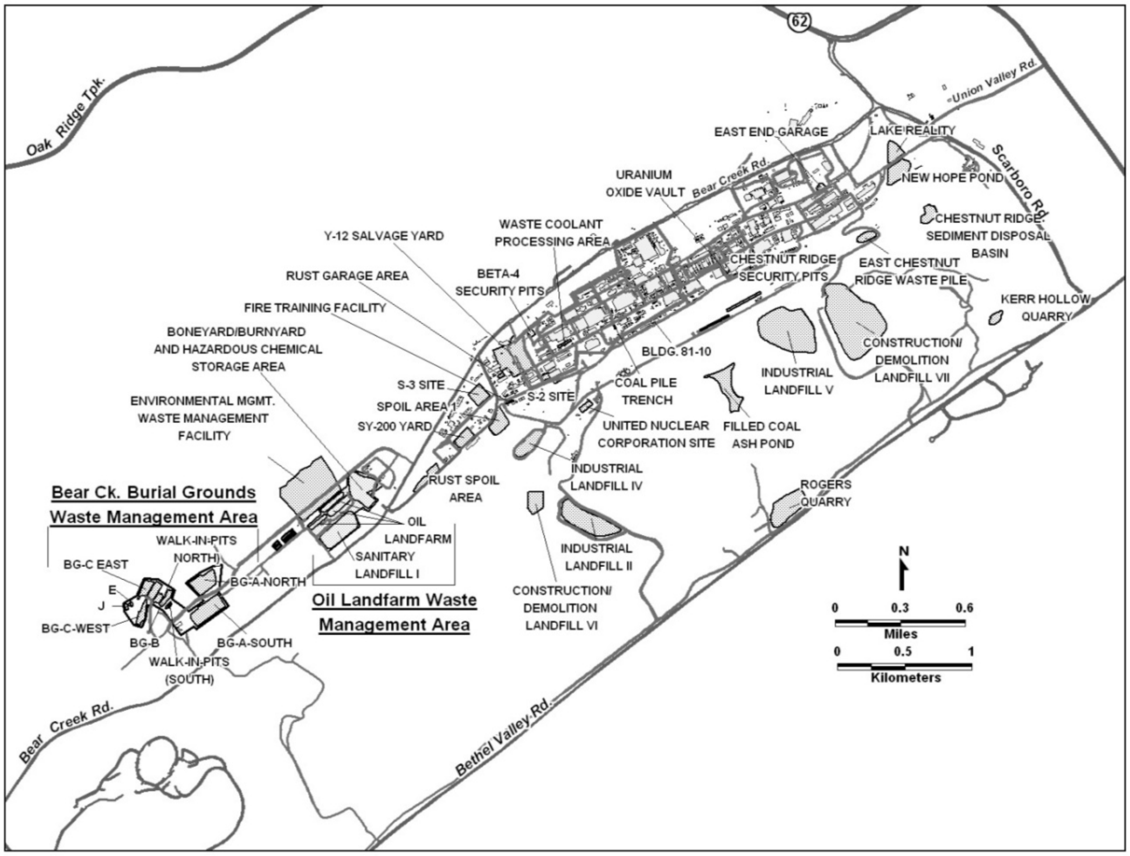

Fig. 4.35. Known or potential contaminant sources for which groundwater monitoring was performed at the Y-12 Complex during CY 2010.

4.6.1 Hydrogeologic Setting

The Y-12 Complex is divided into three hydrogeologic regimes (i.e., Bear Creek, Upper East Fork Poplar Creek, and Chestnut Ridge), which are delineated by surface water drainage patterns, topography, and groundwater flow characteristics (Fig. 4.36). Most of the Bear Creek and Upper East Fork Poplar Creek regimes are underlain by the shales, siltstones, and sandstones with a subordinate and locally variable amount of carbonate bedrock mentioned in Section 1.3.5 and hydrostratigraphically referred to as aquitards. Aquitards are rock units that contain water but do not readily yield significant water to pumping wells. Geologic units that are considered aquitards can often yield water in quantities sufficient for domestic or small farm use. (Domenico and Schwartz 1990). The southern portion of the two regimes is underlain by the Maynardville Limestone, which is part of the Knox Aquifer. The entire Chestnut Ridge regime is underlain by the Knox Aquifer. In general, groundwater flow in the water table interval follows the topography. Shallow groundwater flow in the Bear Creek and the Upper East Fork regimes is divergent from the topographic and groundwater divide located near the western end of the Y-12 Complex that defines the boundary between the two. In addition, flow converges on the primary surface streams (Bear Creek and Upper East Fork Poplar Creek) from Pine Ridge and Chestnut Ridge. In the Chestnut Ridge regime, a groundwater divide exists that approximately coincides with the crest of the ridge. Shallow groundwater flow tends to be toward either flank of the ridge, with discharge primarily to surface streams and springs located in Bethel Valley to the south and Bear Creek Valley to the north.

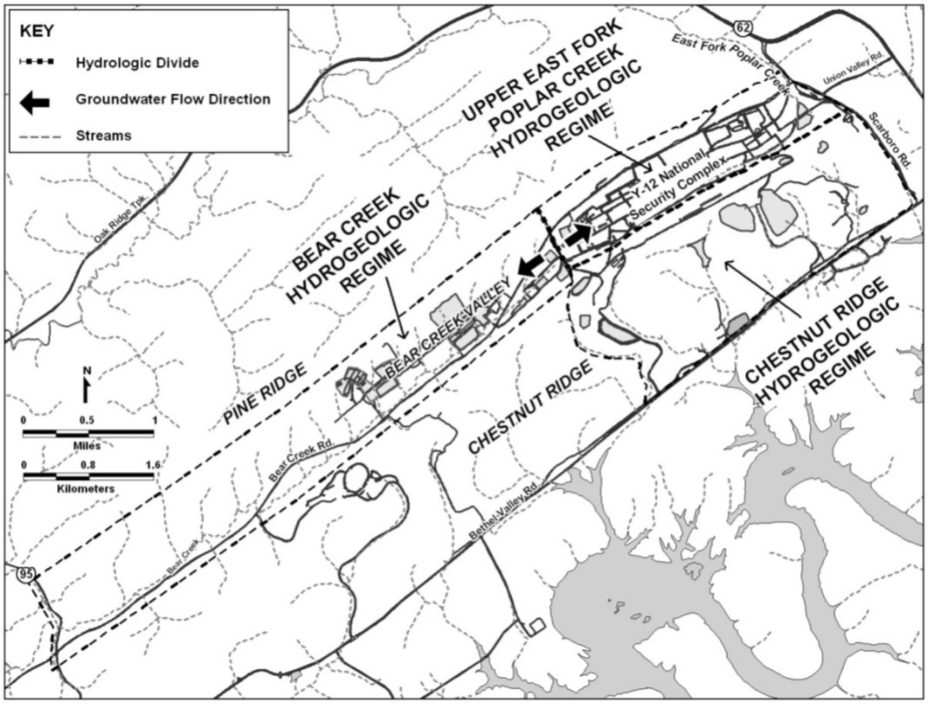

Fig. 4.36. Hydrogeologic regimes at the Y-12 Complex.

In Bear Creek Valley, groundwater in the intermediate and deep intervals moves predominantly through fractures in the aquitard, converging on and then moving through fractures and solution conduits in the Maynardville Limestone. Karst development in the Maynardville Limestone has a significant impact on groundwater flow paths in the water table and intermediate intervals. In general, groundwater flow parallels the valley and geologic strike. Groundwater flow rates in Bear Creek Valley vary widely; they are very slow within the deep interval of the fractured noncarbonate rock (<1 ft/year) but can be quite rapid within solution conduits in the Maynardville Limestone (tens to thousands of feet per day). The rate of groundwater flow perpendicular to geologic strike from the aquitard units of the lower Conasauga Group to the Maynardville Limestone is also very slow below the water table interval.

Contaminant migration is primarily advective (contaminants are transported along with flowing groundwater through the pore spaces, fractures, or conduits of the hydrogeologic system). Strike-parallel transport of some contaminants can occur within the aquitard units for significant distances, where they discharge to surface water tributaries or underground utility and stormwater distribution systems in industrial areas. Continuous elevated levels of nitrate (a groundwater contaminant from legacy waste disposals) within the fractured bedrock of the aquitards are known to extend east and west from the S-3 Site for thousands of feet. Volatile organic compounds (e.g., petroleum products, coolants, and solvents) at source units in the fractured classic dominated bedrock, however, can remain close to source areas because they tend to adsorb to the bedrock matrix, diffuse into pore spaces within the matrix, and degrade prior to migrating to exit pathways, where more rapid transport occurs for longer distances. Regardless, extensive volatile organic compound contamination occurs throughout the groundwater system in both the Bear Creek and Upper East Fork regimes.

Groundwater flow in the Chestnut Ridge regime is through fractures and solution conduits in the Knox Group. Discharge points for intermediate and deep flow are not well known. Groundwater is currently presumed to flow toward Bear Creek Valley to the north and Bethel Valley to the south. Groundwater from intermediate and deep zones may discharge at certain spring locations along the flanks of Chestnut Ridge. Following the crest of the ridge, water table elevations decrease from west to east, demonstrating an overall easterly trend in groundwater flow.

4.6.2 Well Installation and Plugging and Abandonment Activities

A number of monitoring devices are routinely used for groundwater data collection at the Y-12 Complex. Monitoring wells are permanent devices used for the collection of groundwater samples; they are installed according to established regulatory and industry standards. Figure 4.37 shows a cross section of a typical groundwater monitoring well. Other devices or techniques are sometimes employed to gather groundwater data, including drive points and push probes.

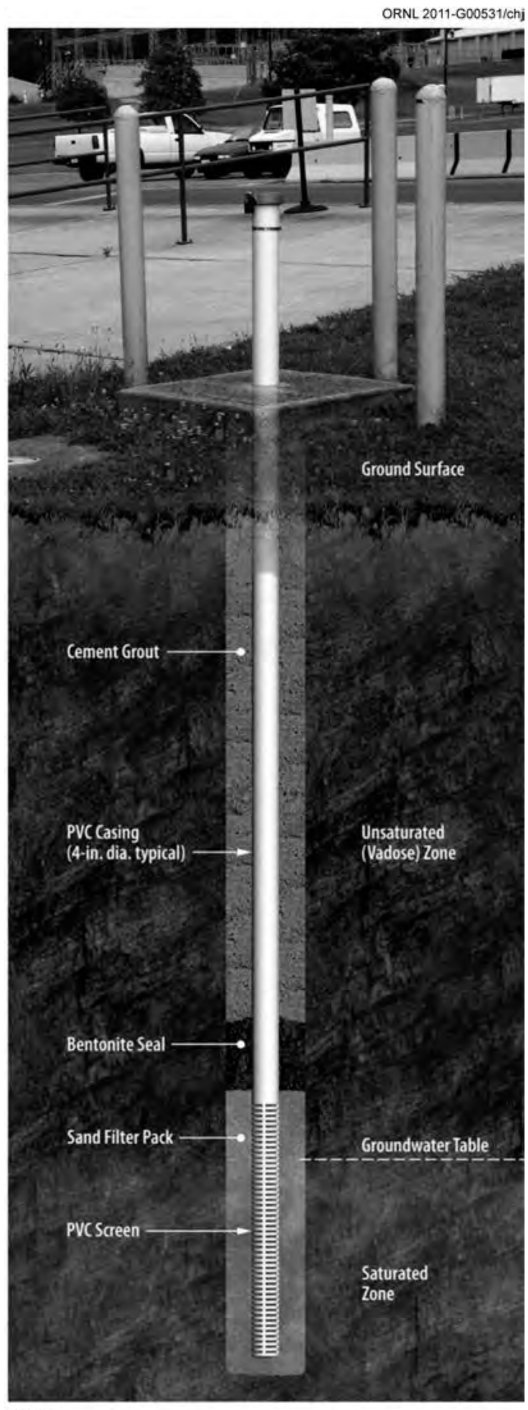

Fig. 4.37. Cross section of a typical groundwater monitoring well.

In CY 2010, eight monitoring wells were installed at Y-12. Two new wells were installed at the Environmental Management Waste Management Facility (EMWMF) to support monitoring requirements of a newly constructed disposal cell. Six wells were installed in support of research activities by the Environmental Remediation Sciences Oak Ridge Field Research Center. The purpose of the Field Research Center is to investigate the interactions and processes within a contaminated groundwater system to assist in the development of remediation strategies and tools for groundwater cleanup.

No monitoring wells were plugged and abandoned during the year.

4.6.3 CY 2009 Groundwater Monitoring

Groundwater monitoring in CY 2010 was performed to comply with DOE orders and regulations by the Y-12 Groundwater Protection Program, the Water Resources Restoration Program, and other projects. Compliance requirements were met by monitoring 203 wells and 43 surface water locations and springs (Table 4.18). Figure 4.38 shows the locations of Y-12 Complex perimeter/exit pathway groundwater monitoring stations.

Table 4.18. Summary groundwater monitoring at the Y-12 Complex, 2010

	Purpose for which monitoring was performed				
	Restoration[a]	**Waste management**[b]	**Surveillance**[c]	**Other**[d]	**Total**
Number of active wells	60	31	112	125	328
Number of other monitoring stations (e.g., springs, seeps, surface water)	26	6	11	4	47
Number of samples taken[e]	190	40*	149	2,120	2,459
Number of analyses performed	14,771	3,488*	11,006	16,760	46,025
Percentage of analyses that are non-detects	80.2	88.9	80.8	27.0	61.6
Ranges of results for positive detections, VOCs (µg/L)[f]					
Chloroethenes	0.99–5,000	5–11	1–60,000	NA[g]	
Chloroethanes	1.3–510	11.2–38	1–2,200	NA	
Chloromethanes	1–1,200	ND[h]	1–4,100	NA	
Petroleum hydrocarbons	1–7,800	ND	1–2,000	NA	
Uranium (mg/L)	0.0041–0.4	ND	0.00052–0.56	0.145-61.059	
Nitrates (mg/L)	0.0046–7,600	0.59-2.5	0.055–10,999	614 -48,550	
Ranges of results for positive detections, radiological parameters (pCi/L)[i]					
Gross alpha activity	1.85–455	0.88–2.28	2.6–350	NA	
Gross beta activity	2.69–14,800	3.28–13.1	7.3–14,000	NA	

[a] Monitoring to comply with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements and with Resource Conservation and Recovery Act post closure detection and corrective action monitoring.

[b] Solid waste landfill detection monitoring and CERCLA landfill detection monitoring; * = excludes EMWMF

[c] DOE Order 450.1 surveillance monitoring

[d] Research-related groundwater monitoring associated with activities of the DOE Environmental Remediation Sciences Oak Ridge Field Research Center

[e] The number of unfiltered samples, excluding duplicates, determined for unique location/date combinations

[f] These ranges reflect concentrations of individual contaminants (not summed VOC concentrations):
Chloroethenes—includes tetrachloroethene, trichloroethene, 1,2-dichloroethene (*cis* and *trans*) 1,1-dichloroethene, and vinyl chloride
Chloroethanes—includes 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane
Chloromethanes—includes carbon tetrachloride, chloroform, and methylene chloride
Petroleum hydrocarbon—includes benzene, toluene, ethylbenzene, and xylene

[g] NA – not analyzed

[h] ND – not detected

[i] 1 pCi = 3.7×10^2 Bq

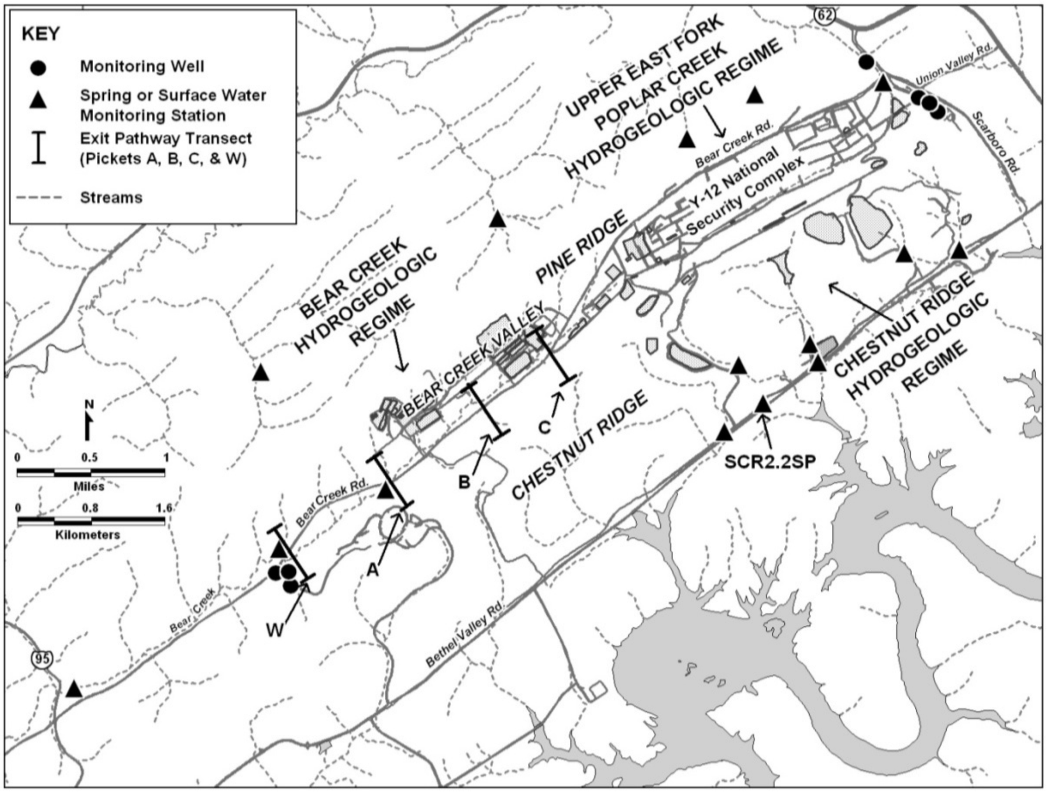

Fig. 4.38. Location of Y-12 complex perimeter/exit pathway well, spring, and surface water monitoring stations.

In an attempt to gain efficiencies in sampling activities, the Y-12 Groundwater Protection Program initiated the use of passive diffusion bag samplers in 2009 and continued to use them in 2010 (Fig. 4.39). The passive diffusion bag sampling method is suitable only for monitoring for the presence and concentration of selected volatile organic compounds in groundwater. This method involves suspending a polyethylene bag (semipermeable membrane) filled with deionized water at a selected depth within the monitored interval of the well and leaving the passive diffusion bag in place for a prescribed period (at least 2 weeks). The chemical concentration gradient between the uncontaminated deionized water in the passive diffusion bag and the surrounding contaminated groundwater induces volatile organic compounds in the groundwater to diffuse through the bag into the deionized water until equilibrium conditions are achieved. When retrieved, the water in the passive diffusion bag is decanted into volatile organic compound sample bottles and analyzed using standard procedures.

Comprehensive water quality results of groundwater monitoring activities at Y-12 in CY 2010 are presented in the annual *Calendar Year 2010 Groundwater Monitoring Report* (B&W Y-12 2011a).

Details of monitoring efforts performed specifically for CERCLA baseline and remediation evaluation are published in the FY 2010 and FY 2011 Water Resources Restoration Program sampling and analysis plans (Bechtel Jacobs Company 2009; Bechtel Jacobs Company 2010) and the 2010 and 2011 Remediation Effectiveness Reports (DOE 2010a and DOE 2011).

Groundwater monitoring compliance reporting to meet RCRA postclosure permit requirements can be found in the annual RCRA Groundwater Monitoring Report (Bechtel Jacobs Company 2011).

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Fig 4.39. Groundwater sampling at Y-12. Technicians use a passive diffusion bag to sample for volatile organic compounds in groundwater.

4.6.4 Y-12 Groundwater Quality

Historical monitoring efforts have shown that there are four primary contaminants that have impacted groundwater quality at the Y-12 Complex: nitrate, volatile organic compounds, metals, and radionuclides. Of those, volatile organic compounds are the most widespread due to their common use and disposal. Uranium and technetium-99 are the radionuclides of greatest concern. Trace metals, the least extensive groundwater contaminants, generally occur close to source areas. Historical data have shown that plumes from multiple-source units have mixed with one another and that contaminants (other than nitrate and technetium-99) are no longer easily associated with a single source.

4.6.4.1 Upper East Fork Poplar Creek Hydrogeologic Regime

Among the three hydrogeologic regimes on the Y-12 Complex, the Upper East Fork regime encompasses most of the known and potential sources of surface water and groundwater contamination. A brief description of waste management sites is given in Table 4.19. Chemical constituents from the S-3 Site (primarily nitrate and technetium-99) and volatile organic compounds from multiple source areas are observed in the groundwater in the western portion of the Upper East Fork regime; groundwater in the eastern portion, including Union Valley, is predominantly contaminated with volatile organic compounds.

Table 4.19. History of waste management units and underground storage tanks included in groundwater monitoring activities, Upper East Fork Poplar Creek Hydrogeologic Regime, 2010

Site	Historical data
New Hope Pond	Built in 1963. Regulated flow of water in Upper East Fork Poplar Creek before exiting the Y-12 Complex grounds. Sediments include PCBs, mercury, and uranium but not hazardous according to toxicity characteristic leaching procedure. An oil skimmer basin was built as part of the pond when constructed. This basin collected oil and floating debris from Upper East Fork Poplar Creek prior to discharge into the pond. Closed under RCRA in 1990
Salvage Yard Scrap Metal Storage Area	Used from 1950 to present for scrap metal storage. Some metals contaminated with low levels of depleted or enriched uranium. Runoff and infiltration are the principal release mechanisms to groundwater. From 2009–2011 a CERCLA action to characterize and remove the scrap was performed.
Salvage Yard Oil/Solvent Drum Storage Area	Primary wastes included waste oils, solvents, uranium, and beryllium. Both closed under RCRA. Leaks and spills represent the primary contamination mechanisms for groundwater
Salvage Yard Oil Storage Tanks	Used from 1978 to 1986. Two tanks used to store PCB-contaminated oils, both within a diked area
Salvage Yard Drum Deheader	Used from 1959 to 1989. Sump tanks 2063-U, 2328-U, and 2329-U received residual drum contents. Sump leakage is a likely release mechanism to groundwater.
Building 81-10 Area	Mercury recovery facility operated from 1957 to 1962. Potential historical releases to groundwater and surface water from leaks and spills of liquid wastes or mercury. The building structure was demolished in 1995.
Rust Garage Area	Former vehicle and equipment maintenance area, including four former petroleum USTs. Petroleum product releases to groundwater are documented.
9418-3 Uranium Oxide Vault	Originally contained an oil storage tank. Used from 1960 to 1964 to dispose of nonenriched uranium oxide. Leakage from the vault to groundwater is the likely release mechanism.
Fire Training Facility	Used for hands-on firefighting training. Sources of contamination to soil include flammable liquids and chlorinated solvents. Infiltration is the primary release mechanism to groundwater.
Beta-4 Security Pits	Used from 1968 to 1972 for disposal of classified materials, scrap metals, and liquid wastes. Site is closed and capped. Primary release mechanism to groundwater is infiltration.
S-2 Site	Used from 1945 to 1951. An unlined reservoir received liquid wastes. Infiltration is the primary release mechanism to groundwater.
Waste Coolant Processing Area	Used from 1977 to 1985. Former biodegradation facility used to treat waste coolants from various machining processes. Closed under RCRA in 1988
East End Garage	Used from 1945 to 1989 as a vehicle fueling station. Five USTs used for petroleum fuel storage were excavated, 1989 to 1993. Petroleum releases to the groundwater are documented.
Coal Pile Trench	Located beneath the current steam plant coal pile. Disposals included solid materials (primarily alloys). Trench leachate is a potential release mechanism to groundwater.

Abbreviations
PCB = polychlorinated biphenyl
RCRA = Resource Conservation and Recovery Act
UST = underground storage tank

4.6.4.1.1 Plume Delineation

Sources of groundwater contaminants monitored during CY 2010 include the S-2 Site, the Fire Training Facility, the S-3 Site, the Waste Coolant Processing Facility, petroleum USTs, New Hope Pond, the Beta-4 Security Pits, the Y-12 Salvage Yard, and process/production buildings throughout the Y-12 Complex. Although the S-3 Site, now closed under RCRA, is located west of the current hydrologic divide that separates the Upper East Fork regime from the Bear Creek regime, it has contributed to groundwater contamination in the western part of the Upper East Fork regime. As previously mentioned, contaminant plumes in the East Fork regime are elongated in shape due to the result of preferential transport of the contaminants parallel to strike (parallel to the valley axis) in both the Knox Aquifer and the fractured bedrock of the aquitard units.

4.6.4.1.2 Nitrate

Nitrate concentrations in groundwater at the Y-12 Complex exceed the 10-mg/L drinking water standard in a large part of the western portion of the Upper East Fork regime (a complete list of national drinking water standards is presented in Appendix D). The two primary sources of nitrate contamination are the S-2 and S-3 sites. The extent of the nitrate plume is essentially defined in the unconsolidated and shallow bedrock zones. In CY 2010, groundwater containing nitrate concentrations as high as 8,850 mg/L (Well GW-275) occurred in the shallow bedrock just east of the S-3 Site (Fig. 4.40). These results are consistent with results from previous years.

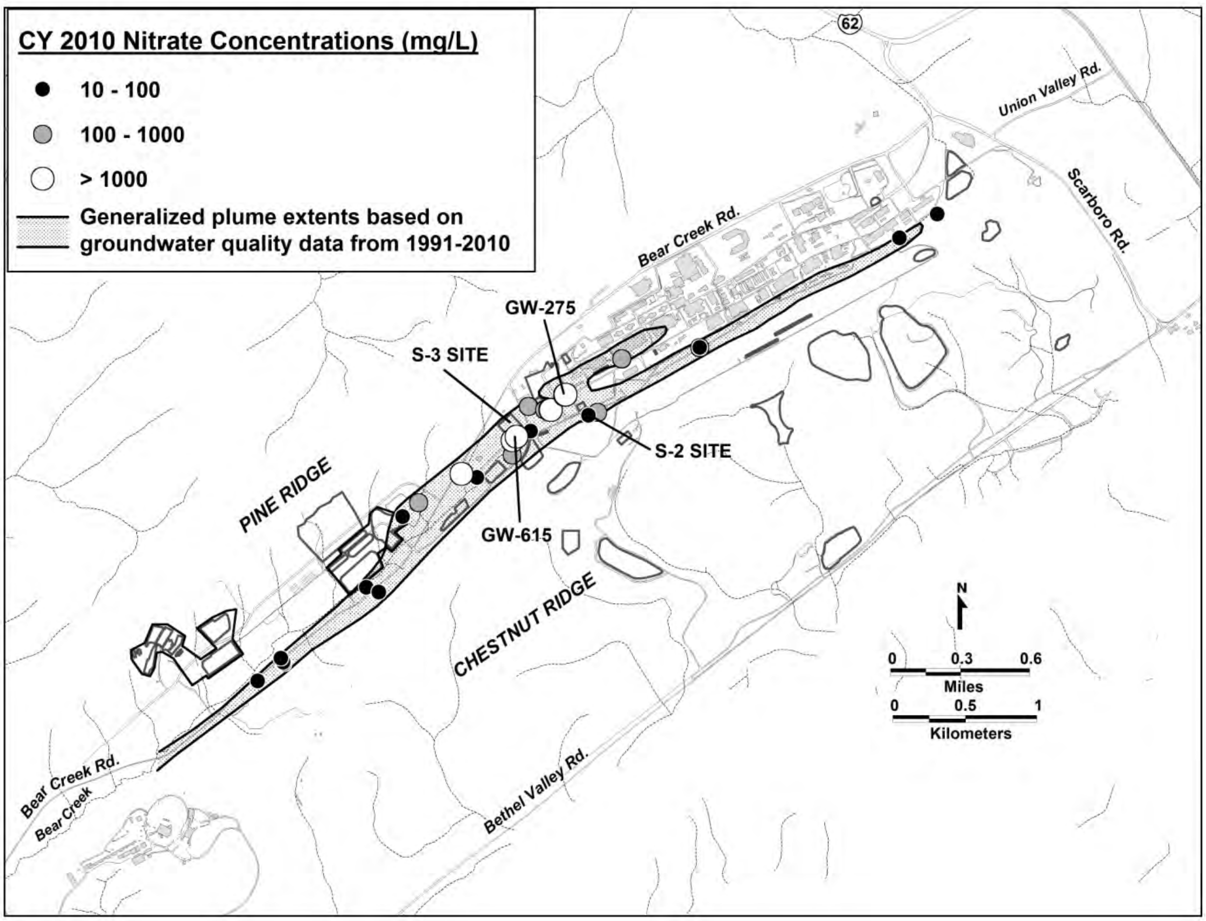

Fig. 4.40. Nitrate observed in groundwater at the Y-12 Complex, 2010.

4.6.4.1.3 Trace Metals

Concentrations of barium, beryllium, cadmium, chromium, lead, nickel, thallium, and uranium exceeded drinking water standards during CY 2010 in samples collected from various monitoring wells and surface water locations downgradient of the S-2 Site, the S-3 Site, the Salvage Yard, and throughout the complex. Trace metal concentrations above standards tend to occur only adjacent to the source areas due to their low solubility in natural water systems.

Concentrations of uranium exceed the standard (0.03 mg/L) in a number of source areas (e.g., S-3 Site, production areas and the Former Oil Skimmer Basin) and contribute to the uranium concentration in Upper East Fork Poplar Creek.

One trace metal absent from the list of those that exceed drinking water standards in CY 2010 is mercury. Due to very low solubility in water and a very high affinity for clay-rich soils such as those on the ORR, mercury exhibits little tendency for extensive transport in diffuse groundwater plumes. Additionally, the hydrogeologic complexities of the fracture/conduit flow system underlying Y-12 make it challenging to delineate the vertical and horizontal extents of any groundwater contamination. Elevated mercury concentrations (above analytical detection limits) in groundwater have been consistently observed only near known source areas (Fig. 4.41). In the past, mercury concentrations above the drinking water standard (0.002 mg/L) have been observed in groundwater monitoring wells at the identified source areas presented in Fig. 4.41.

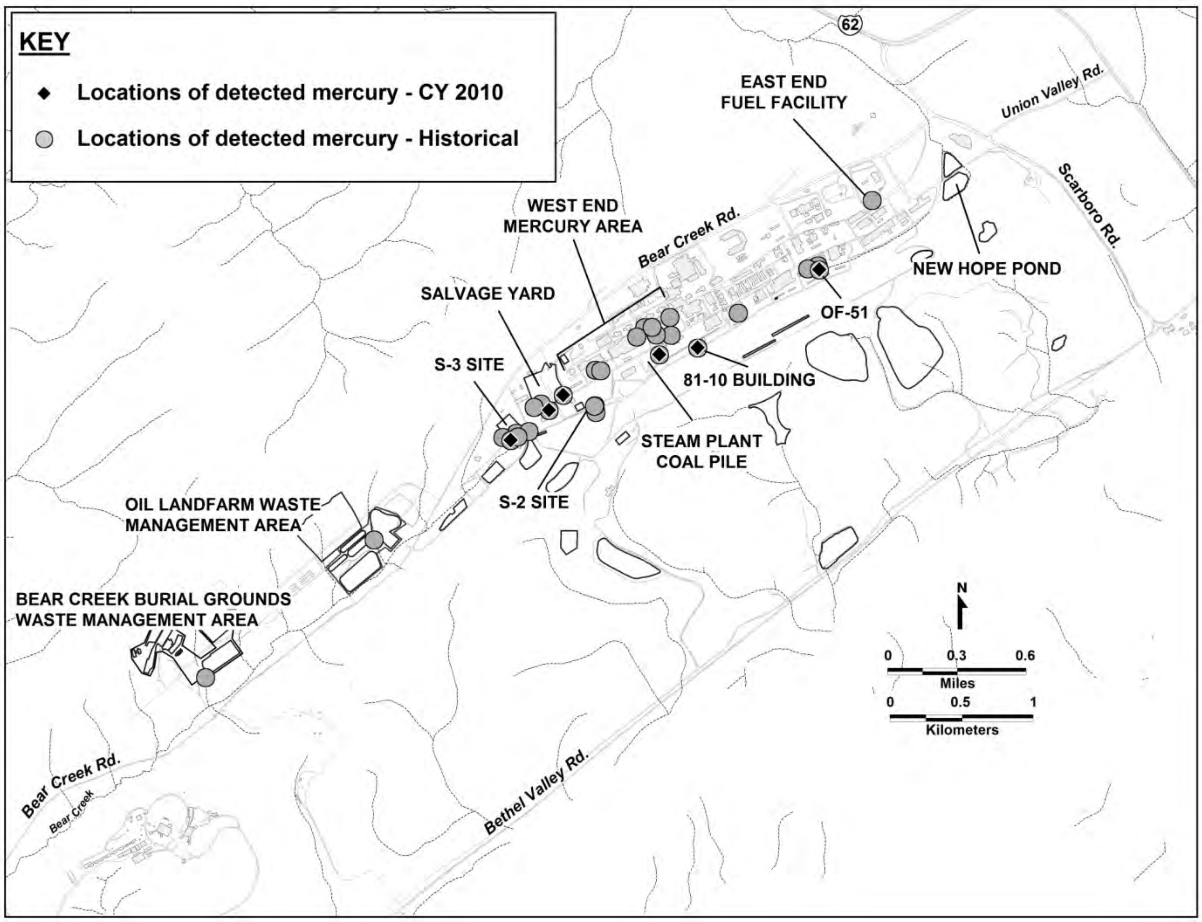

Fig. 4.41. Y-12 groundwater monitoring stations where mercury has been detected.

Due to past processes and disposal practices, mercury is a legacy contaminant at Y-12. It is commonly found in the soils near specific areas where it was used in processes in the 1950s and 1960s. This metal is a contaminant of concern in surface waters discharging from these areas. However, the transport mechanisms and connections between soil contamination, storm drains, shallow groundwater, buried tributaries, and stream channels are not well understood. When mercury is discharged from the storm drain system into the open creek channel, it is rapidly sequestered by particulate materials, and sediment/particle transport becomes the primary mechanism of mobility.

In tightly fractured shale and other noncarbonate bedrock, the natural flow paths are such that significant transport of mercury is not likely. In industrialized areas of Y-12 where the shallow subsurface has been reworked extensively, some preferential transport along building foundations and underground utilities is occurring. This is evident from elevated surface water concentrations of mercury.

Interconnection between the surface water and groundwater systems have been demonstrated by tracer investigations (DOE 2001) and the discharge of elevated concentrations of mercury from a buried spring (i.e., OF-51) adjacent to East Fork Poplar Creek. This discharge is presently captured and treated to remove the mercury at the Big Springs Water Treatment System. It has been proposed that dissolved mercury in the spring discharge arises from metallic mercury that has infiltrated into the solution cavities and conduits of the karstic Maynardville Limestone Formation below the water table. Although the subsurface inventory of metallic mercury in the limestone bedrock has not been determined, it could account for a part of the quantities lost during operational use. Subsurface storage may also minimize mobility of mercury due to decreased surface area (i.e., immobilized in filled seams, fractures, and conduits, in contrast to the surface exposure of mercury as particles) (Rothschild et al. 1984).

4.6.4.1.4 Volatile Organic Compounds

Because of the many legacy source areas, volatile organic compounds are the most widespread groundwater contaminants in the East Fork regime. Dissolved volatile organic compounds in the regime primarily consist of chlorinated solvents and petroleum hydrocarbons. In CY 2010, the highest summed concentration of dissolved chlorinated solvents (69,764 µg/L) was again found in groundwater at Well 55-3B in the western portion of the Y-12 Complex adjacent to manufacturing facilities. The highest dissolved concentration of petroleum hydrocarbons (19,070 µg/L) was obtained from Well GW-658 at the closed East End Garage.

The CY 2010 monitoring results generally confirm findings from the previous years of monitoring. A continuous dissolved plume of volatile organic compounds in groundwater in the bedrock zone extends eastward from the S-3 Site over the entire length of the regime (Fig. 4.42). The primary sources are the Waste Coolant Processing Facility, fuel facilities (Rust Garage and East End), Y-12 Salvage Yard, and other waste-disposal and production areas throughout the Y-12 Complex. Chloroethene compounds (tetrachloroethene, trichloroethene, dichloroethene, and vinyl chloride) tend to dominate the volatile organic plume composition in the western and central portions of the Y-12 Complex. However, tetrachloroethene and isomers of dichloroethene are almost ubiquitous throughout the extent of the plume, indicating many source areas. Chloromethane compounds (carbon tetrachloride, chloroform, and methylene chloride) are the predominant volatile organic compounds in the eastern portion of the Complex.

Variability in concentration trends of chlorinated volatile organic compounds near source areas is seen within the Upper East Fork regime. As seen in previous years, data from most of the monitoring wells have remained relatively constant (i.e., stable) or have decreased since 1988. Increasing trends are observed in monitoring wells associated with the Rust Garage and S-3 site in western Y-12, some production/process facilities in central areas, and the chloroethene component of the East End volatile organic compound plume, indicating that some portions of the plume are still showing activity.

Within the exit pathway the general trends are also stable or decreasing. The trends west of New Hope Pond are indicators that the contaminants from source areas are attenuating due to factors such as (1) dilution by surrounding uncontaminated groundwater, (2) dispersion through a complex network of fractures and conduits, (3) degradation by chemical or biological means, or (4) adsorption by surrounding bedrock and soil media. Wells to the southwest to southeast of New Hope Pond are displaying the effects of the pumping well (GW-845) operated to capture the plume prior to migration off of the ORR into Union Valley. Wells east of the New Hope Pond and north of Well GW-845 exhibit an increasing trend in volatile organic compound concentrations, indicating that little impact or attenuation from the plume capture system is apparent across lithologic units (perpendicular to strike). However, no subsequent downgradient detection of these compounds is apparent, so either migration is limited or some downgradient across-strike influence by the plume capture system is occurring.

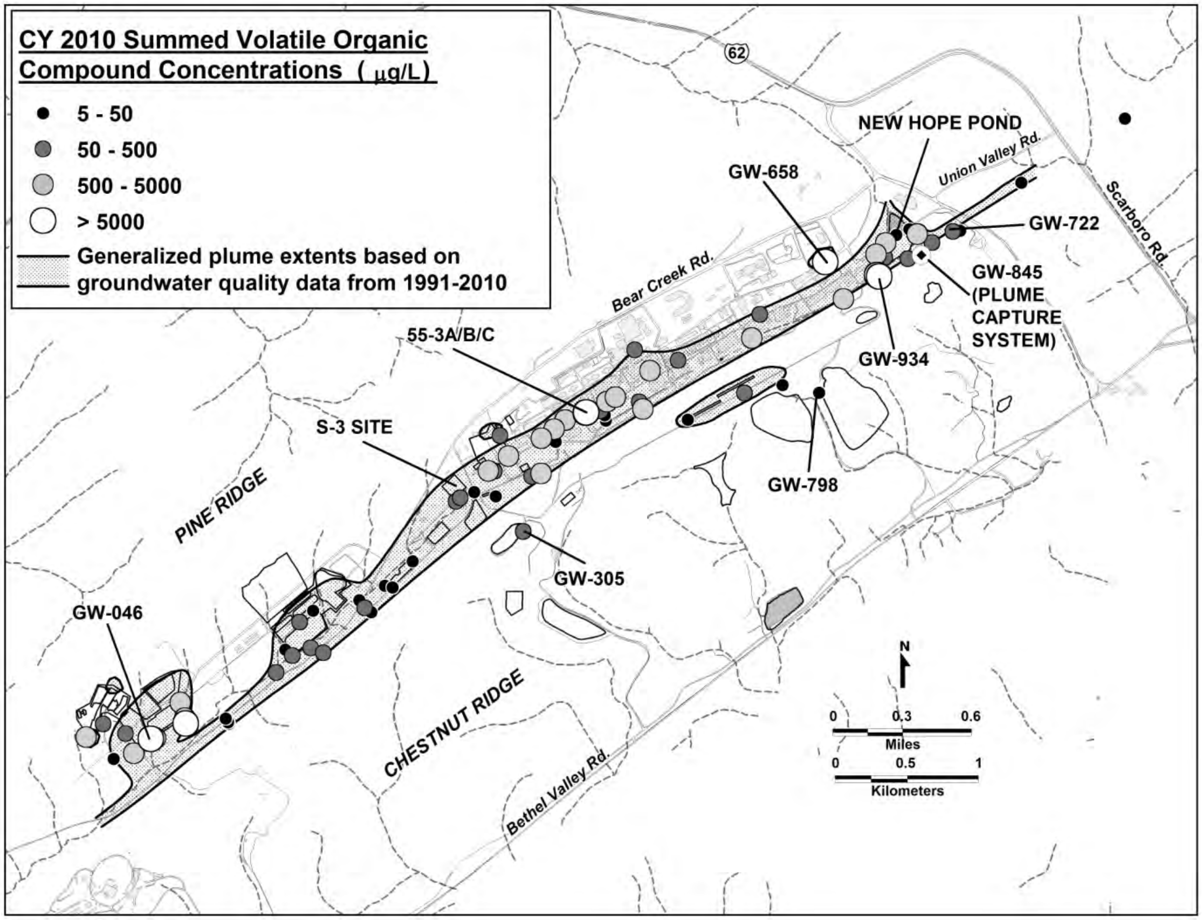

Fig. 4.42. Summed volatile organic compounds observed in groundwater at the Y-12 Complex, 2010.

A multiport Westbay Well, GW-934, was sampled by the Y-12 Groundwater Protection Program for the first time in August 2010. This well is located in the southeast area of Y-12 and was installed in 2002 for downgradient monitoring of a proposed (and never installed) injection well. The proposed injection well was to be installed and used to evaluate in situ technologies to enhance or improve performance of the pump and treat system. There are eight sample ports at various depths along the length of well GW-934. The summed concentrations of volatile organics in several of these ports and in an adjacent conventional well are significantly higher (368–5822 µg/L) than results obtained over the past 15 years from wells in this area. Also noteworthy is that the bottom port (378.8 ft below ground surface) of GW-934 yielded a summed VOC concentration of 5,453 µg/L, indicating that a deeper contaminant plume within the Maynardville Limestone persists upgradient of the plume capture system (GW-845).

4.6.4.1.5 Radionuclides

The primary alpha-emitting radionuclides found in the East Fork regime during CY 2010 are isotopes of uranium. Historical data show that gross alpha activity consistently exceeds the drinking water standard (15 pCi/L) and that it is most extensive in groundwater in the unconsolidated zone in the western portion of the Y-12 Complex near source areas such as the S-3 Site and the Y-12 Salvage Yard. However, the highest gross alpha activity (455 pCi/L) in groundwater continues to be observed on the east end of the Y-12 Complex in Well GW-154, east of the Former Oil Skimmer Basin (Fig. 4.43).

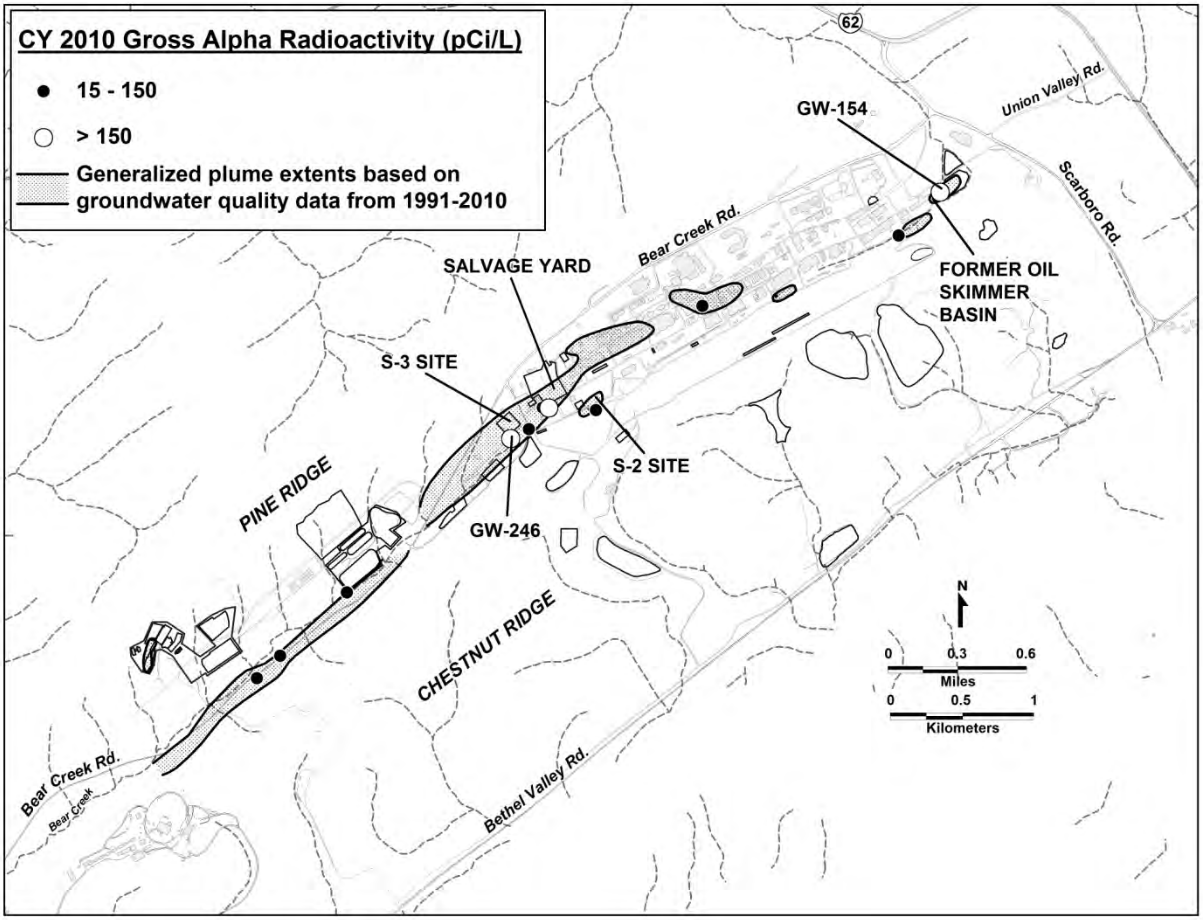

Fig. 4.43. Gross alpha radioactivity observed in groundwater at the Y-12 Complex, 2010.

The primary beta-emitting radionuclides observed in the Upper East Fork regime during CY 2010 are technetium-99, isotopes of uranium, and associated daughter products. Elevated gross beta activity in groundwater in the Upper East Fork regime shows a pattern similar to that observed for gross alpha activity, where technetium-99 is the primary contaminant exceeding the screening level of 50 pCi/L in groundwater in the western portion of the regime, with the primary source being the S-3 Site (Fig. 4.44). The highest gross beta activity in groundwater was observed during CY 2010 from well GW-108 (14,800 pCi/L), east of the S-3 site.

4.6.4.1.6 Exit Pathway and Perimeter Monitoring

Data collected to date indicate that volatile organic compounds are the primary class of contaminants that are migrating through the exit pathways in the Upper East Fork regime. Historically, the compounds have been observed at depths of almost 500 ft in the Maynardville Limestone, the primary exit pathway on the east end of the Y-12 Complex. The deep fractures and solution channels that constitute flow paths within the Maynardville Limestone appear to be well connected, resulting in contaminant migration for substantial distances off the ORR into Union Valley to the east of the complex.

In addition to the intermediate-to-deep pathways within the Maynardville Limestone, shallow groundwater within the water table interval of that geologic unit near New Hope Pond, Lake Reality, and Upper East Fork Poplar Creek is also monitored. Historically, volatile organic compounds have been observed near Lake Reality from wells, a dewatering sump, and the New Hope Pond distribution channel underdrain. In that area, shallow groundwater flows north-northeast through the water table interval east of New Hope Pond and Lake Reality, following the path of the distribution channel for Upper East Fork Poplar Creek.

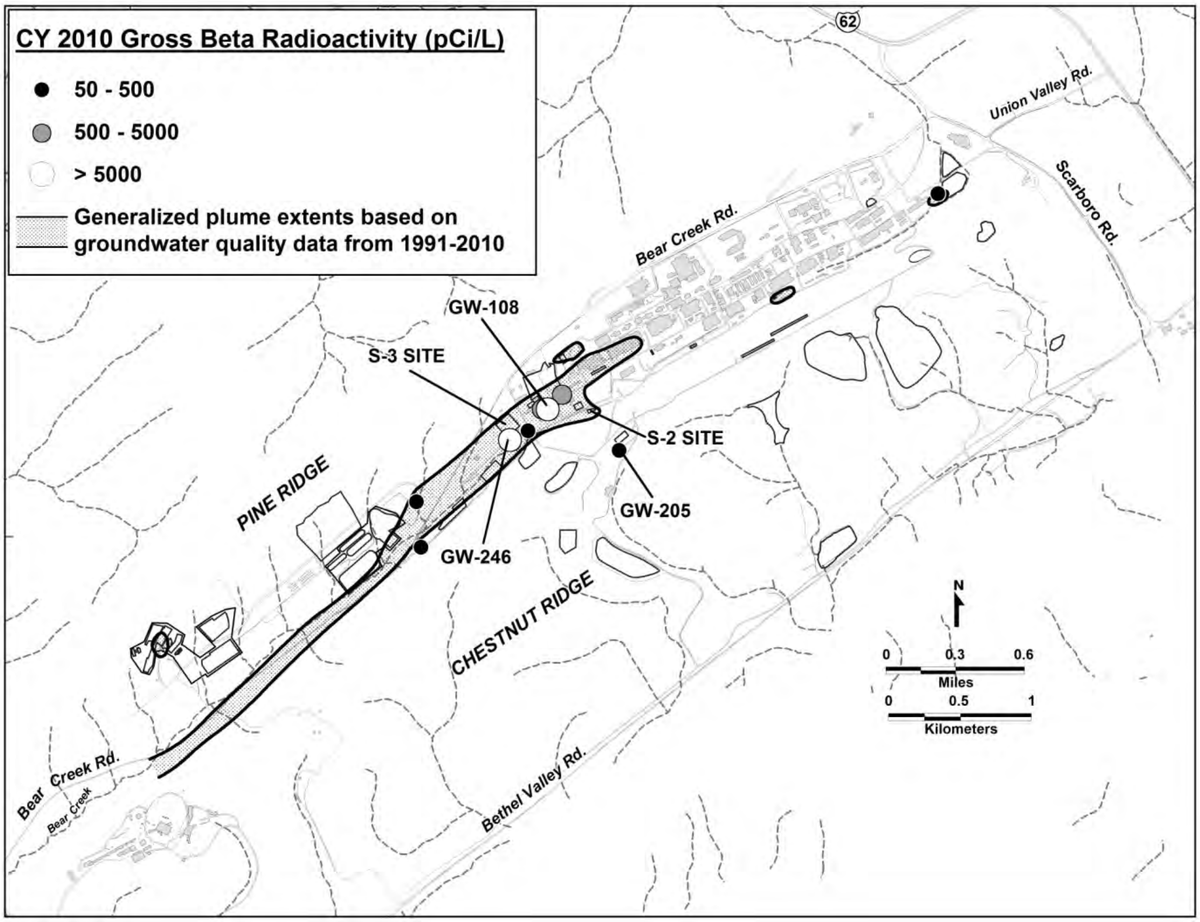

Fig. 4.44. Gross beta radioactivity observed in groundwater at the Y-12 Complex, 2010.

During CY 2010, the observed concentrations of volatile organic compounds at the New Hope Pond distribution channel underdrain continue to remain low (<25 μg/L). This may be because the continued operation of the groundwater plume–capture system in Well GW-845 southeast of New Hope Pond is effectively reducing the levels of volatile organic compounds in the area. The installation of the plume capture system was completed in June 2000. This system pumps groundwater from the intermediate bedrock depth to mitigate off-site migration of volatile organic compounds. Groundwater is continuously pumped from the Maynardville Limestone at about 95 L/min (25 gal/min), passes through a treatment system to remove the volatile organic compounds, and then discharges to Upper East Fork Poplar Creek.

Monitoring wells near Well GW-845 continue to show an encouraging response to the pumping activities. The multiport system installed in Well GW-722, approximately 153 m (500 ft) east and downgradient of Well GW-845, permits sampling of vertically discrete zones within the Maynardville Limestone between 27 and 130 m (87 and 425 ft) below ground surface. This well has been instrumental in characterizing the vertical extent of the east-end plume of volatile organic compounds and is critical in the evaluation of the effectiveness of the plume capture system. Monitoring results from the sampled zones in Well GW-722 indicate reductions in volatile organic compounds due to groundwater pumping upgradient at Well GW-845 (Fig. 4.45). Other wells also show decreases that may be attributable to the plume capture system operation. These indicators show that operation of the plume capture system is decreasing volatile organic compounds upgradient and downgradient of Well GW-845.

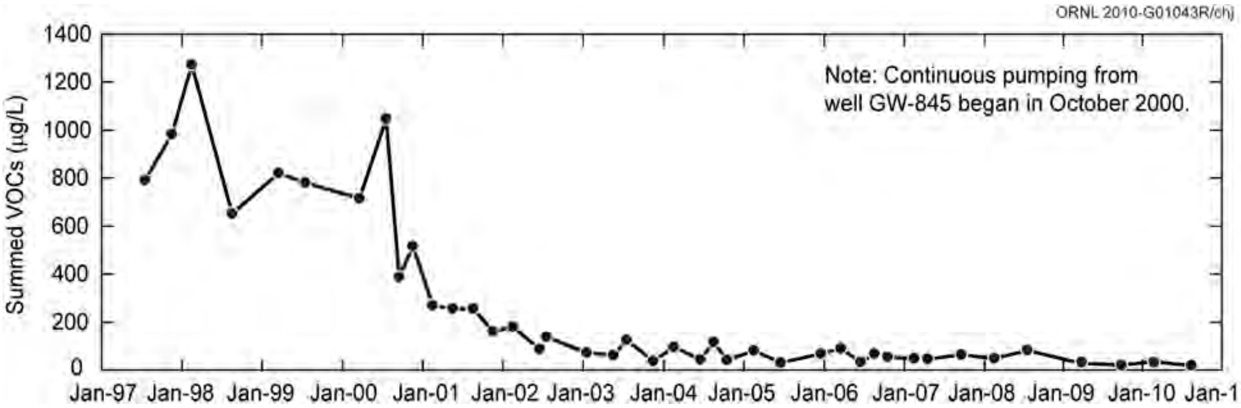

Fig. 4.45. Decreasing summed volatile organic compounds observed in exit pathway Well GW-722-17 near the New Hope Pond, 2010.

Upper East Fork Poplar Creek flows north from the Y-12 Complex through a large gap in Pine Ridge. Shallow groundwater moves through the exit pathway, and very strong upward vertical flow gradients exist. Continued monitoring of the wells since about 1990 has shown no indication of any contaminants moving via that exit pathway (Fig. 4.38). Only one shallow well was monitored in CY 2010, and no groundwater contaminants were observed.

Three sampling locations continue to be monitored north and northwest of the Y-12 Complex to evaluate possible contaminant transport from the ORR. Those locations are considered unlikely groundwater or surface water contaminant exit pathways; however, monitoring was performed due to previous public concerns regarding potential health impacts from Y-12 operations to nearby residences. One of the stations monitored a tributary that drains the north slope of Pine Ridge on the ORR and discharges into the adjacent Scarboro Community. One location monitors an upper reach of Mill Branch, which discharges into the residential areas along Wiltshire Drive. The remaining location monitors Gum Hollow Branch as it discharges from the ORR and flows adjacent to the Country Club Estates community. Samples were obtained and analyzed for metals, inorganic parameters, volatile organic compounds, and gross alpha and gross beta activities. No results exceeded a drinking water standard, nor were there any indications that contaminants were being discharged from the ORR into those communities.

4.6.4.1.7 Union Valley Monitoring

Groundwater monitoring data obtained during the early 1990s provided the first strong indication that volatile organic compounds were being transported off the ORR through the deep Maynardville Limestone exit pathway. The Upper East Fork Poplar Creek remedial investigation (DOE 1998) provided a discussion of the nature and extent of the volatile organic compounds.

In CY 2010, monitoring of locations in Union Valley continued, showing an overall decreasing trend in the concentrations of contaminants forming the groundwater contaminant plume in Union Valley.

Under the terms of an interim Record of Decision (ROD), administrative controls, such as restrictions on potential future groundwater use, have been established and maintained. Additionally, the previously discussed plume capture system (Well GW-845) was installed and initiated to mitigate the migration of groundwater contaminated with volatile organic compounds into Union Valley (DOE 2010a; DOE 2011).

In July 2006, the Agency for Toxic Substances and Diseases Registry, the principal federal public health agency charged with evaluating the human health effects of exposure to hazardous substances in the environment, published a report in which they evaluated groundwater contamination across the ORR (ATSDR 2006). In the report, it was acknowledged that extensive groundwater contamination exists throughout the ORR, but the authors concluded that there is no public health hazard from exposure to contaminated groundwater originating from the ORR. The Y-12 Complex east end volatile organic compound groundwater contaminant plume was acknowledged as the only confirmed off-site contaminant plume migrating across the ORR boundary. The report recognized that the institutional and administrative controls established in the ROD do not provide for reduction in toxicity, mobility, or volume of contaminants of concern, but they conclude that the controls are protective of public health to the extent that they limit or prevent community exposure to contaminated groundwater in Union Valley.

4.6.4.2 Bear Creek Hydrogeologic Regime

Located west of the Y-12 Complex in Bear Creek Valley, the Bear Creek regime is bounded to the north by Pine Ridge and to the south by Chestnut Ridge. The regime encompasses the portion of Bear Creek Valley extending from the west end of the Y-12 Complex to State Highway 95. Table 4.20 describes each of the waste management sites within the Bear Creek regime.

4.6.4.2.1 Plume Delineation

The primary groundwater contaminants in the Bear Creek regime are nitrate, trace metals, volatile organic compounds, and radionuclides. The S-3 Site is a source of all four contaminants. The Bear Creek Burial Grounds and the Oil Landfarm waste management areas are significant sources of uranium and other trace metals and volatile organic compounds. High concentrations of chlorinated hydrocarbons and PCBs have been observed as deep as 82 m (270 ft) below the Bear Creek Burial Grounds.

Contaminant plume boundaries are essentially defined in the bedrock formations that directly underlie many waste disposal areas in the Bear Creek regime, particularly the Nolichucky Shale. This fractured noncarbonate rock unit is positioned north of and adjacent to the exit pathway unit, the Maynardville Limestone. The elongated shape of the contaminant plumes in the Bear Creek regime is the result of preferential transport of the contaminants parallel to strike (parallel to the valley axis) in both the Maynardville Limestone and the fractured noncarbonate rock.

4.6.4.2.2 Nitrate

Unlike many groundwater contaminants, nitrate is highly soluble and moves easily with groundwater. The limits of the nitrate plume probably define the maximum extent of subsurface contamination in the Bear Creek regime. The horizontal extent of the nitrate plume is essentially defined in groundwater in the upper to intermediate bedrock intervals of the aquitard and aquifer [less than 92 m (300 ft) below the ground surface].

Data obtained during CY 2010 indicate that nitrate concentrations in groundwater exceed the drinking water standard in an area that extends west from the source area at the S-3 Site. The highest nitrate concentration (10,999 mg/L) was observed at Well GW-615 adjacent to the S-3 Site at a depth of 68 m (223 ft) below ground surface (Fig. 4.40), indicating that high concentrations persist deeper in the subsurface groundwater system. In previous years, elevated concentrations of nitrate have been observed as deep as 226 m (740 ft) below ground surface.

Table 4.20. History of waste management units included in CY 2010 groundwater monitoring activities, Bear Creek Hydrogeologic Regime

Site	Historical data
S-3 Site	Four unlined surface impoundments constructed in 1951. Received liquid nitric acid/uranium–bearing wastes via the Nitric Acid Pipeline until 1983. Closed and capped under RCRA in 1988. Infiltration was the primary release mechanism to groundwater
Oil Landfarm	Operated from 1973 to 1982. Received waste oils and coolants tainted with metals and PCBs. Closed and capped under RCRA in 1989. Infiltration was the primary release mechanism to groundwater
Boneyard	Used from 1943 to 1970. Unlined shallow trenches used to dispose of construction debris and to burn magnesium chips and wood. Excavated and restored in 2002–2003 as part of Boneyard/Burnyard remedial activities
Burnyard	Used from 1943 to 1968. Wastes, metal shavings, solvents, oils, and laboratory chemicals were burned in two unlined trenches. Excavated and restored in 2002–2003
Hazardous Chemical Disposal Area	Used from 1975 to 1981. Built over the Burnyard. Handled compressed gas cylinders and reactive chemicals. Residues placed in a small, unlined pit. The northwest portion was excavated and restored in 2002–2003 as part of Boneyard/Burnyard remedial activities
Sanitary Landfill I	Used from 1968 to 1982. TDEC-permitted, nonhazardous industrial landfill. May be a source of certain contaminants to groundwater. Closed and capped under TDEC requirements in 1985.Evaluation under CERCLA determined that no further action was needed
Bear Creek Burial Grounds: A, C, and Walk-in Pits	A and C received waste oils, coolants, beryllium and uranium, various metallic wastes, and asbestos into unlined trenches and standpipes. Walk-in Pits received chemical wastes, shock-sensitive reagents, and uranium saw fines. Activities ceased in 1981. Final closure certified for A (1989), C (1993), and the Walk-in Pits (1995). Infiltration is the primary release mechanism to groundwater
Bear Creek Burial Grounds: B, D, E, J, and Oil Retention Ponds 1 and 2	Burial Grounds B, D, E, and J, unlined trenches, received depleted uranium metal and oxides and minor amounts of debris and inorganic salts. Ponds 1 and 2, built in 1971 and 1972, respectively, captured waste oils seeping into two Bear Creek tributaries. The ponds were closed and capped under RCRA in 1989. Certification of closure and capping of Burial Grounds B and part of C was granted February 1995
Rust Spoil Area	Used from 1975 to 1983 for disposal of construction debris, but may have included materials bearing solvents, asbestos, mercury, and uranium. Closed under RCRA in 1984. Site is a source of volatile organic compounds to shallow groundwater according to CERCLA remedial investigation
Spoil Area I	Used from 1980 to 1988 for disposal of construction debris and other stable, nonradioactive wastes. Permitted under TDEC solid waste management regulations in 1986; closure began shortly thereafter. Soil contamination is of primary concern. CERCLA record of decision issued in 1997
SY-200 Yard	Used from 1950 to 1986 for equipment and materials storage. No documented waste disposal at the site occurred. Leaks, spills, and soil contamination are concerns. CERCLA ROD issued in 1996
Above-Grade LLW Storage Facility	Constructed in 1993. Consists of six above-grade storage pads used to store inert, low-level radioactive debris and solid wastes packaged in steel containers
Environmental Management Waste Management Facility	Constructed in 2002. CERCLA Landfill receiving legacy wastes from ETTP, ORNL, Y-12, and nearby offsite CERCLA action sites within the state of Tennessee.

Abbreviations

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
LLW = low-level radioactive waste
PCB = polychlorinated biphenyl
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation

4.6.4.2.3 Trace Metals

During CY 2010, arsenic, uranium, barium, cadmium, chromium, lead, beryllium, and nickel were identified from groundwater monitoring as the trace metal contaminants in the Bear Creek regime that exceeded drinking water standards. Historically, elevated concentrations of many of the trace metals were observed at shallow depths near the S-3 Site. In the Bear Creek regime, where natural geochemical conditions prevail, the trace metals may occur sporadically and in close association with source areas because conditions are typically not favorable for dissolution and migration. Disposal of acidic liquid wastes at the S-3 Site reduced the pH of the groundwater, which allows the metals to remain in solution longer and migrate further from the source area.

The most prevalent trace metal contaminant observed within the Bear Creek regime is uranium, indicating that geochemical conditions are favorable for its migration. Early characterization indicated that the Boneyard/Burnyard site was the primary source of uranium contamination of surface water and groundwater. Historically, uranium has been observed at concentrations exceeding the drinking water standard of 0.03 mg/L in shallow monitoring wells, springs, and surface water locations downgradient from all of the waste areas. In 2003, the final remedial actions at the Boneyard/Burnyard were performed with the objective of removing materials contributing to surface water and groundwater contamination to meet existing ROD goals. Approximately 65,752 m^3 (86,000 yd^3) of waste materials was excavated and placed in the EMWMF (DOE 2007). There were significant decreases in uranium concentration and flux in the surface water tributary immediately downstream of the Boneyard/Burnyard (NT-3), which indicate that the remedial actions performed from 2002 to 2003 were successful in removing much of a primary source of uranium in Bear Creek Valley. However, beginning in 2007, flow proportionate composite samples from NT-3 show an increase in the uranium flux that continues to be observed. These increases indicate that even with overall decreasing uranium concentrations (Table 4.21), certain areas still present a significant impact to the overall health of Bear Creek.

Additional monitoring has been initiated to attempt to determine uranium inputs to the stream from source areas and the karst groundwater system underlying Bear Creek. Other trace metal contaminants that have been observed in the Bear Creek regime are mercury, selenium, strontium, thallium, and zinc. Concentrations have commonly exceeded background values in groundwater near contaminant source areas.

Table 4.21. Nitrate and uranium concentrations in Bear Creek[a]

Bear Creek Monitoring Station (distance from S-3 site)	Contaminant	Average Concentration (mg/L) 1990–1993	1994–1997	1998–2001	2002–2005	2006–2010
BCK[b]-11.84 to 11.97	Nitrate	119	80	80	79.5	42.2
(~0.5 miles downstream)	Uranium	0.196	0.134	0.139	0.133	0.128
BCK-09.20 to 09.47	Nitrate	16.4	9.6	10.6	11.3	8.2
(~2 miles downstream)	Uranium	0.091	0.094	0.171	0.092	0.060
BCK-04.55	Nitrate	4.6	3.6	2.6	2.9	1.1
(~5 miles downstream)	Uranium	0.034	0.031	0.036	0.026	0.017

[a] Excludes results that do not meet data quality objectives.
[b] BCK = Bear Creek kilometer

4.6.4.2.4 Volatile Organic Compounds

Volatile organic compounds are widespread in groundwater in the Bear Creek regime. The primary compounds are tetrachloroethene, trichloroethene, 1,2-dichloroethene, 1,1-dichloroethane, and vinyl chloride. In most areas, they are dissolved in the groundwater and can occur in bedrock at depths up to 92 m (300 ft) below ground surface. Groundwater in the fractured bedrock of the aquitard units that contains detectable levels of volatile organic compounds occurs primarily within about 305 m (1,000 ft) of the source areas. The highest concentrations observed in CY 2010 in the Bear Creek regime occurred in the intermediate bedrock zone at the Bear Creek Burial Ground waste management area, with a maximum summed volatile organic compound concentration of 9,460 µg/L in Well GW-046 (Fig. 4.42).

High concentrations of volatile organic compounds like this and in other near source wells, coupled with increasing trends observed downgradient of the Bear Creek Burial Ground waste management area in the clastic (noncarbonated) dominated fractured bedrock of the aquitard units (Fig. 4.46), indicate that a considerable mass of dense non-aqueous phase organic compounds is still present at a depth below the Bear Creek Burial Grounds, providing a source for dissolved phase migration of volatile organic compounds. This migration through the fractured aquitard units parallel to the valley axis and toward the exit pathway (Maynardville Limestone) is occurring in both the unconsolidated and bedrock intervals.

Significant transport of volatile organic compounds has occurred in the Maynardville Limestone. Data obtained from exit pathway monitoring locations show that in the shallow groundwater interval, an apparently continuous dissolved plume extends at least 2,440 m (8,000 ft) westward from the S-3 Site to just southeast of the Bear Creek Burial Ground waste management area.

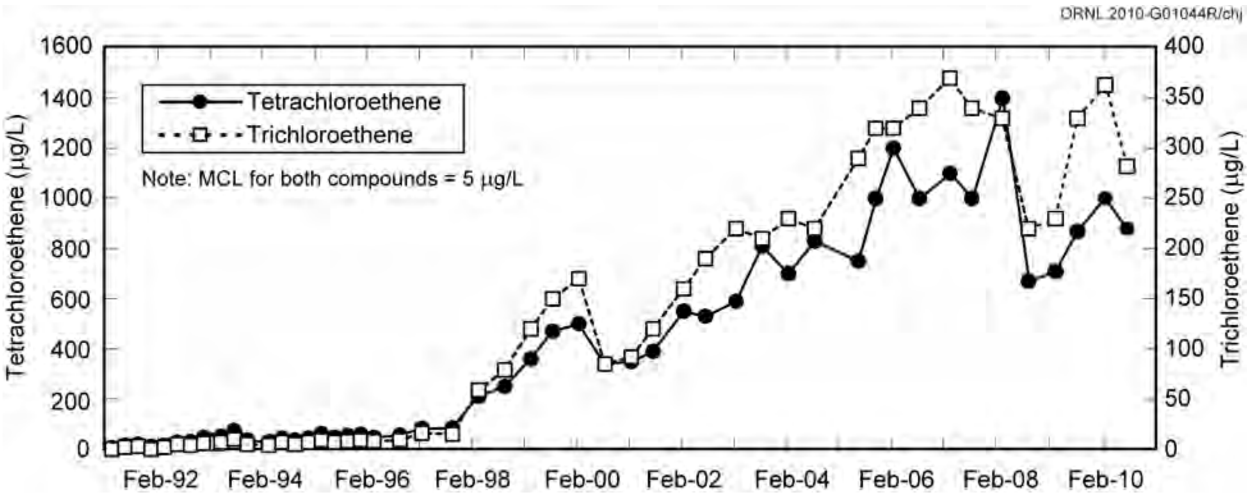

Fig. 4.46. Increasing volatile organic compounds observed in groundwater at Well GW-627 west and downgradient of the Bear Creek Burial Grounds, 2010.

4.6.4.2.5 Radionuclides

The primary radionuclides identified in the Bear Creek regime are isotopes of uranium and technetium-99. Neptunium, americium, radium, strontium, thorium, plutonium, and tritium are secondary and less widespread radionuclides, primarily present in groundwater near the S-3 Site. Evaluations of their extent in groundwater in the Bear Creek regime during CY 2010 were based primarily on measurements of gross alpha activity and gross beta activity. If the annual average gross alpha activity in groundwater samples from a well exceeded 15 pCi/L (the drinking water standard for gross alpha activity), then one (or more) of the alpha-emitting radionuclides (e.g., uranium) was assumed to be present at elevated levels in the groundwater monitored by the well. A similar rationale was used for annual average gross beta activity that exceeded 50 pCi/L. Technetium-99, a more volatile radionuclide, is qualitatively screened by gross beta activity analysis and, at certain monitoring locations, is evaluated isotopically.

Groundwater with elevated levels of gross alpha activity occurs near the S-3 Site and the Oil Landfarm and Bear Creek Burial Grounds waste management areas. In the bedrock interval, gross alpha activity exceeds 15 pCi/L in groundwater in the fractured bedrock of the aquitard units only near source areas (Fig. 4.43). Data obtained from exit pathway monitoring stations during CY 2010 show that gross alpha activity in groundwater in the Maynardville Limestone and in the surface waters of Bear Creek exceeds the drinking water standard for over 2,286 m (7,500 ft) west of the S-3 Site. The highest gross alpha activity observed in CY 2010 was 350 pCi/L in Well GW-246 located adjacent to the S-3 Site.

The distribution of gross beta radioactivity in groundwater is similar to that of gross alpha radioactivity. During CY 2010, the lateral extent of gross beta activity within the exit pathway groundwater interval and surface water above the drinking water standard has decreased from those observed in recent years. Gross beta activities exceeded 50 pCi/L within the Maynardville Limestone exit pathway for 914 m (3,000 ft) from the S-3 Site (Fig. 4.44). This apparent oscillation in the plume length is dependent on rainfall and other seasonal factors The highest gross beta activity in groundwater in the Bear Creek Regime in 2010 was 14,000 pCi/L at Well GW-246 located adjacent to the S-3 Site.

4.6.4.2.6 Exit Pathway and Perimeter Monitoring

Exit pathway monitoring began in 1990 to provide data on the quality of groundwater and surface water exiting the Bear Creek regime. The Maynardville Limestone is the primary exit pathway for groundwater. Bear Creek, which flows across the Maynardville Limestone in much of the Bear Creek regime, is the principal exit pathway for surface water. Various studies have shown that the surface water in Bear Creek, the springs along the valley floor, and the groundwater in the Maynardville Limestone are hydraulically connected. Surveys have been performed that identify gaining (groundwater discharging into surface waters) and losing (surface water discharging into a groundwater system) reaches of Bear Creek. The western exit pathway well transect (Picket W) serves as the perimeter well location for the Bear Creek regime (Fig. 4.38).

Exit pathway monitoring consists of continued monitoring at four well transects (pickets) and selected springs and surface water stations. Groundwater quality data obtained during CY 2010 from the exit pathway monitoring wells indicate that groundwater is contaminated above drinking water standards in the Maynardville Limestone as far west as Picket A and trends are generally decreasing (Fig. 4.47).

Surface water samples collected during CY 2010 indicate that water in Bear Creek contains many of the compounds found in the groundwater. Additionally, nitrate and uranium concentrations and gross beta activities exceeding their respective drinking water standards have been observed in surface water west of the burial grounds as far as Picket W. The concentrations in the creek decrease with distance downstream of the waste disposal sites (Table 4.21). Even though increases in uranium flux have been observed in surface water, which will require additional evaluation to pinpoint ungauged sources, individual monitoring locations along Bear Creek also show a general decrease in concentration with respect to time.

4.6.4.3 Chestnut Ridge Hydrogeologic Regime

The Chestnut Ridge Hydrogeologic Regime is flanked to the north by Bear Creek Valley and to the south by Bethel Valley Road (Fig. 4.36). The regime encompasses the portion of Chestnut Ridge extending from Scarboro Road, east of the complex, to Dunaway Branch, located just west of Industrial Landfill II.

The Chestnut Ridge Security Pits area is the only documented source of groundwater contamination in the regime. Contamination from the Security Pits is distinct and does not mingle with plumes from other sources. Table 4.22 summarizes the operational history of waste management units in the regime.

4.6.4.3.1 Plume Delineation

Through extensive monitoring of the wells on Chestnut Ridge, the horizontal extent of the volatile organic compound plume at the Chestnut Ridge Security Pits seems to be reasonably well defined in the water table and shallow bedrock zones. With two possible exceptions, historical monitoring indicates that the volatile organic compound plume from the Chestnut Ridge Security Pits has not migrated very far in any direction [305 m (<1,000 ft)]. Groundwater quality data obtained during CY 2010 indicate that the western lateral extent of the plume of volatile organic compounds at the site has not changed significantly from previous years. The continued observation of volatile organic compound contaminants over the past several years at a well approximately 458 m (1,500 ft) southeast of the Chestnut Ridge Security Pits shows that some migration of the eastern plume is apparent. Additionally, dye tracer test results and the intermittent detection of volatile organic compounds (similar to those found in wells adjacent to the Chestnut Ridge Security Pits) at a natural spring approximately 2745 m (9,000 ft) to the east and along geologic strike may indicate that Chestnut Ridge Security Pits groundwater contaminants have migrated much further than the monitoring well network indicates.

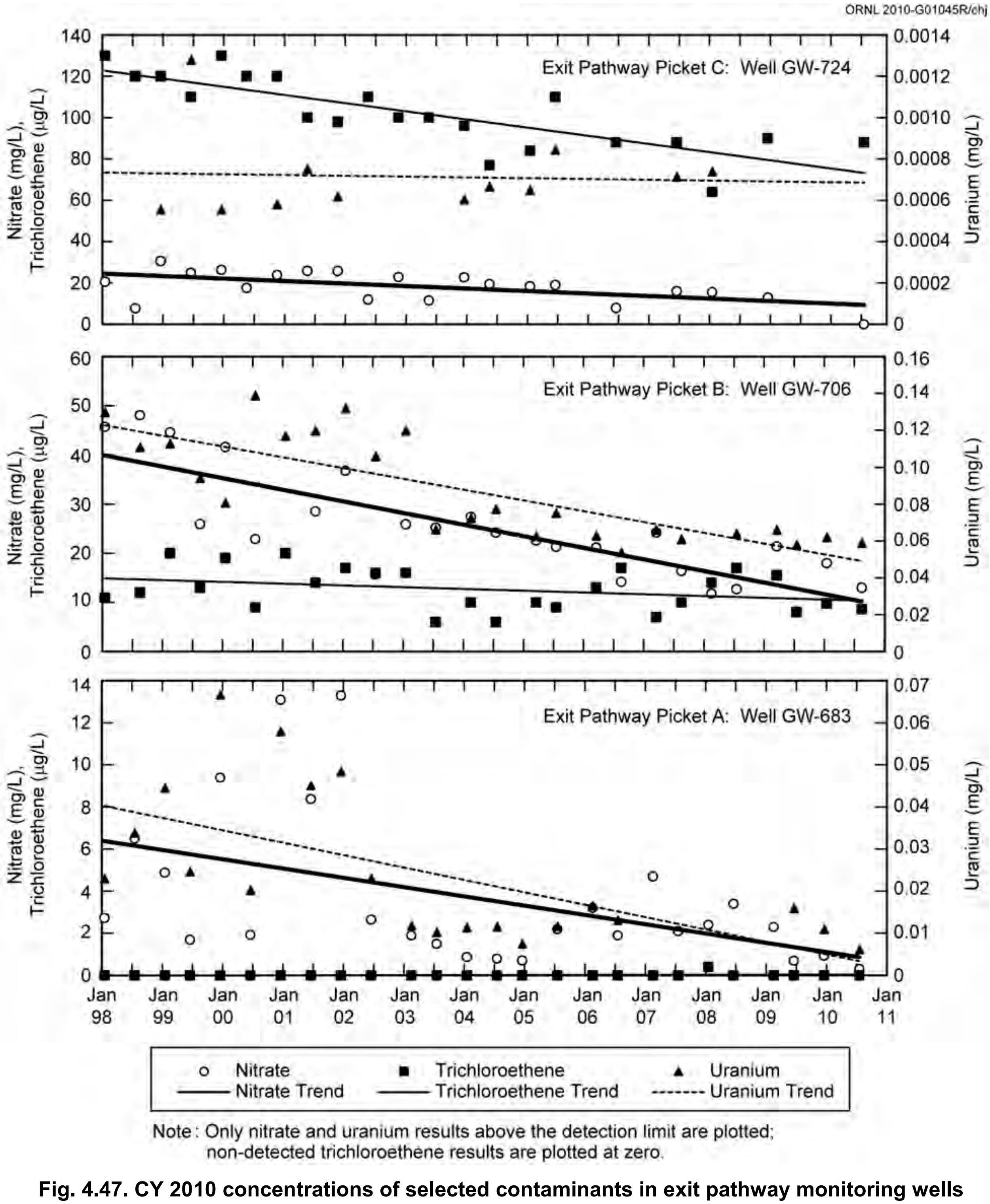

Fig. 4.47. CY 2010 concentrations of selected contaminants in exit pathway monitoring wells GW-724, GW-706, and GW-683 in the Bear Creek Hydrogeologic Regime.

Table 4.22. History of waste management units included in groundwater monitoring activities, Chestnut Ridge Hydrogeologic Regime, 2010

Site	Historical data
Chestnut Ridge Sediment Disposal Basin	Operated from 1973 to 1989. Received soil and sediment from New Hope Pond and mercury-contaminated soils from the Y-12 Complex. Site was closed under RCRA in 1989. Not a documented source of groundwater contamination
Kerr Hollow Quarry	Operated from 1940s to 1988. Used for the disposal of reactive materials, compressed gas cylinders, and various debris. RCRA closure (waste removal) was conducted between 1990 and 1993. Certification of closure with some wastes remaining in place was approved by TDEC February 1995
Chestnut Ridge Security Pits	Operated from 1973 to 1988. Series of trenches for disposal of classified materials, liquid wastes, thorium, uranium, heavy metals, and various debris. Closed under RCRA in 1989. Infiltration is the primary release mechanism to groundwater
United Nuclear Corporation Site	Received about 29,000 drums of cement-fixed sludges and soils demolition materials and low-level radioactive contaminated soils. Closed in 1992; CERCLA record of decision has been issued
Industrial Landfill II	Operated from 1983–1995. Central sanitary landfill for the Oak Ridge Reservation. Detection monitoring under postclosure plan has been ongoing since 1996
Industrial Landfill IV	Opened for operations in 1989. Permitted to receive only nonhazardous industrial solid wastes. Detection monitoring under TDEC solid-waste-management regulations has been ongoing since 1988. Assessment monitoring began in 2008 because of consistent exceedence of a TDEC Groundwater Protection Standard
Industrial Landfill V	Facility completed and initiated operations April 1994. Currently under TDEC solid-waste-management detection monitoring
Construction/Demolition Landfill VI	Facility operated from December 1993 to November 2003. The postclosure period ended and the permit was terminated March 2007
Construction/Demolition Landfill VII	Facility construction completed in December 1994. TDEC granted approval to operate January 1995. Permit-required detection monitoring per TDEC was temporarily suspended October 1997 pending closure of construction/demolition Landfill VI. Reopened and began waste disposal operations in April 2001
Filled Coal Ash Pond	Site received Y-12 Steam Plant coal ash slurries from 1955–1968. A CERCLA record of decision has been issued. Remedial action complete
East Chestnut Ridge Waste Pile	Operated from 1987 to 1989 to store contaminated soil and spoil material generated from environmental restoration activities at Y-12. Closed under RCRA in 2005 and incorporated into RCRA Post Closure Permit issued by TDEC in 2006

Abbreviations
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation

4.6.4.3.2 Nitrate

Nitrate concentrations were below the drinking water standard at all monitoring stations in the Chestnut Ridge Hydrogeologic Regime.

4.6.4.3.3 Trace Metals

A chromium result exceeding the drinking water standard (0.1 mg/L) was observed in a groundwater sample from one well (GW-141) at the Industrial Landfill IV (Fig. 4.35) with a maximum concentration of 0.113 mg/L. The presence of this trace metal in groundwater at the Y-12 Complex, with the exception of the S-3 Site, is not due to historical waste disposal but to corrosion of well casings. Chromium is a primary component of stainless steel, and its presence indicates the occurrence of corrosion and subsequent dissolution of stainless steel well casing and screen materials due to chemical or biochemical processes (LMES 1999).

4.6.4.3.4 Volatile Organic Compounds

Monitoring of volatile organic compounds in groundwater attributable to the Chestnut Ridge Security Pits has been in progress since 1987. A review of historical data indicates that concentrations of volatile organic compounds in groundwater at the site have generally decreased since 1988. However, a shallow increasing trend in volatile organic compounds in groundwater samples from monitoring well GW-798 to the southeast and downgradient of the Chestnut Ridge Security Pits has been developing since CY 2000 (Fig. 4.42). Elevated concentrations observed in GW-798 appear to fluctuate with changing precipitation conditions. The volatile organic compounds detected in CY 2010 in Well GW-798 continue to be characteristic of the Chestnut Ridge Security Pits plume.

At Industrial Landfill IV, a number of volatile organic compounds have been observed since 1992. Monitoring well GW-305, located immediately to the southeast of the facility, has historically displayed concentrations of compounds below applicable drinking water standards, but the concentrations have exhibited a shallow increasing trend. In CY 2010, samples continue to exceed the drinking water standard for 1,1-dichloroethene (7 μg/L). This has resulted in an increased level of monitoring to further evaluate the trend.

4.6.4.3.5 Radionuclides

In CY 2010, no gross alpha activity above the drinking water standard of 15 pCi/L was observed in any groundwater samples collected in the Chestnut Ridge Hydrogeologic Regime. Gross beta activities continue to exceed the screening level of 50 pCi/L at monitoring well GW-205 (Fig. 4.44) at the United Nuclear Corporation site (the maximum detected activity was 50.6 pCi/L). This location has consistently exceeded the screening level since August 1999. Isotopic analyses show a correlative increase in the beta-emitting radionuclide potassium-40, which is not a known contaminant of concern at the United Nuclear Corporation Site. The source of the radioisotope is not known.

4.6.4.3.6 Exit Pathway and Perimeter Monitoring

Contaminant and groundwater flow paths in the karst bedrock underlying the Chestnut Ridge regime have not been well characterized by conventional monitoring techniques. A number of tracer studies have been conducted that show groundwater from Chestnut Ridge discharging into Scarboro Creek and other tributaries that feed into Melton Hill Lake. However, no springs or surface streams that represent discharge points for groundwater have been conclusively correlated to a waste management unit at Y-12 that is a known or potential groundwater contaminant source. Water quality from a spring along Scarboro Creek is monitored quarterly by the TDEC DOE Oversight Office, and trace concentrations of volatile organic compounds are intermittently detected. The detected volatile organic compounds are suspected to originate from the Chestnut Ridge Security Pits; however, this has not been confirmed.

Monitoring of natural groundwater exit pathways is a basic monitoring strategy in a karst regime such as that of Chestnut Ridge. Perimeter springs and surface water tributaries were monitored to determine whether contaminants are exiting the downgradient (southern) side of the regime. Five springs and three surface water monitoring locations were sampled during CY 2010. No contaminants were detected in any of these natural discharge points above drinking water standards.

4.6.5 Quality Assurance

All groundwater monitoring is performed under quality controls to ensure that representative samples and analytical results are obtained. Since there are a number of organizations responsible for performing groundwater sampling and analysis activities to meet separate requirements, there may be some minor differences in sampling and analysis procedures and methodology, but ultimately the final results are comparable for use by all projects and programs. This permits the integrated use of groundwater quality data obtained at the Y-12 Complex.

A number of quality assurance measures are performed to ensure accurate, consistent, and comparable groundwater results. These measures are described in sampling and analysis plans and include the following:

- Groundwater sampling is performed across the Y-12 Complex using a number of sampling methods and procedures. The predominant method of sampling is by using a low-flow minimum drawdown method. Using this method, a sample is obtained from a discrete depth interval without introducing stagnant water from the well casing. Groundwater is pumped from the well at a flow rate low enough to minimize drawdown of the water level in the well; field readings are also taken to ensure that the sample is representative of the groundwater system and not the well casing itself. All sampling methods follow industry/regulator–recognized protocols to ensure that consistent and repeatable samples are obtained.
- Quality controls such as field blank, trip blank, duplicate, and equipment rinsate samples are collected.
- All groundwater samples are controlled under chain of custody from their collection in the field through the analytical laboratory that performed the analyses.
- Laboratory analyses are performed using standard methodologies and protocols within established holding times.

During 2010 all groundwater monitoring and related analytical activities were performed in accordance with the established protocols.

4.7 Quality Assurance Program

It is the intent of the B&W Y-12 Quality Assurance Program to be fully consistent with and supportive of the ISMS program’s functions and guiding principles. Management requirement Y60-101PD, *Quality Program Description*, details the methodologies employed to carry out work processes safely and securely and in accordance with established procedures. It also describes mechanisms in place to seek continuous improvements by identifying and correcting findings and preventing recurrence.

Many factors can potentially affect the results of environmental data collection activities, including sampling personnel, methods, and procedures; field conditions; sample handling, preservation, and transport; personnel training; analytical methods; data reporting; and record keeping. Quality assurance programs are designed to minimize these sources of variability and to control all phases of the monitoring process.

Field sampling QA encompasses many practices that minimize error and evaluate sampling performance. Some key quality practices include the following:

- use of work control processes and standard operating procedures for sample collection and analysis;
- use of chain-of-custody and sample-identification procedures;
- instrument standardization, calibration, and verification;
- sample technician and laboratory analyst training;
- sample preservation, handling, and decontamination; and
- use of QC samples, such as field and trip blanks, duplicates, and equipment rinses.

Analytical results may be affected by a large number of factors inherent to the measurement process. Laboratories that support the Y-12 environmental monitoring programs employ internal QA/QC programs to ensure the early detection of problems that may arise from contamination, inadequate calibrations, calculation errors, or improper procedure performance. Internal laboratory QA/QC programs include routine calibrations of counting instruments, yield determinations, frequent use of check sources and background counts, replicate and spiked sample analyses, matrix and reagent blanks, and maintenance of control charts to indicate analytical deficiencies. These activities are supported by the use of standard materials or reference materials (e.g., materials of known composition that are used in the calibration of instruments, methods standardization, spike additions for recovery tests, and other practices). Certified standards traceable to the National Institute of Standards and Technology (NIST), DOE sources, or EPA are used (when available) for such work.

The Y-12 Analytical Chemistry Organization (ACO) Quality Assurance Plan describes QA program elements that are based on the B&W Y-12 Quality Assurance Program; customer-specific requirements; certification program requirements, International Standard ISO/IEC 17025, General Requirements for Competence of Testing and Calibration Laboratories; federal, state and local regulations; and Waste Acceptance Criteria. As a government-owned client-operated (GOCO) laboratory that performs work for the DOE, the ACO laboratory operates in accordance with DOE Order 414.1C, “Quality Assurance,” and DOE Order 450.1A, “Environmental Protection Program.” In order to meet these requirements, the ACO laboratory adheres to the latest edition of the *DOE Quality Systems for Analytical Services* (DOE 2010b) where it applies.

Other internal practices employed to ensure that laboratory results are representative of actual conditions include staff training and management; adequacy of the laboratory environment; safety; the storage, integrity, and identity of samples; record keeping; the maintenance and calibration of instruments; and the use of technically validated and properly documented methods.

Verification and validation of environmental data are performed as components of the data collection process, which includes planning, sampling, analysis, and data review. Some level of verification and validation of field and analytical data collected for environmental monitoring and restoration programs is necessary to ensure that data conform with applicable regulatory and contractual requirements. Validation of field and analytical data is a technical review performed to compare data with established quality criteria to ensure that data are adequate for the intended use. The extent of project data verification and validation activities is based on project-specific requirements.

For routine environmental effluent monitoring and surveillance monitoring, data verification activities may include processes of checking whether (1) data have been accurately transcribed and recorded, (2) appropriate procedures have been followed, (3) electronic and hard-copy data show one-to-one correspondence, and (4) data are consistent with expected trends. Typically, routine data verification actions alone are sufficient to document the validity and accuracy of environmental reports. For restoration projects, routine verification activities are more contractually oriented and include checks for data completeness, consistency, and compliance against a predetermined standard or contract.

Certain projects may require a more thorough technical validation of the data as mandated by the project’s data quality objectives. Sampling and analyses conducted as part of a remedial investigation to support the CERCLA process may generate data that are needed to evaluate risk to human health and the environment, to document that no further remediation is necessary, or to support a multimillion-dollar construction activity and treatment alternative. In these cases, the data quality objectives of the project may mandate a thorough technical evaluation of the data against rigorous predetermined criteria. The validation process may result in the identification of data that do not meet predetermined QC criteria or in the ultimate rejection of data for their intended use. Typical criteria evaluated in the validation of Contract Laboratory Program data include the percentage of surrogate recoveries, spike recoveries, method blanks, instrument tuning, instrument calibration, continuing calibration verifications, internal standard response, comparison of duplicate samples, and sample-holding times.

4.8 Environmental Management and Waste Management Activities

4.8.1 Upper East Fork Poplar Creek Remediation

Remediation of the Upper East Fork Poplar Creek Watershed is being conducted in two stages under Records of Decision using a phased approach. Phase 1 addresses remediation of mercury-contaminated soil, sediment, and groundwater discharges that contribute contamination to surface water.

The initial project of the Phase 1 Record of Decision, construction of the Big Springs Water Treatment System, was completed in 2006. The system has been fully operational since September 2006, removing mercury from local spring and sump waters that discharge to Upper East Fork Poplar Creek.

With ARRA funding, cleanup and repair of storm sewers in the West End Mercury Area (historic mercury use area) was initiated in FY 2009 and continued in 2010 (see Sect. 4.8.2).

4.8.2 ARRA-Funded Removal Actions at Y-12

ARRA funding is being used to expedite removal of legacy wastes and building demolition at the Y-12 National Security Complex. As of the end of December, B&W Y-12 had completed

- all 34 planned milestones, many of them ahead of schedule;
- almost 1,500,000 job-hours without a lost workday injury (as of the end of December);
- a total of 63,623 cubic meters of waste disposal shipments; and
- had awarded $73.1 million in procurements, 77% of them to small businesses.

Building 9735 D&D

Demolition of Building 9735, the last building to be removed from Engineering Row, was completed in June 2010. Demolition of Engineering Row reduced the Y-12 facility footprint by 92,690 ft^2. The other six buildings that once comprised Engineering Row were demolished in 2008. In addition to eliminating safety and environmental risks, this project provided space for Y-12 to add an employee parking lot, as part of a separate NNSA-funded site improvement project (Fig. 4.48).

ORNL 2011-G00655/chj

Fig. 4.48. Building 9735 deactivation and demolition.

Biology Complex D&D

The Biology Complex Deactivation and Demolition (D&D) project is part of Y-12's ongoing footprint reduction effort, designed to minimize maintenance and security costs. The project eliminates 135,812 ft^2 of unused building space and the risk associated with the deteriorated facilities. These buildings have been vacant since late 2003. Building sites demolished to slab in 2010 are Buildings 9220, 9224, 9769, and 9211. Buildings 9769 and 9211 (a four-story structure) presented unique challenges in dismantling structural anomalies while maintaining a high level of commitment to worker safety. Site stabilization activities will be completed in January 2011, and the project was 92% complete at end of 2010 (Fig. 4.49).

9204-4 Legacy Material Removal Project

This project comprises removal and disposal of legacy materials from the second floor of Building 9204-4, also known as Beta 4, to prepare for deactivation and demolition of the facility as part of the site transformation plan. Beta 4 is a large, three-story building that features a flat roof and is supported by a cast-concrete foundation.

Disposition plans for Beta 4 waste were accelerated with ARRA funding. Results of these efforts are improved site safety and security, reduced operating costs, and reduced environmental risk to site personnel and to the immediate and surrounding areas. The Beta 4 project was 97% complete at the end of 2010.

ORNL 2011-G00656/chj

Fig. 4.49. Building 9211 demolition.

9201-5 Legacy Materials Removal Project

Building 9201-5, also known as Alpha-5, is the largest building at Y-12, measuring 613,642 ft^2. The project is tasked with removing and disposing legacy materials from the building as well as characterizing the building structure to prepare for eventual deactivation and demolition by the EM Program. Y-12 reached the first project milestone in March with the completion of the fourth-floor cleanup (1,857 m^3 removed). The second floor was cleared in July, and total material removal on that floor was 7,082 m^3. The project was 74% complete at the end of December 2010. The building is scheduled to be emptied completely by September 30, 2011 (Fig. 4.50).

ORNL 2011-G00657/chj

Fig. 4.50. At the 9201-5 Legacy Materials Removal Project, radiological control technicians and material handlers check containers before disposal.

Building 9206 Filter House Removal

The Building 9206 Filter House Removal Project involves the removal of a contaminated process system. It includes the deactivation and demolition of the filter baghouse, secondary furnace, associated piping and ductwork, heat exchanger, cyclone separator, spark arrester, and associated utilities. All material will be packaged, characterized, and shipped to an appropriate disposal facility. Removal of this process system reduces exposure from the potential release of radiological and hazardous materials in out-of-service equipment. Deactivation also eliminates the need for daily monitoring of the process systems. As of December 2010, the Building 9206 Filter House Project was 83% complete.

West End Mercury Area Storm Sewer Remediation Project

The initial phase of this project involved videotaping the storm sewer system using a track-mounted video camera. An engineering study, completed in 2009, documented the results of the camera survey and the extent of remediation required, as the pipes are a known mercury pathway to Upper East Fork Poplar Creek. A Remedial Action Work Plan/Waste Management Plan was prepared during 2010 that specifies the method of accomplishment for storm sewer remediation and was approved by the Environmental Protection Agency and the state of Tennessee. As of December 2010, the project was 22% complete, the remediation subcontract was awarded, and storm sewer remediation is expected to start in spring of 2011.

Old Salvage Yard Cleanup Project

The 7-acre site, established in the early 1970s, was used for storing scrap metal and liquid hazardous wastes from Y-12 operations until 1999. The Old Salvage Yard received scrap into open piles until 1995, when new procedures required that all scrap metal be placed inside containers. As of December 2010, the cleanup project was 91% complete and had removed approximately 20,445 cubic meters of potentially radioactively contaminated scrap metal, including material in piles and approximately 1,100 containers (B-24 and B-25) of radioactive scrap metal.

The primary contaminants of concern in the scrap yard include uranium and thorium. Forklifts, an abandoned crane, and other equipment were also removed. In addition to the material removal and disposition, the Old Salvage Yard Scrap Removal Project received additional ARRA funding in August 2010 to characterize the underlying soils. Based on the results of that characterization, Y-12 anticipates remediating those soils to the extent required by regulators (Fig 4.51).

ORNL 2011-G00658/chj

Fig. 4.51. Old Salvage Yard cleanup project.

4.8.3 Waste Management

Much of the waste generated during FY 2010 cleanup activities was disposed at facilities on the Oak Ridge Reservation. Environmental Management Waste Management Facility (EMWMF), located in Bear Creek Valley west of the Y-12 Complex, is an engineered landfill that accepts waste generated from Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions and cleanup activities on the Oak Ridge Reservation. It currently consists of four active disposal cells, with a fifth cell awaiting final regulatory approval for use and a sixth cell under construction at the end of FY 2010. Construction of the ARRA-funded Cell 5 EMWMF expansion was completed in May 2010. The addition of Cell 5 brings the capacity of EMWMF up to 1,650,000 yd3. A sixth cell is being added and will bring the total facility capacity to 2,180,000 yd3. The Cell 6 construction effort is scheduled to conclude in April 2011.

Further expansion, beyond Cell 6, at EMWMF is constrained by physical limitations of the site. Therefore, DOE is considering other locations to build a new disposal facility. DOE began evaluating disposal alternatives in FY 2010 for future Reservation cleanup waste.

EMWMF accepts low-level radioactive and hazardous wastes that meet specific waste acceptance criteria developed in accordance with agreements with state and federal regulators. Waste types that qualify for disposal include soil, dried sludge and sediment, solidified wastes, stabilized waste, building debris, scrap equipment, and personal protective equipment.

During FY 2010, EMWMF operations collected, analyzed, and dispositioned approximately 4.8 million gallons of leachate and 1.3 million gallons of contact water at the ORNL Liquid/Gaseous Waste Operations Facility. An additional 10 million gallons of contact water was collected, analyzed, and released to the storm water retention basin after determining that it met the release criteria. Operating practices also effectively controlled site erosion and sediments.

EMWMF received approximately 22,700 truckloads of waste accounting for approximately 262,000 tons during FY 2010. Projects that have disposed of waste at EMWMF during the year include the following:

- K-25 Building Demolition Project, including waste generated from the west wing demolition;
- ETTP Decontamination and Decommissioning Project, including K-770 Scrapyard, K-1070-B Burial Ground, and K-1036/K-1058 demolition debris;
- Y-12 Old Salvage Yard Project, Alpha 5 Project, and Biology Project; and
- ORNL Building 3026 and 2000 Complex.

DOE also operates the Oak Ridge Reservation Landfills (ORRL), which are solid waste disposal facilities located south the Y-12 Complex on Chestnut Ridge. The ORRL are engineered facilities used for the disposal of sanitary, industrial, construction, and demolition waste. In FY 2010, approximately 139,000 yd^3 of industrial wastes, construction/demolition wastes, and spoil materials waste were disposed in the ORRL. Operation of the ORRL generated approximately 1.48 million gallons of leachate that was collected, monitored, and discharged to the Y-12 National Security Complex sanitary sewer system, which discharges to the Oak Ridge sewer system under an industrial sewer user permit.

Construction of the ARRA-funded expansion at the ORRL, located near the Y-12 Complex, started in April 2010. When completed, Area 4 at Industrial Landfill V will add 385,000 yd^3 of capacity. A new Truck Receiving Station will enhance the safety and productivity of operations by providing permanent steel platforms for performing the required load inspections instead of having to use ladders. Also, a leachate header was installed at Industrial Landfill IV to pump leachate into the city of Oak Ridge sewer system for disposal.

4.8.4 Wastewater Treatment

The National Nuclear Security Administration (NNSA) at the Y-12 Complex treated 116.5 million gallons of contaminated ground/sump water at the Groundwater Treatment Facility, the Central Mercury Treatment System, Big Springs Water Treatment System, and the East End Volatile Organic Compounds (VOC) Treatment System.

The Big Springs Water Treatment System treated 104 million gallons of mercury-contaminated groundwater. The East End Volatile Organic Compound Treatment System treated 11 million gallons of VOC-contaminated groundwater. The West End Treatment Facility and the Central Pollution Control Facility at the Y-12 Complex processed 1.2 million gallons of wastewater primarily in support of NNSA operational activities.

The Central Pollution Control Facility also down-blended more than 37,000 gallons of enriched wastewaters using legacy and newly generated uranium oxides from on-site storage.

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5. Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL), managed by UT-Battelle, LLC, is DOE's largest science and energy laboratory. ORNL's mission is to provide solutions to America's scientific challenges, and a diverse, highly qualified staff of more than 4,800 continues a rich tradition of scientific exploration to support this mission. In addition, more than 3,000 visiting scientists spend 2 weeks or longer in Oak Ridge each year at the 12 advanced research user facilities made available to scientists all over the world. As an international leader in a range of scientific areas that support DOE's mission, ORNL has six major mission roles: neutron science, energy, high-performance computing, systems biology, materials science at the nanoscale, and national security. ORNL's leadership role in the nation's energy future includes hosting the U.S. project office for the ITER international fusion experiment and the Office of Science−sponsored Bioenergy Science Center. During 2010 UT-Battelle, Wastren Advantage, Inc. (WAI), and Isotek operations were conducted in compliance with contractual and regulatory environmental requirements with the exception of two interrelated exceedances of National Pollutant Discharge Elimination System permit discharge limits. There were no notices of violation or penalties issued by the regulatory agencies.

Due to differing permit reporting requirements and instrument capabilities, various units of measurement are used in this report. The list of units of measure and conversion factors provided on page xxvii is intended to help readers convert numeric values presented herein as needed for specific calculations and comparisons.

5.1 Description of Site and Operations

5.1.1 Mission

ORNL lies in the southwest corner of DOE's Oak Ridge Reservation (ORR) (Fig. 5.1) and is managed for the DOE by UT-Battelle, LLC, a partnership of the University of Tennessee and Battelle Memorial Institute. The main ORNL site occupies approximately 1,809 ha (4,470 acres) and includes facilities in two valleys (Bethel and Melton) and on Chestnut Ridge. ORNL was established in 1943 as a part of the secret Manhattan Project to pioneer a method for producing and separating plutonium. During the 1950s and 1960s, and with the creation of DOE in the 1970s, ORNL became an international center for the study of nuclear energy and related research in the physical and life sciences. By the turn of the century, the Laboratory supported the nation with a peacetime science and technology mission that was just as important as, but very different from, the work carried out in the days of the Manhattan Project. ORNL is an international leader in a range of scientific areas that supports DOE's mission and is completing a $350 million project to provide a modern campus for the next generation of great science. The $1.4 billion Spallation Neutron Source (SNS), located adjacent to the new Center for Nanophase Materials Sciences, combines with one of the nation's largest research reactors to continue the Laboratory's reputation as a leader in the study of materials.

With unmatched capacity for open scientific research, Oak Ridge's Jaguar supercomputer has broken the "petaflop" barrier, or 1,000 trillion mathematical calculations per second, making it possible to model the most complex scientific problems. ORNL's Bioenergy Science Center, funded by DOE, is developing new forms of cellulosic ethanol that can be grown on millions of acres of marginal land with little need for water of fertilizer.

UT-Battelle also manages several facilities located off the main ORNL campus. These include several buildings and trailers located at the Y-12 Complex, at the American Museum of Science and Energy in the city of Oak Ridge, and several others locations around the Oak Ridge vicinity.

Fig. 5.1. Location of ORNL within the ORR and its relationship to other local DOE facilities.

The National Transportation Research Center (NTRC), an alliance among UT-Battelle; the University of Tennessee; DOE; NTRC, Inc.; and the Development Corporation of Knox County, is the site of activities that span the whole range of transportation research. The center is an 85,000-ft^2 building, located on a 2.4-ha site in the Pellissippi Corporate Center and is leased to UT-Battelle and the University of Tennessee separately by Pellissippi Investors LLC.

The TransuranicWaste Processing Center (TWPC), managed by Wastren Advantage Inc. (WAI) for DOE, is located on the western boundary of ORNL on about 10 ha of land adjacent to the Melton Valley Storage Tanks along State Route 95. The TWPC's mission is to receive TRU wastes for processing, treatment, repackaging, and shipment to designated facilities for final disposal. The TWPC consists of the Waste Processing Facility, the Personnel Building, and numerous support buildings and storage areas. The TWPC began processing supernatant liquid from the Melton Valley Storage Tanks in 2002, the contact-handled debris waste in December 2005, and the remote-handled debris waste in May 2008. Based on the definition of TRU waste, some waste that is currently being managed as TRU is later determined to be LLW or MLLW.

In March 2007, Isotek Systems, LLC (Isotek) assumed responsibility for surveillance and maintenance activities at the Building 3019 Complex at ORNL. DOE awarded the contract to Isotek to accomplish the following principal objectives:

- process, downblend, and package the DOE inventory of ^{233}U (and the 715 gal of ^{233}U-contaminated thorium nitrate stored in Tank P-24) to eliminate the need for safeguards, security, and nuclear criticality controls and to render these materials suitable for safe disposition;
- remove the ^{233}U material from the Building 3019 Complex;
- transport the downblended material to one or more licensed disposal facilities; and
- place the Building 3019 Complex in safe and stable shutdown condition.

During 2010, Isotek continued to manage the Building 3019 Complex in a surveillance and maintenance mode and design the facilities and operations needed to accomplish the above objectives. At the end of 2010, 90% design had been achieved and remaining design comments continued to be resolved. In January 2010, an environmental assessment for the U-233 Material Downblending and Disposition Project was completed, and a Finding of No Significant Impact under the National Environmental Policy Act (NEPA) process was issued [see *Final Environmental Assessment for U-233*

Material Downblending and Disposition Project at the Oak Ridge National Laboratory, Oak Ridge, Tennessee (DOE 2010)].

UT-Battelle performs air and water quality monitoring for the 3019 facility, water quality monitoring for the TWPC, and the discussions in this chapter include the results for the Isotek and WAI operations at ORNL.

Approximately 5 ha in the central portion of the ORNL has been leased to Halcyon, LLC, a subsidiary of the Community Reuse Organization of East Tennessee (CROET) for development into the Oak Ridge Science and Technology Park (ORSTP). The ORSTP will provide space for private companies doing research at ORNL, partner universities, start-up companies built around ORNL technologies, and ORNL contractors to conduct business within a short distance of ORNL researchers and DOE user facilities such as the SNS, the Center for Nanophase Materials Sciences, and the High Flux Isotope Reactor (HFIR). Construction of the first ORSTP facility, Pro2Serve's 115,000-ft^2 National Security Engineering Center, was completed in 2009, and the company has moved into the building. In addition, the former Building 2033, which has been leased to Halcyon, LLC, and is now known as the Halcyon Commercialization Center (HCC), and continues to attract tenants. Currently, the largest tenant in the HCC is Roane State Community College, which is offering job training classes on site in the areas of carbon fiber and solar energy. Other tenants in the HCC include several consulting firms and a carbon fiber manufacturer that is partnering with ORNL for research. Expansion of the ORSTP will continue as more environmental cleanup in ORNL's central campus is completed. The EPA has designated ORSTP lessees as colocated workers since these tenants are located on DOE property and are issued security badges to access the facilities. These badges provide access to the ORSTP facilities and, during regular business hours, the ORNL Conference Center (Building 5200) only. Access to any other ORNL facility requires additional DOE approval.

5.2 Environmental Management Systems

An important priority for DOE contractors performing management and operations activities at ORNL is the demonstration of environmental excellence through high-level policies that clearly state expectations for continual improvement, pollution prevention, and compliance with regulations and other requirements.

UT-Battelle, WAI, Bechtel Jacobs Company (BJC), and Isotek have implemented Environmental Management Systems (EMSs), modeled after the International Organization for Standardization (ISO) standard 14001:2004 (ISO 2004), as a tool to measure, manage, and control environmental impacts. An EMS is a continuing cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental goals. UT-Battelle’s EMS was initially registered to the ISO 14001 Standard by a third-party registrar in 2004 and was reregistered in June 2007 and June 2010 by NSF International Strategic Registrations, Ltd. No nonconformities were identified during the most recent reregistration audit. Detailed information on the UT-Battelle EMS is provided in Sects. 5.2.1 through 5.2.1.7. WAI’s EMS for activities at TWPC was registered to the ISO 14001:2004 Standard by NSF International Strategic Registrations, Ltd., in May 2008. NSF International Strategic Registrations, Ltd., conducted a Surveillance Audit for the WAI EMS program in May 2010, and no nonconformities or issues were identified and several significant practices were noted. Section 5.2.2 describes the WAI EMS and associated implementation activities. In June 2009, DOE conducted an external validation audit and concluded “that Isotek Systems, LLC (Isotek) has implemented an Environmental Management System (EMS) that is consistent with the requirements of DOE Order 450.l A, Environmental Protection Program.” This validation is good through 2012.

5.2.1 UT-Battelle EMS

The UT-Battelle EMS is a fully integrated set of environmental management services for UT-Battelle activities and facilities. Services include pollution prevention, waste management, effluent management, regulatory review, reporting, permitting, and other environmental management programs. Through the UT-Battelle Standards-Based Management System (SBMS), the EMS establishes the environmental policy and translates environmental laws, applicable DOE orders, and other requirements into Laboratory-wide subject area documents (procedures and guidelines). SBMS information is based on an evaluation of external requirements (i.e., directives and federal, state, and local laws), corporate policies, and best management practices that have been determined applicable to UT-Battelle operations and processes. Through environmental protection officers, environmental compliance representatives, and waste service representatives, the EMS assists the line organizations in identifying and addressing environmental issues in accordance with the SBMS requirements.

5.2.1.1 Integration with ISMS

The UT-Battelle EMS and Integrated Safety Management System (ISMS) are integrated to provide a unified strategy for the management of resources; the control and attenuation of risks; and the establishment and achievement of the organization's environment, safety, and health goals. ISMS and EMS both strive for continual improvement through "plan-do-check-act" cycles. Under ISMS, the term "safety" also encompasses environmental safety and health, including pollution prevention, waste minimization, and resource conservation. Therefore, the guiding principles and core functions in ISMS apply both to the protection of the environment and to safety. Figure 5.2 depicts the relationship between EMS and ISMS.

Fig. 5.2. The relationship between the UT-Battelle Environmental Management System and the Integrated Safety Management System.

The UT-Battelle EMS is consistent with ISMS and includes the following elements:

- environmental policy;
- planning;
- legal and other requirements;
- objectives, targets, and programs;
- implementation and operation;
- resources, roles, responsibility, and authority;
- competence, training, and awareness;
- communication;
- documentation;
- control of documents;
- operational control;

- emergency preparedness and response;
- checking;
- monitoring and measurement;
- evaluation of compliance;
- nonconformity, corrective action, and preventative action;
- control of records;
- internal audit; and
- management review.

The DOE Office of Health, Safety and Security (HSS) annual environmental progress reports on implementation of EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management (Executive Order 2007) and Office of Management and Budget's Environmental Stewardship Scorecard gave UT-Battelle an EMS scorecard rating for FY 2010 of green, indicating full implementation of EO 13423 requirements.

5.2.1.2 UT-Battelle Policy

The UT-Battelle environmental policy statements are part of the UT-Battelle Policy for ORNL (Fig. 5.3), which is the highest level statement of how UT-Battelle conducts business. By clearly stating expectations, the policy provides the framework for setting and reviewing environmental objectives and targets.

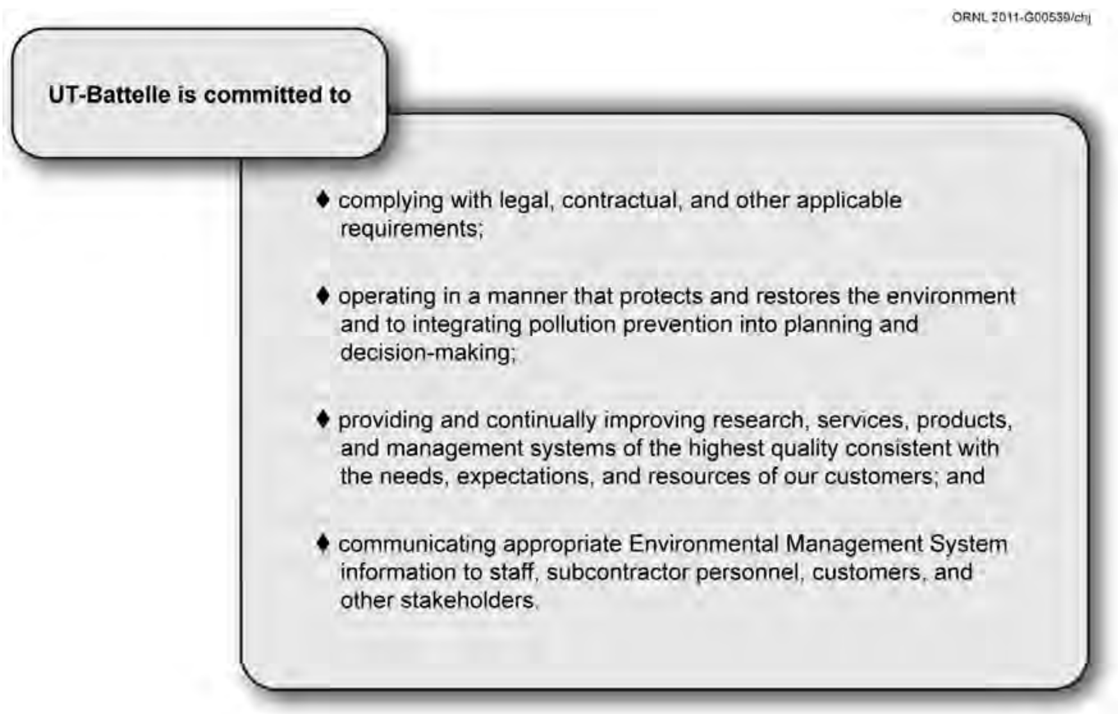

Fig. 5.3. ORNL environmental policy statements.

5.2.1.3 Planning

5.2.1.3.1 UT-Battelle Environmental Aspects

Environmental aspects are elements of an organization's activities, products, or services that can interact with the environment. Environmental aspects associated with UT-Battelle activities, products, and services have been identified at both the project and activity level. Activities that are relative to any of these aspects are carefully controlled to minimize or eliminate impacts to the environment. The following aspects have been identified as potentially having significant environmental impacts:

- hazardous waste,
- radioactive waste,
- mixed waste,
- energy use/intensity,
- greenhouse gas emissions,
- permitted air emissions,
- regulated liquid discharges, and
- storage or use of chemicals or radioactive materials.

5.2.1.3.2 UT-Battelle Legal and Other Requirements

Legal and other requirements that apply to the environmental aspects identified by UT-Battelle include federal, state, and local laws and regulations, environmental permits, applicable DOE orders, UT-Battelle contract clauses, waste acceptance criteria, and voluntary requirements such as ISO 14001:2004. UT-Battelle has established procedures to ensure that all applicable requirements are reviewed and that changes and updates are communicated to staff and incorporated into work-planning activities. UT-Battelle's environmental compliance status is discussed in Section 5.3.

5.2.1.3.3 UT-Battelle Objectives and Targets

To improve environmental performance, UT-Battelle has established and implemented objectives, targets, and performance indicators for appropriate functions and activities. Where practical, the objectives, targets, and performance indicators are measurable and, in all cases, are consistent with the UT-Battelle Policy, and are supportive of the laboratory mission. These objectives and targets were entered into a commitment tracking system and tracked to completion. In 2010, lab-level and organization-level objectives and targets focused on chemical inventory reduction, energy conservation, waste minimization, and recycling. Thirteen EMS objectives and targets were identified and accomplished in 2010 and are described below.

- **Objective: Reduce environmental impact associated with two division activities**
- **Targets:** Specific line organization targets, actions, responsible persons, and due dates. Project specifics are captured in an internal tracking system

- **Objective: Update ORNL Executable Plan to implement requirements of DOE Order 430.2B**
- **Target:** Complete Executable Plan and submit to DOE

- **Objective: Reduce energy intensity**
- **Target:** By 2015, achieve no less than a 30% energy intensity reduction across the contractor's facility/site in accordance with the executable plan

- **Objective: Maximize use of renewable energy**
- **Target:** Maximize installation of on-site renewable energy projects at the contractor's facility/site where technically and economically feasible to acquire at least 7.5% of each site's annual electricity and thermal consumption from on-site renewable sources by FY 2010

- **Objective: Reduce potable water consumption**
- **Target:** Reduce potable water consumption at least 16% relative to the baseline of the facility/site's potable water consumption in FY 2007

- **Objective: Maximize the acquisition and use of environmentally preferable products in the conduct of operations**
- **Target:** A number of actions are being taken to continue UT-Battelle's performance in this area. Project specifics are captured in an internal tracking system

- **Objective: Upgrade building management systems**
- **Target:** Improve HVAC control in 4500N, 4500S, 4501/4505, 4508, 5500, and 6000

- **Objective: Advance metering and energy awareness campaign**
- **Target:** Installation of advanced electricity metering system and implementation of Sustainable Energy Education and Communication campaign

- **Objective: Transportation/fleet management requirements**
- **Target:** Specific targets are contained in DOE O 430.2B

- **Objective: Sustainable design/high-performance building requirements**
- **Target:** Specific targets are contained in DOE O 430.2B

- **Objective: Reduce or eliminate the generation and/or toxicity of waste and other pollutants at the source through pollution prevention**
- **Target:** Specific targets have been established and met by the ORNL Pollution Prevention Program

- **Objective: Reduce or eliminate the environmental impacts of electronic assets**
- **Target:** Specific targets were established and met by enabling energy savings features on computers and recycling excess electronic equipment

- **Objective: Reduce degradation and depletion of environmental resources through post-consumer material recycling**
- **Target:** Specific targets have been established and met by the ORNL Pollution Prevention Program

5.2.1.3.4 UT-Battelle Programs

UT-Battelle has established an organizational structure to ensure that environmental stewardship practices are integrated into all facets of UT-Battelle's missions at ORNL. This includes programs led by experts in environmental protection and compliance, energy and resource conservation, pollution prevention, and waste management to ensure that Laboratory activities are conducted in accordance with the environmental policy outlined in Fig. 5.3. Information on UT-Battelle's 2010 compliance status, activities, and accomplishments is presented in Sect. 5.3.

Environmental protection staff provides critical support services to maintain a proper balance between cost and risk in many areas, including the following:

- waste management,
- NEPA compliance,
- air quality compliance,
- water quality compliance,
- U.S. Department of Agriculture (USDA) compliance,
- environmental sampling and data evaluation, and
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) interface.

The UT-Battelle staff also includes experts who provide critical waste management and disposition support services to ORNL research, operations, and support divisions. These include

- waste services representatives who work with waste generators to identify, characterize, package, and certify wastes for disposal;
- the waste-handling team, which performs waste-packing operations and conducts inspections of waste items, areas, and containers;
- the waste and materials disposition team, which coordinates off-site disposition of ORNL's newly generated waste;
- the hazardous material spill response team, which is the first line of response to hazardous materials spills at ORNL and controls and contains such spills until the situation is stabilized; and
- the Environmental Management Program Office (EMPO) coordinates and directs specific CERCLA decommissioning and demolition work being done on the ORNL site. EMPO activities include

developing and implementing interface agreements applicable to multiple contractors, CERCLA Applicable or Relevant and Appropriate Requirements, and project work plans.

5.2.1.4 UT-Battelle Sustainable Campus Initiative

"The Sustainable Campus for the Year 2018 Initiative" is an ORNL-wide effort that builds upon the Laboratory's strength as a premier science and technology organization in integrating energy efficiency, cutting-edge technologies, and operational and business processes to achieve sustainability. UT-Battelle implemented this multidisciplinary initiative to provide an overarching support structure to capture current efforts, to accelerate future implementation, and to provide a comprehensive sustainable vision of ORNL in the future. The ultimate goal is to achieve benchmark sustainability in campus operation and in the research, development, and deployment of key technologies by 2018. The initiative was launched in October 2008 and continues a modernization program that began in 2002.

A diverse team, representing multiple organizations and areas of expertise, was formed to develop and implement a roadmap to achieve a sustainable campus at ORNL by 2018. Implementation of this roadmap began in 2009. Four components collectively build a base for the roadmap. The first component, foundational methods, includes historically proven methods such as energy efficiency in buildings and processes, zero process water discharge, zero solid waste discharge, zero adverse health effects, recycle and reuse strategies, and employee and family engagement. The second component, known technology, includes recently proven methods such as renewable energy sources, green building design, hybrid vehicles, and certain alternative fuel applications. The third component, leading-edge technology, involves bringing together known technologies in innovative ways and includes methods currently being tested such as solar covered parking with plug-in hybrid electric vehicles (PHEVs), solar application with highly efficient buildings, innovative transportation technology, advanced building design technologies, and biofuel developments. The fourth component, transformational technology, is forward-thinking high-impact demonstration projects identified by appointed panels of scientists.

Sustainable successes achieved at ORNL during 2010 are discussed in the following sections (Fig. 5.4). For more information see http://sustainability-ornl.org.

ORNL 2011-G00719/chj

Fig. 5.4. Demolition activities at Building 2000.

5.2.1.4.1 Modernization and Facilities Revitalization

In 1943, more than 6,000 workers began construction of some 150 buildings that became known as ORNL. More than 65 years later, a massive effort to modernize and revitalize the Laboratory continues. Since 2000, more than 2,000,000 ft^2 of aged, expensive-to-maintain buildings have been vacated and some 1,500,000 ft^2 of new and renovated space has been constructed. The average age of ORNL facilities has decreased from 42 to 32 years. A combination of federal, state, and private financing has supported the construction of the new facilities.

During 2010, modernization and revitalization efforts at ORNL provided new facilities, enhanced staff interaction and space utilization, and upgraded utility systems and demolished old, expensive-to-maintain facilities (Fig. 5.5).

ORNL 2011-G00720/chj

Fig. 5.5. Modernization and facilities revitalization.

During 2010, UT-Battelle made substantial progress toward completion of new research facility and infrastructure projects in the East Campus. Occupancy of the Materials and Chemical Sciences Building [commonly known as the Multiprogram Laboratory Facility (MLF)], a three-story building housing 160,000 ft^2 of research laboratory and support space, is scheduled for summer 2011. Construction of critical parking and utility infrastructure projects for the Bethel Valley East Campus continued in 2010, including replacement of a 3 million gallon reservoir, which has been in continuous use since 1948, that provides potable and fire water to ORNL and improvements to electric power equipment and distribution systems.

Much work remains for modernization of the Bethel Valley Central Campus including completion of DOE Environmental Management Program (EM) demolition and remediation followed by phased redevelopment of the area.

Modernization activities completed during the year included the following:

- expansion to the Advanced Microscopy Laboratory located on the southwest side of the existing building to house a number of vibration-sensitive instruments used for materials characterization,
- construction of the West Campus Greenhouse was substantively completed,
- construction on Chestnut Ridge of the Guest House commenced, and a new state of Tennessee building, the Joint Institute for Neutron Sciences, was commissioned, and
- construction continued on the American Reinvestment and Recovery Act (ARRA)–funded Melton Valley Maintenance Facility, which will consolidate maintenance operations in Melton Valley.

Integrated Facilities Disposition Initiative at ORNL

Plans to disposition 1,500,000 ft^2 of aged, expensive-to-maintain facilities located at ORNL are proposed as part of the DOE Oak Ridge Office (DOE-ORO) Integrated Facility Disposition Project (IFDP). The IFDP is a multibillion-dollar collaborative proposal developed by DOE Offices of Environmental Management, Science, and Nuclear Energy and the National Nuclear Security Administration (NNSA) that will complete the environmental cleanup of the ORR and enable ongoing modernization efforts at ORNL and the Y-12 National Security Complex.

The IFDP will reduce risk to workers and the public, minimize ORNL and Y-12 mission risks resulting from the presence of deteriorating facilities and excess “legacy” materials, and provide valuable real estate for modernization and the continued enhancement of complex facilities and infrastructure.

Although the details of the IFDP baseline plan for the next 10 years have yet to be finalized, it is expected that the remaining 95 Office of Science facilities identified in the approved Critical Decision-1 will be demolished by the IFDP in future years.

During FY 2010, ORNL's complementary Excess Facilities Deactivation and Disposition Program activities focused on readying facilities for transfer to the IFDP for demolition. As noted, the influx of ARRA funding accelerated the IFDP demolition schedule and, as a result, operations in several Office of Science facilities had to be relocated, facilities had to be cleaned out to meet space return criteria for transfer, and the real property asset information management system had to be updated to reflect the facility status change. Concurrently, these facilities were deactivated and all utilities isolated and air-gapped prior to transfer and demolition. Efforts over the 10-year planning period will continue to support the IFDP but will expand to support the UT-Battelle master plan for the 7000 area. Efforts will focus on clean out and demolition of facilities to support new facilities construction.

Over the next 10 years, a total of approximately 172 facilities, structures, and trailers will be demolished by these two programs.

5.2.1.4.2 Energy Management and Conservation

The UT-Battelle Energy Management Program makes improvements in energy efficiency in UT-Battelle facilities, coordinates energy-related efforts across UT-Battelle organizations, and promotes employee awareness of energy conservation programs and opportunities. The plan also addresses activities related to the accomplishment of the goals of Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management" and the DOE Transformational Energy Action Management (TEAM) initiative. In a major effort, the DOE and Johnson Controls, Inc., Energy Savings Performance Contract (ESPC) has implemented the Sustainable Energy Education and Communications Program, which will allow ORNL staff to go through comprehensive web-based instructional modules on many aspects of energy management and conservation.

The Energy Policy Act of 2005 established the goal of reducing building energy intensity using 2003 as the baseline year (EPAct 2005). Executive Order 13423 sets a more stringent reduction goal of 3% per year for the same time period, resulting in a planned 30% reduction over 10 years. As shown in Fig. 5.6, UT-Battelle energy conservation efforts have exceeded those levels with a 16.9% building energy intensity reduction between FY 2003 and FY 2010. In fact, UT-Battelle has realized energy intensity reductions at ORNL of about 37% since 1985.

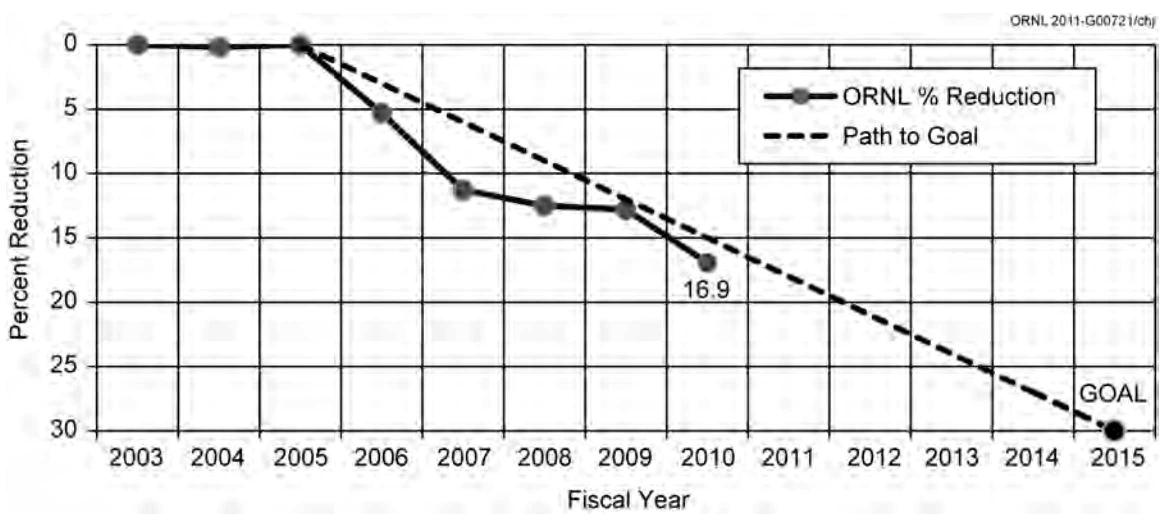

Fig. 5.6. ORNL Building Energy Reduction versus the DOE Transformational Energy Action Management Goal.

UT-Battelle is making steady progress toward the required reduction in energy intensity of 30% by FY 2015 from a FY 2003 baseline. This will be accomplished through continued construction of new facilities and demolition of legacy facilities. Aggressive energy reduction activities in current facilities will be combined with ongoing audit and Energy Conservation Measures (ECM) program and new efforts in building commissioning. The ESPC Biomass Steam Plant project is on schedule for completion, and projections show attaining the energy intensity target on or in advance of the deadline. Additional actions for FY 2011 will focus on planning for future projects in high-energy mission-specific (HEMS) facilities at ORNL. Although these facilities have been granted exclusions from the energy intensity reduction goals, they are major contributors to the greenhouse gas (GHG) emissions at ORNL. It is appropriate to develop a strategy for energy reductions in these facilities since energy consumption in them makes up a significant portion of the GHG reductions needed.

Based on FY 2010 data, Buildings Category energy usage at ORNL is 1.29×10^{12} BTUs, accounting for ORNL excluded facilities as defined by the Energy Policy Act of 1992 (EPAct 1992). Given a building area of 4,272,150 gross square feet (GSF), the FY 2010 estimated energy intensity is 302,810 BTUs/GSF, which represents a 4.74% reduction compared to FY 2009. When compared to the EPAct 2005 baseline year of FY 2003, this represents a 16.93% reduction to date.

The EPAct also requires federal agencies to install advanced electric metering, where practical, to improve the operating efficiencies of federal buildings. Measuring and managing energy use at the building level provide baseline data for assessing the effectiveness of energy savings programs and promote energy use awareness among building managers and occupants.

Data obtained through metering activities is essential for identifying cost-effective equipment retrofit opportunities, optimizing building and equipment operations, purchasing energy resources, planning, and allocating resources. UT-Battelle has proactively employed a policy of installing, as a minimum, standard electric meters at ORNL facilities for several years.

Table 5.1 shows a summary of actual and planned overhead funding for the categories shown based on the Annual Consolidated Energy Data Report (CEDR) Tab 5 data. It is understood that all out-year projects and their costs estimates identified in the CEDR Tab 5 are considered planning information and may change based on emerging requirements and evolving priorities.

Table 5.1. Summary of Overhead Funded Projects in CEDR Tab 5 ($K)

Category:	FY 2010 Actual	FY 2011 Plan	FY 2012 Projected	FY 2013 Projected
Water	13	50	100	100
Energy Efficiency (non-data centers)	345	750	600	500
Energy Efficiency (data centers)	0	0	200	200
High-Performance Sustainable Buildings (HPSB)[a]	120	120	120	120
Metering	100	100	100	100
Cool Roofs	0	0	0	0
Behavior Change	150	150	150	150
Lighting	170	200	100	100
High-Energy Mission-Specific Buildings	0	0	200	200
Sustainable Campus Initiative Management and Roadmap Project Funding	2,928	2,100	2,100	2,100
Total	3,826	3,470	3,670	3,570

[a]HPSB – only include in this category projects that are specific to meeting the Guiding Principles and contain a mix of tasks such as lighting, meters, roofing, HVAC, etc.

Sustainable Building Design

As discussed in Section 5.2.1.4.1, UT-Battelle continued to make significant progress on the implementation of the Facility Revitalization Project at ORNL during 2010.

These six new buildings save more than 14 million gal of water annually compared to the water used by similar older buildings at ORNL, and energy demands are 54% less than those at typical existing ORNL buildings. The heating and air-conditioning systems are 25 to 30% more efficient than American Society of Heating, Refrigerating and Air-Conditioning Engineers standard ASHRAE 90.1. The standard is a recognized, comprehensive industry standard that outlines the best practices and expectations for efficient, sound, heating, ventilating and air-conditioning design. In 2010, construction continued on two additional facilities, the Melton Valley Maintenance Facility (25,000–30,000 ft^2) and the Chemical and Material Science Building (160,000 ft^2). This will result in an additional 190,000 ft^2 of sustainable construction in FY 2011.

Energy Savings Performance Contracting

At ORNL, the ESPC with Johnson Controls, Inc. (JCI) is the primary mechanism for achieving the goals established in the Executive Order 13423. A Delivery Order with JCI was awarded in July 2008. Most ECMs are in place, with the balance expected to be completed during FY 2011. ESPC/ECMs include steam system decentralization, building management system improvements, mechanical equipment upgrades, and a biomass steam production system. In recent years, additional ECMs, not addressed by the ESPC, have been implemented to further reduce energy usage. These additional measures include Energy Star assessments and related actions; improvements in heating, ventilation, and air-conditioning (HVAC) equipment; lighting improvements; replacing motors with more efficient units; and improving the efficiency of the steam distribution system.

Table 5.2 demonstrates the ESPC goals implemented to meet or exceed Transformational Energy Action Management (TEAM) goals.

The status of the ECMs is outlined in Table 5.3.

Table 5.2. Energy savings performance contracting goals

	TEAM goal[a]	Projected results
Percentage energy intensity reduction	30	50
Percentage water usage reduction	16	23
Required advanced electric metering installations	100	100
Percentage of energy from renewable sources	7.5	21
Measurement and verification of results	Yes	Yes
Incorporate sustainable designs	Yes	Yes

[a]TEAM: Transformational Energy Action Management Initiative

Table 5.3. Energy conservation measure status

Central Steam Plant Biomass Solution	Construction will be completed in mid-FY 2011.
Select Steam Decentralization of Remote buildings	Design and procurements are nearly complete; installation of equipment in the 7000 area is complete; and commissioning has begun on the new Melton Valley Steam Plant.
Building Management System Upgrade	Design and procurements are finalized and installation of equipment is under way.
Advanced Electric Metering	Installation of equipment is at 90%.
Comprehensive HVAC Upgrade	Design is being finalized and procurements have begun.
Energy-Efficient Lighting Upgrade	Complete
Water Conservation	Domestic water projects are complete. The once-through cooling project is designed with completion scheduled for FY 2011.

Energy Audits

The energy audit program is progressing with audits completed in FY 2009 and FY 2010 covering more than 60% of the ORNL campus square footage. Potential ECMs developed during these audits are being vetted to determine which actions are most cost-effective and complementary to the Laboratory mission and existing building use and plans. Once this evaluation is completed, additional audit-related ECMs will be identified for FY 2011 implementation. Additionally, as described elsewhere in this report, projects are being evaluated and will be included in the Consolidated Energy Data Report (CEDR) upon Laboratory management review and approval.

Planning will begin in FY 2011 for addressing energy consumption in HEMS facilities at ORNL. These include the Spallation Neutron Source (SNS), High Flux Isotope Reactor (HFIR), Holifield Radioactive Ion Beam Facility (HRIBF), and the supercomputing facilities. In the past these facilities have been given exclusions from the energy intensity reduction requirements, in recognition of the fact that the science mission energy loads in these facilities were difficult to modify without directly impacting mission. The Federal GHG target goals that were recently established as a result of Executive Order (EO) 13514, Federal Leadership in Environmental, Energy, and Economic Performance, do not allow for exclusion of these high-energy facilities. The goal of EO 13514 is "to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of greenhouse gas emissions (GHG) a priority for Federal agencies."

Since these critical loads must be included in reduction goals in FY 2011, UT Battelle will develop a process that will accommodate energy saving projects in these facilities, while continuing to acknowledge the following.

- Mission critical outcomes must be maintained.
- No funding mechanism for "self-financing" is in place.
- Due to operational and research complexities, the planning horizon for projects affecting these facilities represents a long-term commitment.

A multi-organization team will develop a process for vetting potential energy savings projects, identifying funding mechanisms, and integrating the projects within the planning horizon of the respective facilities.

Electric Metering

As required by DOE O 430.2B, Departmental Energy, Renewable Energy and Transportation Management, ORNL implemented an Electrical Metering Plan in 2006. An updated plan was submitted in August 2010. This update shows significant progress toward the electrical metering requirements, with completion anticipated ahead of schedule. A copy of the latest update, submitted in August 2010, is available as an attachment to the 2010 ORNL Site Sustainability Plan, which can be found at http://sustainability-ornl.org/sc18/. Metering systems represent the first critical component of a comprehensive energy data center and energy management plan.

Based on information provided in the latest metering plan, ORNL has approximately 450 structures, many of which are storage sheds, warehouses, etc., with minimal energy use. Approximately 120 buildings represent 70% of the space and 80% of the total energy usage on the ORNL campus.

- Using DOE criteria, 42 buildings at ORNL should have advanced meters. To date, 30 meters have been installed, leaving about 29% of eligible buildings to be metered in 2011.
- The latest Metering Plan, submitted to DOE in August 2010, shows progress on all buildings initially deemed appropriate for metering.
- Four buildings have been, or are slated to be, demolished.
- One building is no longer under ORNL control – having been transferred to Community Reuse Organization of East Tennessee (CROET), a regional economic development entity.
- The metering installation in three buildings is on hold, awaiting an appropriate power outage, given research under way in those buildings.

Steam metering was initiated in FY 2010 and will continue in FY 2011. A water metering plan is currently being developed, including a table prioritizing water meter installation that will be implemented as funds are identified. Currently plans call for the water meter installation project to be completed in FY 2016.

A comprehensive energy data system utilizing data from electricity, water, gas, and steam metering will enable UT-Battelle to improve conservation efforts and meet a variety of DOE and EO goals. This system is currently being piloted in FY 2011.

Green Transportation

UT-Battelle performs a broad range of green transportation–related research and development activities at ORNL and also embraces current technologies and techniques to reduce fuel consumption. UT-Battelle has implemented a multi-pronged approach to green transportation: (1) encouraging personnel to walk and to ride bikes through innovative campus design, (2) encouraging shared transportation, (3) integrating maximized fuel efficiency features when upgrading roads, (4) continuing the expansion of alternative vehicles and fuel including hybrid vehicles, flex fuel vehicles using E-85, electric vehicles, and diesel vehicles using B20 bio-diesel, and (5) researching and implementing future alternative vehicles and fuel options. These efforts have helped ORNL reduce its fleet from 515 vehicles in 2006 to 496 vehicles in 2010.

In FY 2010, UT-Battelle had a vehicle fleet that included 37 electric vehicles and 41 hybrid cars (Fig. 5.7). There were also 278 flex fuel vehicles in the fleet (56%), and 79% of new vehicle procurements during the year were flex fuel vehicles. During 2010 a reduction in vehicle emissions was achieved in part due to the use of 74,882 gal of E85 to fuel the ORNL fleet, which is up from 50,503 gal in 2009. In addition there are 91 diesel vehicles at ORNL and numerous pieces of equipment that use bio-diesel as opposed to diesel fuel, resulting in additional reductions in emissions. As part of the Sustainable Campus Initiative, the Laboratory is in the process of implementing the use and support of plug-in hybrid electric vehicles (PHEV) in combination with solar-covered parking.

ORNL 2011-G00724/chj

Fig. 5.7. Vehicle Fleet.

5.2.1.4.3 Sustainable Practices

Green building and landscaping as well as energy management efforts are included in all activities at ORNL including research, design, construction, retrofit, operation, and maintenance. Over 1 million square feet of Leadership in Energy and Environmental Design (LEED)–certified campus space provides a multitude of opportunities to perform research on emerging energy-efficient technologies, green construction, and proper operation and maintenance of green facilities. An aggressive commitment to building LEED-certified buildings at ORNL along with the incorporation of other energy-saving measures has added 35% more facility and building area with only a 6% increase in energy consumption when comparing FY 2009 data to a 2000 baseline.

UT-Battelle has also maintained and expanded sustainable landscaping activities at ORNL including native planting on 17 acres at ORNL (Fig. 5.8) and 307 acres across the ORR and removal of invasive plants from 140 acres at ORNL and 500 acres across the ORR.

Fig. 5.8. Going Green.

Four solar arrays on the ORNL campus provide research opportunities as well as renewable energy to the laboratory. ORNL's first solar collector, an array of 24 solar panels, was originally used as a symbol of alternative energy research and continues to generate renewable electricity. The second solar collector is an 88 m by 3 m (288 ft by 10 ft) collector made up of 168 modules. Designed to provide 51.25 kW at peak power, the array feeds direct current to an inverter, which produces alternating current for the ORNL distribution grid. A total of 88 MWh of direct current is produced annually, or about 70 MWh alternating current (equivalent to the average annual power needs of 5.5 Tennessee homes). This array is designed to be 18.7% efficient and to displace approximately 51,710 kg (114,000 lb) of carbon dioxide every year (more than seven times the amount produced annually by the average American). The electricity added to the grid is used to offset electricity for Buildings 3147 and 3156. This array supports ORNL's aggressive maximum energy-efficient building goal, which will transform the four buildings that comprise the ORNL Buildings Technology and Research Integration Center to maximum energy-efficient buildings. ORNL accomplished the first step in meeting this goal by achieving certification of Building 3156 as a net-zero-energy building, which included decreasing its power consumption from about 100 MWh/yr to 65 MWh/yr, which is offset by the solar power. During 2011, ORNL is completing the installation of two additional arrays, one of 50 kW for solar-assisted EV charging and one atop the new MLF Building on campus (B4100).

In addition, ORNL has made substantial progress in diverting waste from the landfill, reducing desktop computer energy consumption (34% reduction), employee engagement, improving the vehicle fleet to a higher percentage of alternatively fueled vehicles, and developing key regional partnerships, as well as in a host of other areas.

UT-Battelle Employee Energy Conservation Education and Involvement Opportunities

UT-Battelle has developed numerous programs, processes, and activities that are intended to increase awareness and promote behavioral changes across the campus in conjunction with the Sustainable Campus Initiative. The goal is to implement policies and procedures that encourage sustainable practices, including reduced waste production, reduced use of energy, reduced GHG emissions, and changes in transportation habits. Additionally, the sustainability efforts undertaken through the various programs are intended to extend to the surrounding communities and beyond.

As the sustainable campus effort has evolved, it is apparent that many of the associated roadmap elements encourage behavior changes that will complement other projects and sustainability objectives as a whole. This relationship provides an ideal catalyst to encourage behavior changes and engage employees in the drive to achieve both a sustainable campus and a sustainable community. Examples of roadmap segments and aspects directed at influencing behavior are listed as follows.

Employee, Family, and Community Engagement Roadmap

ORNL's Sustainable Campus Initiative includes a large, active Employee, Family, and Community Engagement Roadmap, which encourages a broad suite of outreach activities. For instance, the Employee Engagement Roadmap team developed and actively maintains a Web site (http://sustainability-ornl.org) and a related discussion and question blog. This site contains information about how UT-Battelle is moving toward sustainability, and what people can do at work, at home, and in their communities to achieve greater sustainability. The Roadmap Team launched a monthly e-newsletter in 2010, held four Sustainability at Home seminars as well as an ORNL-oriented discussion forum, and posted an average of 2–3 items on each week's internal ORNL e-newsletter to raise awareness about sustainability and the Sustainable Campus Initiative. In addition, UT-Battelle sponsored a large Earth Day celebration and participated in community Earth Day and related celebrations or events.

ORNL's Earth Day 2010 Celebration was held on Monday, April 19, titled "The Green Generation." The event involved a variety of activities, including a poster display, green transportation show, "Green" Vendors Fair and an East Campus Pond Tour. Also featured was the first annual "Green Mile" bike ride, consisting of a short route around campus, as well as a long route off campus. The poster display showcased exhibits including pollution prevention and recycling, energy conservation and management, and research topics such as CO_2 sorption in coal, switch grass and battery production and longevity (Fig. 5.9).

Items such as water bottles, tote bags, and reusable lunch bags were offered as incentives to participate in these events, and to encourage more sustainable behavior.

ORNL 2011-G00722/chj

Fig. 5.9. 2010 Earth Day.

Training for managers of energy and water management programs

UT-Battelle is currently developing training that incorporates a sustainability component for individuals who direct energy and water management programs, which will be implemented in 2011 and 2012. In addition UT-Battelle's Energy Management Program Director and the Energy Manager have both held Facility Manager Certifications since 2005.

Employee Transportation Survey

During 2010 a survey was conducted to record the commute behaviors of ORNL employees in order to identify and implement opportunities for employees to modify transportation habits. These include the following.

- Investigation of shared transit to ORNL from regional park and ride lots
- Implementation of travel policies to reduce travel emissions through web-based meetings
- Electric Vehicle (EV) facilitation for staff
- Installation of solar-assisted EV charging in order to encourage staff purchases of EVs
- Various initiatives, including involving Nissan in special financing offers and work-from-home programs

5.2.1.4.4 Pollution Prevention

UT-Battelle implemented 42 new pollution prevention projects at ORNL during 2010, eliminating more than 42 million kg (~92 million lb) of waste and leading to cost savings/avoidance of more than $13 million (including ongoing reuse/recycle projects). Major 2010 pollution prevention successes at ORNL included source reduction projects such as the certification of a LEED-Existing Building (EB) facility, Green Information Technology (IT) power management, water conservation efforts, and recycling, including radioactive lead, Tyvek, and electronics (Fig 5.10).

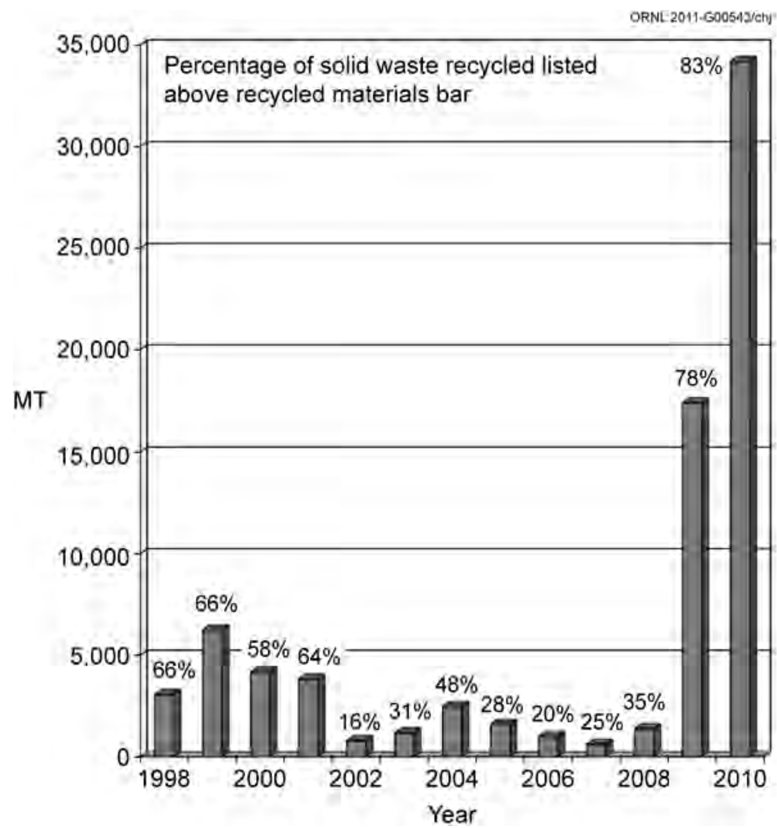

Fig 5.10. ORNL Recycling Program.

One of UT-Battelle's established sustainability goals is to achieve LEED-EB certification for 10 buildings at ORNL by 2014. A process has been developed by a multidisciplinary group to ensure cross-cutting collaboration to reach this goal, and to provide documentation and information on lessons learned. This will ensure consistency and improved efficiency in future certification activities.

Building 1059 was selected to be the pilot for UT-Battelle's efforts to pursue LEED-EB certification for existing facilities. The 6,998 ft^2 building was built in 1993 and is one of several standard office buildings located on the West Campus of ORNL. LEED-EB, gold level certification for Building 1059 was achieved in 2010. Enhancements include lighting control; Metasys Building Automation System (BAS); roofing upgrade; low-flow plumbing; exterior site upgrades; energy awareness; source reduction, salvage, reuse, and recycling improvements; finish materials upgrades; and electronics energy usage enhancements.

While several new buildings on ORNL's East Quad have received LEED certification, Building 1059 is the first retrofitted building on the ORNL campus to achieve this distinction.

In FY 2010, the Information Technology Services Division completed the deployment of the Verdiem Surveyor, a software application system than enforces a set of energy management policies through the central information technology system.

UT-Battelle has implemented numerous water-saving activities during the past several years and has funded additional projects that will reap results in the future. These projects include integration of low-flow fixtures and faucets in new construction and the reuse of rainwater for irrigation. The entire modernized East Campus research complex saves more than 32 million liters (8.5 million gal) of water per year. In addition to water-savings measures incorporated into new construction, several existing facilities have been retrofitted with a variety of water-saving options, and as a result, a reduction in the use and discharge of an additional 25 million liters (6.5 million gal) of water per year was realized.

In 2010, UT-Battelle continued to drive down the use of water and improve water quality by (1) expanding the Physics Division's cooling water flow reduction efforts, reducing approximately 20.7 million gallons per year, and (2) installing a mercury treatment system which will pretreat more than 6 million gallons of water a year to significantly reduce trace amounts of mercury contamination.

These initiatives have reduced water usage and the associated waste water generation, improved operational efficiency, reduced total regulated air emissions, reduced natural gas and fuel oil use, and resulted in significant cost savings. In FY 2010 alone, ORNL's water conservation efforts reduced water usage and the associated wastewater generation by more than 20.7 million gal per year with an associated cost avoidance of more than $27,000. In the last 3 fiscal years, ORNL has reduced more than 96 million gal per year with an associated cost avoidance of more than $367,000. In total, once all identified water conservation efforts are complete, a total of more than 282 million gal per year of water and associated wastewater generation will be reduced with an associated cost avoidance of more than $5 million, which includes all cost avoidance associated with the biomass gasification steam plant (BGSP).

During the year UT-Battelle aggressively supported the recycling program at ORNL with more than 83% of FY 2010–generated materials being diverted for recycle or beneficial use. One successful FY 2010 activity involved piloting zero waste employee gatherings. The ORNL Environmental Protection and Waste Services Division (EP&WSD) successfully hosted a picnic for 75–100 people while completely avoiding the generation of waste.

For more information on these and other ORNL conservation and recycling activities, see http://sustainability-ornl.org.

ORNL Site Pollution Prevention (P2) Awards

- Federal Energy and Water Management Award – ORNL received this award for ORNL's Sustainable Campus Initiative.
- DOE's Management Award – ORNL received this award in 2010 for outstanding achievements in energy, water, and fleet management in FY 2009 specifically associated with ORNL's Sustainable Campus Initiative.
- DOE's Environmental Sustainability (EStar) Awards – ORNL received notification that ORNL's LEED-EB Effort, LEED by Example, Going for Gold Lab-wide nomination will receive a DOE Headquarters 2011 EStar Award and that ORNL's Goes Beyond Comprehensive Energy and Fleet Management to Comprehensive Sustainability Management nomination will receive a 2011 EStar Honorable Mention.
- DOE Office of Science Best in Class Award – ORNL received notification that DOE Office of Science awarded ORNL an Office of Science Best in Class Award for environmental sustainability and recognized two other initiatives with Noteworthy Practices Awards. Best in Class and

Noteworthy Practices Awards were received for accomplishments associated with ORNL's LEED-EB Effort and ORNL's Comprehensive Energy Efficiency/Renewable Energy and Fleet Management Efforts and in recognition of DOE Headquarters' support to the sites.

- Tennessee Department of Environment and Conservation (TDEC) Tennessee Pollution Prevention Partnership (TP3) Performer Member Flag, Performer Level Status Maintained – UT-Battelle completed the required project summary information and annual review required for maintaining the TP3 Performer Level that demonstrates a commitment to preventing pollution of air, land, and water while conserving natural resources.

5.2.1.5 Implementation and Operation

5.2.1.5.1 Structure and Responsibility

The UT-Battelle Environmental Policy (Fig. 5.3) represents the philosophy of UT-Battelle management for the conduct of research, operations, and other activities at ORNL. A key tenet of the policy is the integration of environmental and pollution prevention principles into work practices at all levels. Prior to performing any work at ORNL, all staff are required to complete comprehensive site orientation and training that outline employee responsibilities for environmental compliance and set forth expectations for all employees to comply with the policy statements and with the UT-Battelle EMS. Specific roles and responsibilities are further defined in position descriptions and individual performance plans.

An Environmental Protection Officer (EPO) Program, an Environmental Compliance Representative (ECR) Program, and a Waste Services Representative (WSR) Program have also been established to ensure that work planning activities for all UT-Battelle organizations address environmental protection and pollution prevention measures. The objectives of these programs are as follows.

- The EPO and ECR Programs
  - coordinate efforts to seek, accomplish, and maintain environmental compliance across all UT-Battelle organizations;
  - communicate environmental requirements and compliance strategies; and
  - provide liaisons between individual UT-Battelle organizations and the Environmental Protection and Waste Services Division.
- The WSR Program
  - provides a technical interface between waste generators and the Environmental Protection and Waste Services Division;
  - provides expertise in identifying, characterizing, packaging, and certifying wastes for disposal; and
  - coordinates the support required to complete necessary forms, properly classify waste streams, and develop the characterization basis to successfully complete the waste certification and disposal process.

5.2.1.5.2 Communication and Community Involvement

Information on the UT-Battelle EMS is routinely communicated internally to staff and externally to stakeholders in several ways.

- EPO, ECR, WSR, and management system owner meetings and workshops dedicated to EMS topics
- Environmental Protection web sites
- SBMS documentation available to all employees
- Notices on ORNL Today, an electronic publication which provides current information to ORNL staff on activities, programs, and events at the Laboratory
- EMS brochures and badge cards

- ORR Annual Site Environmental Report, which includes information on significant aspects, compliance status, pollution prevention programs, and other EMS elements and is made available to the public, regulators, and stakeholders

5.2.1.6 Emergency Preparedness and Response

The Emergency Management System provides the resources and capabilities to provide emergency preparedness services and, in the event of an accident, emergency response services. Emergency Preparedness personnel perform hazard surveys and hazard assessments to identify potential emergency situations. Procedures and plans have been developed to prepare for and respond to a wide variety of potential emergency situations. Training is provided to ensure appropriate response and performance during emergency events. Frequent exercises and drills are scheduled to ensure the effective performance of the procedures and plans. An environmental subject matter expert is a member of the emergency response team and participates in drills and exercises to ensure that environmental requirements are met and that environmental impacts from the event (and the response) are mitigated.

5.2.1.7 Checking

5.2.1.7.1 Monitoring and Measurement

UT-Battelle has developed monitoring and measurement processes for each operation or activity that can have a significant impact on the environment. Several SBMS subject areas include requirements for managers to establish performance objectives, indicators, and targets; conduct performance assessments to collect data and monitor progress; and evaluate the data to identify strengths and weaknesses in performance and areas for improvement.

5.2.1.7.2 EMS Assessments

Several methods are used by UT-Battelle to evaluate compliance with legal and other environmental requirements. Most of the compliance evaluation activities are implemented by the EMS or are a part of line-organization assessment activities. Should a nonconformance be identified, the ORNL issues management process requires that any regulatory or management system nonconformance be reviewed for cause and corrective and/or preventive action developed. These actions are then implemented and tracked to completion.

The SBMS Assessments subject area requires organizations to perform periodic environmental assessments that cover both legal and other requirements and requires management system owners to conduct annual self-assessments of their systems to ensure the systems are effective and are continually improving.

UT-Battelle also uses the results from numerous external compliance inspections conducted by regulators to verify compliance with requirements. In addition to regulatory compliance assessments, there are internal and external EMS assessments performed annually to ensure that the UT-Battelle EMS continues to conform to ISO requirements. In 2010, an internal audit and an external reregistration audit were conducted and verified that the EMS continued to conform to ISO 14001:2004. In addition to verifying conformance, these management system assessments also identify continual improvement opportunities.

5.2.2 Environmental Management System for the TRU Waste Processing Center

The WAI EMS for activities at the TWPC was registered to the ISO 14001:2004 Standard by NSF International Strategic Registrations, Ltd., in May 2008. NSF International Strategic Registrations, Ltd. conducted a Surveillance Audit for the WAI EMS program in May 2010, and again no nonconformances or issues were identified and several significant practices were noted. The WAI TWPC EMS and ISMS are integrated to provide a unified strategy for the management of resources; the control and reduction of risks; and the establishment and achievement of the organization's environment, safety, and health goals.

The EMS and ISMS are incorporated into the *Integrated Safety Management Description Plan* (BJC 2009), and both strive for continual improvement through a “plan-do-check-act” cycle.

The WAI EMS incorporates applicable environmental laws, DOE orders, and other requirements (i.e., directives and federal, state, and local laws) through WAI’s contract requirements document (WAI 2010) and its Regulatory Management Plan (WAI 2008), which dictate how the various requirements are incorporated into subject area documents (procedures and guidelines). Through environmental program personnel and EMS representatives, the EMS assists the line organizations in identifying and addressing environmental issues with the EMS requirements.

Environmental aspects are elements of an organization’s activities, products, or services that can interact with the environment. WAI has identified environmental aspects associated with TWPC activities, products, and services at both the project and activity level and has identified waste management activities, air emissions, storm water contamination, pollution prevention, habitat alteration, and energy consumption as potentially having significant environmental impacts. Activities that are relative to any of those aspects are carefully controlled to minimize or eliminate impacts to the environment.

WAI has established and implemented objectives and measurable performance indicators for the targets associated with the identified significant impacts.

The P2 programs at TWPC involve waste reduction efforts and implementation of sustainable practices that reduce the environmental impacts of the activities conducted at the TWPC. The WAI EMS establishes annual goals and targets to reduce the impact of the TWPC’s environmental aspects.

WAI has a well-established recycling program at TWPC and continues to identify new material-recycling streams and to expand the types of materials included in the program. Currently, recycle streams at the TWPC range from office materials such as paper, aluminum cans, plastic drinking bottles, and toner cartridges to operations-oriented materials, such as scrap metal, cardboard, and batteries. WAI evaluated and put into place during the last part of 2009 a “single stream” recycling program that allows the mixing of multiple types of recyclables and increases the population of recyclable items. In 2010, WAI also began a recycling program for alkaline batteries. In addition, WAI implemented a Styrofoam cup recycling program.

“Environmentally preferable purchasing” is a term used to describe an organization’s policy to reduce packaging and to purchase products made with recycled material or bio-based materials and other environmentally friendly products. In 2010, WAI procured environmentally preferable materials totaling approximately $81,767 for use at TWPC.

Several methods are used by WAI to evaluate compliance with legal and other requirements. Most of these compliance evaluation activities are implemented by internal and external environmental and management assessment activities and routine reporting and reviews. WAI also uses the results from numerous external compliance inspections conducted by regulators and contractors to verify compliance with requirements.

5.3 Compliance Programs and Status

During 2010 UT-Battelle, BJC, WAI, and Isotek operations were conducted in compliance with contractual and regulatory environmental requirements with the exception of two unrelated exceedances of National Pollutant Discharge Elimination System (NPDES) permit discharge limits and one reportable release associated with BJC operations in 2010. While performing excavation operations at the White Oak Dam near ORNL on July 8, 2010, a hydraulic line on an excavator ruptured, releasing a small quantity (approximately ½ gallon) of hydraulic fluid to the White Oak Creek Embayment of the Clinch River. This resulted in a visible sheen on the water, which required notification to the National Response Center. The sheen was cleaned up, and subsequent monitoring has revealed no detectable adverse impact to the environment from the spill. In addition, operational changes were instituted to prevent a recurrence.

There were no notices of violation or penalties issued by the regulatory agencies. Table 5.4 presents a summary of environmental audits conducted at ORNL in 2010.

Table 5.4. Summary of regulatory environmental audits, evaluations, inspections, and assessments conducted at ORNL, 2010

Date	Reviewer	Subject	Issues
February 9	Knox County	Annual CAA Inspection for NTRC Facility	0
May 10–12	TDEC	Annual RCRA Inspection	0
May 25	TDEC	Underground Storage Tanks	0
November 16–18	TDEC	Annual RCRA inspection at Y-12 Complex	0

Abbreviations

CAA Clean Air Act
NTRC National Transportation Research Center
RCRA Resource Conservation and Recovery Act
TDEC Tennessee Department of Environment and Conservation

ORNL does not operate any Resource Conservation and Recovery Act (RCRA) Subtitle D disposal facilities. ORNL's industrial solid waste is sent to the Y-12 industrial solid waste disposal landfills. ORNL complies with the requirements by meeting the waste acceptance criteria at the Y-12 facilities.

The following discussions summarize the major environmental programs and activities carried out at ORNL during 2010 and provide an overview of compliance status for the year.

5.3.1 Environment Permits

Table 5.5 contains a list of environmental permits that were effective in 2010 at ORNL.

5.3.2 National Environmental Policy Act/National Historic Preservation Act

NEPA provides a means to evaluate the potential environmental impact of proposed federal activities and to examine alternatives to those actions. UT-Battelle, WAI, and Isotek maintain compliance with NEPA through the use of site-level procedures and program descriptions that establish effective and responsive communications with program managers and project engineers to establish NEPA as a key consideration in the formative stages of project planning. Table 5.6 summarizes NEPA activities conducted at ORNL during 2010.

During 2010, UT-Battelle and WAI continued to operate under site-level procedures that provide requirements for project reviews and NEPA compliance. These procedures call for a review of each proposed project, activity, or facility to determine the potential for impacts to the environment. To streamline the NEPA review and documentation process, DOE-ORO has approved “generic” categorical exclusions (CXs) that cover proposed bench- and pilot-scale research activities and generic CXs that cover proposed non-research activities (e.g., maintenance activities, facilities upgrades, personnel safety enhancements). A CX is one of a category of actions defined in 40 CFR 1508.4 that does not individually or cumulatively have a significant effect on the human environment and for which neither an environmental assessment nor an environmental impact statement is normally required.

UT-Battelle utilizes SBMS as the delivery system to manage and control work at ORNL. NEPA is an integral part of SBMS, and a UT-Battelle NEPA coordinator, along with principal investigators, environmental compliance representatives, and environmental protection officers within each UT-Battelle division, participate in determining appropriate NEPA decisions.

In 2010, an environmental assessment for the Isotek-managed U-233 Material Downblending and Disposition Project (Building 3019 Complex) was completed, and a Finding of No Significant Impact under the NEPA process was issued (DOE 2010).

Table 5.5. ORNL environmental permits, 2010

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CAA	Radioactive Materials Analytical Laboratory	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Steam Plant	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Manipulator Boot Shop	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	SNS Central Utilities Building Boilers	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Surface Coating and Cleaning Operation	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	SNS and CNF (construction permit)	956542P	10/29/04	03-01-08[a]	DOE	UT-B	UT-B
CAA	SNS Central Laboratory and Office Boilers	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	EGCR Boilers	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Air Stripper (BJC permit)	547563	10/21/04	10-21-09[a]	DOE	BJC	BJC
CAA	HFIR & Radiochemical Engineering Development Center	556850	10/21/04	10-21-09[a]	DOE	UT-B	UT-B
CAA	Off Gas & Hot Cell Ventilation (BJC permit)	547563	10/21/04	10-21-09[a]	DOE	BJC	BJC
CAA	NTRC	0941-02[b]	03/12/09	Annually[a]	DOE	UT-B	UT-B
CAA	NTRC (Construction Permit)	0941-03[b]	12/22/10	12/22/11	DOE	UT-B	UT-B
CAA	TN Operating Permit (emissions source)	057077P	04/13/04	10-31-14[a]	DOE	WAI	WAI
CAA	Radiochemical Development Facility	560898	07/27/09	07-26-14[a]	DOE	Isotek	Isotek
CAA	Biomass Boiler and Melton Valley Steam Plant (construction permit)	962300F	03/27/09	03-01-10[a]	DOE	UT-B	UT-B, JCI
CAA	CNMS, Boilers (Construction)	963740F	08/18/10	09/01/11	DOE	UT-B	UT-B
CWA	ORNL NPDES Permit (ORNL sitewide wastewater discharge permit)	TN0002941	07/01/08	07-30-13	DOE	DOE	UT-B, BJC
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—SNS	TNR139975	09-30-00	05-23-16	DOE	DOE	UT-B
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—Spallation Neutron Source	TNR139975	10-10-00	05-23-16	DOE	DOE	UT-B

Table 5.5. (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—ORNL Modernization of Laboratory Facilities	TNR133485	05-29-09	05-23-16	DOE	DOE	UT-B
CWA	Corps of Engineers Nationwide Permit #39, Commercial and Institutional Developments for “Minor Wetland Fill Associated with Proposed Parking Structure, White Oak Creek Mile 2.7R, Clinch River mile 50.8R, Roane County, Tennessee, ORNL Parking Structure.”	LRN-2009-01598	12-03-09	12-03-11	DOE	DOE	UT-B
CWA	Tennessee General Permit No. TNR10-0000, Stormwater Discharges from Construction Activity—ORNL Decommissioning & Demolishing Buildings	TNR1301343	05-26-05	NA	DOE	DOE	UT-B
CWA	Individual ARAP, “Installation of approximately 200 feet of culvert in an unnamed tributary to Fifth Creek and the fill of approximately 0.08 acres of associated wetland for the construction of a parking structure.”	NRS09.320	01-15-10	01-14-11	DOE	DOE	UT-B
CWA	Tennessee Storm Water Multi-Sector General Permit for Industrial Activities for Storm Water Discharges Associated with Construction Activity (CGP)—0975 Water Reservoir	TNR133727	07-08-10	05-14-14	DOE	DOE	UT-B
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—ORNL Steam Plant Boiler Building (Melton Valley Steam Plant)	TNR133507	06-09-10	05-23-16	DOE	DOE	JCI
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—Biomass Gassification System Project	TNR133428	06-09-10	05-23-16	DOE	DOE	JCI
CWA	Tennessee General (NPDES) Permit No. TNR10-0000, Storm Water Discharges from Construction Activities—Pro2Serve National Security Engineering Center		10-06	NA	DOE	DOE	CROET
CWA	TN Operating Permit (sewage)	SOP-02056	02-01-08	12-31-12	DOE	WAI	WAI
CWA	Tennessee General Permit No. TNR10-0000, Stormwater Discharges from Construction Activity—Site Expansion Project	TNR 133560	08-31-09	NA	DOE	WAI	WAI

Table 5.5. (continued)

Regulatory driver	Permit title/description	Permit number	Issue date	Expiration date	Owner	Operator	Responsible contractor
RCRA	Hazardous Waste Transporter Permit	TN18900900 03	01-24-11	01-31-12	DOE	DOE	UT-B, BJC
RCRA	Hazardous Waste Corrective Action Permit	TNHW-121	09-28-04	09-28-14	DOE	DOE/all[c]	DOE/all
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-134	09-26-08	09-26-18	DOE	DOE/UT-B	UT-B
RCRA	Hazardous Waste Container Storage and Treatment Units	TNHW-145[d]	02-03-10	02-03-20	DOE	DOE/BJC/ WAI	BJC/WAI

Abbreviations

BJC	Bechtel Jacobs Company
CAA	Clean Air Act
CNF	Central Neutralization Facility
CROET	Community Reuse Organization of East Tennessee
CWA	Clean Water Act
DOE	U.S. Department of Energy
EGCR	Experimental Gas-Cooled Reactor
HFIR	High Flux Isotope Reactor
JCI	Johnson Controls, Inc.
NPDES	National Pollutant Discharge Elimination System
NTRC	National Transportation Research Center
ORNL	Oak Ridge National Laboratory
RCRA	Resource Conservation and Recovery Act
SNS	Spallation Neutron Source
UT-B	UT-Battelle
WAI	Wastren Advantage Inc.

[a]Continued construction/operation under an expired permit is allowed under air pollution control regulations when timely renewal or construction permit applications are submitted.

[b]Permit issued by Knox County Department of Air Quality Management.

[c]DOE and Oak Ridge Reservation contractors are co-operators of hazardous waste permits.

[d]In 2010, TNHW-145 replaced permit TNHW-097.

Table 5.6. National Environmental Policy Act (NEPA) activities, 2010

Types of NEPA documentation	Number of instances
ORNL	
Environmental Assessment	1
Categorical exclusions (CXs) approved	6
Approved under general actions or generic CX documents	85[a]
WAI	
Approved under general actions or generic CX documents	10[a]
Isotek	
Environmental Assessment approved and Finding of No Significant Impacts (FONSI) issued	1

[a]Projects that were reviewed and documented through the site NEPA compliance coordinator.

In 2010 an environment assessment was initiated and documented in *Spruce and Peatland Responses under Climatic and Environmental Change Experiment (SPRUCE)*, DOE/EA-1764 (DOE 2011). This research project would be conducted by ORNL researchers at the Marcell Experimental Forest near Grand Rapids, Minnesota.

Compliance with National Historic Preservation Act (NHPA) at ORNL is achieved and maintained in conjunction with NEPA compliance. The scope of proposed actions is reviewed in accordance with the Cultural Resource Management Plan (DOE 2001).

5.3.3 Clean Air Act Compliance Status

The Clean Air Act (CAA), passed in 1970 and amended in 1977 and 1990, forms the basis for the national air pollution control effort. This legislation established comprehensive federal and state regulations to limit air emissions and includes four major regulatory programs: the National Ambient Air Quality Standards, State Implementation Plans (SIPs), New Source Performance Standards (NSPS), and National Emission Standards for Hazardous Air Pollutants (NESHAP). Airborne discharges from DOE Oak Ridge facilities, both radioactive and nonradioactive, are subject to regulation by EPA and the TDEC Division of Air Pollution Control. ORNL was issued its first sitewide operating air permit in 2004. To demonstrate compliance with this Title V Major Source Operating Permit, more than 1500 data points are collected and reported every year. In addition, there are two continuous monitors for criteria pollutants, 9 continuous samplers for radionuclide emissions, 15 minor radionuclide sources, and numerous demonstrations of compliance with generally applicable air quality protection requirements (asbestos, stratospheric ozone, etc.). Also, a Knox County Air Quality permit is maintained for the offsite NTRC. In 2010, an annual compliance report was submitted for this permit. In summary, there were no UT-Battelle, Isotek, or WAI CAA violations or exceedances in 2010. Section 5.4 provides detailed information on 2010 activities conducted at ORNL in support of the CAA.

5.3.4 Clean Water Act Compliance Status

The objective of the Clean Water Act (CWA) is to restore, maintain, and protect the integrity of the nation's waters. This act serves as the basis for comprehensive federal and state programs to protect the nation's waters from pollutants. (See Appendix D for water quality reference standards.) One of the strategies developed to achieve the goals of the CWA was EPA's establishment of limits on specific pollutants allowed to be discharged to U.S. waters by municipal sewage treatment plants and industrial facilities. The EPA established the NPDES Permitting Program to regulate compliance with pollutant limitations. The program was designed to protect surface waters by limiting effluent discharges into streams, reservoirs, wetlands, and other surface waters. EPA has delegated authority for implementation and enforcement of the NPDES program to the state of Tennessee.

In 2010, compliance with the ORNL NPDES Permit was determined by approximately 2,300 laboratory analyses and field measurements. The NPDES permit limit compliance rate for all discharge points for 2010 was nearly 100%, with only one measurement exceeding numeric NPDES permit limits. This occurred at the ORNL Sewage Treatment Plant when a daily maximum limit for E. coli bacteria was exceeded at the ORNL Sewage Treatment Plant due to a rain event on May 5, 2010. A second permit nonconformance occurred on June 18, 2010, when miscommunication resulted in missed effluent measurement at the ORNL Steam Plant Wastewater Treatment Facility. Section 5.5 contains detailed information on the activities and programs carried out in 2010 by UT-Battelle in support of the CWA.

5.3.5 Safe Drinking Water Act Compliance Status

ORNL's water distribution system is designated as a "non-transient, non-community" water system by TDEC's Division of Water Supply. TDEC's Bureau of Environment Division of Water Supply Chapter 1200-5-1, Public Water Systems (TDEC 2009) sets limits for biological contaminants and for chemical activities and chemical contaminants. TDEC requires sampling for the following constituents for compliance with state and federal regulations:

- chlorine residual levels,
- bacteriological (total coliform), and
- disinfectant by-products (trihalomethanes and haloacetic acids).

The city of Oak Ridge supplies potable water to the ORNL water distribution system and meets all regulatory requirements for drinking water. The water treatment plant, located on the ORR, north of the Y-12 Complex, is owned and operated by the city of Oak Ridge.

In 2010, sampling results for ORNL's water system chlorine residual levels, bacterial constituents, and disinfectant by-products were all within acceptable limits. TDEC requires triennial sampling of the ORNL potable water system for lead and copper; the next sampling is scheduled to be performed during June –September 2012.

5.3.6 RCRA Compliance Status

The Hazardous Waste Program under the Resource Conservation and Recovery Act (RCRA) establishes a system for regulating hazardous wastes from the initial point of generation through final disposal. In Tennessee, TDEC has been delegated authority by EPA to implement the Hazardous Waste Program; EPA retains an oversight role. In 2010, DOE and its contractors at ORNL were jointly regulated as a large-quantity generator of hazardous waste under EPA ID No. TN1890090003 because, collectively, more than 1,000 kg of hazardous/mixed wastes were generated in at least 1 calendar month during 2010. Mixed wastes are both hazardous (under RCRA regulations) and radioactive. Hazardous/mixed wastes were accumulated in satellite accumulation areas or less than 90-day accumulation areas by DOE and its contractors including UT-Battelle, BJC, WAI, and Isotek. Hazardous/mixed wastes were also stored and/or treated in RCRA-permitted units by DOE, UT-Battelle, BJC, and WAI. The RCRA units operate under three permits at ORNL: TNHW-145, TNHW-134, and TNHW-121, as shown in Table 5.7. TNHW-145 was issued in early 2010 and replaced the TNHW-097 permit. In 2010, UT-Battelle and BJC were permitted to transport hazardous wastes under ORNL's EPA ID number, and UT-Battelle was registered to operate a transfer facility for temporary storage (less than 10 days) of hazardous wastes transported from off-site locations (such as DOE's NTRC).

Table 5.7. ORNL Resource Conservation and Recovery Act operating permits, 2010

TNHW permit number	Building/description
	ORNL
TNHW-134	Building 7651 Container Storage Unit
	Building 7652 Container Storage Unit
	Building 7653 Container Storage Unit
	Building 7654 Container Storage Unit
	Portable Unit 2 Storage & Treatment Unit
TNHW-145	Portable Unit 1 Storage Unit
	Building 7572 Container Storage Unit
	Building 7574 Container Storage Unit
	Building 7823 Container Storage Unit
	Building 7855 Container Storage Unit
	Building 7860A Container Storage Unit
	Building 7879 Container Storage Unit
	Building 7883 Container Storage Unit
	Building 7880A TWPC-1 (Contact-Handled Storage Area) Container Storage Unit
	TWPC-2 (Second Floor WPB) Container Storage Unit
	TWPC-3 (Drum Aging Criteria) Container Storage Unit
	TWPC-4 (First Floor WPB) Container Storage Unit
	TWPC-5 (Container Storage Area) Container Storage Unit
	Building 7880BB TWPC-6 (Contact-Handled Marshaling Building) Container Storage Unit
	Building 7880AA TWPF-7 (Drum Venting Building) Container Storage Unit
	Macroencapsulation T-1 Treatment Unit
	Amalgamation T-2[a] Treatment Unit
	Solidification/Stabilization T-3[a] Treatment Unit
	Hot Cell Table T-4 [a] Treatment Unit
	Size Reduction T-5[a] Treatment Unit
	Oak Ridge Reservation
TNHW-121	Hazardous Waste Corrective Action Permit

[a]Treatment operating units within Building 7880.

ORNL currently reports hazardous waste activities on 42 active waste streams, some of which are mixed wastes. The quantity of hazardous/mixed waste generated at ORNL in 2010 was 708,859 kg. Mixed wastewater accounted for 449,199 kg. Excluding the wastewater generation, which remains fairly constant from year to year, 2010 hazardous waste generation increased approximately 122%. The increase was primarily due to (1) increased generation of macroencapsulated waste, (2) increased generation of transuranic mixed waste, (3) generation of contaminated debris from building clean-outs and demolitions, and (4) waste from laboratory clean-outs. ORNL generators treated 5,736 kg of hazardous/mixed waste by elementary neutralization and silver recovery; 1,105 kg of mixed wastewaters was received from the East Tennessee Technology Park for treatment in an onsite wastewater treatment system at ORNL and 377 kg of hazardous/mixed waste was received from UT-Battelle generators at the Y-12 Complex, which was stored at ORNL and then shipped offsite to a commercial RCRA-permitted facility for treatment. The quantity of hazardous/mixed waste treated in RCRA-permitted treatment facilities at ORNL in 2010 was 66,176 kg. This includes waste treated by macroencapsulation, amalgamation, size reduction, and stabilization/solidification. In addition, 449,199 kg of mixed waste was treated at an onsite wastewater treatment facility. The amount of hazardous/mixed waste shipped offsite to commercial treatment, storage, and disposal facilities increased approximately 280% to 512,501 kg in 2010. The increase is due primarily to (1) transuranic waste shipped to the Waste Isolation Pilot Plant, (2) macroencapsulated waste shipped to the Nevada Test Site, and (3) shipments of contaminated debris and laboratory clean-out wastes noted above. Excluding these large waste streams, the amount of hazardous/mixed waste shipped offsite in 2010 increased by approximately 86%.

In May 2010, TDEC conducted an annual RCRA inspection of ORNL generator areas, battery collection areas, RCRA-permitted treatment, storage, and disposal facilities, and RCRA records including required training, generator inspections, permitted facility records, shipments, transfer facility log, the 2009 RCRA Annual Report of Hazardous Waste Activities, and the 2009 Hazardous Waste Reduction Progress Report. All activities and records were found to be in compliance with RCRA regulations and the RCRA permits, and there were no notices of violation or penalties associated with this inspection.

At NTRC, DOE and UT-Battelle were regulated as a conditionally exempt small-quantity generator in 2010, meaning that less than 100 kg of hazardous waste per month was generated.

There were no hazardous/mixed wastes generated, accumulated, or shipped by DOE and UT-Battelle at the 0800 Area or the DOE Office of Scientific and Technical Information, ORNL Records in 2010.

5.3.7 ORNL RCRA-CERCLA Coordination

The ORR Federal Facility Agreement is intended to coordinate the corrective action processes of RCRA required under the Hazardous and Solid Waste Amendments permit with CERCLA response actions. Annual updates for 2010 for ORNL's Solid Waste Management Units and Areas of Concern were consolidated with updates for ETTP, Y-12, and the ORR and were reported to TDEC, DOE, and EPA Region 4 in January 2011.

In May 2005 BJC applied for, but has not yet received, a RCRA postclosure permit for SWSA 6. RCRA groundwater monitoring data is reported yearly to TDEC and EPA in the annual CERCLA Remediation Effectiveness Report (DOE 2011a) for the ORR.

Periodic updates of proposed construction and demolition activities and facilities at ORNL have been provided to managers and project personnel from the TDEC DOE Oversight Division and EPA Region 4. A CERCLA screening process is used to identify proposed construction and demolition projects and facilities that warrant CERCLA oversight. The goal is to ensure that modernization efforts do not impact the effectiveness of previously completed CERCLA environmental remedial actions and do not adversely impact future CERCLA environmental remedial actions.

The UT-Battelle Environmental Management Program Office (EMPO) manages the DOE-EM-funded IFDP and ARRA work at ORNL. Although the conduct of DOE-EM-related work (i.e., environmental remediation and building decontamination and demolition) is not a UT-Battelle core business function, UT-Battelle has endorsed participation in ARRA-funded cleanup work to accelerate ORNL revitalization by removing legacy facilities and materials. This reduces the liabilities and risks to current and future ORNL science missions. During 2010, the demolition of 10 buildings at ORNL was completed (2001, 2019, 2024, 2087, 2088, 2092, 3074, 2009, 2018, 2517), and remediation activities in SWSA 1 were completed under the Record of Decision/RAWP for the Bethel Valley Burial Grounds. These activities and other 2010 EM accomplishments at ORNL are discussed in more detail in Section 5.8 and in the FY 2010 Cleanup Progress Annual Report to the Oak Ridge Community (DOE 2010a).

5.3.7.1 RCRA Underground Storage Tanks

Underground storage tanks (USTs) containing petroleum and hazardous substances are regulated under Subtitle I of RCRA (40 CFR 280). TDEC has been granted authority by EPA to regulate USTs containing petroleum under TDEC Rule 1200-1-15; however, hazardous-substance USTs are still regulated by EPA.

ORNL has three USTs registered with TDEC under Facility ID Number 0-730089; all three are in service (petroleum) and are state-of-the-art USTs that meet the 1998 standards for new UST installations.

5.3.8 Comprehensive Environmental Response, Compensation, and Liability Act Compliance Status

CERCLA, also known as Superfund, was passed in 1980 and was amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA). Under CERCLA, a site is investigated and remediated if it poses significant risk to health or the environment. The EPA National Priorities List (NPL) is a comprehensive list of sites and facilities that have been found to pose a sufficient threat to human health and/or the environment to warrant cleanup under CERCLA.

In 1989, the ORR was placed on the NPL. In 1992, the ORR Federal Facility Agreement among EPA, TDEC, and DOE became effective and established the framework and schedule for developing, implementing, and monitoring remedial actions on the ORR. The on-site CERCLA Environmental Management Waste Management Facility (EMWMF) is operated by the BJC for DOE. Located in Bear Creek Valley, EMWMF is used for disposal of waste resulting from CERCLA cleanup actions on the ORR, including ORNL. The EMWMF is an engineered landfill that accepts low-level radioactive, hazardous, asbestos, and PCB wastes and combinations of the aforementioned wastes in accordance with specific waste acceptance criteria under an agreement with state and federal regulators.

5.3.9 Toxic Substances Control Act Compliance Status

PCB waste generation, transportation, and storage at ORNL are regulated under the EPA ID number TN1890090003. In 2010, UT-Battelle operated approximately 28 PCB waste storage areas in generator buildings and RCRA-permitted storage buildings at ORNL for longer-term storage of PCB/radioactive wastes when necessary. Four PCB waste storage areas were operated at UT-Battelle facilities at Y-12. The continued use of authorized PCBs in electrical systems and/or equipment (e.g., transformers, capacitors, rectifiers) is regulated at ORNL. The majority of equipment at ORNL that required regulation under the Toxic Substances Control Act has been disposed of. However, some of the ORNL facilities at Y-12 continue to use (or store for future reuse) PCB equipment (such as transformers, capacitors, and rectifiers).

Because of the age of many of the ORNL facilities and the varied uses for PCBs in gaskets, grease, building construction, and equipment, DOE self-disclosed unauthorized use of PCBs to EPA in the late 1980s. As a result, DOE and ORNL contractors negotiated a compliance agreement with EPA (see Table 2.1) to address the compliance issues related to these unauthorized uses and to allow for continued use pending decontamination or disposal. As a result of that agreement, DOE continues to notify EPA when additional unauthorized uses of PCBs, such as PCBs in paint, adhesives, electrical wiring, or floor tile, are found at ORNL. In 2010, there was a discovery of unauthorized uses of PCBs in paints at Building 4508.

5.3.10 Emergency Planning and Community Right-to-Know Act Compliance Status

The Emergency Planning and Community Right-to-Know Act (EPCRA) and Title III of SARA require that facilities report inventories and releases of certain chemicals that exceed specific release thresholds. The reports are submitted to the local emergency planning committee and the state emergency response commission. Table 5.8 describes the main elements of the Act. UT-Battelle complied with these requirements in 2010 through the submittal of reports under EPCRA Sections 302, 303, 311, and 312. These reports reflect information pertinent to all DOE prime contractors and their subcontractors who reported activities at the ORNL site.

ORNL had no releases of extremely hazardous substances, as defined by EPCRA, in 2010.

5.3.10.1 Material Safety Data Sheet/Chemical Inventory (Section 312)

Inventories, locations, and associated hazards of hazardous and extremely hazardous chemicals were submitted in an annual report to state and local emergency responders as required by EPCRA’s Section 312 requirements. Of the 101 chemicals identified for 2010 on the ORR, 20 were located at ORNL.

Private-sector lessees associated with the reindustrialization effort were not included in the 2010 submittals. Under the terms of their lease, lessees must evaluate their own inventories of hazardous and extremely hazardous chemicals and must submit information as required by the regulations.

Table 5.8. Main elements of the Emergency Planning and Community Right-to-Know Act (EPCRA)

Title	Description
Sections 302 and 303, Planning Notification	Requires that local planning committee and state emergency response commission be notified of EPCRA-related planning
Section 304, Extremely Hazardous Substance Release Notification	Addresses reporting to state and local authorities of off-site releases
Sections 311–312, Material Safety Data Sheet/Chemical Inventory	Requires that either material safety data sheets or lists of hazardous chemicals for which they are required be provided to state and local authorities for emergency planning. Requires that an inventory of hazardous chemicals maintained in quantities over thresholds be reported annually to the Environmental Protection Agency (EPA)
Section 313, Toxic Chemical Release Reporting	Requires that releases of toxic chemicals be reported annually to EPA

5.3.10.2 Toxic Chemical Release Reporting (EPCRA Section 313)

DOE submits annual toxic release inventory reports to EPA and TDEC on or before July 1 of each year. The reports cover the previous calendar year and address releases of certain toxic chemicals to air, water, and land as well as waste management, recycling, and pollution prevention activities. Threshold determinations and reports for each of the ORR facilities are made separately. Operations involving toxic release inventory chemicals were compared with regulatory thresholds to determine which chemicals exceeded the reporting thresholds based on amounts manufactured, processed, or otherwise used at each facility. After threshold determinations were made, releases and other waste management activities were calculated for each chemical that exceeded one or more of the thresholds.

For CY 2010, ORNL reported the otherwise use of 32,092 lb of nitric acid and the manufacture of 55,260 lb of nitrate compounds (Table 5.9). Of this, 31,744 lb of the nitric acid was used for waste treatment at the Process Waste Treatment Complex (PWTC) and 348 lb was sent off site for disposition. Nitrate compounds are coincidentally manufactured as by-products of neutralizing nitric acid waste and as by-products of sewage treatment. The nitrate compounds from the sewage treatment plant (STP) are released into the environment. The discharge of nitrate compounds is not regulated in the NPDES permit for the sewage plant.

Table 5.9. Emergency Planning and Community Right-to-Know Act Section 313 toxic chemical release and off-site transfer summary[a] for ORNL, 2009 and 2010

Chemical	Year	Quantity (lb)
Nitrate compounds	2009	73,041
	2010	55,260
Nitric acid	2009	52,762
	2010	32,092
Total	2009	125,803
	2010	87,352

[a]Represents total releases to air, land, and water and includes off-site waste transfers. Also includes quantities released to the environment as a result of remedial actions, catastrophic events, or one-time events not associated with production processes.

5.3.11 U.S. Department of Agriculture/Tennessee Department of Agriculture

In 2010, UT-Battelle personnel had eight domestic soil agreements for receipt of or movement of quarantined soils, three soil permits for receipt of or movement of nondomestic soils (from outside the continental United States), and eight other permits or approvals for receipt of other material regulated by the USDA, such as animal or plant viruses or genetically engineered organisms. The domestic soil agreements are jointly issued by the USDA and the Tennessee Department of Agriculture, whereas permits are issued by the USDA.

All activities conducted under soil compliance agreements and soil permits were in compliance with the applicable regulations.

5.4 Air Quality Program

5.4.1 Construction and Operating Permits

Permits issued by the state of Tennessee convey the clean air requirements that are applicable to ORNL. New projects are governed by construction permits until converted to operating status. The sitewide Title V Major Source Operating Permit includes requirements that are generally applicable to large operations such as a national laboratory (e.g., asbestos and stratospheric ozone), as well as specific requirements directly applicable to individual air emission sources. Source-specific requirements include NESHAP for Radionuclides (see Sect. 5.4.3), requirements applicable to sources of ambient air criteria pollutants, and sources of other hazardous air pollutants (nonradiological). DOE/UT-Battelle holds a Title V permit for 10 emission sources. In April 2009, an application was submitted to the state of Tennessee to renew this sitewide permit.

The permit renewal application was updated in September 2010 to reflect facility changes and also identify new regulatory requirements that have been issued since the original submittal in April 2009. On August 18, 2010, TDEC issued a construction permit for two natural-gas-fired boilers to be constructed for the Center for Nanophase Materials Science.

The primary emission points of nonradioactive emissions at ORNL included three boilers located on the main ORNL site, two boilers located at the 7600 complex, four boilers located at the SNS site, and four new boilers located at the Melton Valley Steam Plant.(MVSP). All of these units use fossil fuels; therefore, criteria pollutants are emitted. Actual and allowable emissions from the sources are compared in Table 5.10. Actual emissions were calculated from fuel usage and EPA emission factors. Boiler 6, located on the main ORNL site, is a 125-MBtu/h boiler and is subject to the new source performance standards of 40 CFR 60 Subpart Db with continuous emission monitoring requirements for NO_x and opacity. In 2010 ORNL also replaced the continuous in-stack NO_x monitoring system on boiler 6 with a Predictive Emissions Monitoring System (PEMS). The PEMS monitors inputs from existing boiler control sensors and uses statistical based software to predict actual NO_x emissions. The PEMS was approved by both EPA and TDEC as an approved method to demonstrate continual compliance with 40 CFR 60 Subpart Db monitoring requirements for NO_x. The advantages of the PEMS will be an increase in operational availability and reduced operating expenses.

Table 5.10. Actual versus allowable air emissions from ORNL steam production, 2010

Pollutant	Emissions (tons per year)[a]		Percentage of allowable (%)
	Actual	Allowable	
Sulfur dioxide	23.6	1277	1.8
Particulate matter	3.4	71	4.8
Carbon monoxide	33.1	196	16.9
Volatile organic compounds	2.1	14	15.0
Nitrogen oxides	64.0	380	16.8

[a] 1 ton = 907.2 kg.

As part of the ESPC construction project, initiated in 2009, the MVSP was brought on-line in December 2010. As an energy saving measure the MVSP will provide local steam and building heat for the 7900 complex area. Significant progress was also realized through physical modifications to improve operating efficiency to boilers 5 and 6 located at the main ORNL site steam plant. The biomass gasification boiler, the main component in the ESPC

Project, is still under construction and is expected to be brought on-line in early 2012. The biomass boiler will gasify wood fuel to provide a clean source of steam and will significantly displace fossil fuels used by the existing steam plant and will reduce fossil fuel consumption at ORNL. All UT-Battelle emission sources operated in compliance with Title V permit conditions during 2010.

For state fiscal year 2010, UT-Battelle paid $7,500 in annual emission fees to TDEC. The fees are based on a combination of actual and allowable emissions.

DOE/WAI has an operating air permit for one emission source, a TRU waste processing facility. DOE/Isotek has a Title V Major Source Operating permit for the Radiochemical Development Facility. During CY 2010, no permit limits were exceeded.

5.4.2 NESHAP for Asbestos

There are numerous facilities, structures, components, and various pieces of equipment associated with facilities at ORNL that contain asbestos-containing material (ACM). ORNL's Asbestos Management Program manages the compliance of work activities involving the removal and disposal of ACM, which include notifications to TDEC for all demolition activities and required renovation activities, and current use of engineering controls and work practices, inspections, and monitoring for proper removal and waste disposal activities of ACM. No releases of reportable quantities of ACM occurred at ORNL during 2010.

5.4.3 ORNL Radiological Airborne Effluent Monitoring

Radioactive airborne discharges at ORNL consist primarily of ventilation air from radioactively contaminated or potentially contaminated areas, vents from tanks and processes, and ventilation for hot cell operations and reactor facilities. (See Appendix F, Table F.1, for a list of radionuclides and associated radioactive half-lives.) The airborne emissions are treated and then filtered with high-efficiency particulate air filters and/or charcoal filters before discharge. Radiological airborne emissions from ORNL consist of solid particulates, adsorbable gases (e.g., iodine), tritium, and nonadsorbable gases (e.g., noble gases).

The major radiological emission point sources for ORNL consist of the following six stacks located in Bethel and Melton Valleys and the SNS Central Exhaust Facility stack located on Chestnut Ridge (Fig. 5.11).

- 2026 Radioactive Materials Analytical Laboratory
- 3020 Radiochemical Development Facility
- 3039 central off-gas and scrubber system, which includes the 3500 and 4500 areas' cell ventilation system, isotope solid-state ventilation system, 3025 area cell ventilation system, 3042 ventilation system, and 3092 central off-gas system
- 7503 Molten Salt Reactor Experiment Facility
- 7880 TWPC
- 7911 Melton Valley complex, which includes HFIR and the Radiochemical Engineering Development Center (REDC)
- 8915 SNS Central Exhaust Facility stack

In 2010, there were 15 minor point/group sources, and emission calculations/estimates were made for each of them.

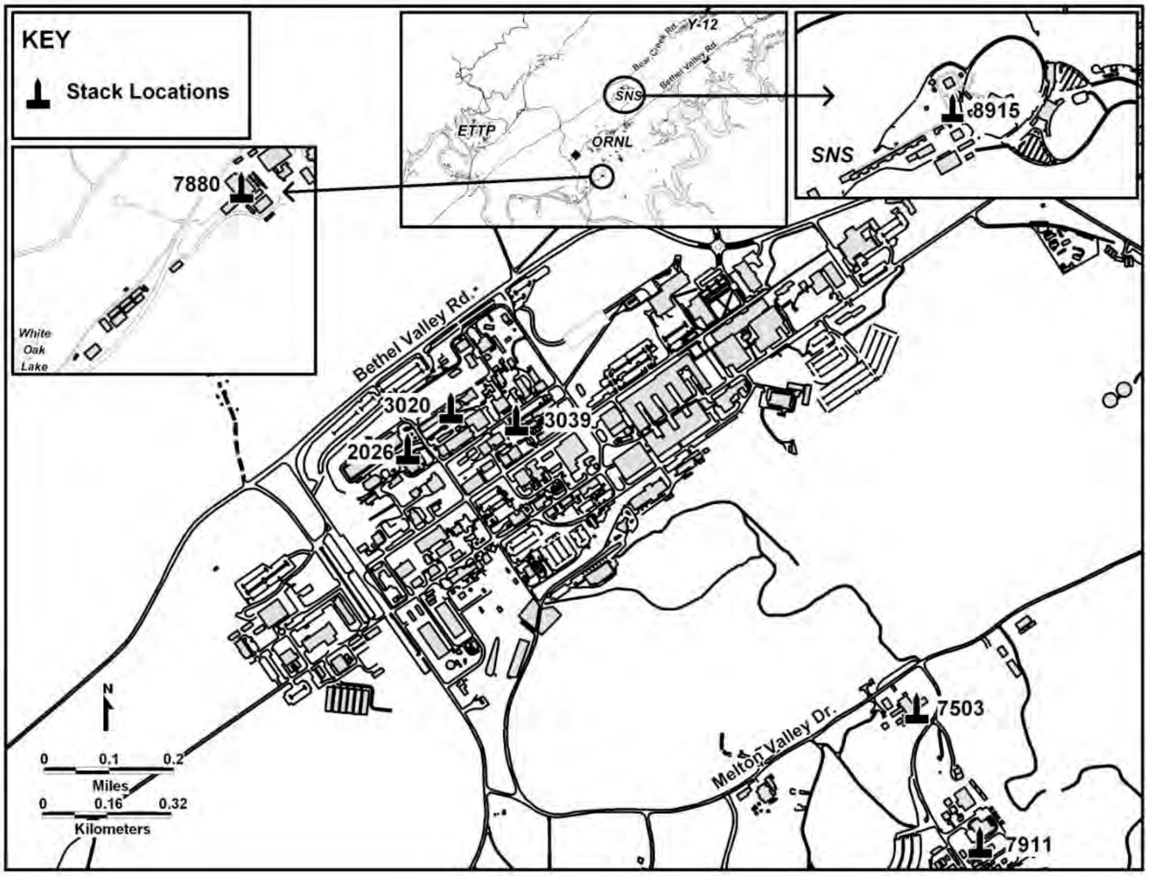

Fig. 5.11. Locations of major radiological emission points at ORNL.

5.4.3.1 Sample Collection and Analytical Procedure

Five of the major point sources (2026, 3020, 3039, 7503, and 7911) are equipped with in-stack source-sampling systems that comply with criteria in the American National Standards Institute (ANSI) standard ANSI N 13.1-1969 (ANSI 1969). The sampling systems generally consist of a multipoint in-stack sampling probe, a sample transport line, a particulate filter, activated charcoal cartridges, a silica-gel cartridge (if required), flow-measurement and totalizing instruments, a sampling pump, and a return line to the stack. In addition to that instrumentation, the system at Stack 7911 includes a high-purity germanium detector with a NOMAD™ analyzer, which allows continuous isotopic identification and quantification of radioactive noble gases (e.g., ^{41}Ar) in the effluent stream. The sample probes are annually removed, inspected, and cleaned. The 7880 stack is equipped with an in-stack source-sampling system that complies with criteria in the ANSI Health Physics Society standard ANSI/HPS N13.1-1999 (ANSI 1999). The system consists of a stainless-steel, shrouded probe; an in-line filter-cartridge holder placed at the probe to minimize line losses; a particulate filter; a sample transport line; a rotary vane vacuum pump; and a return line to the stack. The sample probe is annually removed, inspected, and cleaned. The 8915 stack is equipped with an in-stack radiation detector that complies with criteria in ANSI/HPS N13.1-1999. The detector monitors radioactive gases flowing through the exhaust stack and provides a continual readout of detected activity using a scintillator probe. The detector is calibrated to correlate with isotopic emissions.

Velocity profiles are performed quarterly following the criteria in EPA Method 2 (EPA 2010) at major and some minor sources. The profiles provide accurate stack flow data for subsequent emission-rate calculations. An annual leak-check program is carried out to verify the integrity of the sample transport system. For the 7880 stack, an annual comparison between the effluent flow rate totalizer and EPA Method 2 is performed. The stack effluent-flow-rate monitoring system response is checked quarterly against the manufacturer's instrument test procedures. The stack sampler rotameter is calibrated at least quarterly in comparison with a secondary (transfer) standard. Only a certified secondary standard is used for all rotameter tests.

In addition to the major sources, ORNL has a number of minor sources that have the potential to emit radionuclides to the atmosphere. A minor source is defined as any ventilation system or component such as a vent, laboratory hood, room exhaust, or stack that does not meet the approved regulatory criteria for a major source but that is located in or vents from a radiological control area as defined by Radiological Support Services of the UT-Battelle Nuclear and Radiological Protection Division. A variety of methods are used to determine the emissions from the various minor sources. Methods used for minor source-emission calculations comply with EPA criteria. The minor sources are evaluated on a 1- to 5-year basis. Emissions, major and minor, are compiled annually to determine the overall ORNL source term and associated dose.

The charcoal cartridges, particulate filters, and silica-gel traps are collected weekly to biweekly. The use of charcoal cartridges is a standard method for capturing and quantifying radioactive iodine in airborne emissions. Gamma spectrometric analysis of the charcoal samples quantifies the adsorbable gases. Analyses are performed weekly to biweekly. Particulate filters are held for 8 days prior to a weekly gross alpha and gross beta analysis to minimize the contribution from short-lived isotopes such as ^{220}Rn and its daughter products. At Stack 7911, a weekly gamma scan is conducted to better detect short-lived gamma isotopes. The filters are then composited quarterly and are analyzed for alpha-, beta-, and gamma-emitting isotopes. At Stack 7880, the filters are composited monthly and analyzed for alpha-, beta-, and gamma-emitting isotopes. The sampling system on Stack 7880 requires no other type of radionuclide collection media. Compositing provides a better opportunity for quantification of the low-concentration isotopes. Silica-gel traps are used to capture water vapor that may contain tritium. Analysis is performed weekly to biweekly. At the end of the year, the sample probes for all of the stacks are rinsed, except for 8915 and 7880, and the rinsate is collected and submitted for isotopic analysis identical to that performed on the particulate filters. A probe-cleaning program has been determined unnecessary for 8915 because the sample probe is a scintillator probe used to detect radiation and not to extract a sample of stack exhaust emissions. It is not anticipated that contaminant deposits would collect on the scintillator probe. A probe-cleaning program for 7880 has established that rinse analysis has historically shown no detectable contamination. Therefore, the frequency of probe rinse collection and analysis is no more often than every 3 years unless there is an increase in particulate emissions, increase in detectable radionuclides in the sample media, or process modifications.

The data from the charcoal cartridges, silica gel, probe wash, and the filter composites are compiled to give the annual emissions for each major source and some minor sources.

5.4.3.2 Results

Annual radioactive airborne emissions for ORNL in 2010 are presented in Table 5.11. All data presented were determined to be statistically different from zero at the 95% confidence level. Any number not statistically different from zero was not included in the emission calculation. Because measuring a radionuclide requires counting random radioactive emissions from a sample, the same result may not be obtained if the sample is analyzed repeatedly. This deviation is referred to as the "counting uncertainty." Statistical significance at the 95% confidence level means that there is a 5% chance that the results could be erroneous.

Table 5.11 shows total radionuclide emissions from point sources on the ORR. Also shown are the assumed lung clearance type and activity median aerodynamic diameters (AMADs). The designation of F, M, and S refers to the lung clearance type—Fast (F), Moderate (M), and Slow (S) for the given radionuclide. The default AMAD of 1.0 µm was used for modeling unless it was a gas, vapor, or otherwise requested. The chemical form used in most cases was unspecified, except when the chemical form was known and available in CAP88PC Version 3.

Table 5.11. Radiological airborne emissions from all sources at ORNL, 2010 (Ci)[a]

Isotope	Solubility	Stack							Total Minor Source	ORNL Total
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915		
^{225}Ac	M								1.16E-09	1.16E-09
^{110}Ag	M								2.76E-12	2.76E-12
^{110m}Ag	M								7.99E-12	7.99E-12
^{110m}Ag	S					2.90E-06				2.90E-06
^{241}Am	M	1.48E-07	5.89E-07				8.05E-08		2.80E-07	1.10E-06
^{241}Am	F			4.13E-07	1.53E-08	1.57E-06			1.75E-08	2.02E-06
^{243}Am	M								7.57E-12	7.57E-12
^{41}Ar	G						9.47E+02	1.00E+01		9.57E+02
^{139}Ba	M						1.16E-01			1.16E-01
^{140}Ba	M						8.31E-04			8.31E-04
^{140}Ba	S					1.02E-04				1.02E-04
^{7}Be	M	2.04E-07	4.32E-07						4.47E-06	5.10E-06
^{7}Be	S			1.20E-05		3.58E-05			4.11E-07	4.82E-05
^{207}Bi	M								9.70E-11	9.70E-11
^{210}Bi	M								3.00E-16	3.00E-16
^{212}Bi	M								4.73E-13	4.73E-13
^{212}Bi	S								1.58E-08	1.58E-08
^{214}Bi	M								2.05E-13	2.05E-13
^{11}C	G							8.00E+02		8.00E+02
^{14}C	M								1.00E-08	1.00E-08
^{109}Cd	M								5.00E-11	5.00E-11
^{141}Ce	M						8.80E-06		8.00E-09	8.81E-06
^{144}Ce	M								4.16E-11	4.16E-11
^{252}Cf[b]	M						1.43E-08		6.47E-11	1.44E-08
^{36}Cl	M								5.00E-10	5.00E-10
^{242}Cm	M								5.65E-08	5.65E-08
^{243}Cm	F				4.03E-08	7.50E-07			7.47E-10	7.91E-07
^{243}Cm	M						1.80E-08		5.07E-12	1.80E-08
^{244}Cm	M	1.15E-06	1.34E-07				1.80E-08		3.68E-06	4.98E-06
^{244}Cm	F			1.08E-07	4.03E-08	7.50E-07			4.16E-09	9.02E-07
^{245}Cm	M								7.08E-11	7.08E-11
^{247}Cm	M								1.14E-13	1.14E-13
^{248}Cm[c]	M								1.85E-13	1.85E-13
^{57}Co	M								6.26E-13	6.26E-13
^{57}Co	S			4.49E-07						4.49E-07
^{58}Co	M						1.79E-05		3.37E-07	1.82E-05

Table 5.11. (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{60}Co	M								7.12E-07	7.12E-07
^{60}Co	S			3.13E-06		3.13E-06				6.26E-06
^{51}Cr	M								9.11E-10	9.11E-10
^{134}Cs	F								1.07E-08	1.07E-08
^{134}Cs	S					2.72E-06				2.72E-06
^{135}Cs	F								2.18E-13	2.18E-13
^{137}Cs	F	2.44E-06	2.76E-06				3.27E-06		2.87E-04	2.96E-04
^{137}Cs	S			1.42E-04	2.72E-08	3.01E-06			2.62E-03	2.77E-03
^{138}Cs	F						7.12E+02			7.12E+02
^{253}Es	M								2.14E-10	2.14E-10
^{152}Eu	F			7.43E-07						7.43E-07
^{152}Eu	M								2.41E-07	2.41E-07
^{154}Eu	M								1.45E-07	1.45E-07
^{155}Eu	M								2.43E-10	2.43E-10
^{156}Eu	M								1.38E-16	1.38E-16
^{55}Fe	M								2.36E-07	2.36E-07
^{59}Fe	M								1.13E-10	1.13E-10
^{153}Gd	M								1.00E-10	1.00E-10
^{3}H	V	9.17E-01		7.08E+00	1.62E+00		9.11E+01	6.90E+01	4.22E+00	1.74E+02
^{181}Hf	M								3.31E-14	3.31E-14
^{203}Hg	M								1.02E-13	1.02E-13
^{124}I	F								2.84E-16	2.84E-16
^{125}I	F							1.50E-01	2.70E-05	1.50E-01
^{126}I	F								6.00E-09	6.00E-09
^{129}I	F								1.79E-04	1.79E-04
^{131}I	F					1.90E-05	3.71E-02		1.59E-06	3.71E-02
^{132}I	F						3.69E-01			3.69E-01
^{133}I	F						1.97E-01			1.97E-01
^{134}I	F						5.59E-01			5.59E-01
^{135}I	F						6.02E-01			6.02E-01
^{192}Ir	M								1.21E-11	1.21E-11
^{40}K	S								5.91E-05	5.91E-05
^{40}K	M		7.96E-07						3.96E-07	1.19E-06
^{79}Kr	G							1.73E+01		1.73E+01
^{81}Kr	G								2.90E-13	2.90E-13
^{85}Kr	G						3.87E+02		2.91E-05	3.87E+02
^{85m}Kr	G						6.46E+00	5.33E+01		5.98E+01

Table 5.11. (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{87}Kr	G						7.29E+01	2.31E+01		9.60E+01
^{88}Kr	G						6.91E+01	9.40E+00		7.85E+01
$^{89}Kr^{d}$	G						5.30E+01			5.30E+01
^{140}La	M						2.85E-04		4.45E-10	2.85E-04
^{140}La	S					4.37E-05				4.37E-05
^{177}Lu	M								8.64E-07	8.64E-07
^{54}Mn	M								3.64E-08	3.64E-08
^{54}Mn	S					3.09E-06				3.09E-06
^{93}Mo	M								4.09E-10	4.09E-10
^{13}N	G							1.75E+01		1.75E+01
^{22}Na	M								3.72E-14	3.72E-14
^{93m}Nb	M								2.05E-11	2.05E-11
^{94}Nb	M								1.24E-10	1.24E-10
^{95}Nb	M								5.82E-08	5.82E-08
^{147}Nd	M								3.10E-12	3.10E-12
^{59}Ni	M								1.06E-07	1.06E-07
^{63}Ni	M								1.34E-07	1.34E-07
^{237}Np	M								4.81E-11	4.81E-11
^{239}Np	M								4.81E-12	4.81E-12
^{191}Os	S			3.18E-03					1.11E-06	3.18E-03
^{191}Os	M		3.21E-04				2.78E-08			3.21E-04
^{32}P	M								3.37E-11	3.37E-11
^{33}P	M								1.29E-17	1.29E-17
^{210}Pb	M								4.34E-11	4.34E-11
^{212}Pb	M	5.35E-01	5.29E-01				1.98E-02		6.51E-14	1.08E+00
^{212}Pb	S			9.94E-01	9.77E-02				2.73E-02	1.12E+00
^{214}Pb	M								4.17E-13	4.17E-13
^{147}Pm	M								2.41E-12	2.41E-12
$^{209}Po^{e}$	M								5.00E-11	5.00E-11
^{210}Po	M								3.00E-14	3.00E-14
^{238}Pu	M	5.33E-08	1.74E-08				1.36E-09		7.32E-07	8.04E-07
^{238}Pu	F			4.36E-08	5.59E-09	1.91E-06			4.55E-10	1.96E-06
^{239}Pu	F			1.60E-06	2.05E-08	5.45E-07			5.35E-10	2.17E-06
^{239}Pu	M	2.10E-07	2.53E-07				2.46E-09		1.68E-07	6.34E-07
^{240}Pu	F					5.45E-07			2.03E-10	5.45E-07
^{240}Pu	M						2.46E-09		1.16E-09	3.62E-09
^{241}Pu	M								1.78E-07	1.78E-07

Table 5.11. (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{242}Pu	M								8.29E-14	8.29E-14
^{224}Ra	M								2.40E-12	2.40E-12
^{225}Ra	M								9.31E-09	9.31E-09
^{226}Ra	M		1.63E-07				3.27E-07		2.67E-15	4.90E-07
^{88}Rb	M							3.10E+00		3.10E+00
^{188}Re	M								8.30E-08	8.30E-08
^{103}Ru	S					5.66E-06				5.66E-06
^{103}Ru	M								1.01E-09	1.01E-09
^{106}Ru	M								2.27E-08	2.27E-08
^{106}Ru	S								1.40E-04	1.40E-04
^{35}S	M								1.04E-09	1.04E-09
^{124}Sb	M								1.01E-07	1.01E-07
^{125}Sb	M								2.63E-07	2.63E-07
^{46}Sc	M								9.58E-11	9.58E-11
^{75}Se	F								1.41E-11	1.41E-11
^{75}Se	S			3.17E-05		2.94E-06				3.46E-05
^{113}Sn	M								1.79E-11	1.79E-11
^{119m}Sn	M								1.47E-10	1.47E-10
^{85}Sr	M								9.71E-13	9.71E-13
^{89}Sr	S			1.88E-05	1.59E-08				2.89E-04	3.08E-04
^{89}Sr	M	2.98E-07	9.40E-07				4.03E-06		6.78E-09	5.27E-06
^{90}Sr	M	2.98E-07	9.40E-07				4.03E-06		1.24E-04	1.29E-04
^{90}Sr	S			1.88E-05	1.59E-08	8.15E-06			2.89E-04	3.16E-04
^{179}Ta	M								5.95E-14	5.95E-14
^{182}Ta	M								3.40E-11	3.40E-11
^{95m}Tc	M								5.83E-13	5.83E-13
^{99}Tc	M								9.84E-11	9.84E-11
^{99}Tc	S					8.86E-06				8.86E-06
^{129}Te	M								9.92E-12	9.92E-12
^{129m}Te	M								3.76E-07	3.76E-07
^{228Th}	S	1.01E-08	1.55E-08	1.23E-08			2.81E-08		8.19E-08	1.48E-07
^{230Th}	F			2.00E-08	9.13E-10				4.32E-09	2.52E-08
^{230Th}	S	2.78E-09	7.01E-09				8.64E-10		4.30E-09	1.50E-08
^{232}Th	F			7.00E-09	6.23E-10				1.25E-09	8.88E-09
^{232}Th	S	4.31E-10	2.47E-09				4.83E-09		3.25E-09	1.10E-08
^{208}Tl	M								1.46E-13	1.46E-13
^{232}U	M								2.82E-12	2.82E-12

Table 5.11. (continued)

Isotope	Solubility	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{233}U	S				2.03E-08	4.32E-07			9.15E-05	9.20E-05
^{233}U	M						1.15E-07		8.70E-12	1.15E-07
^{234}U	S			5.90E-07	2.03E-08	4.32E-07	1.15E-07		9.15E-05	9.27E-05
^{234}U	M	3.90E-07	2.32E-07						1.28E-04	1.28E-04
^{235}U	M	1.43E-08	1.63E-08						4.85E-05	4.86E-05
^{235}U	S			4.49E-08	3.85E-09	9.50E-07	2.79E-08		7.22E-06	8.25E-06
^{236}U	M								1.44E-12	1.44E-12
^{236}U	S								1.03E-05	1.03E-05
^{238}U	M	6.56E-09	3.55E-08						3.65E-03	3.65E-03
^{238}U	S			3.52E-08	3.76E-09	8.36E-07	2.82E-08		9.38E-06	1.03E-05
^{181}W	M								1.19E-11	1.19E-11
^{185}W	M								3.57E-08	3.57E-08
^{188}W	M								6.85E-08	6.85E-08
^{125}Xe	G							1.29E+01		1.29E+01
^{127}Xe	G							1.68E+01	1.96E-09	1.68E+01
^{129m}Xe	G								6.16E-10	6.16E-10
^{131m}Xe	G						1.53E+02		7.56E-07	1.53E+02
^{133}Xe	G						3.93E+00		1.47E-07	3.93E+00
^{133m}Xe	G						3.60E+00		1.01E-18	3.60E+00
^{135}Xe	G						3.92E+01			3.92E+01
^{135m}Xe	G						1.70E+01			1.70E+01
$^{137}Xe^{f}$	G						6.22E+01			6.22E+01
^{138}Xe	G						9.35E+01			9.35E+01
^{88}Y	F					4.85E-06				4.85E-06
^{91}Y	M								1.60E-08	1.60E-08
^{65}Zn	F					6.98E-06				6.98E-06
^{65}Zn	M								2.70E-10	2.70E-10
^{95}Zr	M								2.64E-08	2.64E-08
^{95}Zr	S					7.46E-06				7.46E-06

[a] 1 Ci = 3.7E+10
[b] ^{248}Cf surrogate for ^{252}Cf
[c] ^{245}Cm surrogate for ^{248}Cm
[d] ^{88}Kr surrogate for ^{89}Kr
[e] ^{210}Po surrogate for ^{209}Po
[f] ^{135}Xe surrogate for ^{137}Xe

Historical trends for ^{3}H and ^{131}I are presented in Figs. 5.12 and 5.13, respectively. For 2010, ^{3}H emissions totaled approximately 170.4 Ci (Fig. 5.12), an increase from 2009; ^{131}I emissions totaled 0.04 Ci (Fig. 5.13), a significant decrease from 2009 but in line with historical emissions from the previous 5 years. The increase in ^{3}H was due to research activities in 2010 in the REDC involving the processing of heavy element targets and increases in beam power at the SNS. (REDC emissions discharge through the 7911 Melton Valley complex stack.) For 2010, the major dose contributors to the radiation dose at ORNL were ^{212}Pb, ^{125}I, ^{11}C, ^{238}U, ^{138}Cs, and ^{41}Ar with dose contributions of approximately 75%, 10%, 4%, 3%, 1%, and 1%, respectively. Emissions of ^{212}Pb result from the radiation decay of legacy material stored onsite and contamination areas containing isotopes of ^{228}Th, ^{232}Th, and ^{232}U. Emissions of ^{212}Pb were from the following stacks: 2026, 3020, 3039, 3544, 7503, 7856, 7877, 7935, and 7911. Emissions of ^{125}I and ^{11}C result from Spallation Neutron Source (SNS) operations and research activities. Emissions of ^{41}Ar result from High Flux Isotope Reactor (HFIR) operations and research activities and are emitted as a nonadsorbable gas from the 7911 Melton Valley complex stack. Emissions of ^{138}Cs result from research activities in the Radiochemical Engineering Development Center (REDC), which also exhaust through the 7911 Melton Valley complex stack. For 2010, ^{212}Pb emissions totaled 2 Ci, ^{125}I emissions totaled 0.15 Ci, ^{11}C emissions totaled 800 Ci, ^{238}U emissions totaled 3.65E-03 Ci, ^{138}Cs emissions totaled 712 Ci, and ^{41}Ar emissions totaled 957 Ci (Fig. 5.14). Emissions of ^{41}Ar increased slightly in 2010 but are comparable to 2009 emissions. Emissions of ^{138}Cs decreased because less heavy-element target process work was performed in 2010 than in 2009.

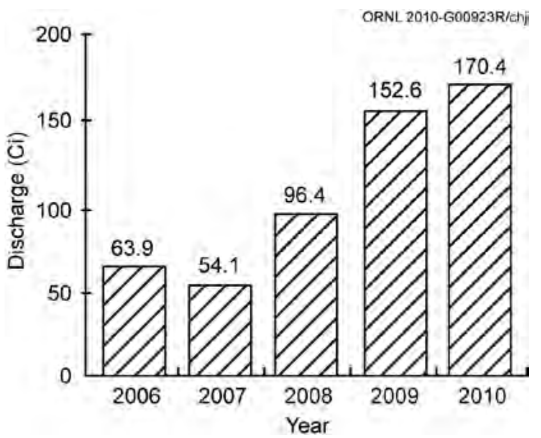

Fig. 5.12. Total discharges of ^{3}H from Oak Ridge National Laboratory to the atmosphere, 2006-2010.

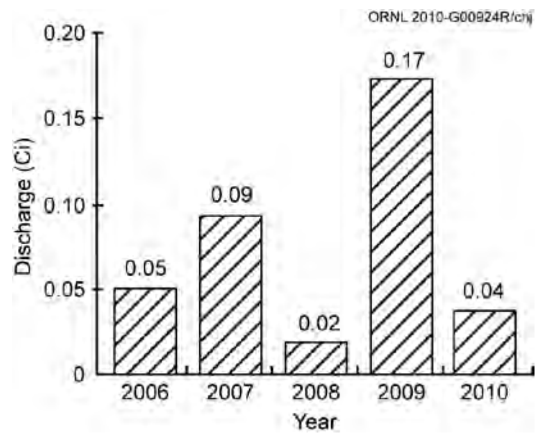

Fig. 5.13. Total discharges of ^{131}I from Oak Ridge National Laboratory to the atmosphere, 2006-2010.

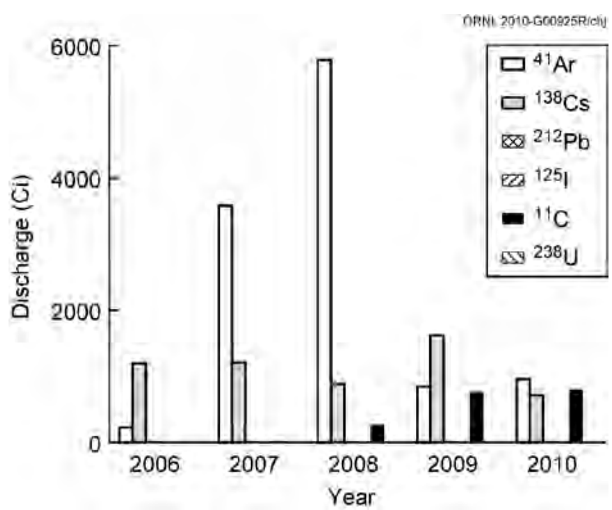

Fig. 5.14. Total discharges of ^{41}Ar, ^{138}Cs and ^{212}Pb from ORNL to the atmosphere, 2006-2010

The calculated radiation dose to the maximally exposed individual (MEI) from all radiological airborne release points at the Oak Ridge Reservation (ORR) during 2010 was 0.4 mrem. The dose contribution to the MEI from all ORNL radiological airborne release points was 0.34 mrem. In 2010, the MEI was an on-site member of the public (business) located within the ORR and on the ORNL site. Historically, the MEI location has been outside the boundary of the ORR (off-site). In 2010, the dose to the off-site MEI was estimated to be about 0.3 mrem/year, which was slightly below the on-site MEI dose. The ORNL contribution to the off-site MEI dose was 0.1 mrem. The dose to both the on-site and off-site MEI locations are well below the NESHAP standard of 10 mrem and is less than 0.13% of the 310 mrem that the average individual receives from natural sources of radiation. (See Sect. 7.1.2.1 for an explanation of how the airborne radionuclide dose was determined.)

5.4.4 Stratospheric Ozone Protection

As required by Title VI of the CAA Amendments of 1990, actions have been implemented to comply with the prohibition against intentionally releasing ozone-depleting substances during maintenance activities performed on refrigeration equipment. In addition, service requirements for refrigeration systems (including motor vehicle air conditioners), technician certification requirements, and labeling requirements have been implemented. ORNL has implemented a plan to phase out the use of all Class I ozone-depleting substances. All critical applications of Class I ozone-depleting substances have been eliminated, replaced, or retrofitted with other materials. Work is progressing as funding becomes available for noncritical applications.

5.4.5 Ambient Air

The objectives of the ORNL ambient air monitoring program are to collect samples at site perimeter air monitoring (PAM) stations located in areas most likely to show impacts of airborne emissions from ORNL and to provide information to support emergency response activities. Four stations, identified as Stations 1, 2, 3, and 7 (Fig. 5.15) make up the ORNL PAM network. Sampling is conducted at each station to quantify levels of tritium; uranium; adsorbable gases (e.g., iodine); and gross alpha-, beta-, and gamma-emitting radionuclides (Table 5.12).

The sampling system consists of a low-volume air sampler for particulate collection in a 47-mm glass-fiber filter. The filters are collected biweekly, composited annually, then submitted to the laboratory for analysis. A charcoal cartridge located behind the glass-fiber particulate filter is used to collect adsorbable gases. The charcoal cartridges are changed out and analyzed biweekly. A silica-gel column is used for collection of tritium as tritiated water. These samples are typically collected biweekly or weekly, depending on ambient humidity levels, and composited quarterly for tritium analysis.

5.4.5.1 Results

The ORNL PAM stations are designed to provide data for collectively assessing the specific impact of ORNL operations on local air quality. Sampling data from the ORNL PAM stations (Table 5.12) are compared with the derived concentration guides (DCGs) for air established by DOE as reference values for conducting radiological environmental protection programs at DOE sites. (DCGs are listed in DOE Order 5400.5.) During 2010, average radionuclide concentrations measured for the ORNL network were less than 1% of the applicable DCGs in all cases.

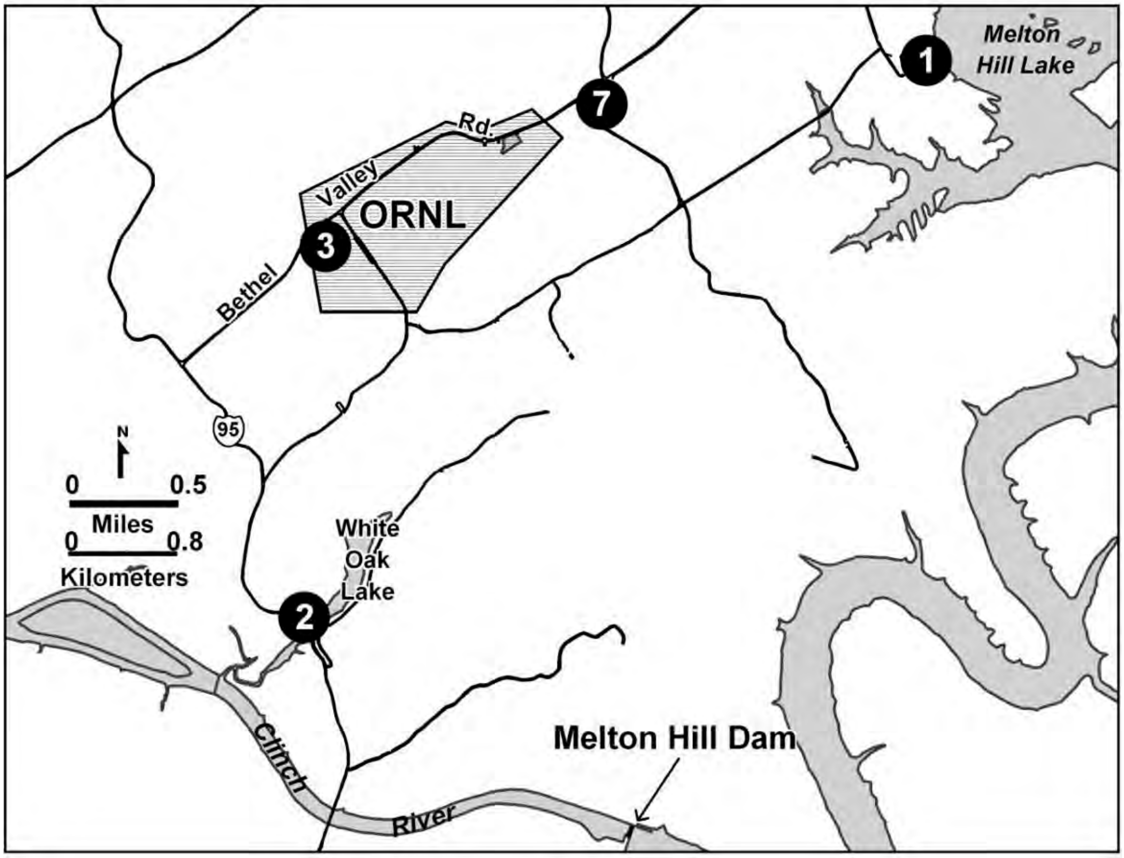

Fig. 5.15. Locations of ambient air monitoring stations at ORNL.

Table 5.12. Radiological airborne emissions from all sources at ORNL, 2010 (Ci)[a]

Isotope	Solubility[b]	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{225}Ac	M								1.16E-09	1.16E-09
^{110}Ag	M								2.76E-12	2.76E-12
^{110m}Ag	M								7.99E-12	7.99E-12
^{110m}Ag	S					2.90E-06				2.90E-06
^{241}Am	M	1.48E-07	5.89E-07				8.05E-08		2.80E-07	1.10E-06
^{241}Am	F			4.13E-07	1.53E-08	1.57E-06			1.75E-08	2.02E-06
^{243}Am	M								7.57E-12	7.57E-12
^{41}Ar	G						9.47E+02	1.00E+01		9.57E+02
^{139}Ba	M						1.16E-01			1.16E-01
^{140}Ba	M						8.31E-04			8.31E-04
^{140}Ba	S					1.02E-04				1.02E-04
^{7}Be	M	2.04E-07	4.32E-07						4.47E-06	5.10E-06
^{7}Be	S			1.20E-05		3.58E-05			4.11E-07	4.82E-05
^{207}Bi	M								9.70E-11	9.70E-11
^{210}Bi	M								3.00E-16	3.00E-16
^{212}Bi	M								4.73E-13	4.73E-13
^{212}Bi	S								1.58E-08	1.58E-08
^{214}Bi	M								2.05E-13	2.05E-13
^{11}C	G							8.00E+02		8.00E+02
^{14}C	M								1.00E-08	1.00E-08

Table 5.12. (continued)

Isotope	Solubility[b]	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{109}Cd	M								5.00E-11	5.00E-11
^{141}Ce	M						8.80E-06		8.00E-09	8.81E-06
^{144}Ce	M								4.16E-11	4.16E-11
^{252}Cf[c]	M						1.43E-08		6.47E-11	1.44E-08
^{36}Cl	M								5.00E-10	5.00E-10
^{242}Cm	M								5.65E-08	5.65E-08
^{243}Cm	F				4.03E-08	7.50E-07			7.47E-10	7.91E-07
^{243}Cm	M						1.80E-08		5.07E-12	1.80E-08
^{244}Cm	M	1.15E-06	1.34E-07				1.80E-08		3.68E-06	4.98E-06
^{244}Cm	F			1.08E-07	4.03E-08	7.50E-07			4.16E-09	9.02E-07
^{245}Cm	M								7.08E-11	7.08E-11
^{247}Cm	M								1.14E-13	1.14E-13
^{248}Cm[d]	M								1.85E-13	1.85E-13
^{57}Co	M								6.26E-13	6.26E-13
^{57}Co	S			4.49E-07						4.49E-07
^{58}Co	M						1.79E-05		3.37E-07	1.82E-05
^{60}Co	M								7.12E-07	7.12E-07
^{60}Co	S			3.13E-06		3.13E-06				6.26E-06
^{51}Cr	M								9.11E-10	9.11E-10
^{134}Cs	F								1.07E-08	1.07E-08
^{134}Cs	S					2.72E-06				2.72E-06
^{135}Cs	F								2.18E-13	2.18E-13
^{137}Cs	F	2.44E-06	2.76E-06				3.27E-06		2.87E-04	2.96E-04
^{137}Cs	S			1.42E-04	2.72E-08	3.01E-06			2.19E-04	3.64E-04
^{138}Cs	F						7.12E+02			7.12E+02
^{253}Es	M								2.14E-10	2.14E-10
^{152}Eu	F			7.43E-07						7.43E-07
^{152}Eu	M								2.41E-07	2.41E-07
^{154}Eu	M								1.45E-07	1.45E-07
^{155}Eu	M								2.43E-10	2.43E-10
^{156}Eu	M								1.38E-16	1.38E-16
^{55}Fe	M								2.36E-07	2.36E-07
^{59}Fe	M								1.13E-10	1.13E-10
^{153}Gd	M								1.00E-10	1.00E-10
^{3}H	V	9.17E-01		7.08E+00	1.62E+00		9.11E+01	6.90E+01	6.86E-01	1.70E+02
^{181}Hf	M								3.31E-14	3.31E-14
^{203}Hg	M								1.02E-13	1.02E-13
^{124}I	F								2.84E-16	2.84E-16
^{125}I	F							1.50E-01	2.70E-05	1.50E-01
^{126}I	F								6.00E-09	6.00E-09
^{129}I	F								1.79E-04	1.79E-04
^{131}I	F					1.90E-05	3.71E-02		1.59E-06	3.71E-02
^{132}I	F						3.69E-01			3.69E-01
^{133}I	F						1.97E-01			1.97E-01
^{134}I	F						5.59E-01			5.59E-01
^{135}I	F						6.02E-01			6.02E-01
^{192}Ir	M								1.21E-11	1.21E-11
^{40}K	S								5.91E-05	5.91E-05

Table 5.12. (continued)

Isotope	Solubility[b]	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{40}K	M		7.96E-07						3.96E-07	1.19E-06
^{79}Kr	G							1.73E+01		1.73E+01
^{81}Kr	G								2.90E-13	2.90E-13
^{85}Kr	G						3.87E+02		2.91E-05	3.87E+02
^{85m}Kr	G						6.46E+00	5.33E+01		5.98E+01
^{87}Kr	G						7.29E+01	2.31E+01		9.60E+01
^{88}Kr	G						6.91E+01	9.40E+00		7.85E+01
^{89}Kr[e]	G						5.30E+01			5.30E+01
^{140}La	M						2.85E-04		4.45E-10	2.85E-04
^{140}La	S					4.37E-05				4.37E-05
^{177}Lu	M								8.64E-07	8.64E-07
^{54}Mn	M								3.64E-08	3.64E-08
^{54}Mn	S					3.09E-06				3.09E-06
^{93}Mo	M								4.09E-10	4.09E-10
^{13}N	G							1.75E+01		1.75E+01
^{22}Na	M								3.72E-14	3.72E-14
^{93m}Nb	M								2.05E-11	2.05E-11
^{94}Nb	M								1.24E-10	1.24E-10
^{95}Nb	M								5.82E-08	5.82E-08
^{147}Nd	M								3.10E-12	3.10E-12
^{59}Ni	M								1.06E-07	1.06E-07
^{63}Ni	M								1.34E-07	1.34E-07
^{237}Np	M								4.81E-11	4.81E-11
^{239}Np	M								4.81E-12	4.81E-12
^{191}Os	S			3.18E-03					1.11E-06	3.18E-03
^{191}Os	M		3.21E-04				2.78E-08			3.21E-04
^{32}P	M								3.37E-11	3.37E-11
^{33}P	M								1.29E-17	1.29E-17
^{210}Pb	M								4.34E-11	4.34E-11
^{212}Pb	M	5.35E-01	5.29E-01				1.98E-02		6.51E-14	1.08E+00
^{212}Pb	S			9.94E-01	9.77E-02				2.73E-02	1.12E+00
^{214}Pb	M								4.17E-13	4.17E-13
^{147}Pm	M								2.41E-12	2.41E-12
^{209}Po[f]	M								5.00E-11	5.00E-11
^{210}Po	M								3.00E-14	3.00E-14
^{238}Pu	M	5.33E-08	1.74E-08				1.36E-09		7.32E-07	8.04E-07
^{238}Pu	F			4.36E-08	5.59E-09	1.91E-06			4.55E-10	1.96E-06
^{239}Pu	F			1.60E-06	2.05E-08	5.45E-07			5.35E-10	2.17E-06
^{239}Pu	M	2.10E-07	2.53E-07				2.46E-09		1.68E-07	6.34E-07
^{240}Pu	F					5.45E-07			2.03E-10	5.45E-07
^{240}Pu	M						2.46E-09		1.16E-09	3.62E-09
^{241}Pu	M								1.78E-07	1.78E-07
^{242}Pu	M								8.29E-14	8.29E-14
^{224}Ra	M								2.40E-12	2.40E-12
^{225}Ra	M								9.31E-09	9.31E-09
^{226}Ra	M		1.63E-07				3.27E-07		2.67E-15	4.90E-07
^{88}Rb	M							3.10E+00		3.10E+00
^{188}Re	M								8.30E-08	8.30E-08
^{103}Ru	S					5.66E-06				5.66E-06

Table 5.12. (continued)

Isotope	Solubility[b]	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{103}Ru	M								1.01E-09	1.01E-09
^{106}Ru	M								2.27E-08	2.27E-08
^{106}Ru	S								1.40E-04	1.40E-04
^{35}S	M								1.04E-09	1.04E-09
^{124}Sb	M								1.01E-07	1.01E-07
^{125}Sb	M								2.63E-07	2.63E-07
^{46}Sc	M								9.58E-11	9.58E-11
^{75}Se	F								1.41E-11	1.41E-11
^{75}Se	S			3.17E-05		2.94E-06				3.46E-05
^{113}Sn	M								1.79E-11	1.79E-11
^{119m}Sn	M								1.47E-10	1.47E-10
^{85}Sr	M								9.71E-13	9.71E-13
^{89}Sr	S			1.88E-05	1.59E-08				2.41E-05	4.29E-05
^{89}Sr	M	2.98E-07	9.40E-07				4.03E-06		6.78E-09	5.27E-06
^{90}Sr	M	2.98E-07	9.40E-07				4.03E-06		1.24E-04	1.29E-04
^{90}Sr	S			1.88E-05	1.59E-08	8.15E-06			2.41E-05	5.11E-05
^{179}Ta	M								5.95E-14	5.95E-14
^{182}Ta	M								3.40E-11	3.40E-11
^{95m}Tc	M								5.83E-13	5.83E-13
^{99}Tc	M								9.84E-11	9.84E-11
^{99}Tc	S					8.86E-06				8.86E-06
^{129}Te	M								9.92E-12	9.92E-12
^{129m}Te	M								3.76E-07	3.76E-07
^{228}Th	S	1.01E-08	1.55E-08	1.23E-08			2.81E-08		8.19E-08	1.48E-07
^{230}Th	F			2.00E-08	9.13E-10				4.32E-09	2.52E-08
^{230}Th	S	2.78E-09	7.01E-09				8.64E-10		4.30E-09	1.50E-08
^{232}Th	F			7.00E-09	6.23E-10				1.25E-09	8.88E-09
^{232}Th	S	4.31E-10	2.47E-09				4.83E-09		3.25E-09	1.10E-08
^{208}Tl	M								1.46E-13	1.46E-13
^{232}U	M								2.82E-12	2.82E-12
^{233}U	S				2.03E-08	4.32E-07			7.66E-06	8.11E-06
^{233}U	M						1.15E-07		8.70E-12	1.15E-07
^{234}U	S			5.90E-07	2.03E-08	4.32E-07	1.15E-07		7.67E-06	8.83E-06
^{234}U	M	3.90E-07	2.32E-07						1.28E-04	1.28E-04
^{235}U	M	1.43E-08	1.63E-08						4.85E-05	4.86E-05
^{235}U	S			4.49E-08	3.85E-09	9.50E-07	2.79E-08		6.06E-07	1.63E-06
^{236}U	M								1.44E-12	1.44E-12
^{236}U	S								8.56E-07	8.56E-07
^{238}U	M	6.56E-09	3.55E-08						3.65E-03	3.65E-03
^{238}U	S			3.52E-08	3.76E-09	8.36E-07	2.82E-08		7.91E-07	1.69E-06
^{181}W	M								1.19E-11	1.19E-11
^{185}W	M								3.57E-08	3.57E-08
^{188}W	M								6.85E-08	6.85E-08
^{125}Xe	G							1.29E+01		1.29E+01
^{127}Xe	G							1.68E+01	1.96E-09	1.68E+01
^{129m}Xe	G								6.16E-10	6.16E-10
^{131m}Xe	G						1.53E+02		7.56E-07	1.53E+02
^{133}Xe	G						3.93E+00		1.47E-07	3.93E+00
^{133m}Xe	G						3.60E+00		1.01E-18	3.60E+00

Table 5.12. (continued)

Isotope	Solubility[b]	Stack								
		X-2026	X-3020	X-3039	X-7503	X-7880	X-7911	X-8915	Total Minor Source	ORNL Total
^{135}Xe	G						3.92E+01			3.92E+01
^{135m}Xe	G						1.70E+01			1.70E+01
^{137}Xe[g]	G						6.22E+01			6.22E+01
^{138}Xe	G						9.35E+01			9.35E+01
^{88}Y	F					4.85E-06				4.85E-06
^{91}Y	M								1.60E-08	1.60E-08
^{65}Zn	F					6.98E-06				6.98E-06
^{65}Zn	M								2.70E-10	2.70E-10
^{95}Zr	M								2.64E-08	2.64E-08
^{95}Zr	S					7.46E-06				7.46E-06
Totals		**1.45E+00**	**5.29E-01**	**8.08E+00**	**1.72E+00**	**2.69E-04**	**2.71E+03**	**1.03E+03**	**4.26E+00**	**3.76E+03**

[a] 1 Ci = 3.7E+10 Bq

[b] This table shows total radionuclide emissions from point sources on the ORR. Also shown are the assumed lung clearance type and activity median aerodynamic diameters (AMADs). The designation of F, M, and S refers to the lung clearance type – Fast (F), Moderate (M), and Slow (S) for the given radionuclide. The default AMAD of 1.0 µm was used for modeling unless it was a gas, vapor, or otherwise requested. The chemical form used in most cases was unspecified, except when the chemical form was known and available in CAP88PC Version 3.

[c] ^{248}Cf surrogate for ^{252}Cf

[d] ^{245}Cm surrogate for ^{248}Cm

[e] ^{88}Kr surrogate for ^{89}Kr

[f] ^{210}Po surrogate for ^{209}Po

[g] ^{135}Xe surrogate for ^{137}Xe

5.5 ORNL Water Quality Program

NPDES Permit (TN 0002941), issued to DOE for the ORNL site, was renewed by the state of Tennessee in 2008, and includes requirements for discharging wastewaters from the three ORNL on-site wastewater treatment facilities and for the development and implementation of a Water Quality Protection Plan (WQPP). The permit calls for the WQPP to "establish better linkages between water quality monitoring and detecting and abating water quality and ecological impact." Rather than prescribing rigid monitoring schedules, the WQPP is flexible, allows an annual assessment of all outfalls, and focuses on significant findings. The goals of the WQPP are to meet the requirements of the NPDES permit, improve the quality of aquatic resources on the ORNL site, prevent further impacts to aquatic resources from current activities, identify the stressors that contribute to impairment of aquatic resources, use available resources efficiently, and communicate outcomes with decision makers and stakeholders.

The WQPP was developed by UT-Battelle and approved by TDEC in 2008, and WQPP monitoring was initiated in 2009. The WQPP incorporated several control plans that were required under the previous NPDES permit, including a Biological Monitoring and Abatement Plan (BMAP) (ORNL 1986), a Chlorine Control Strategy, a Storm Water Pollution Prevention Plan (ORNL 2007), a Non-Storm Water Best Management Practices Plan (ORNL 1997), and a Radiological Monitoring Plan. The WQPP has been reviewed and revised annually, and submitted to TDEC for review and comment.

To prioritize the stressors and/or contaminant sources that may be of greatest concern to water quality, and to define conceptual models that would guide any special investigations, the WQPP strategy was defined using EPA's Stressor Identification Guidance (EPA 2000). A summary of this process is shown in Fig. 5.16. The Stressor Identification Guidance involves three major steps for identifying the cause of any impairment:

1. list candidate causes of impairment (based on historical data and a working conceptual model),
2. analyze the evidence (using both case study and outside data), and
3. characterize the cause.

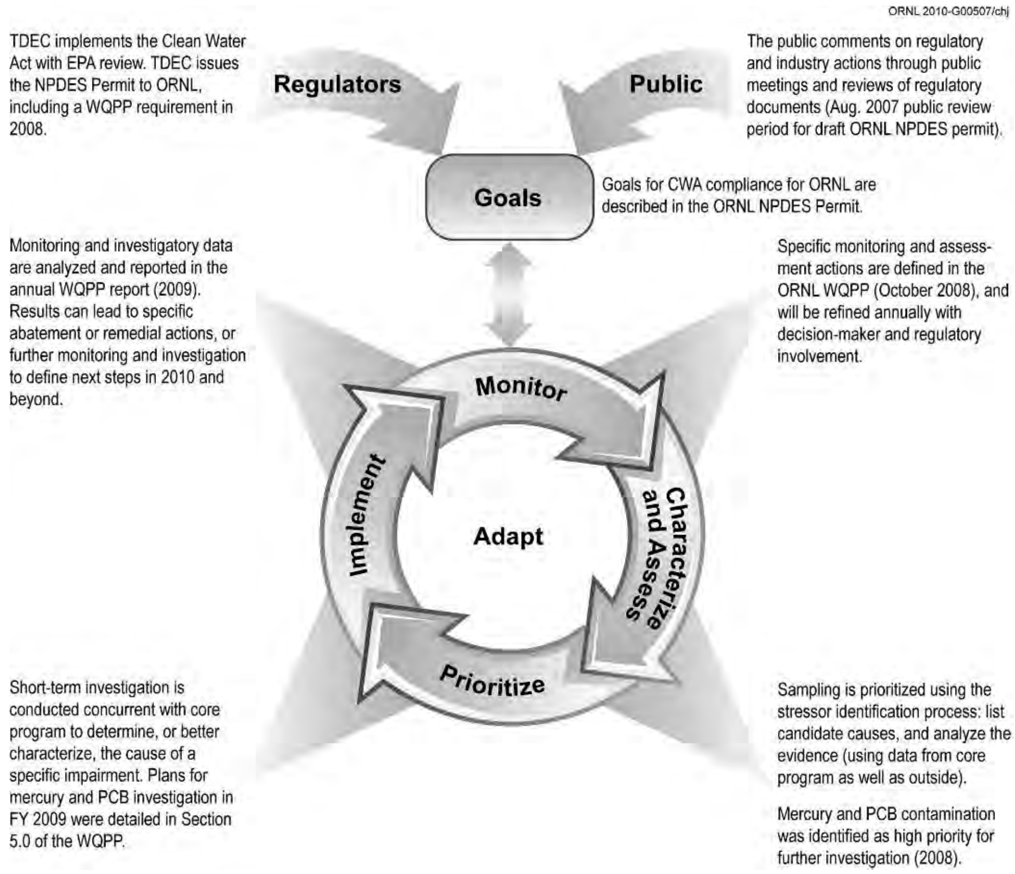

Fig. 5.16. Diagram of the adaptive management framework, with step-wise planning specific to the ORNL Water Quality Protection Plan. Adapted from EPA.

The first two steps of the stressor identification process were initiated in 2009, focusing first on mercury impairment (Fig. 5.17) and then on PCBs, since mercury and PCB concentrations in fish from White Oak Creek (WOC) are at or near human health risk thresholds (e.g., EPA ambient water quality criteria and TDEC fish advisory limits). Some of the major sources of mercury to biota in the WOC watershed are known, providing a good basis from which to define an appropriate conceptual model for mercury contamination in WOC. A list of potential causes of PCB contamination was also developed.

After listing potential causes and analyzing the available evidence on mercury and PCB contamination in the WOC watershed, it was clear that additional investigation was needed to complete the third step of the stressor identification process, “characterizing the cause.” Special investigations were designed to identify specific source areas and to revise the conceptual model of the major causes of contamination in the WOC watershed.

At the end of each year, monitoring and investigation data collected under the WQPP will be analyzed, interpreted, reported, and compared with past results in the WQPP annual report. This information will provide a solid, overall assessment of the status of ORNL’s receiving-stream watersheds and the impact of ongoing efforts to protect and restore those watersheds, and will guide efforts to improve the water quality in the watershed.

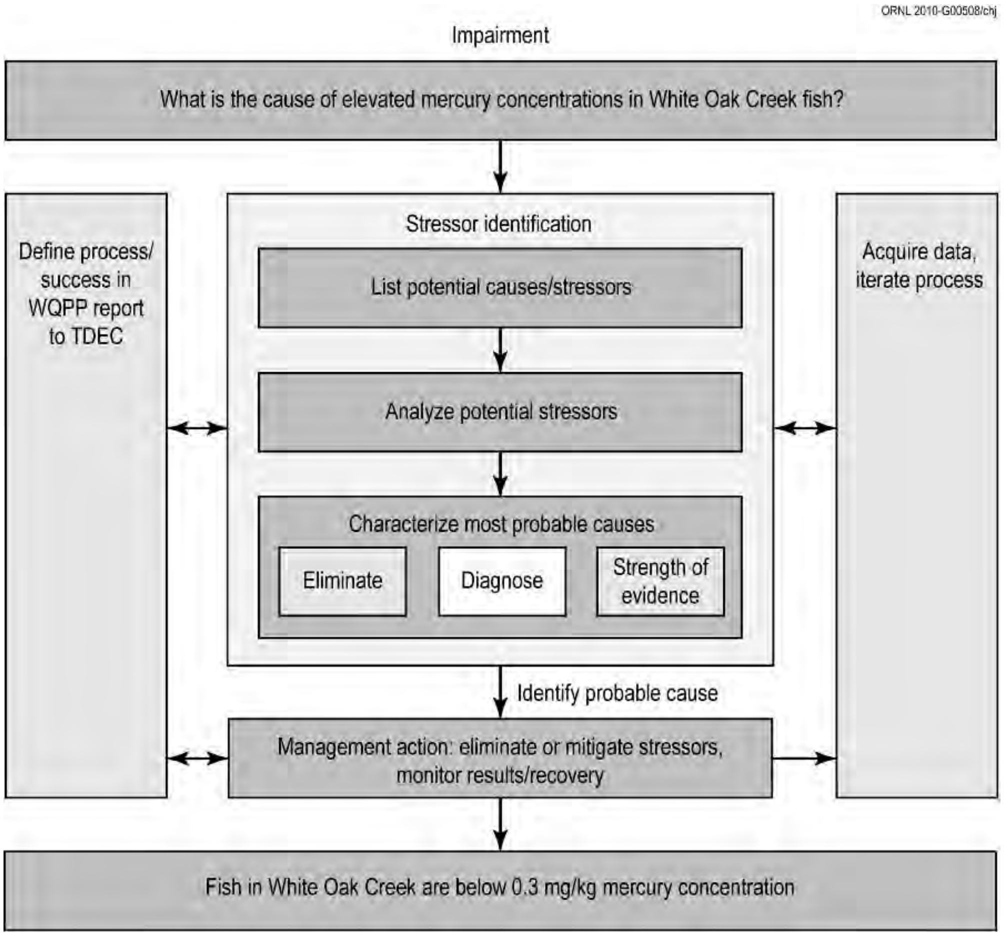

Fig. 5.17. Application of stressor identification guidance to address mercury impairment in the White Oak Creek watershed. Diagram modified from EPA.

5.5.1 Treatment Facility Discharges

Three onsite wastewater treatment systems are operated at ORNL to provide appropriate treatment of the various research and development, operational, and domestic wastewaters generated by site staff and activities. All three are permitted to discharge treated wastewater and are monitored under National Pollutant Discharge Elimination System (NPDES) Permit TN 0002941, issued to DOE for the ORNL site by TDEC. These are the ORNL STP (Outfall X01), the Steam Plant Wastewater Treatment Facility (SPWTF - Outfall X02), and the PWTC (Outfall X12). The ORNL NPDES Permit requirements include monitoring the three ORNL wastewater treatment facility effluents for conventional, water-quality-based, and radiological constituents, as well as for effluent toxicity, with numeric parameter-specific compliance limits established by TDEC as determined to be necessary [see Table 5.13 and Table 2.8 in *Environmental Monitoring on the Oak Ridge Reservation: 2010 Results* (DOE 2010b)].

The results of field measurements and laboratory analyses to assess compliance for the parameters required by the NPDES permit, as well as rates of compliance with numeric limits established in the permit, are also provided in Table 5.13. The three ORNL wastewater treatment facilities achieved 99.9% compliance with permit limits and conditions in 2010.

Table 5.13. National Pollutant Discharge Elimination System (NPDES) compliance at ORNL, 2010

(NPDES permit effective August 1, 2008)

Effluent parameters	Permit limits					Permit compliance		
	Monthly average (lb/d)	Daily max. (lb/d)	Monthly average (mg/L)	Daily max. (mg/L)	Daily min. (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[a]
X01 (Sewage Treatment Plant)								
LC_{50} for *Ceriodaphnia* (%)					69.4	0	2	100
LC_{50} for fathead minnows (%)					69.4	0	2	100
Ammonia, as N (summer)	6.26	9.39	2.5	3.75		0	26	100
Ammonia, as N (winter)	13.14	19.78	5.25	7.9		0	26	100
Carbonaceous biological oxygen demand	19.2	28.8	10	15		0	52	100
Dissolved oxygen					6	0	52	100
Escherichia coliform (col/100 mL)			941	126		1[b]	52	98
IC_{25} for *Ceriodaphnia* (%)					15.5	0	2	100
IC_{25} for fathead minnows (%)					15.5	0	2	100
Oil and grease	19.2	28.8	10	15		0	12	100
pH (standard units)				9	6	0	52	100
Total suspended solids	57.5	86.3	30	45		0	52	100
X02 (Steam Plant Wastewater Treatment Facility)								
pH (standard units)				9.0	6	1[c]	51	100
Total suspended solids				50		0	6	100
X12 (Process Waste Treatment Complex)								
LC_{50} for *Ceriodaphnia* (%)					100	0	2	100
LC_{50} for fathead minnows (%)					100	0	2	100
Arsenic, total			0.007	0.014		0	6	100
Cadmium, total	1.73	4.60	0.003	0.038		0	6	100
Chromium, total	11.40	18.46	0.22	0.44		0	6	100
Copper, total	13.8	22.53	0.07	0.11		0	6	100
Cyanide, total	4.33	8.00	0.008	0.046		0	2	100
Lead, total	2.87	4.60	0.028	0.69		0	6	100
IC_{25} for *Ceriodaphnia* (%)					30.5	0	2	100
IC_{25} for fathead minnows (%)					30.5	0	2	100

Table 5.13. (continued)

Effluent parameters	Permit limits					Permit compliance		
	Monthly average (lb/d)	Daily max. (lb/d)	Monthly average (mg/L)	Daily max. (mg/L)	Daily min. (mg/L)	Number of noncompliances	Number of samples	Percentage of compliance[a]
Oil and grease	66.7	100	10	15		0	12	100
pH (standard units)				9.0	6.0	0	52	100
Temperature (ºC)				30.5		0	52	100
In-stream chlorine monitoring points								
Total residual oxidant			0.011	0.019		0	288	100

[a]Percentage compliance = 100 – [(number of noncompliances/number of samples) × 100].

[b]The exceedance of E. coli at X01 occurred on May 5, 2010, and was attributed to heavy rainfall which resulted in modified operations at the Sewage Treatment Plant.

[c]On June 18, 2010, the SPWTF treated and discharged a batch of wastewater without NPDES effluent measurements being taken. Operational data indicated that the effluent met specifications but the missed NPDES measurement constitutes permit nonconformance.

Abbreviations

LC_{50} the concentration (as a percentage of full-strength wastewater) that kills 50% of the test species in 48 h.

IC_{25} inhibition concentration; the concentration as a percentage of full-strength wastewater that caused 25% reduction in survival, reproduction, or growth of the test organisms.

Effluent toxicity testing provides an assessment of any harmful effects that could occur from the total combined constituents in the ORNL wastewater treatment facility effluents. The STP and SPWTF have been tested for toxicity to aquatic species under the NPDES Permit every year since 1986, and the PWTC since it went into operation in 1990. Test species have been *Ceriodaphnia dubia*, an aquatic invertebrate, and fathead minnow (*Pimephales promelas*) larvae. These have been tested using EPA chronic and acute test protocols at frequencies ranging from two to four times per year. Test results have been excellent. SPWTF and PWTC effluent have always been shown to be nontoxic. The STP has shown isolated indications of effluent toxicity, but confirmatory tests conducted as required by the permit have shown that either the result of the routine test was an anomaly or that the condition of toxicity that existed at the time of the routine test was temporary and of short duration.

Toxicity test requirements under the current NPDES permit include testing of the STP and PWTC twice per year each, using two test species. The toxicity potential of the SPWTF was mitigated in 2003 by the removal of the ORNL Steam Plant's Coal Yard (the Steam Plant was converted from coal burning to natural gas), thereby removing the need to treat and discharge coal yard storm water runoff. It was determined by TDEC that toxicity testing of the SPWTF effluent, which now includes only treated boiler blowdown and water-softener regeneration wastewaters from the ORNL Steam Plant, was no longer necessary. In 2010, toxicity test results for the ORNL wastewater treatment facilities were once again favorable, with no indication of toxicity in any of the tests that were conducted (Table 5.13).

5.5.2 Residual Bromine and Chlorine Monitoring

Chlorine is added to drinking water to disinfect it and to keep it safe for consumption. Chlorine and bromine are added to cooling system water to prevent bacterial growth in the system. When waters are discharged to streams, residual chlorine and bromine can be toxic to fish and other aquatic life. The ORNL NPDES permit controls the discharge of chlorinated and bromated waters, reported as TRO, by limiting the TRO mass loading from outfalls and the TRO concentration in-stream. Outfalls with lower potential to discharge chlorinated water are generally monitored semiannually; outfalls with known sources that are dechlorinated are monitored more frequently to ensure operational integrity of the dechlorinator. In-stream locations are monitored bimonthly.

NPDES permit outfalls are monitored for TRO to ensure effective operation of cooling towers and dechlorination systems and maintenance of water lines. When the permit action level of 1.2 grams per day is exceeded at an outfall, the staff investigates and implements treatment and reduction measures. TRO is also monitored at in-stream points twice per month to verify that releases are not creating adverse conditions for fish and other aquatic life.

Thirty-two individual outfalls were checked for TRO either semiannually, quarterly, monthly, or bimonthly throughout the year for a total of 270 attempts. Flow was detected 239 times. Table 5.14 lists instances in 2010 where outfalls were found to be in excess of the TRO action level. Three outfalls, 265 and 368, on Fifth Creek, and 312, on White Oak Creek, exceeded the action level during 2010. The sources for Outfalls 265 and 368 have been determined to be from aging, underground water pipes that are leaking drinking water. Outfall 312 was inadvertently receiving once-through cooling water that has now been removed from that storm drain network.

Table 5.14. Outfalls exceeding total residual oxidant (TRO) action level[a] in 2010

Sample date	Outfall	TRO concentration (mg/L)	Flow (gpm)	Load (grams/ day)	Receiving stream	Downstream integration point	Instream TRO point
2/11/2010	312	0.255	12	16.35	White Oak Creek	WCK 3.9	X24
2/11/2010	368	1.25	15	102.2	Fifth Creek	FFK 0.2	X20
4/5/2010	265	0.2	6.5	7.08	Fifth Creek	FFK 0.2	X19
4/5/2010	312	0.15	6.5	5.31	White Oak Creek	WCK 3.9	X24

[a] 1.2 grams per day.

5.5.3 Cooling Tower Blowdown Monitoring

As part of the WQPP at ORNL, cooling tower blowdown effluents were monitored twice in 2010. Only field parameters (conductivity, dissolved oxygen, pH, and temperature) were collected during the March sampling event. In August, field parameters were measured along with the following laboratory analyses: chemical oxygen demand, total suspended solids, and total metals. All samples were grab samples.

The cooling towers that were monitored in 2010 are listed in Table 5.15. In the second half of 2010, monitoring was added for two relatively new cooling towers—5309 and 5807. Cooling tower 6001 was decommissioned after the March sampling event and replaced with new cooling tower 6018 before the August sampling event. Two towers were targeted for sampling but were not sampled: tower 2535 was not operating during any sampling events, and tower 7923 was not sampled because blowdown does not reach a receiving stream (blowdown infiltrates into the ground before reaching a receiving stream). Field measurements are presented in Table 5.16, and results from laboratory analyses are presented in Table 5.17.

Where possible, cooling towers were sampled at the outfalls where blowdown is discharged to the receiving streams. In a few instances, tower water was sampled at the basin under the cooling tower. This was necessary in cases where it was not possible to determine if and when blowdown was present at the outfall. The release of cooling tower blowdown is intermittent, and its presence or absence can be masked when blowdown is commingled with other wastewaters prior to discharge.

Table 5.15. Cooling tower/cooling tower systems monitored at ORNL in 2010

Cooling tower/ tower system	NPDES outfall receiving blowdown	Sampled location
2026	249	Tower Basin
2539	204	Tower Basin
3047	367	Tower Basin
3517	304	Tower Basin
4510/4521	014	Outfall
5300	363	Outfall
5309[1]	363	Tower Basin
5600	227	Outfall
5807[1]	231	Tower Basin
6001[2]	314	Tower Basin
6018[2]	314	Tower Basin
7619	291	Outfall
7626	191	Outfall
7902	281	Outfall
8913	435	Outfall

[1] Towers 5309 and 5807, relatively new towers, were added to the sampling task for the second half of 2010.

[2] The 6001 tower was decommissioned and replaced with tower 6018 in 2010.

The state of Tennessee has established water quality criteria (WQC) for instream temperature as a basis to control the effects of wastewater discharges on receiving waters designated for fish and aquatic life, recreation, domestic water supply, and/or industrial water supply uses. The WQC addresses maximum instream temperature (30.5°C), maximum rate of instream temperature change (2°C per hour), and instream temperature change relative to an upstream control point (3°C). Monitoring of instream temperature in the vicinity of the major cooling water discharges at ORNL was conducted on August 23, 2010. Monitoring was targeted to the third calendar quarter of the year when stream flows are typically low, air and water temperatures are warm and cooling demand is typically at a maximum. In-stream temperature measurements at all monitored locations were in compliance with the aforementioned WQC. Individual temperature measurements from the August 23 monitoring are presented in *Environmental Monitoring on the Oak Ridge Reservation: 2010 Results,* Table [TBD] (was 5.18)], and results of calculations of rates of temperature change and temperature changes relative to upstream control points are provided in Table [TBD] (was 5.19)] (DOE 2010b).

Table 5.16. Field measurements collected in blowdown from ORNL cooling towers

Cooling Tower[a]	Sampled location	Date	Flow[b] (gpm)	Conductivity (mS/cm)	Dissolved oxygen (mg/L)	pH (standard unit)	Temperature (°C)
2026	2026 basin	3/30/2010	Tower was not operating during the March sampling attempt				
2026	2026 basin	8/17/2010	Unknown	1.2	6.1	8.8	26.9
2539	2539 basin	3/30/2010	Unknown	0.368	8.6	8.2	13.4
2539	2539 basin	8/17/2010	Unknown	0.875	6.5	8.1	23.5
3047	3047 basin	3/30/2010	Tower was not operating during the March sampling attempt				
3047	3047 basin	8/17/2010	Unknown	1.04	7.3	8.9	29.6
3517	3517 basin	3/30/2010	Unknown	0.32	7.1	8.4	18.3
3517	3517 basin	8/17/2010	Unknown	0.386	6.2	8.2	27.2
5300	Outfall 363	3/30/2010	8	0.639	6.9	8	18.7
5300	Outfall 363	8/17/2010	15	0.842	6.2	8.1	24.4
5309	5309 basin	3/30/2010	Tower was added to sampling program after the March event				
5309	5309 basin	8/17/2010	Unknown	0.95	6.1	8.7	26.9
5600	Outfall 227	3/30/2010	35	1.01	7.8	8.4	20.8
5600	Outfall 227	8/17/2010	20	0.809	7.3	8	28.3
5807	5807 basin	3/30/2010	Tower was added to sampling program after the March event.				
5807	5807 basin	8/17/2010	Unknown	1.06	6.8	8.9	27.2
6001	6001 basin	3/30/2010	Tower was not operating during the March sampling attempt				
6001	6001 basin	8/17/2010	Tower was decomissioned prior to the August samplng event				
6018	6018 basin	3/30/2010	Tower was placed into service after the March sampling event				
6018	6018 basin	8/17/2010	Unknown	1.07	7.8	8.9	25.8
7619	Outfall 291	3/30/2010	2.5	0.308	7.9	7.7	12.4
7619	Outfall 291	8/17/2010	0.25	0.318	6	7.7	26.8
7626	Outfall 191	3/30/2010	4	0.237	8.1	7.8	12.1
7626	Outfall 191	8/17/2010	12	0.246	6.2	8	26.4
7902	Outfall 281	3/30/2010	30	0.102	6.5	7.5	22.7
7902	Outfall 281	8/17/2010	45	1.58	7.3	7.8	26.1
8913	Outfall 435	3/30/2010	150	0.244	8.8	8.1	12.6
8913	Outfall 435	8/17/2010	30	0.391	6.2	7.7	22.2
4510/4521	Outfall 014	3/30/2010	Tower was not operating during the March sampling attempt				
4510/4521	Outfall 014	8/17/2010	30	1.2	7.9	8.2	27

[a]Cooling Towers 2535 and 7923 were not operating during either the March or August sampling attempts and are therefore not included in this table.

[b]Cooling tower blowdown flow rates are not known for towers that were sampled at the tower basins.

5.5.4 Radiological Monitoring

Monitoring of effluents and instream locations for radioactivity is conducted under the UT-Battelle WQPP. Table 5.18 details the monitoring frequency and target analyses for three treatment facility outfalls, three in-stream monitoring locations, and 22 category outfalls (outfalls that discharge effluents with relatively minor constituents that receive little or no treatment prior to discharge). Dry-weather discharges from category outfalls are primarily cooling water, groundwater, and condensate. Low levels of radioactivity can be discharged from category outfalls in areas where groundwater contamination exists and where groundwater enters category outfall collection systems from building and facility sumps, building footer drains, and from direct infiltration. In 2010, dry-weather grab samples were collected at 19 of the 22 category outfalls targeted for sampling. The remaining three outfalls were not sampled because there was no discharge present during sampling attempts.

Table 5.17. Results (in mg/L) from laboratory analyses of blowdown from ORNL cooling towers

Date sampled: August 17, 2010

	Cooling Tower (Sample Location)													
	2026 (2026 basin)	2539 (2539 basin)	3047 (3047 basin)	3517 (3517 basin)	4510/4521 (Outfall 014)	5300 (Outfall 363)	5309 (5309 basin)	5600 (Outfall 227)	5807 (5807 basin)	6018[a] (6018 basin)	7619 (Outfall 291)	7626 (Outfall 191)	7902 (Outfall 281)	8913 (Outfall 435)
COD	36.1	25.5	30.8	J9.74	49.2	41.3	57.1	33.4	41.3	67.6	20.3	J17.6	30.8	J17.6
TSS	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	7	17	< 2	< 2
Ag	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619	< 0.000619
As	0.0037	< 0.001	0.00112	< 0.001	0.00296	0.00237	0.00352	0.00127	< 0.001	0.00404	< 0.001	< 0.001	< 0.001	0.00173
Be	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686	< 0.000686
Ca	178	134	153	58.1	188	112	134	123	157	144	66.7	59	212	66.8
Cd	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	< 0.000782	0.00117	< 0.000782	< 0.000782	< 0.000782	< 0.000782
Cr	0.00156	0.00138	0.00105	< 0.001	0.00143	0.00123	0.00132	0.00162	< 0.001	0.00176	< 0.001	0.00287	0.00183	0.00133
Cu	0.339	0.00802	0.0194	0.0306	0.00366	0.0547	0.069	0.0103	0.26	0.0452	0.00279	0.00689	0.00707	0.00272
Fe	0.0691	0.339	< 0.0206	0.0528	< 0.0206	0.0385	1.19	0.0537	0.0365	0.102	0.36	0.321	0.0249	0.103
Mg	58.7	39.3	53.3	15.1	56	35.2	40.7	34.7	46.8	44	12.8	10	61.1	21.5
Mn	0.00678	0.014	0.00167	0.00296	0.0025	0.00664	0.0036	0.00816	0.00277	0.00756	0.196	0.097	0.00251	0.138
Mo	0.063	0.389	0.00515	0.00159	0.172	0.401	0.146	0.0899	0.12	0.774	< 0.000931	0.0381	0.00296	0.00664
Ni	0.00731	0.00523	0.0054	0.00194	0.00779	0.0046	0.00598	0.00434	0.00561	0.00531	0.00187	0.00297	0.00939	0.00212
Pb	< 0.001	< 0.001	0.0012	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.00114	0.00158	< 0.001	< 0.001
Sb	< 0.00081	< 0.00081	< 0.00081	< 0.00081	0.00289	< 0.00081	< 0.00081	< 0.00081	< 0.00081	< 0.00081	< 0.00081	< 0.00081	0.00224	< 0.00081
Se	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406	< 0.0406
Zn	0.132	0.104	0.051	0.0875	0.236	0.227	0.378	0.191	0.286	0.637	< 0.02	0.0408	0.066	0.0374

[a] The 6001 cooling tower was decomissioned prior to the August sampling event. It was replaced with Tower 6018, which was sampled in August.

Table 5.18. Radiological monitoring conducted under the ORNL Water Quality Protection Plan

Location	Frequency	Gross alpha/beta[a]	Gamma scan	^{3}H	Total rad Sr	Isotopic uranium	^{14}C	$^{243/244}Cm$
Outfall 001	Annually	X						
Outfall 080	Monthly	X	X	X	X			X
Outfall 081	Annually	X						
Outfall 085	Quarterly	X	X	X	X	X		
Outfall 203 [b]	Annually	X	X		X			
Outfall 204	Semiannually	X	X		X			
Outfall 205 [b]	Annually	X						
Outfall 207	Quarterly	X	X		X			
Outfall 211	Annually	X						
Outfall 217	Annually	X						
Outfall 219	Annually	X						
Outfall 234	Annually	X						
Outfall 241	Quarterly	X	X	X	X	X		
Outfall 265	Annually	X						
Outfall 281	Quarterly	X		X				
Outfall 282	Quarterly	X						
Outfall 284 [b]	Annually	X						
Outfall 302	Monthly	X	X	X	X			
Outfall 304	Monthly	X	X	X	X			
Outfall 365	Semiannually	X						
Outfall 368	Annually	X						
Outfall 383	Annually	X		X				
Sewage Treatment Plant (X01)	Monthly	X	X	X	X		X	
Steam Plant Wastewater Treatment Facility (X02)	Monthly	X			X			
Process Waste Treatment Complex (X12)	Monthly	X	X	X	X	X		
Melton Branch 1 (X13)	Monthly	X	X	X	X			
WOC (X14)	Monthly	X	X	X	X			
WOD (X15)	Monthly	X	X	X	X			

[a]Isotopic analyses are performed to identify contributors to gross activities when results exceed screening criteria described in the described in the Water Quality Protection Plan, October 2008.

[b]No discharge present during sampling attempts.

The three treatment facilities monitored were the STP, SPWTF and the PWTC. The three instream monitoring locations were X13 on Melton Branch, X14 on White Oak Creek, and X15 at White Oak Dam (WOD) (Fig. 5.18). At each of these treatment facilities and instream monitoring stations, monthly flow-proportional composite samples were collected using dedicated automatic water samplers.

Expressing radioactivity concentrations as percentage of the DOE DCG values is used in this section as a means of comparing effluent points with different radioisotope signatures. Annual average concentrations were compared with DCG concentrations where a DCG existed (there are no DCGs for gross alpha and gross beta activities) and when at least one individual measurement indicated detectable activity [i.e., at least one individual measurement had a concentration greater than or equal to the measurement's minimum detectable activity (MDA)]. For analyses that cannot differentiate between two radioisotopes (e.g., $^{89/90}Sr$), and for radioisotopes that have more than one DCG for different gastrointestinal tract absorption factors, the most restrictive (lowest) DCG was used in the comparison. DCGs are not intended to be thresholds for in-stream values as they are for effluents but are nonetheless

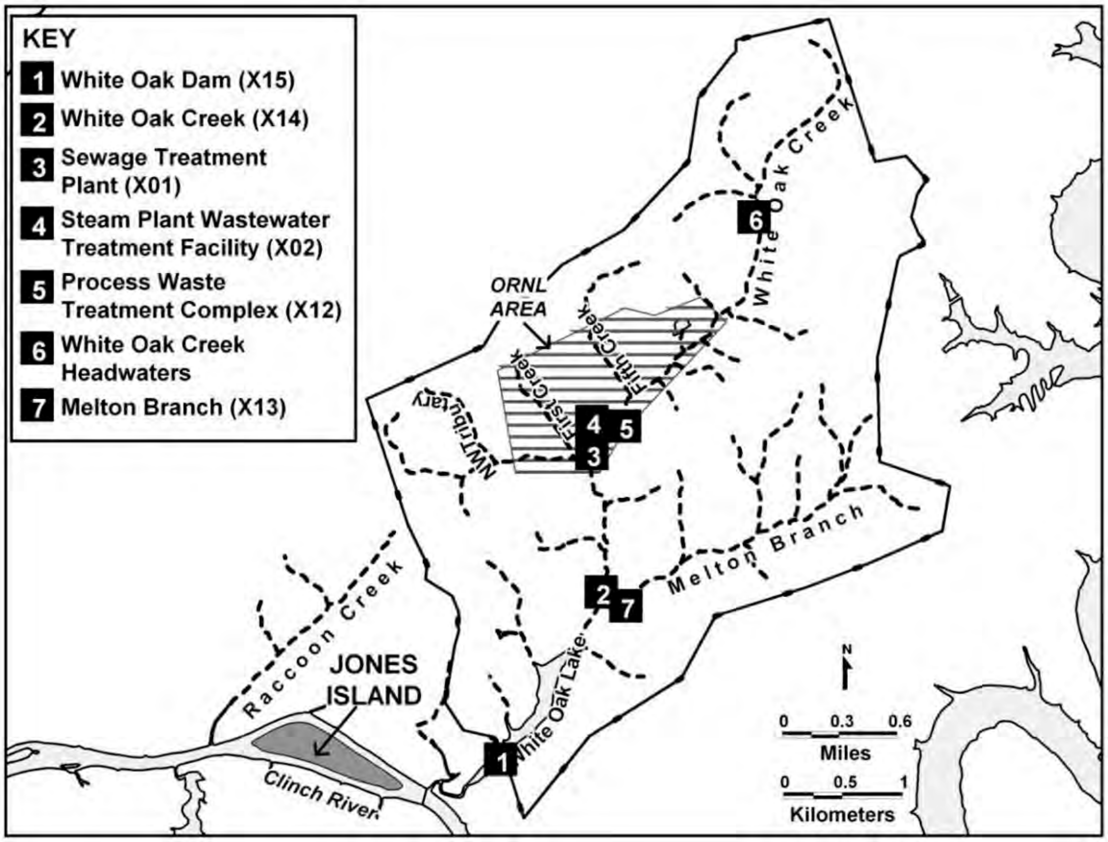

Fig. 5.18. ORNL surface water, National Pollutant Discharge Elimination System, and reference sampling locations.

useful as a frame of reference. Effluents and instream concentrations are compared to DCGs that were established for exposures to humans by ingesting water, but their use in this section does not imply that ORNL effluents or ambient waters are sources of drinking water.

Four percent of the DCG is used as a comparison point. Four percent of the DCG is roughly equivalent to the 4-mrem dose limit on which the EPA radionuclide drinking water standards are based. The annual average concentration of at least one radionuclide exceeded 4% of the relevant DCG concentration in dry-weather discharges from NPDES Outfalls 080, 085, 241, 302, 304, X01, X02 and X12 and at in-stream sampling locations X14 and X15 (Fig. 5.19).

In 2010, two outfalls had annual average radionuclide concentrations exceeding 100% of DCG concentrations. Outfall 080 in Melton Valley has exceeded DCG concentrations most years since 2006 when a release apparently occurred from a nearby remediation activity to grout an abandoned waste pipeline. It is believed that residual waste material in a compromised section of pipeline was lost during the grouting process, and infiltration of contaminated groundwater into the Outfall 080 pipe network occurs when the water table is high enough for groundwater to come into contact with the outfall's pipe network. In 2010, the average of two measurements of $^{243/244}$Cm was 240 pCi/L, 4.8 times the DCG for ^{243}Cm and 4 times the DCG for ^{244}Cm. (Although the analytical test does not differentiate between ^{243}Cm and ^{244}Cm, ^{244}Cm is thought to be the predominant radioisotope in this discharge.) Although these concentrations are greater than DCG levels, they are within the target human health risk range for the Record of Decision for Interim Actions in Melton Valley and no remediation activities are planned for this outfall. Average concentrations of ^{241}Am, $^{239/240}$Pu, and $^{89/90}$Sr were also notable: 28%, 9%, and 12% of their respective DCGs. The flow rates from Outfall 080 are typically low (1.5 and 0.1 gpm during the two sampling events in 2010), and therefore no significant changes in contaminant concentrations have been detected in downstream monitoring. It was first reported in the 2006 ASER, when annual average

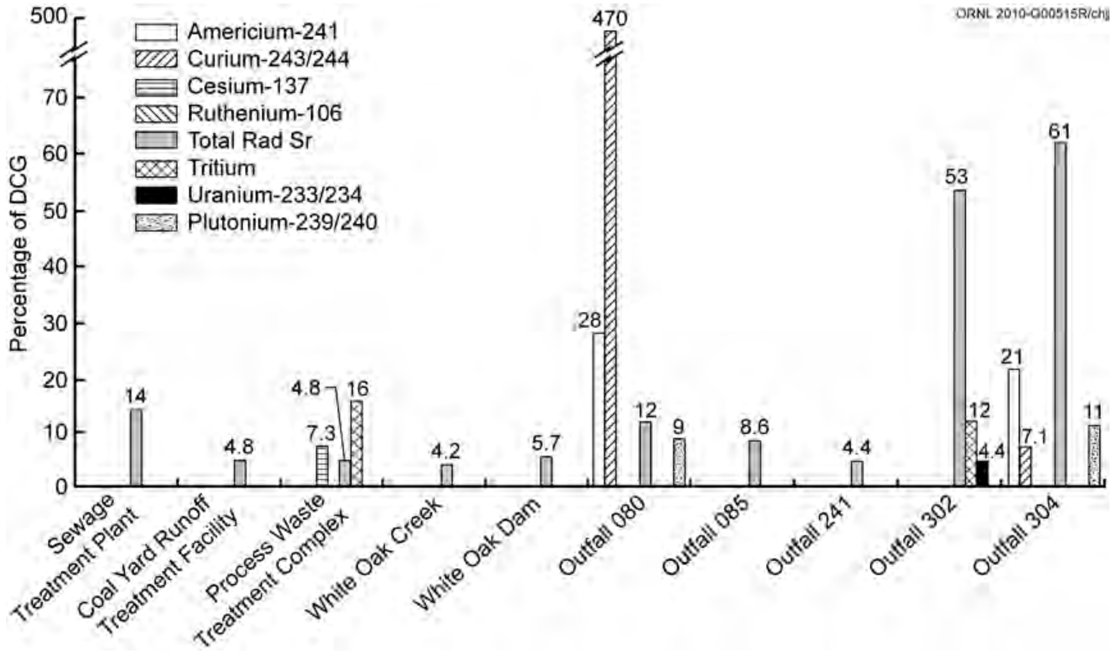

Fig. 5.19. Radionuclides at ORNL sampling sites having average concentrations greater than 4% of the relevant derived concentration guides in 2010.

concentrations were considerably higher, that although concentrations are greater than DCG levels, they are within the target human health risk range for the Record of Decision for Interim Actions in Melton Valley. Therefore no remediation actions are planned for Outfall 080.

During 2010, average radioactivity levels at Outfall 304 exceeded DCG levels on a sum-of-fractions basis (i.e., the annual average concentrations of all individual radiological parameters were below their respective DCG levels, but the summation of DCG percentages of the multiple radiological parameters added up to approximately 108%). The radiological parameters with the largest concentrations at Outfall 304 in terms of percent of their respective DCGs were ^{241}Am (21%), $^{243/244}$Cm (7.1%), ^{137}Cs (2.7%), ^{40}K (2.3%), $^{239/240}$Pu (11%), $^{89/90}$Sr (61%), and $^{233/234}$U (2.6%). A dye tracer test conducted in November 2010 at Process Waste Treatment Complex (Building 3544) identified a hydrologic connection via groundwater between the L-5 clearwell at the southeast corner of the facility and Outfall 304. It was determined that water was leaking from the north cell of the L-5 clearwell to the south cell, which was taken out of service several years prior because of a leak. Repairs were made to the L-5 clearwell in early 2011 to stop the leak between the north and south cells. Levels of radioactivity at Outfall 304 following the repair appear to be decreasing and are expected to return to normal over time.

The dye tracer test of the Building 3544 L-5 clearwell also revealed that some of the leaked water was finding its way into the pipe network leading to Outfall 302. Though concentrations of radioactivity were also elevated at Outfall 302 in 2010, they remained below DCG levels on an annual average basis. Flow rates from both Outfalls 302 and 304 were low enough in comparison to the receiving stream flow rate that significant changes in concentrations of radioactivity were not observed at downstream monitoring stations during the period of the release.

The total annual discharges (or amounts) of radioactivity measured in stream water at WOD, the final monitoring point on WOC before the stream flow leaves ORNL, were calculated from concentration and flow. Results of those calculations for each of the past 5 years are shown in Figs. 5.20 through 5.24. CY 2010 discharges of radioactivity at WOD continue to be generally decreased in comparison to years preceding completion of the waste area caps in Melton Valley. Because discharges of radioactivity are somewhat correlated to stream flow, annual flow volumes measured at the WOD monitoring station are given in Fig. 5.25.

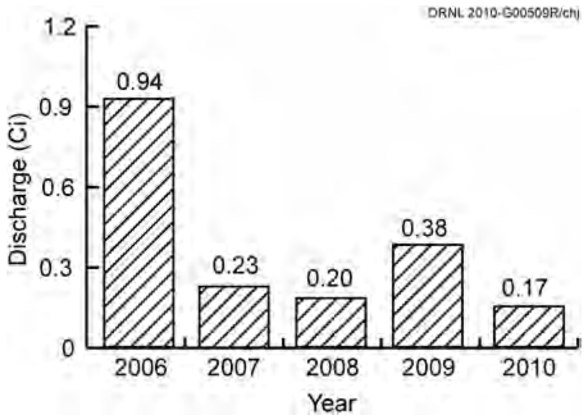

Fig. 5.20. Cesium-137 discharges at White Oak Dam, 2006–2010.

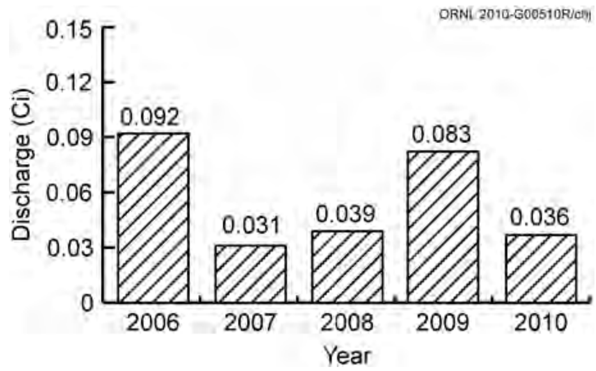

Fig. 5.21. Gross alpha discharges at White Oak Dam, 2006–2010.

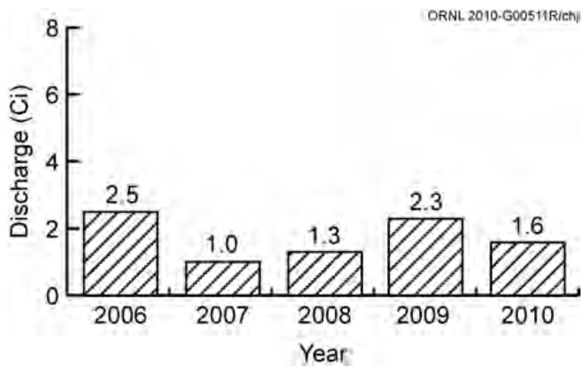

Fig 5.22. Gross beta discharges at White Oak Dam, 2006–2010.

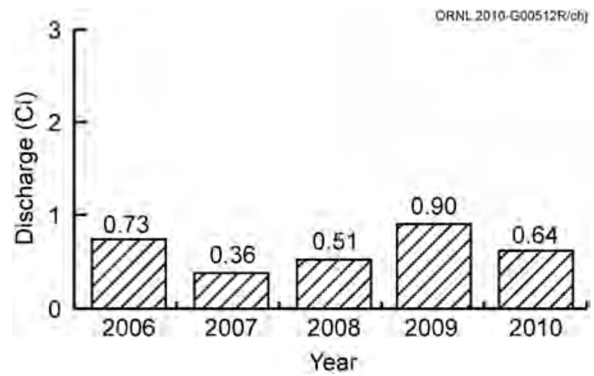

Fig. 5.23. Total radioactive strontium discharges at White Oak Dam, 2006–2010.

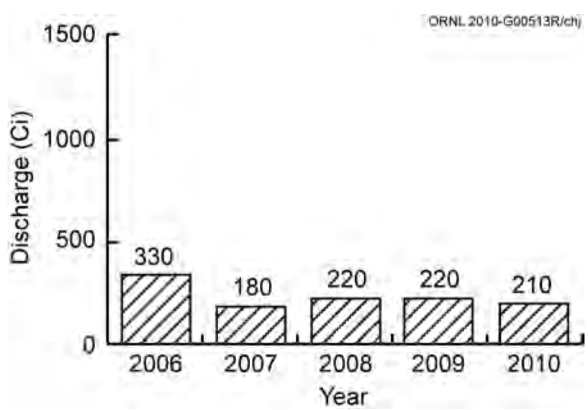

Fig 5.24. Tritium discharges at White Oak Dam, 2006–2010.

5.5.5 Mercury in the WOC Watershed

Legacy mercury environmental contamination exists at ORNL, due largely to spills and releases that occurred in the 1950s during isotope separation pilot-scale work in Buildings 3503, 3592, 4501, and 4505. As a result, mercury is present in soils and groundwater in and around these four facilities. Mercury also is present in Fifth Creek and White Oak Creek surface streams that receive surface runoff and groundwater flow from the area of these buildings.

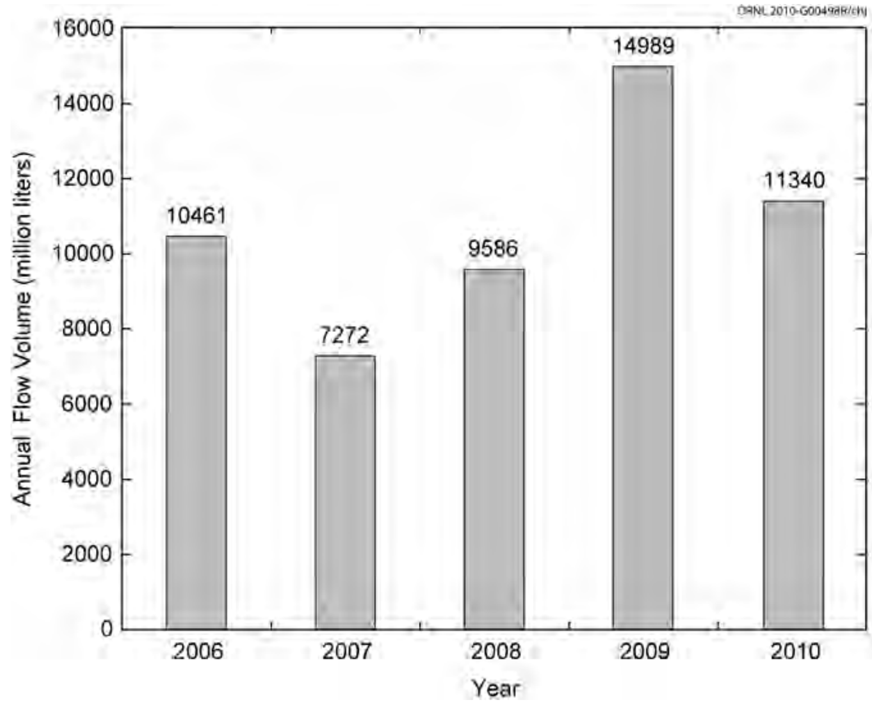

Fig. 5.25. Annual Flow Volume at White Oak Dam, 2006–2010.

Process wastewater drains and building sumps from Buildings 4501 and 4505, the facilities where most of the ORNL mercury work was conducted, are routed via underground collection-system piping to the ORNL PWTC for treatment to remove constituents including mercury prior to discharge to White Oak Creek. In 2007, another groundwater sump in Building 4501 that had accumulated legacy mercury contamination from building foundation drains was rerouted from storm drain Outfall 211 to the PWTC, and in 2009 a mercury pretreatment unit was installed in Building 4501 to remove most of the mercury from the sump discharge prior to routing to the PWTC for final treatment. These recent actions have significantly diminished the release of legacy mercury contamination from the ORNL site to the White Oak Creek watershed (Fig. 5.26).

For the mercury-investigation component of the WQPP, data collected during initial monitoring indicates effluent sampling at additional outfalls and instream reaches needs to be incorporated in future WQPP revisions to help prioritize future abatement actions and to delineate mercury sources

In 2010, monitoring conducted under the WQPP included wet-weather (storm event) sampling at a number of instream points in the White Oak Creek watershed upstream, within, and downstream from ORNL and ORNL NPDES outfalls where previous monitoring or site history has shown the potential for effluent mercury. Flow measurements were made for instream and outfall sampling locations. Concentration and flux values were measured and calculated. Selected results of the 2010 monitoring are shown in Figs. 5.27 and 5.28, and complete mercury monitoring results can be found in the 2010 Environmental Monitoring Results (DOE 2010b).

Monitoring results for 2009 indicated that Tennessee mercury criteria were met at all instream locations with a few stream reaches showing higher concentrations and/or fluxes than the others including Outfall 211 and the area downstream in White Oak Creek; a particular reach of Fifth Creek; and White Oak Creek downstream of the confluence with Fifth Creek. Wet-weather monitoring conducted in 2010 indicates that stormwater runoff in these areas contributes to the releases of mercury from the ORNL site.

In 2010 underground storm drain piping that discharges to Outfall 211 was investigated using remote-control mobile television cameras and resulted in visual evidence of mercury residues within the pipe, and evaluations of potential remedial activities were initiated.

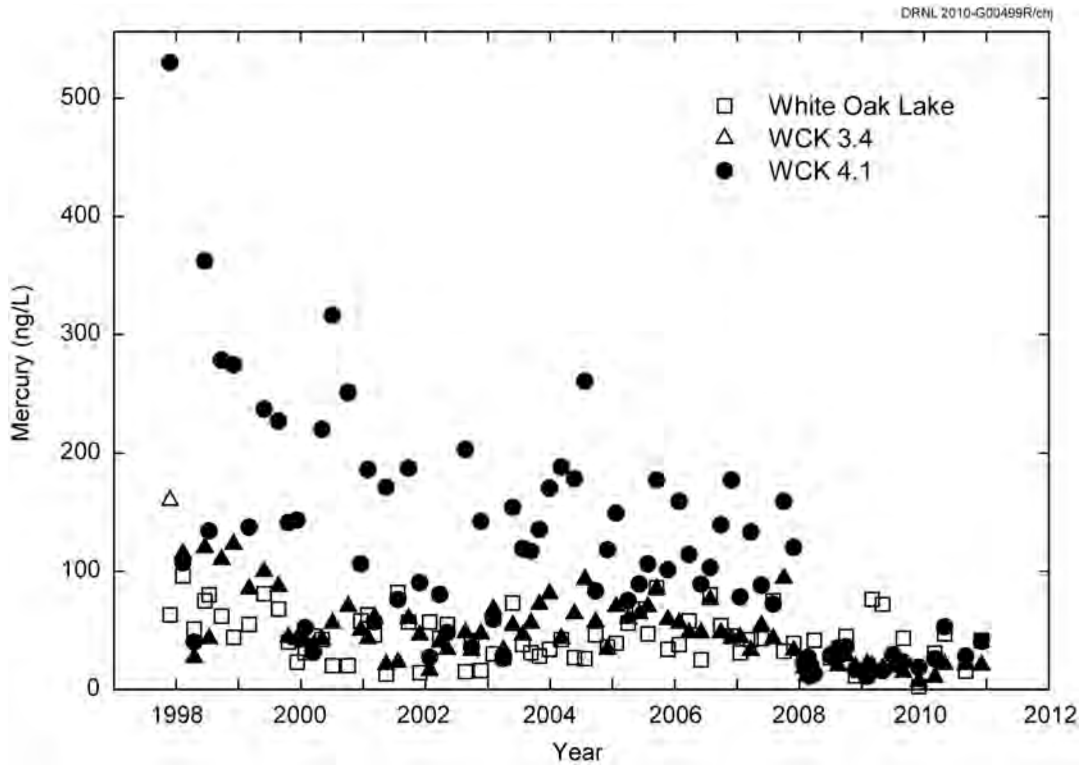

Fig. 5.26. Total aqueous mercury concentrations at sites in White Oak Creek downstream from ORNL, 1998–2010.

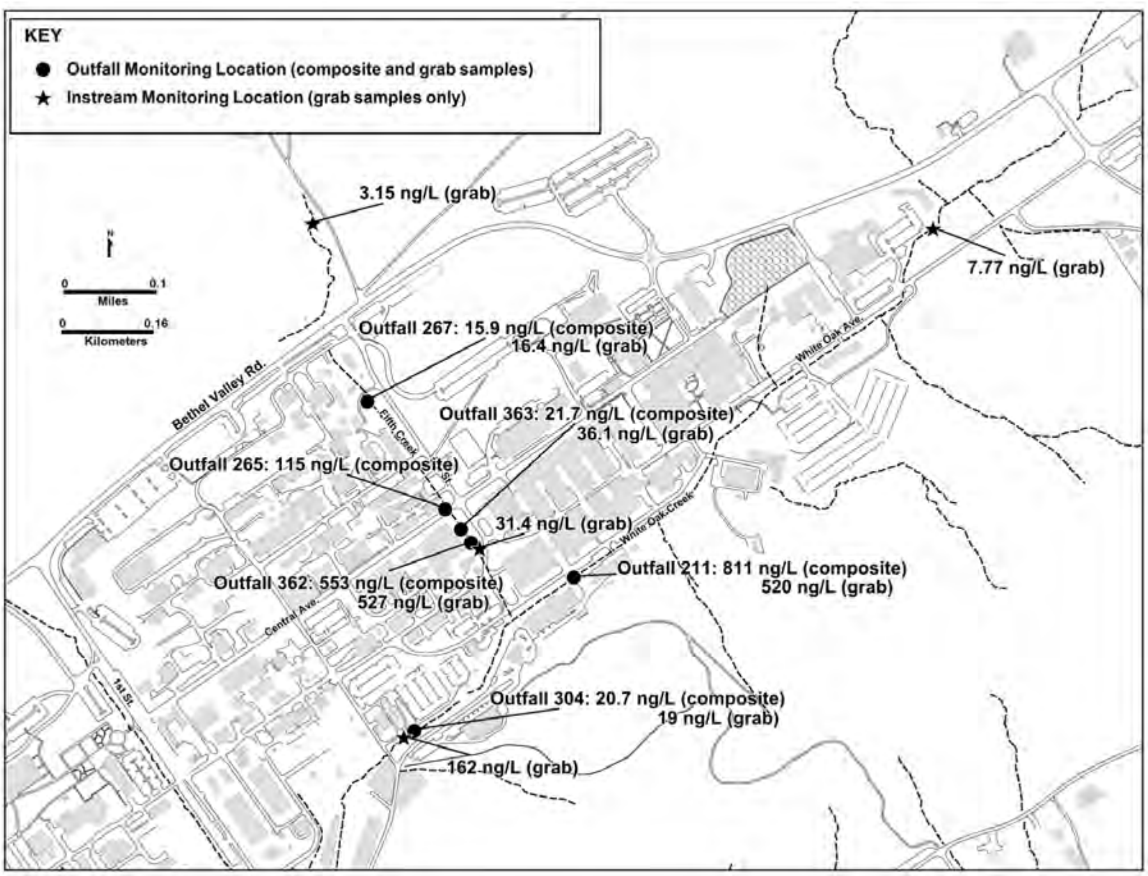

Fig. 5.27. Total mercury concentrations measured in storm water, November 15, 2010.

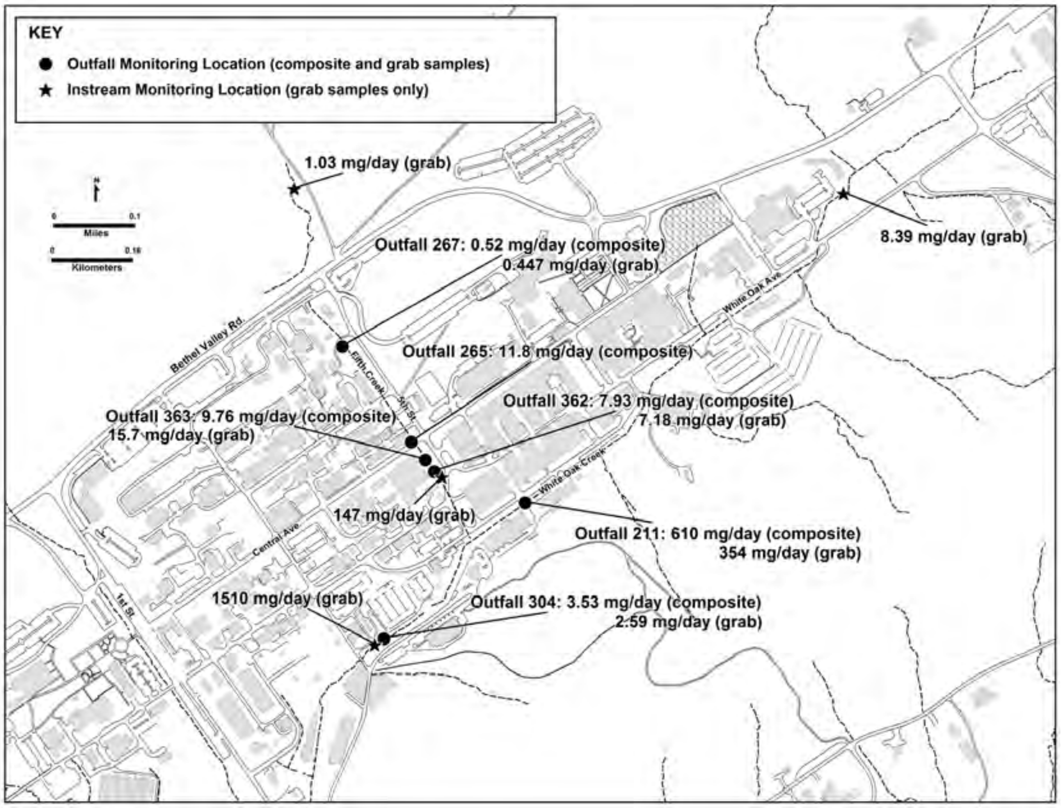

Fig. 5.28. Total mercury fluxes measured in storm water, November 15, 2010.

In 2011, WQPP mercury investigative efforts will focus on areas of interest that were identified from 2010 monitoring activities (e.g., the two stream reaches that indicate unexplained mercury flux increases). A subset of the 2009 characterization-monitoring protocol will also be conducted in 2011, to maintain ongoing data on the presence of mercury in the White Oak Creek watershed.

5.5.6 Water Quality Assessment of Selected Stream Reaches in the ORNL Main Campus Area

In 2010, monitoring was conducted under the ORNL WQPP to characterize water quality in the stream reaches of Fifth Creek, First Creek (FCK) and White Oak Creek that are in the heavily developed central-campus region of the ORNL complex. These characterizations were performed by monitoring water quality at instream locations bounding the selected study reaches while concurrently monitoring the most significant outfalls discharging to those reaches. Monitoring was performed in dry-weather (baseflow) conditions at seven instream locations and ten outfalls (Fig. 5.29) and in wet-weather (storm runoff) conditions at four instream locations and six outfalls (Fig. 5.30). The primary objective of this monitoring was to support one of the overall objectives of the WQPP: to discover the reasons for biological community impairment and to ultimately eliminate or reduce those impairments.

Samples of solids (suspended and dissolved), metals (total and dissolved), and nutrients (total phosphorus, Kjeldahl nitrogen, nitrate+nitrite nitrogen, and ammonia) were collected and submitted for laboratory analysis, using 24-hr time-proportional compositing for assessing dry-weather conditions and a combination of flow proportional compositing and grab (first flush) sampling during wet-weather conditions at instream locations and outfalls, respectively. Field measurements (conductivity, dissolved oxygen, flow, pH, temperature, and turbidity) were conducted on grab samples. Results are presented in the *2010 Environmental Monitoring Results*. These results are being used to guide future efforts under the WQPP and, along with data from future sampling, will be useful in determining causes of biological community impairments in the WOC watershed. The data suggest that parameters warranting additional study under the WQPP are nutrients and metals.

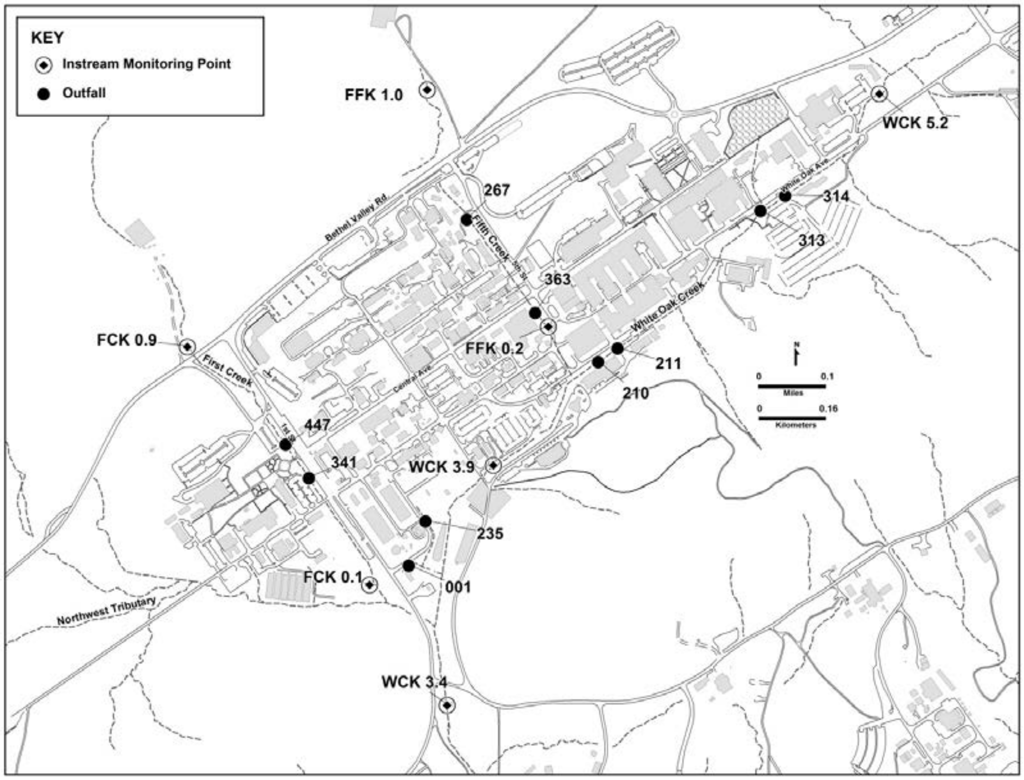

Fig. 5.29. In-stream locations and outfalls sampled for water quality parameters under the ORNL WQPP during dry-weather conditions.

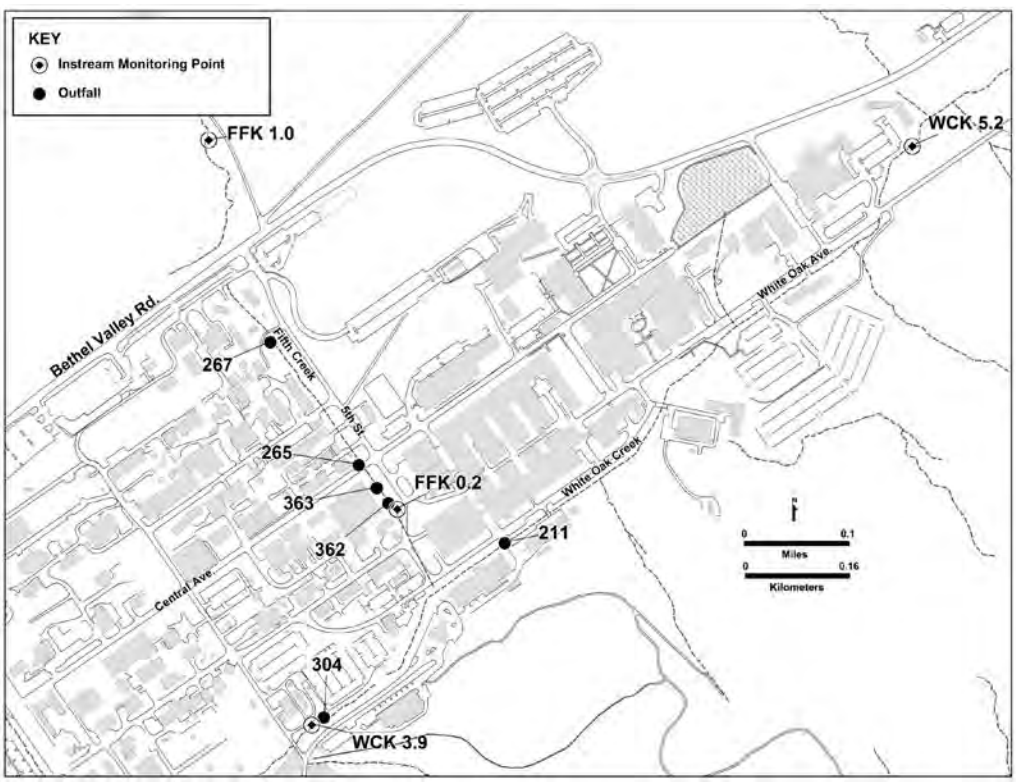

Fig 5.30. In-stream locations and outfalls sampled for water quality parameters under the ORNL WQPP during wet-weather conditions.

5.5.7 Stormwater Surveillances and Construction Activities

Figure 5.31 depicts the location of construction sites that were considered significant in 2010 because of the need to be covered under the General TN NPDES Permit for Construction Activities and/or an Aquatic Resource Alteration Permit or because they had a footprint of greater than 1 acre. (Construction areas that are part of CERCLA remediation follow substantive requirements of the appropriate water pollution control permits but are not required to obtain official permit coverage). Five of these sites were inspected in 2010 to evaluate overall effectiveness of the best management practices in use. In general, while some short-term impacts to receiving streams were noted, no long-term adverse impacts were observed.

NPDES outfall drainage areas were also inspected twice in 2010. Land use within drainage areas is typical of office/industrial settings with surface features including laboratories, support facilities, paved areas, and grassy lawns. Outdoor material storage is most prevalent in the 7000 Area on the east end of the main ORNL facility (where most of the craft and maintenance shops are located), with other smaller outdoor storage areas located throughout the facility in and around loading docks and material delivery areas at laboratory and office buildings. The types of materials stored outside include metal items (sheeting, pipes, and parts); equipment awaiting use, disposal, or repair; construction material; and deicer product. Flaking paint on some buildings (slated to be dismantled in the near future) also poses a potential mobile storm water pollutant source.

Some construction activities are performed by third-party contractors working as tenants under agreement with other local, state, and federal agencies on the DOE reservation. There are mechanisms in place for ensuring effective storm water controls at these third-party sites, one of which includes staff from UT-Battelle acting as points of contact for communication interface on environmental, spill/emergency response, and other key issues.

Certain instream and outfall locations identified under the WQPP were monitored in 2010 in storm conditions. A more detailed description of the WQPP wet-weather monitoring scenario can be found in Sect. 5.5.6.

5.5.8 Biological Monitoring

5.5.8.1 Bioaccumulation Studies

The bioaccumulation task for the BMAP addresses two NPDES permit requirements at ORNL: (1) evaluate whether mercury at the site is contributing to a stream at a level that will impact fish and aquatic life or violate the recreational criteria and (2) monitor the status of PCB contamination in fish tissue in the WOC watershed.

Mercury in Water. In continuation of a monitoring effort initiated in 1997, bimonthly water samples were collected from WOC at four sites in 2010. Stream conditions were selected to be representative of seasonal base-flow conditions (dry weather, clear flow) based on historical results that indicate higher mercury concentrations under these conditions.

The concentration of mercury in WOC upstream from ORNL was <5 ng/L in 2010. Long-term trends in waterborne mercury in the WOC system downstream of ORNL are shown in Fig. 5.26. Waterborne mercury downstream of ORNL declined abruptly in 2008 and remained low through 2010 as a result of rerouting highly contaminated sump water in Building 4501 to the PWTC in December 2007. The mean total mercury concentration at White Oak Creek kilometer (WCK) 4.1 was 36.7 ± 11.8 ng/L in 2010 compared with 108 ± 33 ng/L in 2007. The decrease was also apparent but less pronounced at WCK 3.4, with mercury averaging 18.2 ± 5.4 ng/L in 2010 versus 49 ± 23 ng/L in 2007. Although mercury concentrations at these two sites were significantly lower than levels in 2007, they were slightly higher than in 2009. A pretreatment system for the sump water started operation on October 22, 2009, and will remove almost of the mercury prior to sending the water to the PWTC. This system reduces the mercury concentration in the influent and effluent of the PWTC. Average aqueous mercury concentration at the White Oak Dam was 33.6 ± 13.9 ng/L in 2010, a level similar to results reported in recent years.

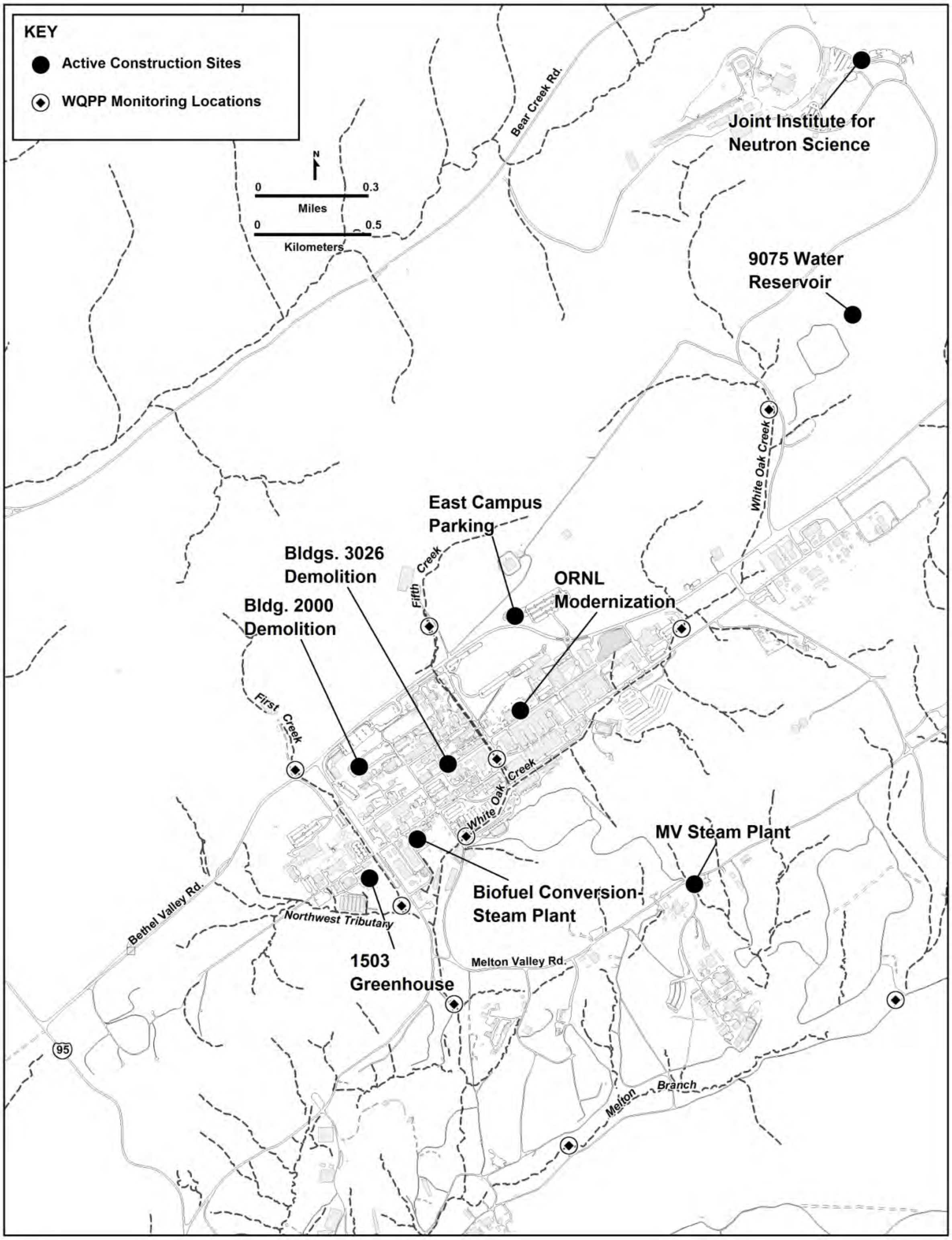

Fig. 5.31. Active construction sites and WQPP monitoring locations at ORNL, 2010.

Bioaccumulation in Fish. In WOC, mercury and PCB concentrations in fish have been at or near human health risk thresholds [e.g., EPA ambient water quality criteria (AWQC), TDEC fish advisory limits]. For the first time in over 10 years, mercury concentrations in redbreast sunfish fillets collected from WCK 2.9 were below the AWQC. Mean fillet concentrations at WCK 3.9 (a site sampled for the first time in 2007) decreased from 0.38 µg/g in 2009 to 0.23 µg/g in 2010, bringing the mean concentrations observed at this site well below the AWQC (Fig. 5.32). It is too early to determine if these decreases are due to natural interannual variation or actual responses to the lowered aqueous concentrations at these sites, but the fact that the decreases in fish tissue were more pronounced at upstream sites where the decreases in aqueous mercury concentrations were most evident suggests a causal response. Mercury concentrations in sunfish and bass collected from WCK 1.5 were within the range of values observed in recent years, although slightly higher in 2010.

Mean PCB concentrations in redbreast sunfish at WCK 3.9 and WCK 2.9 were comparable to recent years (0.40 and 0.32 µg/g, respectively). In contrast, mean PCB concentrations in bluegill from WCK 1.5 were substantially higher in 2010 (1.39 µg/g) than in previous years. The mean PCB concentrations in sunfish and bass collected from WCK 1.5 were both above TDEC’s fish advisory limit in 2010. (Fig. 5.33).

Benthic Macroinvertebrate Communities. Monitoring of benthic macroinvertebrate communities in WOC, First Creek, and Fifth Creek continued in 2010. Additionally, monitoring of the macroinvertebrate community in lower Melton Branch [Melton Branch kilometer (MEK) 0.6] continued under the DOE-EM Water Resources Restoration Program. Benthic macroinvertebrate samples are collected at sites upstream (reference sites) and downstream of the influence of ORNL operations; reference sites for WOC, First Creek, and Fifth Creek also are used as references for the Melton Branch site. The objectives of this activity are to (1) help assess ORNL’s compliance with the current NPDES permit requirements and (2) evaluate and verify the effectiveness of pollution abatement and remedial actions taken at ORNL.

The benthic macroinvertebrate communities in First Creek, Fifth Creek, and WOC downstream of effluent discharges have recovered significantly since 1987, but community characteristics indicate that ecological impairment remains (Figs. 5.34, 5.35, and 5.36). Relative to reference sites, the metrics total taxonomic richness (i.e., the mean number of different species per sample) and richness of the pollution-intolerant taxa (i.e., the mean number of mayfly, stonefly, and caddisfly per sample or *Ephemeroptera, Plecoptera*, and *Trichoptera* [EPT] richness) continue to be lower at sites adjacent to and downstream of the main ORNL campus. Reductions in metric values observed at Fifth Creek kilometer (FFK) 0.2 in 2008 persisted into 2010, indicating that an additional and persistent stress (or stresses) occurred after April 2007. Metric values at FCK 0.1 and WCK 3.9 continued to be within the range of values that have been observed at the sites for ≥10 years, while at WCK 2.3, metric levels were similar to those observed in 2007 when they achieved the highest levels observed since monitoring began in 1987. Since metric values for this site have exhibited extensive annual variation since 2002 compared with reference sites and other sites in WOC watershed, it is not known if the metric increases in 2010 are just a continuation of this pattern of annual change or a possible indication of further recovery. Macroinvertebrate community metrics for lower Melton Branch (MEK 0.6, Fig. 5.37) suggest that conditions at this site continue to be stable. The taxa richness metrics examined for this site continue to show no discernable evidence of degradation based on total and EPT richness. However, compared with reference sites, the combination of relatively high total density and relatively high densities of a few of the most pollution-tolerant species (e.g., Orthocladiinae midges and aquatic worms) and a few of the most tolerant of the EPT species (e.g., the caddisfly *Ochrotricia* and the stonefly *Amphinemura*) continue to suggest that nutrient (i.e., nitrogen and phosphorus) concentrations are possibly modestly elevated. Sources of nutrients in lower Melton Branch could either be from direct inputs (e.g., from effluent discharges or stormwater runoff from fertilized land) or indirect inputs (e.g., natural release from freshly disturbed soils).

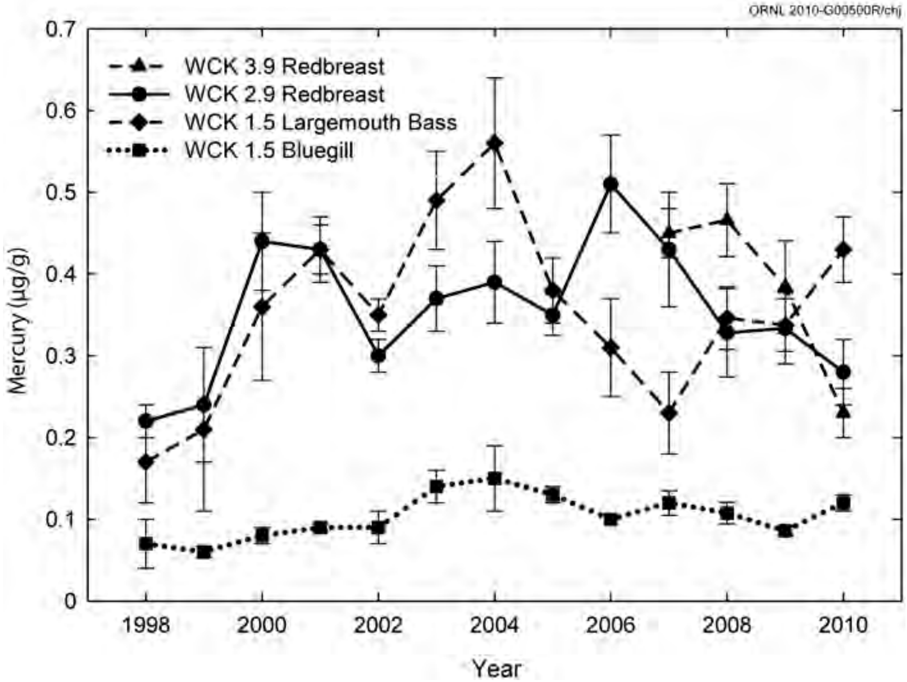

Fig. 5.32. Mean concentrations of mercury (µg/g, ± Standard Error, N = 6) in muscle tissue of sunfish and bass from WOC (WCK 3.9, WCK 2.9) and White Oak Lake (WCK 1.5), 1998–2010.

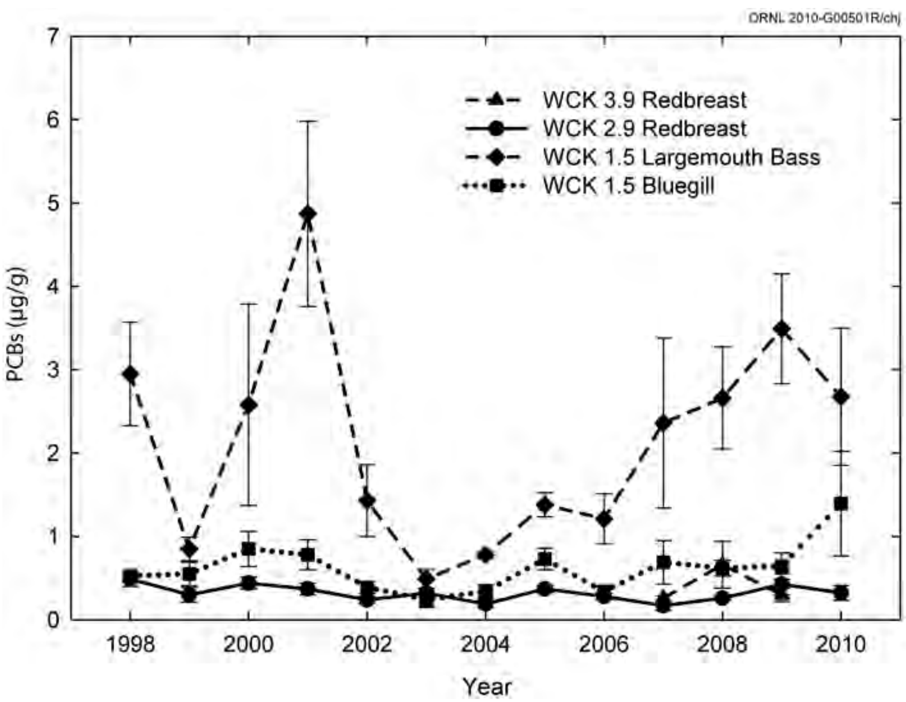

Fig. 5.33. Mean PCB concentrations (µg/g, ± Standard Error N = 6) in fish fillet collected from the WOC watershed, 1998–2010. WCK = WOC kilometer.

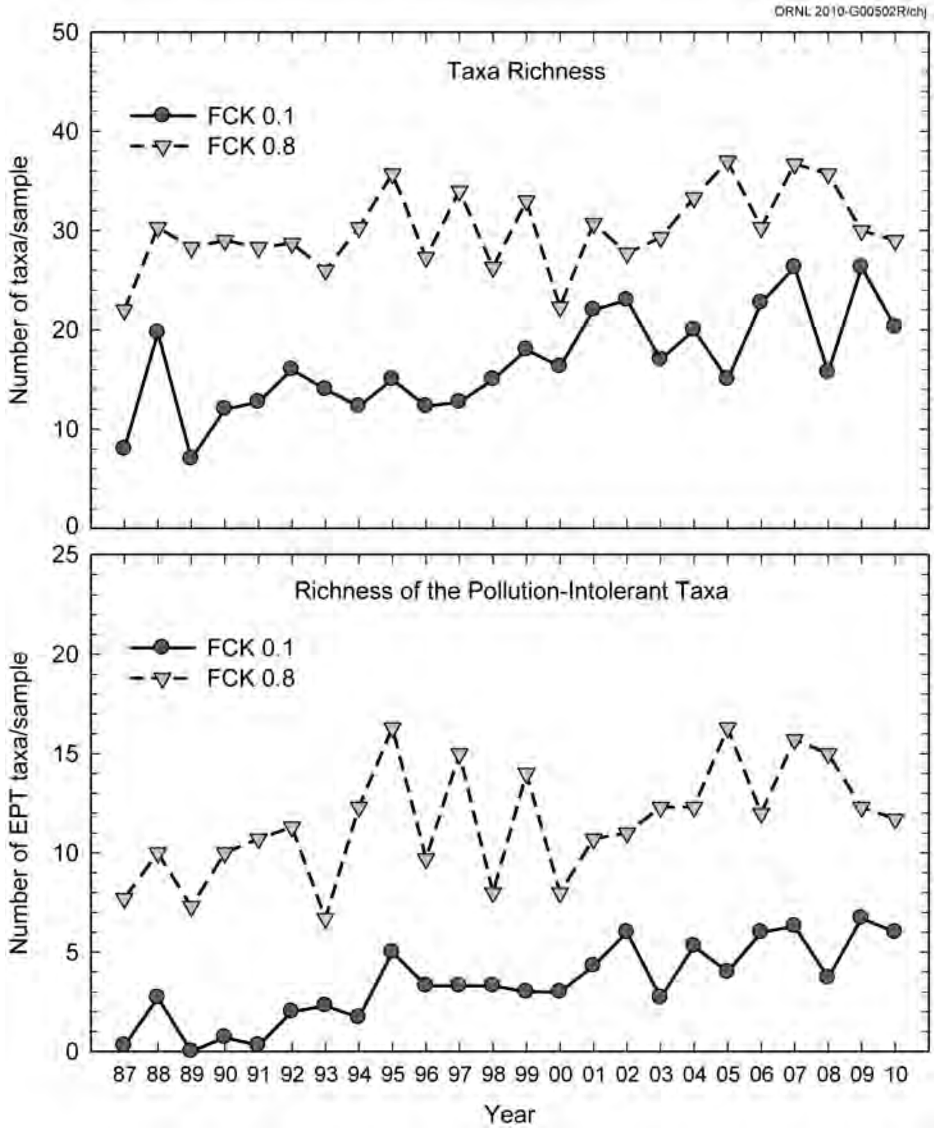

Fig. 5.34. Taxonomic richness (mean number of all taxa/sample) (top) and taxonomic richness of the *Ephemeroptera, Plecoptera,* and *Trichoptera* (mean number of EPT taxa/sample) (bottom) of the benthic macroinvertebrate community in First Creek, April sampling periods, 1987−2010. FCK = First Creek kilometer; EPT = Ephemeroptera, Plecoptera, and Trichoptera; FCK 0.8 = reference site.

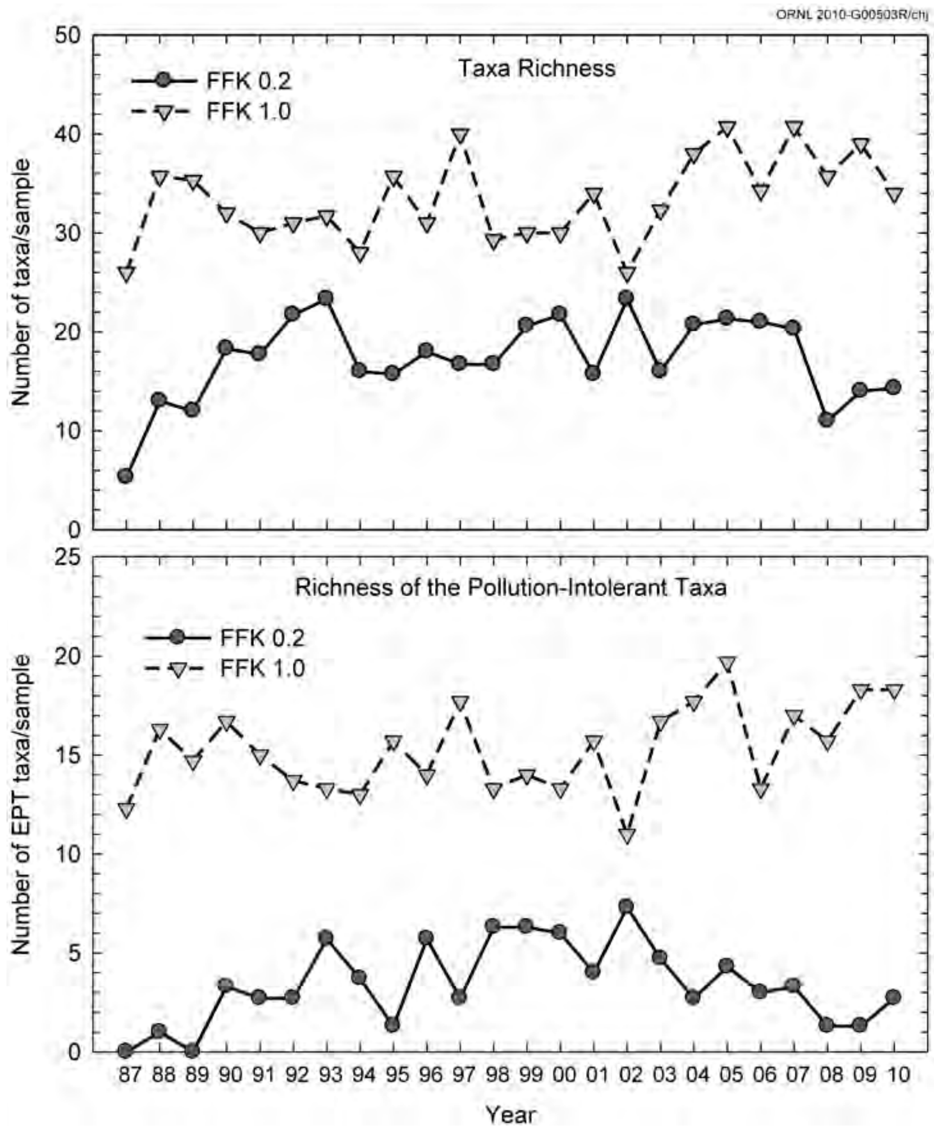

Fig. 5.35. Taxonomic richness (mean number of all taxa/sample) (top) and taxonomic richness of the *Ephemeroptera, Plecoptera,* and *Trichoptera* (mean number of EPT taxa/sample) (bottom) of the benthic macroinvertebrate community in Fifth Creek, April sampling periods, 1987−2010. FFK = Fifth Creek kilometer; EPT = Ephemeroptera, Plecoptera, and Trichoptera; FFK 1. 0 = reference site.

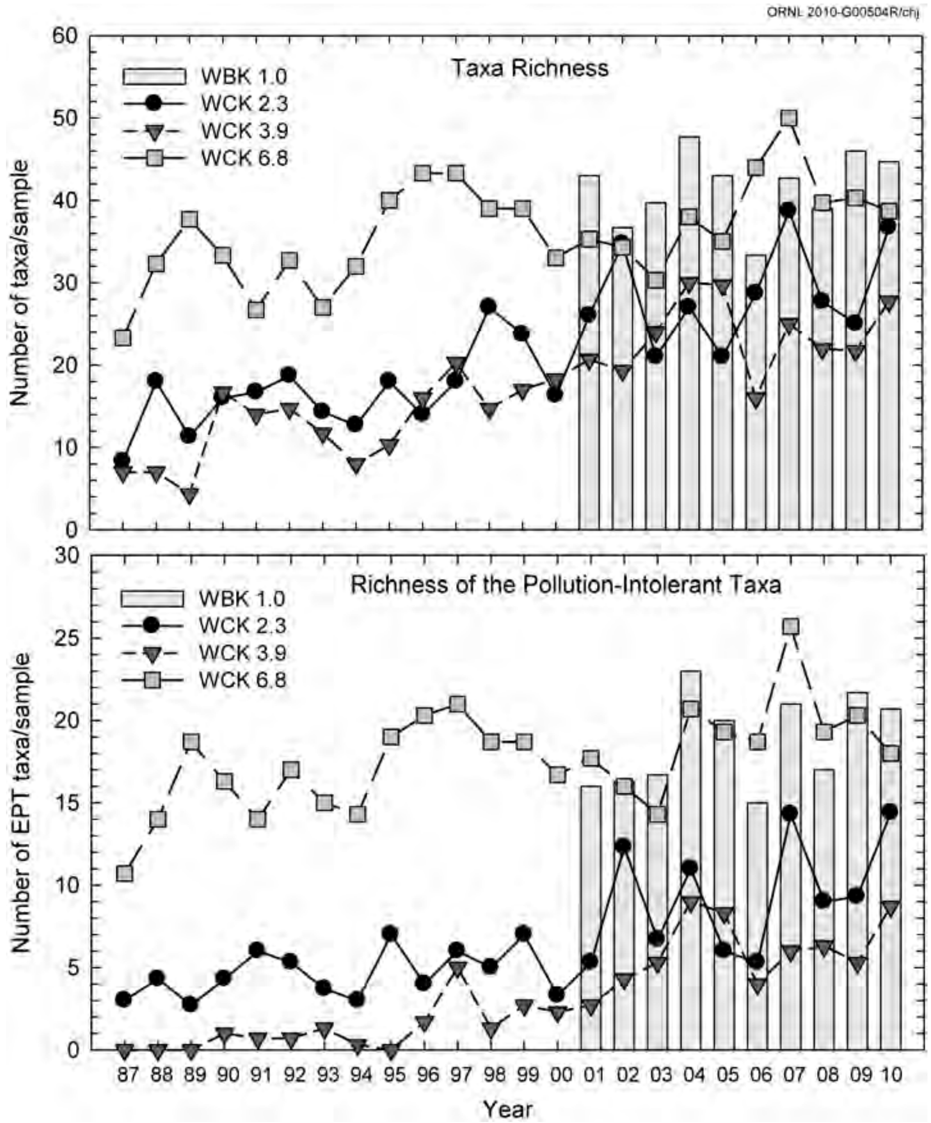

Fig. 5.36. Taxonomic richness (mean number of all taxa /sample) (top) and taxonomic richness of the *Ephemeroptera, Plecoptera*, and *Trichoptera* (mean number of EPT taxa/sample) (bottom) of the benthic macroinvertebrate communities in White Oak Creek, April sampling periods, 1987−2010. WCK = White Oak Creek kilometer; EWBK - Walker Branch kilometer; EPT = Ephemeroptera, Plecoptera, and Trichoptera; WBK 1.0 = reference site.

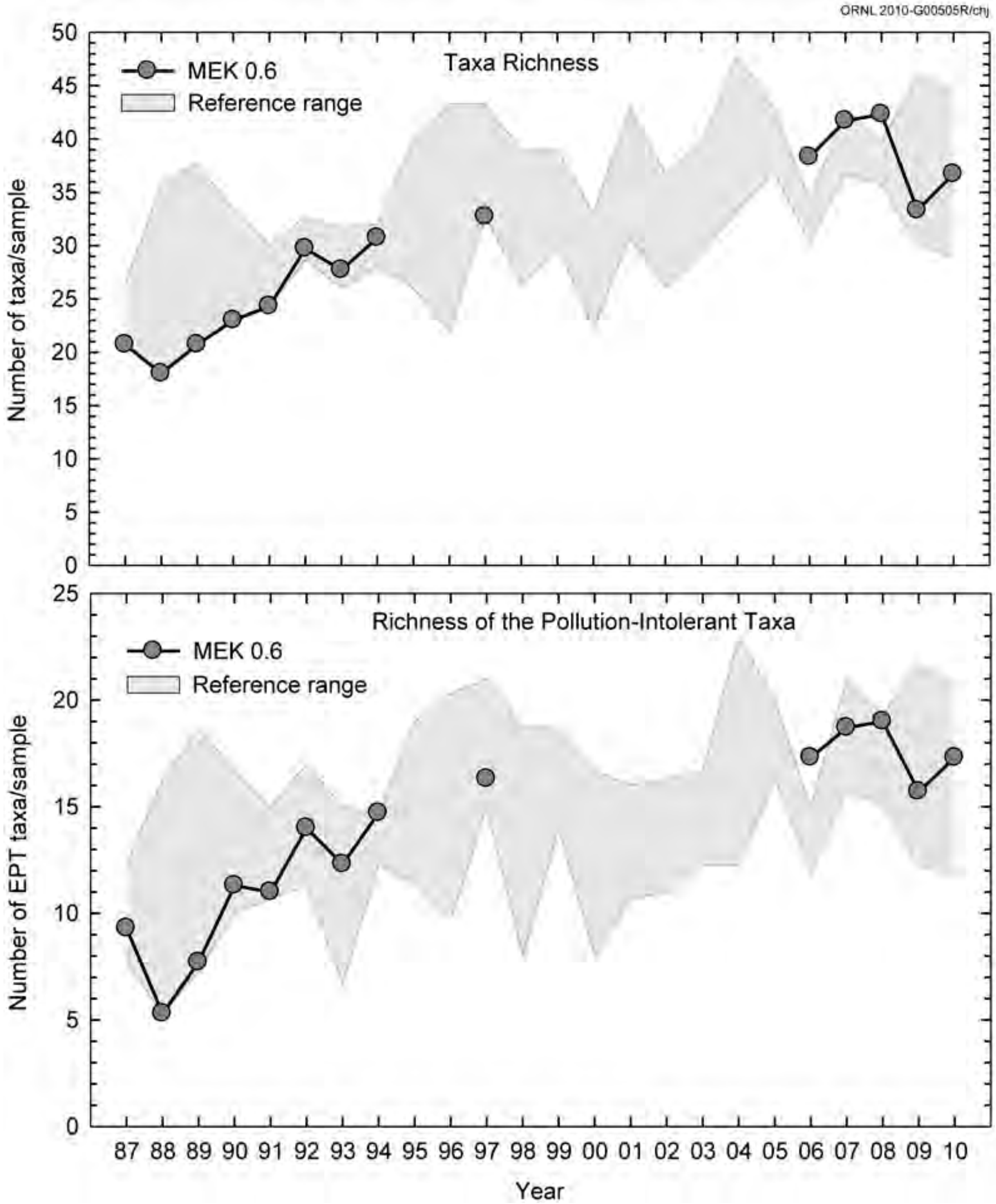

Fig. 5.37. Taxonomic richness (mean number of all taxa /sample) (top) and taxonomic richness of the *Ephemeroptera, Plecoptera*, and *Trichoptera* (mean number of EPT taxa/sample) (bottom) of the benthic macroinvertebrate communities in lower Melton Branch, April sampling periods, 1987−2010. MEK = Melton Branch kilometer; EPT = Ephemeroptera, Plecoptera, and Trichoptera; Reference range—minimum and maximum values for ORNL BMAP reference sites on upper Melton Branch (1987–1997), First Creek, Fifth Creek (1987–2010), Walker Branch (2001–2010), and White Oak Creek (1987–2000, 2007–2010).

5.5.8.2 Fish Communities

Monitoring fish communities in WOC and major tributaries continued in 2010. Fish samples were taken at 11 sites in the WOC watershed in the spring and fall. Streams located near or within the city of Oak Ridge were also sampled as reference sites: Mill Branch as a reference for smaller upstream locations within WOC and Brushy Fork as a reference for the larger downstream portions of WOC.

In WOC, the fish community continued to be degraded in 2010 compared with communities in reference streams, with sites closest to the outfalls having lower species richness (number of species), fewer pollution-sensitive species, more pollution-tolerant species, and elevated density (number of fish per square meter) compared with similar-sized reference streams. A project to introduce missing fish species into the watershed was initiated in 2008 by stocking five native species. Reproduction was noted for three of the species, and several species expanded their range beyond initial introduction sites. Increased richness was observed in most of WOC during 2010, with the highest ever values seen at WCK 2.3 and WCK 3.9. The initial success of the introductions in much of WOC suggests that overall water quality has improved in the watershed over the past 2 decades, and further sites were selected for introductions in 2011.

Generally, the fish communities in tributary sites adjacent to and downstream of ORNL outfalls remained impacted in 2010 relative to reference streams or upstream sites. Some recovery was seen in Fifth Creek where the fish community improved in fall sampling (Fig. 5.38).

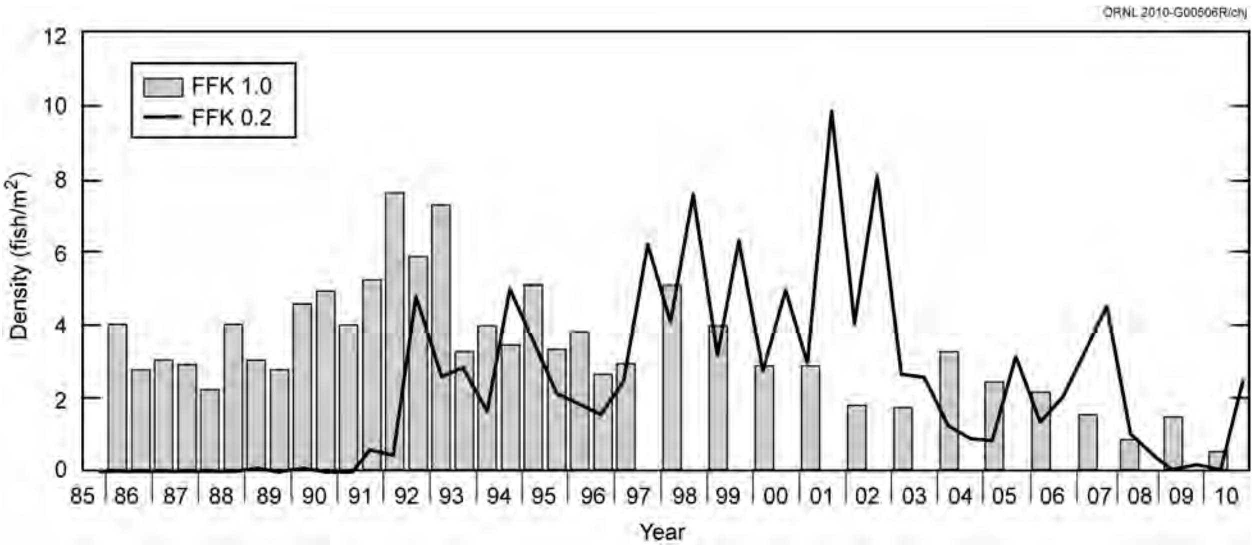

Fig. 5.38. Density estimates of fish communities in Fifth Creek, 1985–2010.

5.5.9 PCBs in the WOC Watershed

Past monitoring has shown that while PCBs are present in the watershed, they are not discharged from ORNL outfalls into the WOC watershed at levels detected by standard analytical methods. Largemouth bass collected from White Oak Lake continue to have tissue PCB concentrations higher than those recommended by TDEC and EPA for frequent consumption. While past monitoring efforts were instrumental in establishing a baseline for PCBs, the focus has historically been on relating PCB levels in fish to safe levels for consumption. These studies were not designed to identify specific stream reaches or sources contributing to PCB bioaccumulation.

The mobility of the fish populations used in traditional bioaccumulation monitoring studies precludes the possibility of source identification. Therefore, the source identification task involved the use of semipermeable membrane devices (SPMDs) to assess the chronic, low-level sources of PCBs at critical sites on the reservation. SPMDs are thin, plastic sleeves filled with oil in which PCBs are soluble.

Because SPMDs remain submerged at a given site for 4 weeks and have a high affinity for PCBs, a time-integrated, semi-quantitative index of the mean PCB concentration in the overlying water during the deployment period is provided. SPMDs also have advantages over “snapshot” water concentration analyses. The long deployment period enables the distinction between the relative PCB inputs at sites whose aqueous PCB concentrations are below detection limits in water.

In 2010, ORNL’s PCB monitoring continued the identification of the stream reaches in the WOC watershed where PCB sources are likely to contribute to bioaccumulation in fish. The key integration points and reference sites within the watershed that were identified and monitored in 2009 were resampled to assess bioaccumulation potential.

The SPMD results in this study provide information on the relative contributions of various stream reaches within the ORNL campus (Fig. 5.39). The 2010 results confirm the 2009 results which show the influence of ORNL activities. SPMDs deployed at reference sites upstream and downstream of the plant had background levels of PCBs, while all sites within the plant were above background levels. The highest levels, which were observed in First Creek, were confirmed in 2010, indicating that this creek may be critical in introducing PCBs to White Oak Creek (Table 5.19).

In 2010, the PCB source evaluation was narrowed to better understand PCB sources in First Creek. In addition to SPMDs, clams were deployed in selected sites in and downstream of First Creek (Fig. 5.40). Clams feed on plankton and other fine particles and provide a relative measure of the total PCB levels in these sites, whereas SPMDs provide a relative measure of dissolved PCBs. The results from this study indicate that the central reach of First Creek is where PCBs are most available for bioaccumulation (Table 5.20).

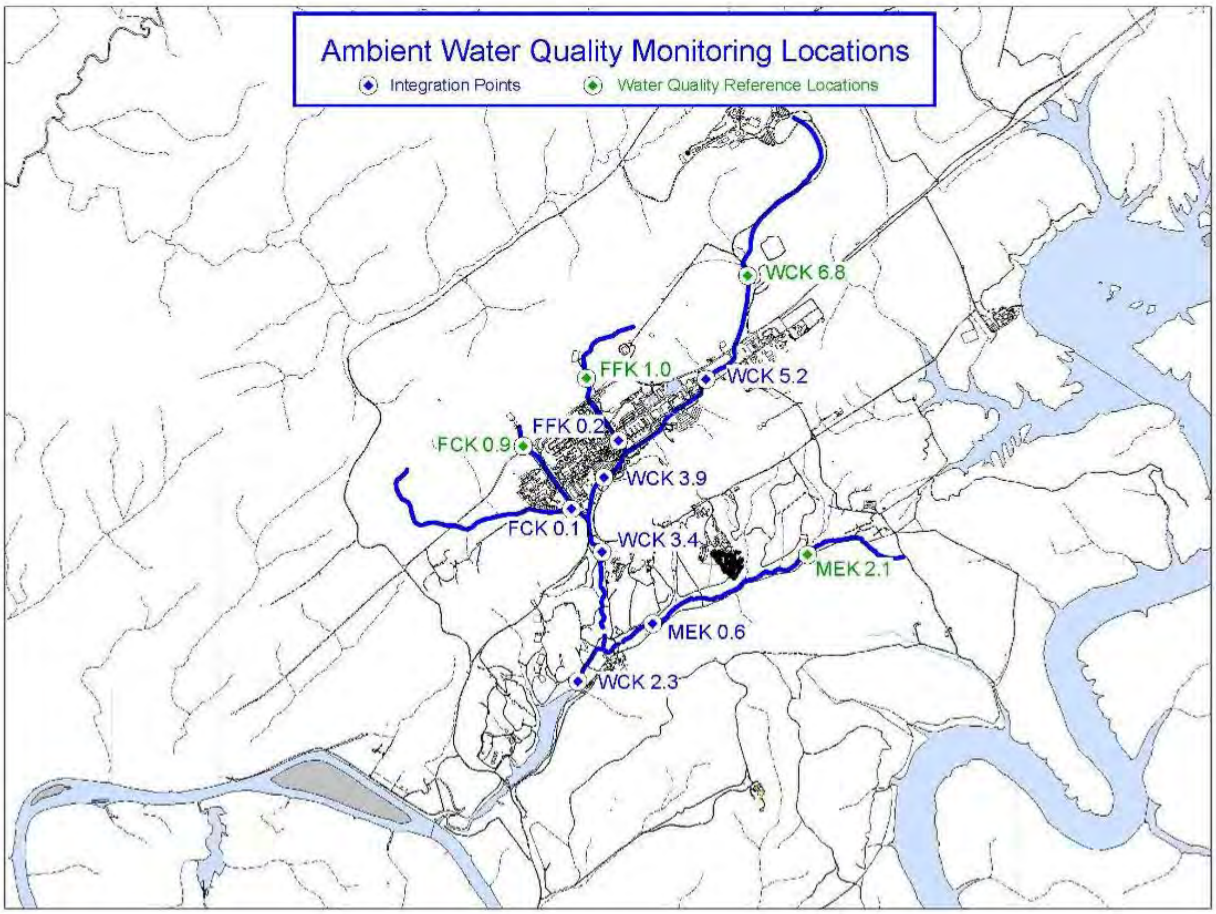

Fig. 5.39. Locations of ambient water quality monitoring integration points and reference locations at ORNL.

Table 5.19. PCB concentrations in semipermeable membrane devices at monitoring locations in the White Oak Creek watershed

Samples recovered in April 2010, after 4 weeks

ORNL stream	Location name	Location type	Total PCBs (ppm)
White Oak Creek	WCK 5.2	Integration point	Sample lost
White Oak Creek	WCK 3.9	Integration point	2350
White Oak Creek	WCK 3.4	Integration point	5800
White Oak Creek	WCK 2.3	Integration point	940
White Oak Creek	WCK 4.1	Integration point	3900
First Creek	FCK 0.1	Integration point	24000
Fifth Creek	FFK 0.2	Integration point	1510
Melton Branch	MEK 0.6	Integration point	87
White Oak Creek	WCK 6.8	Reference site	59
Fifth Creek	FFK 1.0	Reference site	58
First Creek	FCK 0.9	Reference site	82
Melton Branch	MEK 2.1	Reference site	59

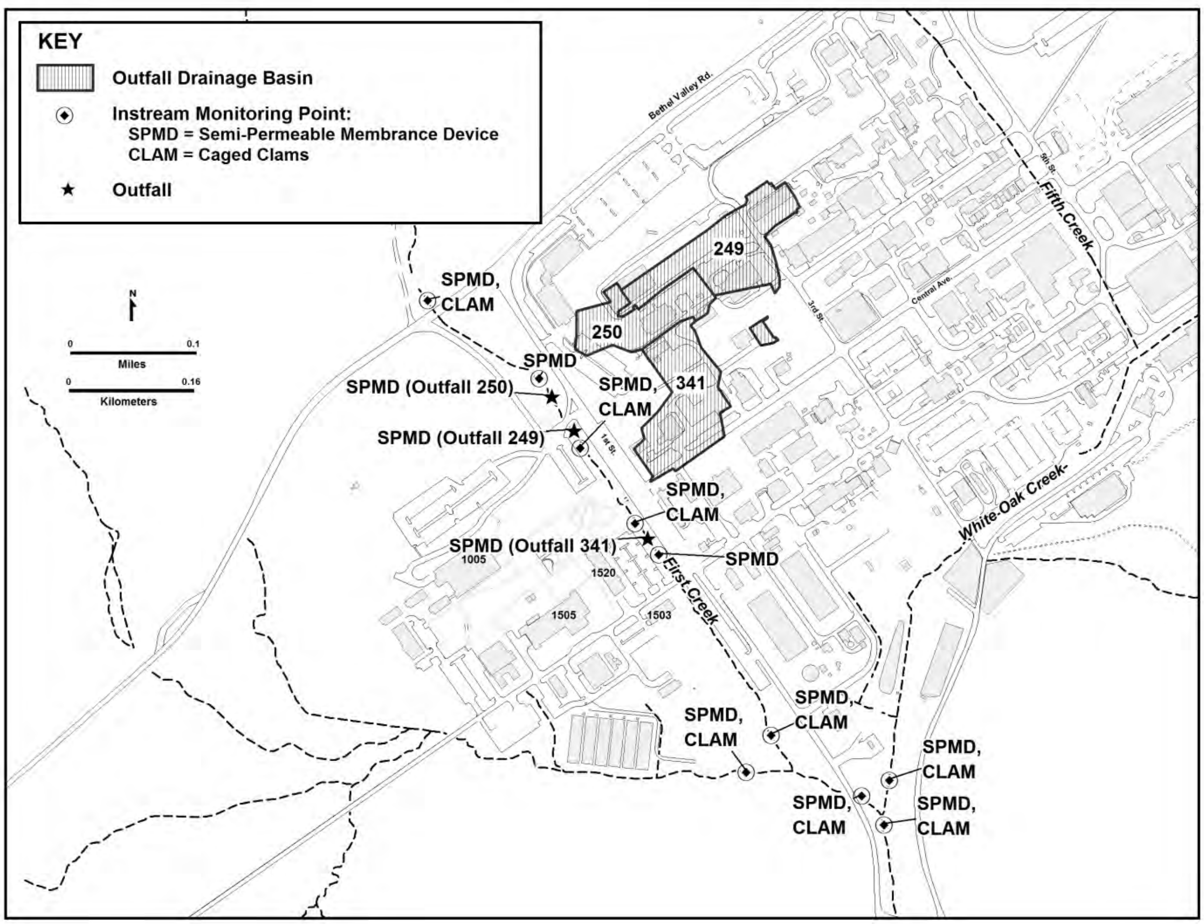

Fig. 5.40. Locations of monitoring points for First Creek source investigation.

Table 5.20. First Creek PCB source assessment June 2010
Total PCBs (parts per billion)

Location Name	Location Type	SPMD	Clams
FCK 0.9	Reference site	69	9.4
Upstream Outfall 250	Instream	400	
Outfall 250	End of Pipe	14100	
Outfall 249	End of Pipe	364	
Downstream Outfall 249	Instream	8200	192.5
Upstream Outfall 341	Instream	26540	1945
Outfall 341	End of Pipe	3200	
Downstream Oufall 341	Instream	17700	
FCK 0.1	Instream	11480	2550
Northwest Tributary upstream of confluence with First Creek	Reference site	71	189.5
Northwest Tributary downstream of confluence with First Creek	Instream	5180	1285
White Oak Creek downstream of confluence with Northwest Tributary	Instream	1980	189.5
White Oak Creek upstream confluence with Northwest Tributary	Instream	1520	163.5

5.5.10 Oil Pollution Prevention

Section 311 of the CWA regulates the discharge of oils or petroleum products to waters of the United States and requires the development and implementation of spill prevention, control, and countermeasures (SPCC) plans to minimize the potential for oil discharges. Each facility on the ORR implements a site-specific SPCC plan. The NTRC, which is located off the ORR, also has a SPCC plan covering the oil inventory at its location. There were no regulatory or permitting actions related to oil pollution prevention at ORNL in 2010. In 2011, ORNL will be implementing new SPCC training requirements that are required to be in place by November 2011.

5.5.11 Surface Water Surveillance Monitoring

The ORNL surface water monitoring program includes sample collection and analysis from 12 locations at ORNL and around the ORR. This program is conducted in conjunction with the ORR surface water monitoring activities discussed in Sect. 6.4 to enable assessing the impacts of past and current DOE operations on the quality of local surface water. Sampling locations include streams downstream of ORNL waste sources and reference points on streams and reservoirs upstream of waste sources (Fig. 5.41).

Sampling frequency and parameters vary by site. Grab samples are collected and analyzed for general water quality parameters and are screened for radioactivity at all locations. Samples are further analyzed for specific radionuclides when general screening levels are exceeded. Samples from White Oak Lake at WOD are also checked for volatile organic compounds (VOCs), PCBs, and metals. Table 5.21 lists sampling locations, frequencies, and parameters.

Four of the 12 sampling locations are classified by the state of Tennessee for freshwater fish and aquatic life. Tennessee water quality criteria associated with these classifications are used as references where applicable. The Tennessee water quality criteria do not include criteria for radionuclides. Four percent of the DOE DCG is used for radionuclide comparison because this value is roughly equivalent to the 4-mrem dose limit from ingestion of drinking water on which the EPA radionuclide drinking water standards are based.

For comparison purposes, the ORR upstream reference site (CRK 66) can be compared with results from this program as applicable (Sect. 6.4.1).

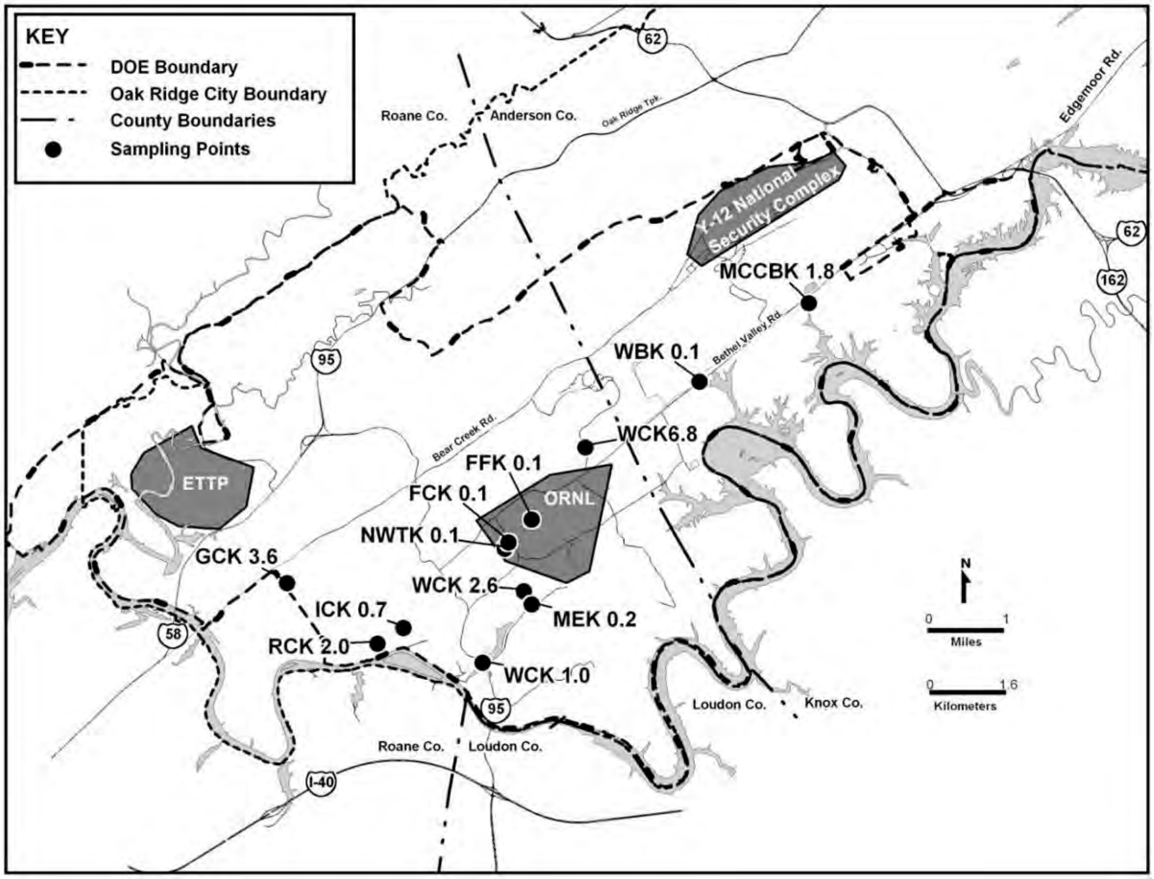

Fig. 5.41. ORNL surface water sampling locations.

Table 5.21. ORNL surface water sampling locations, frequencies, and parameters, 2010

Location[a]	Description	Frequency	Parameters[b]
MEK 0.2	Melton Branch downstream from ORNL	Bimonthly (Jan., March, May, July, Sept., Nov.)	Gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements
WCK 1.0	White Oak Lake at White Oak Dam	Monthly	Volatiles, metals, PCBs, gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements
WCK 2.6	White Oak Creek (WOC) downstream from ORNL	Bimonthly (Jan., March, May, July, Sept., Nov.)	Gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, field measurements
WCK 6.8	WOC upstream from ORNL	Quarterly (Feb., May, Aug., Nov.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
WBK 0.1	Walker Branch prior to entering CRK 53.4	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements
GCK 3.6	Grassy Creek upstream of SEG and IT Corp. at CRK 23	Semiannually (April, Oct.)	Lead, gross alpha, gross beta, gamma scan, field measurements
ICK 0.7	Ish Creek prior to entering CRK 30.8	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements

Table 5.21 (continued)

Location[a]	Description	Frequency	Parameters
MCCBK 1.8	McCoy Branch prior to entering CRK 60.3	Semiannually (April, Oct.)	Gross alpha, gross beta, gamma scan, field measurements
RCK 2.0	Raccoon Creek sampling station prior to entering CRK 31	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
NWTK 0.1	Northwest Tributary prior to the confluence with First Creek	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
FCK 0.1	First Creek prior to the confluence with Northwest Tributary	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements
FFK 0.1	Fifth Creek just upstream of WOC (ORNL)	Semiannually (April, Oct.)	Gross alpha, gross beta, total radioactive strontium, gamma scan, tritium, field measurements

[a]Locations identify bodies of water and locations on them (e.g., WCK 1.0 km upstream from the confluence of White Oak Lake and the Clinch River).

FCK	First Creek kilometer
FFK	Fifth Creek kilometer
GCK	Grassy Creek kilometer
ICK	Ish Creek kilometer
MCCBK	McCoy Branch kilometer
MEK	Melton Branch kilometer
NWTK	Northwest Tributary kilometer
RCK	Raccoon Creek kilometer
WBK	Walker Branch kilometer
WCK	White Oak Creek (WOC) kilometer

[b]Field measurements consist of dissolved oxygen, pH, and temperature.

Radionuclides were detected above MDAs at most of the 12 surface water locations in 2010; the locations with no detected radionuclides were Ish Creek (ICK 0.7) and Walker Branch (WBK 0.1).

The locations with the highest radionuclide levels are in the ORNL main plant area or at locations downstream of the main plant. These locations are near or downstream of CERCLA sites. Over the past few years, several remedial actions have been completed within the main plant area, which have resulted in observed decreases in radionuclide concentrations in surface water samples as compared to concentrations observed in mid-1990s. During 2009 and 2010 ^{90}Sr discharges from Bethel Valley increased because of increased discharges of contaminated groundwater from the Core Hole 8 plume to First Creek. During FY 2011 the EM program started a project to improve groundwater capture and refurbish the existing plume collection system. Future remedial actions in contaminated soil areas are planned, and until completion, little change in surface water contaminant conditions is expected. The results from 2010 sampling at these locations are consistent with historical data and with the processes or legacy activities nearby or upstream from these locations. Volatile organic compounds continue to be detected at WOC at WOD; toluene and chloroform were detected at estimated levels during most sampling events. Sampling locations west, southwest of ORNL [Raccoon Creek (RCK 2.0), Grassy Creek (GCK 3.6), and Ish Creek (ICK 0.7)] are impacted by contaminated groundwater from SWSA 3. Raccoon Creek sampling results continue to demonstrate seasonal variability. Grassy Creek and Ish Creek had fewer detected radionuclides than in previous years, which may be a result of remedial actions in SWSA 3. Remediation activities at the SWSA 3 Area including Contractor's Landfill and the Closed Scrap Metal Area (CSMA) started in FY 2010 and should be completed in summer 2011. SWSA 3 and the CSMA are getting a RCRA cap with drainage for diversion of surface water away from the cap, while the contractor's landfill received 2 ft of soil cover (this portion was completed in November 2010).

5.5.12 Sediment Monitoring

Stream and lake sediments act as a record of some aspects of water quality by concentrating and storing certain contaminants. Sampling sites for sediment are the Clinch River downstream from all DOE inputs (CRK 16), the Clinch River downstream from ORNL (CRK 32), and the Clinch River at the Solway Bridge, upstream from all DOE inputs (CRK 70) (Fig. 5.42). The locations are sampled annually, and gamma scans are performed on the samples.

In addition, each year, two samples containing settleable solids are collected in conjunction with a heavy rain event to characterize sediments that exit ORNL during a storm event. The sampling locations are Melton Branch upstream from ORNL (MEK 2.1), White Oak Lake at White Oak Dam (WCK 1.0), WOC downstream from ORNL (WCK 2.6), and WOC Headwaters as a reference location (Fig. 5.42). These samples are filtered, and the residue (settleable solids) is analyzed for gross alpha, gross beta, and gamma emitters.

Potassium-40, a naturally occurring radionuclide, was detected in sediments at all three locations. The only man-made radionuclide detected in sediments was ^{137}Cs downstream from ORNL at CRK 32. Figure 5.43 shows 7 years of ^{137}Cs results in sediment.

Sampling for heavy-rain-event settleable solids took place in January and December 2009. Radionuclide concentrations for alpha, beta, and ^{137}Cs were higher at the downstream location, WCK 1.0, than those observed at upstream locations.

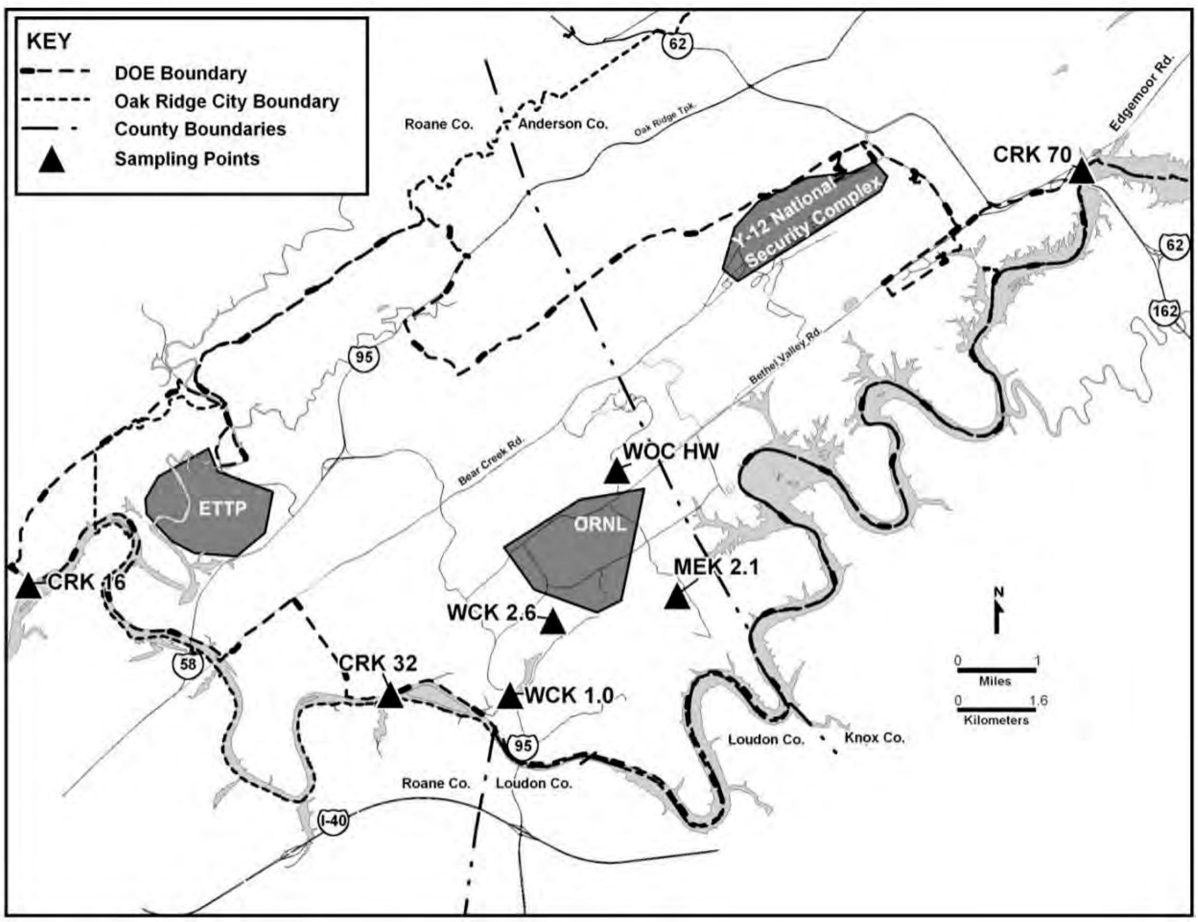

Fig. 5.42. ORNL sediment sampling locations.

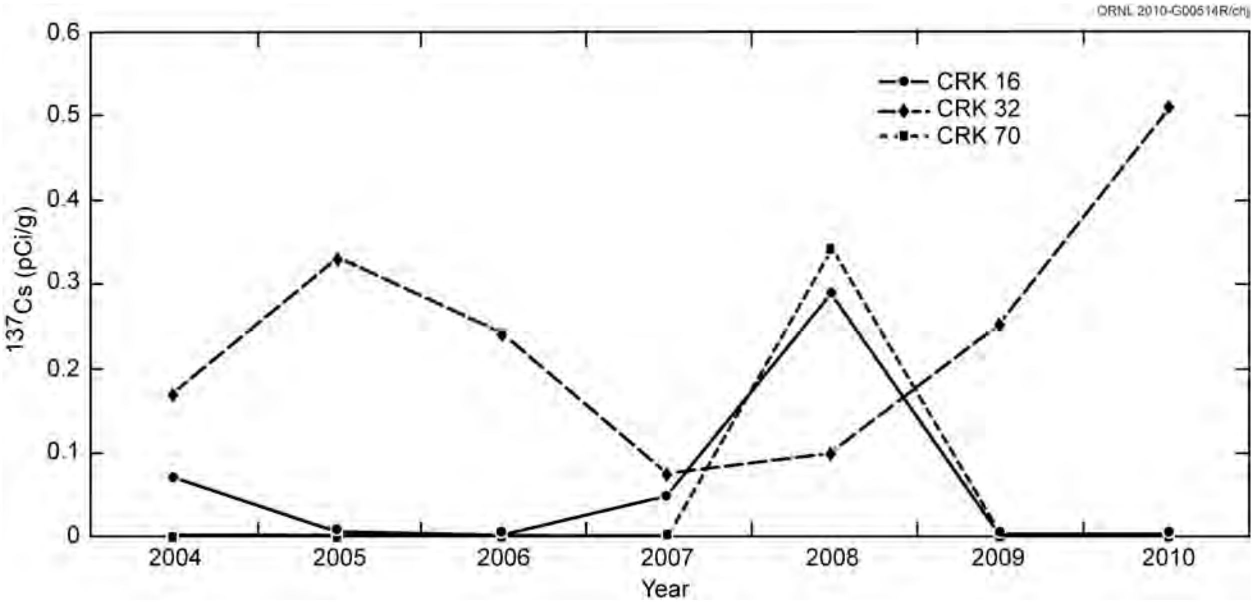

Fig. 5.43. ORNL sediment sampling results for ^{137}Cs, 2004–2010.

5.6 Groundwater Protection Program

As in years past, groundwater monitoring at ORNL was conducted under two sampling programs in 2010: DOE Environmental Management (EM) monitoring and DOE Office of Science (SC) surveillance monitoring. The EM groundwater monitoring program was performed by BJC. The SC groundwater monitoring surveillance program was conducted by UT-Battelle.

Contaminant concentrations in groundwater observed in other watershed or sub-watershed discharge areas were generally consistent with observations described in past annual site environmental reports (ASERs). Several polycyclic aromatic hydrocarbon (PAH) compounds were identified in samples collected from Northwestern and White Oak Creek Discharge Area wells. The sources of these PAH compounds are unknown, but it is hypothesized that they originate in legacy contamination within the main campus area or the burial grounds in Melton Valley. PAH compounds were also identified in samples associated with laboratory or trip blanks. Based on the results of the 2010 monitoring effort, there is no indication that current SC operations are significantly impacting groundwater at ORNL.

5.6.1 DOE-EM Groundwater Monitoring

Monitoring was performed as part of an ongoing comprehensive CERCLA cleanup effort in Bethel and Melton Valleys at ORNL, the two administrative watersheds at the ORNL site. Groundwater monitoring for baseline and trend evaluation in addition to measuring effectiveness of completed CERCLA remedial actions is conducted by the Water Resources Restoration Program (WRRP). The WRRP has been managed by BJC for the DOE-EM program since its inception and is the vehicle for the EM program to carry out the monitoring requirements outlined in CERCLA decision documents. The results of CERCLA monitoring for the ORR for fiscal year 2010, including the monitoring at ORNL, are evaluated and reported in the *2011 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE 2011a) as required by the Federal Facilities Agreement for the ORR. The monitoring results and remedy effectiveness evaluations for Bethel and Melton Valley are reported in Sections 2 and 3, respectively, in this report.

The WRRP also conducts groundwater monitoring at SWSA 6 and submits the required annual groundwater monitoring report to TDEC in response to RCRA Permit.

Groundwater monitoring conducted by the EM program at ORNL includes routine sampling and analysis of groundwater from 27 wells in Bethel Valley. In Melton Valley, where CERCLA remedial actions were completed in 2006 for the extensive waste management areas, the groundwater monitoring program includes monitoring groundwater levels in 80 wells to evaluate the effectiveness of hydrologic isolation of buried waste units. Additionally, groundwater is sampled and analyzed for a wide range of general chemical and contaminant parameters in 46 wells within the interior portion of the closed waste management area.

DOE initiated activities on a groundwater treatability study at the Bethel Valley 7000 Services Area VOC plume. This plume contains trichloroethene and its transformation products cis-1,2-dichloroethene and vinyl chloride, all at concentrations greater than EPA primary drinking water standards. The treatability study is a laboratory and field demonstration that microbes inherent to the existing subsurface microbial population can fully degrade the VOCs to nontoxic end products.

During FY 2010 baseline groundwater sampling and analysis was conducted at two former Low-Level Solid Waste Storage Areas in Bethel Valley—SWSA 1 and SWSA 3. Remedial actions and monitoring were specified in a CERCLA Remedial Action Work Plan that was developed by DOE and was approved by EPA and TDEC prior to project initiation.

During FY 2010 the EM Program installed an offsite groundwater monitoring well array west of the Clinch River adjacent to Melton Valley. During FY 2010 monitoring was initiated in those wells. In addition to monitoring offsite groundwater quality near Melton Valley, exit pathway groundwater monitoring conducted by the EM program in Melton Valley includes sampling at six multiport monitoring wells in western Melton Valley (wells 4537, 4538, 4539, 4540, 4541, 4542).

5.6.1.1 Summary of EM Groundwater Monitoring

5.6.1.1.1 Bethel Valley

During FY 2010, design work was completed and construction was initiated for remedial actions at two former waste storage sites, SWSA 1 and SWSA 3, that were used for disposal of radioactively contaminated solid wastes between 1944 and 1950. The Bethel Valley Record of Decision (DOE 2002) selected hydrologic isolation using multi-layer caps and groundwater diversion trenches as the remedial action for the waste burial grounds and construction of soil covers over the former contractor's landfill and contaminated soil areas near SWSA 3. The baseline monitoring included measurement of groundwater levels to obtain baseline data to allow evaluation of post-remediation groundwater-level suppression. Sampling and analysis of groundwater quality and contaminants were also conducted. Also during FY 2010 the EM Program installed three new groundwater monitoring wells in Bethel Valley to the west of TN Highway 95 to detect and monitor contamination from the SWSA 3 area. These three wells supplement data being collected from a multiport well (4579) near SWSA 3 for exit pathway groundwater monitoring in western Bethel Valley. Groundwater monitoring near SWSA 3, along with the exit pathway, and groundwater monitoring and surface water monitoring at the Northwest Tributary of White Oak Creek and in the headwaters of Raccoon Creek allow integration of data concerning SWSA 3 contaminant releases as presented in the 2011 Remediation Effectiveness Report (DOE 2011a).

The other principal element of the Bethel Valley Record of Decision (DOE 2002) remedy that requires groundwater monitoring is the containment pumping to control and treat discharges from the Core Hole 8 plume in the central campus area of ORNL. The original action for this plume was a CERCLA Removal Action that was implemented in 1995. The remedy had performed well until the latter portion of FY 2008 when conditions changed and ^{90}Sr and $^{233/234}$U concentrations in monitoring wells and the groundwater collection system began increasing. Leaking utility waterlines near the source area are suspected to have increased the mass of contaminants feeding the plume. Increased infiltration of plume water into storm drains has allowed increased contaminant flux to First Creek, a tributary of White Oak Creek. During FY 2009 the remedy did not meet its performance goal, which is a reduction of ^{90}Sr in White Oak Creek. DOE is in the process of modifying the groundwater collection system to increase the plume containment effectiveness. During FY 2010 DOE initiated a project to install additional plume contaminant collection wells and a refurbishment of the existing plume collection infrastructure, which had become unreliable because of its age.

Monitoring of groundwater contaminants in other areas of Bethel Valley showed that contaminant levels are generally stable.

5.6.1.1.2 Melton Valley

The Record of Decision for Interim Actions in Melton Valley (DOE 2000) established goals for a reduction of contaminant levels in surface water, groundwater-level fluctuation reduction goals within hydrologically isolated areas, and minimization of the spread of groundwater contamination. Remedy effectiveness groundwater monitoring in Melton Valley includes groundwater-level monitoring in wells within and adjacent to hydrologically isolated shallow waste burial areas and groundwater quality monitoring in selected wells adjacent to buried waste areas.

Groundwater-level monitoring is showing that the hydrologic isolation component of the Melton Valley remedy is effectively minimizing the infiltration of percolation water from contacting buried waste and is reducing contaminated leachate formation. FY 2010 was the second consecutive year to experience above-average annual rainfall since the remedy was completed in 2006, which provided a good stress test on the hydrologic isolation remedy components. In a few areas, groundwater level within capped areas continue to respond to groundwater fluctuations imposed from areas outside the caps, but contact of groundwater with buried waste is minimal. Overall the hydrologic isolation systems are performing as designed; however, groundwater level control at the SWSA 4 downgradient collection trench was challenged following large rain events. DOE proposes to conduct maintenance actions on that element of the remedy to improve its performance.

Groundwater quality monitoring in the interior of Melton Valley shows that in general groundwater contaminant concentrations are declining or are stable following remedial actions.

Monitoring of groundwater in the Melton Valley exit pathway has detected the presence of site-related contaminants in groundwater near the Clinch River. Low concentrations of ^{90}Sr, ^{3}H, uranium, and VOCs have been detected in a number of the multizone sampling locations. Groundwater in the exit pathway wells has high alkalinity and sodium and exhibits elevated pH. During FY 2010 the EM Program installed an offsite groundwater monitoring well array west of the Clinch River adjacent to Melton Valley. During FY 2010 monitoring was initiated in those wells. Monitoring included groundwater-level monitoring to evaluate potential flowpaths near the river as well as sampling and analysis for a wide array of metals, anions, radionuclides, and volatile organic compounds. Monitoring is planned to continue into 2011 before conclusions are drawn concerning groundwater conditions offsite.

5.6.2 Office of Science Groundwater Monitoring

During 2010 DOE Order 450.1A was the primary requirement for a site-wide groundwater protection program at ORNL. As part of the groundwater protection program, and to be consistent with UT-Battelle management objectives, groundwater surveillance monitoring was performed in order to monitor ORNL groundwater exit pathways and UT-Battelle facilities (“active sites”) potentially posing a risk to groundwater resources at ORNL. Results of the SC groundwater surveillance monitoring program are reported in the following sections.

Exit pathway and active-sites groundwater surveillance monitoring points sampled during 2010 included seep/spring and surface-water monitoring locations in addition to groundwater surveillance monitoring wells. Seep/spring and surface-water monitoring locations were used in the absence of monitoring wells located in appropriate groundwater discharge areas.

Groundwater monitoring performed under the exit-pathway groundwater surveillance and active-sites monitoring programs is not regulated by federal or state regulations. Consequently, no permit or standards exist for evaluating sampling results. To provide a basis for evaluating analytical results and for assessment of groundwater quality at locations monitored by UT-Battelle for the SC, federal drinking water standards and Tennessee water quality criteria for domestic water supplies (TDEC 2009) were used as reference standards in the following discussions. Four percent of the derived concentration guide (DCG) found in DOE Order 5400.5 were used if no federal or state standards have been established for a particular radionuclide. Although drinking water standards and DOE DCGs are used for comparative purposes, it is important to note that no members of the public consume groundwater from ORNL wells, nor do any groundwater wells furnish drinking water to personnel at ORNL.

5.6.2.1 Exit Pathway Monitoring

During 2010, exit pathway groundwater surveillance monitoring was performed in accordance with the *UT-Battelle Sampling and Analysis Plan for Surveillance Monitoring of Exit Pathway Groundwater at Oak Ridge National Laboratory* (Bonine 2010). Groundwater exit pathways at ORNL include areas from watersheds or sub-watersheds where groundwater discharges to the Clinch River/Melton Hill Reservoir to the west, south, and east of the main campus of ORNL. The exit pathway monitoring points were chosen based on hydrologic features, screened interval depths (for wells), and locations relative to discharge areas proximate to DOE facilities operated by, or under the control of, UT-Battelle. The groundwater exit pathways at ORNL include four discharge zones identified by a data quality objectives process. One of the original exit pathway zones was split into two zones for geographic expediency. The Southern Discharge Area Exit Pathway was carved from the East End Discharge Area Exit Pathway.

The five zones are as follows:

- the WOC Discharge Area Exit Pathway,
- the 7000/Bearden Creek Watershed Discharge Area Exit Pathway,
- the East End Discharge Area Exit Pathway,
- the Northwestern Discharge Area Exit Pathway, and
- the Southern Discharge Area Exit Pathway.

Figure 5.44 shows the locations of the exit pathway monitoring points sampled in 2010. Unfiltered samples collected from the UT-Battelle exit pathway groundwater surveillance monitoring points in 2010 were analyzed for VOCs, semi-volatile organic compounds (SVOCs), metals (including mercury), and radionuclides (including gross alpha/gross beta activity, gamma emitters, total radioactive strontium, and ^{3}H). Under the monitoring strategy outlined in the Exit Pathway Sampling and Analysis Plan, samples were collected semiannually during the wet (May) and dry (August) seasons.

5.6.2.1.1 Exit-Pathway Monitoring Results

Statistical trend analyses were performed on 2010 exit pathway monitoring data sets containing data exceeding reference standards. The bases used for the trend analyses were the historical data collected from the late 1980s through 2009. Trend analyses were not performed on data sets that were reported as being "undetected" by the laboratory, even when minimum detection limits exceeded reference standards (semivolatile organic compounds atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) and were not performed on parameters for which there are no reference standards or where data densities were insufficient. Trends for those parameters that exhibited statistically significant (80% to 99% confidence levels) upward or downward trends are reported. Samples were not collected at EE-02 or S-01 during the dry season due to a lack of water flow at these locations. Samples were collected at all other monitoring points during both the wet and dry seasons. Tabularized groundwater sampling results may be found in the 2010 Environmental Monitoring Results report (DOE 2010b).

Exit-Pathway Results for WOC Discharge Area

Monitoring wells 857, 858, 1190, 1191, and 1239 were sampled during May and August 2010. As in past years, radiological constituents were detected in two wells at concentrations greater than the reference standards: ^{3}H in well 1190 and gross beta activity, total radioactive strontium, and ^{3}H in well 1191. No other radionuclides exceeded reference standards in the WOC Discharge Area wells. A statistically significant downward trend exists for all three radiological constituents at both sampling locations. Figure 5.45 shows the downward trends for all three radiological constituents in both wells. Aside from the radionuclides that were detected above reference standard concentrations, the following

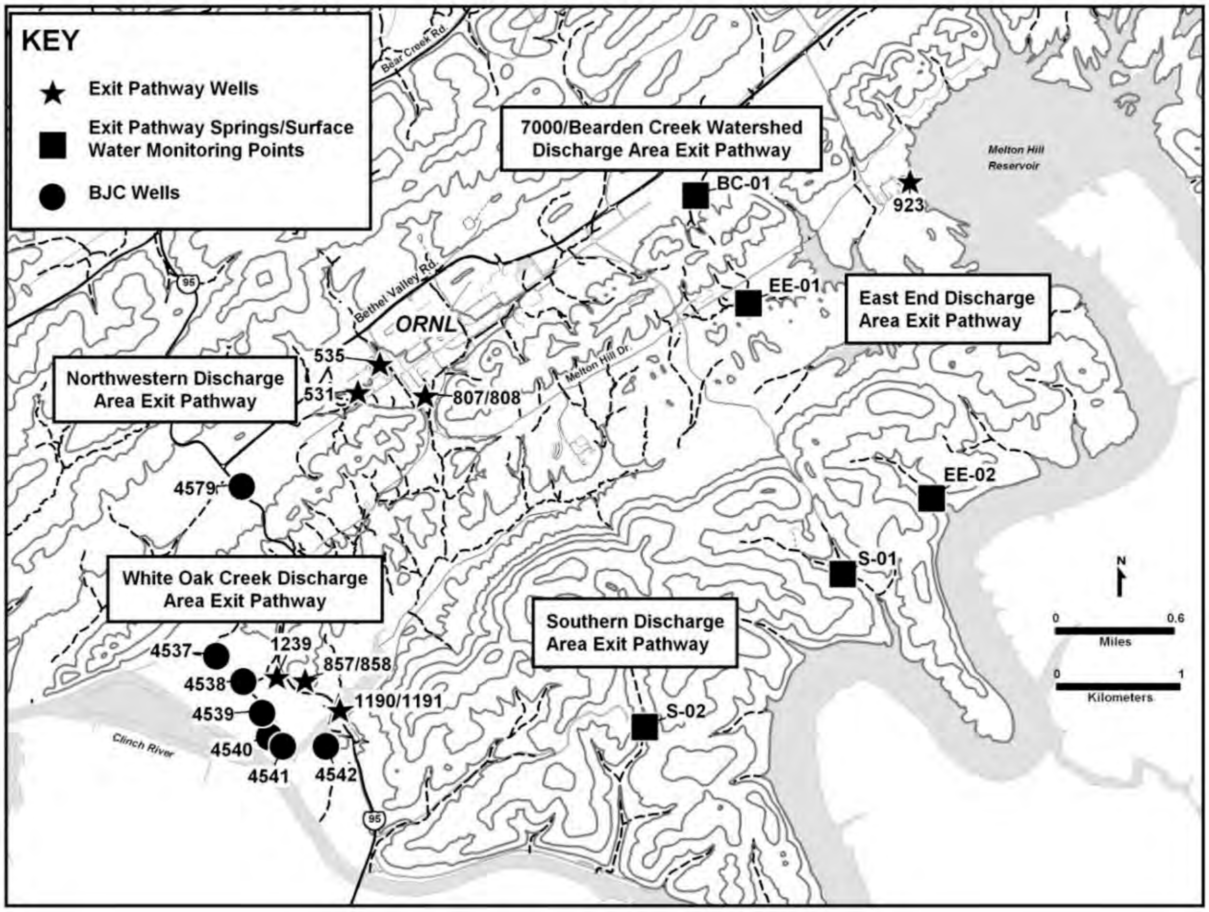

Fig. 5.44. UT-Battelle exit pathway groundwater monitoring locations at ORNL, 2010.

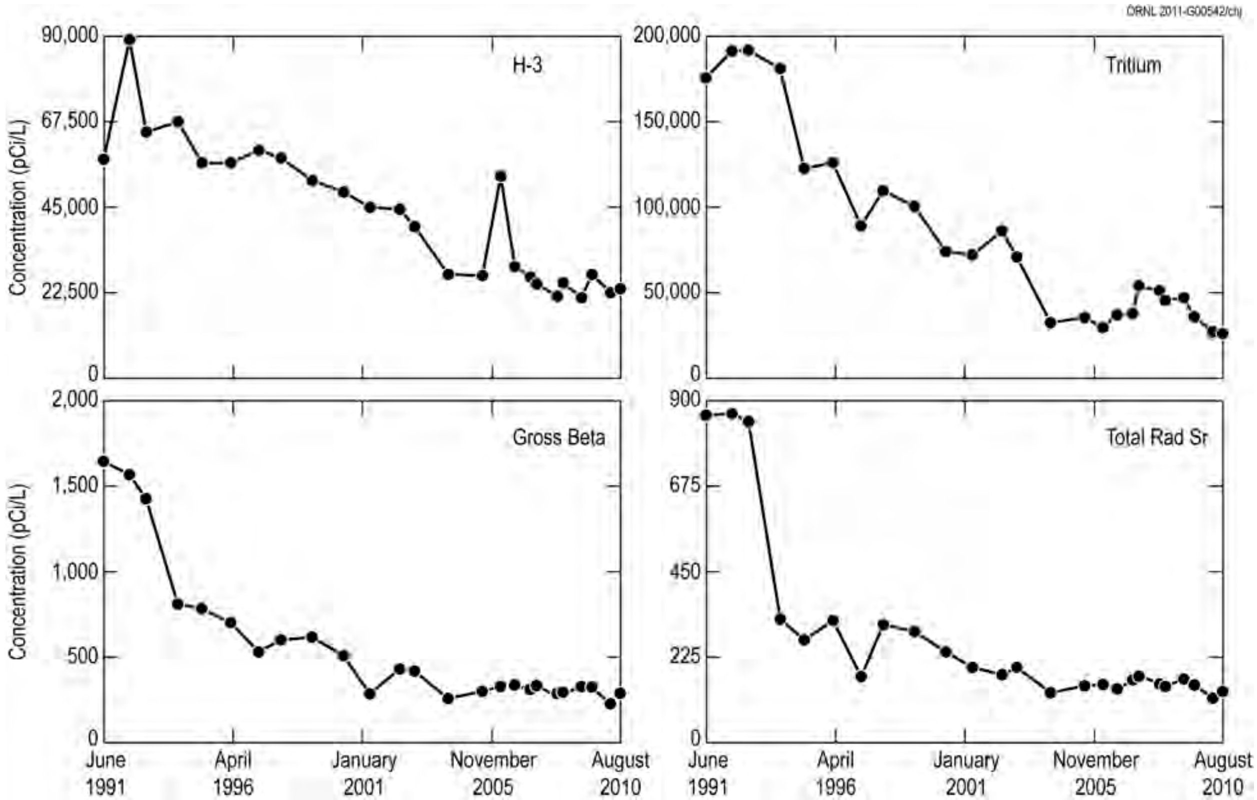

Fig. 5.45. Time series.

radionuclides were detected at low levels in WOC Discharge Area wells: gross beta activity and ^{3}H in well 857; gross beta activity in well 1190; and gross alpha and beta activity in well 1239. The source of these radiological contaminants is most likely from the burial grounds located within Melton Valley.

As in past years, iron, manganese, and aluminum exceeded reference standards in WOC Discharge Area wells during 2010. Aluminum and iron were found to exceed their reference standards in well 857 in addition to iron and manganese in wells 1190 and 1191. Statistical analyses of metals data for these wells show a statistically significant increase in trend for aluminum in well 857 and manganese in well 1191. Statistically significant downward trends exist for manganese and iron in well 1190 in addition to iron in wells 857 and 1191. It is possible that the metals are sorbed onto suspended solids in the groundwater samples collected, contributing to the exceedance of the reference standards used for comparison. Other metals were detected at low concentrations in groundwater samples collected from WOC Discharge Area wells; these results can be found in the 2010 Environmental Monitoring Results (DOE 2010b).

Detection limits for several semivolatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards in samples collected from WOC Discharge Area monitoring points. No other organic compounds were present in concentrations above reference standards in samples collected from WOC Discharge Area wells; however, several PAH compounds (i.e., fluroanthene, naphthalene, and phenanthrene) were detected at low estimated concentrations in well 857. Additionally, PAH compounds benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene were detected in low estimated concentrations in well 1239. The source of the PAH compounds is unknown, but it is possible that these PAH compounds are legacy contaminants from the main campus area of ORNL or the burial grounds in Melton Valley. Departing from past year observations, plasticizers bis (2-ethylhexyl) phthalate and diethyl phthalate were not detected in samples collected from WOC Discharge Area wells.

Low concentrations of acetone were detected in groundwater samples collected from all of the WOC Discharge Area wells in 2010. Acetone was detected in low estimated concentrations in all of the laboratory blanks associated with dry season samples collected from WOC Discharge area wells. Acetone was also found at low concentrations in trip blanks that accompanied dry season samples collected from wells 1190, 1191, and 1239.

Exit-Pathway Results for 7000/Bearden Creek Watershed Discharge Area

Because of sporadic flow at spring/seep BC-01, a new spring was chosen within the same discharge sub-area. A new spring was located downstream of the original location of BC-01 within the same tributary to Bearden Creek, allowing sampling to occur in May and August 2010.

No radionuclides were detected in BC-01 in 2010; however, iron, manganese, and aluminum were detected at concentrations greater than reference standards. None of these metals exhibit a discernable upward or downward trend. Other metals were detected at low concentrations in groundwater samples collected from this discharge area in 2009, and results are provided in the 2010 Environmental Monitoring Results (DOE 2010b).

Detection limits for the semivolatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards. Iodomethane (also known as methyl iodide) was found at a very low estimated concentration in the groundwater sample collected from BC-01 in May 2010. Iodomethane is primarily used as a component of a pesticide. There are no records indicating that an iodomethane-based pesticide has been used at ORNL; consequently, the source of this compound is not known. No other VOCs were detected in BC-01 in 2010.

Exit-Pathway Results for East End Discharge Area

Well 923 and monitoring point EE-01 were sampled in May and August 2010. Well EE-02 was sampled only during the wet season (May 2010), as there was no flow present at this monitoring point during the dry season. No radiological constituents were present above reference standards in samples collected from East End Discharge Area monitoring points; however, low concentrations of gross beta activity were detected in the samples collected from EE-01 and well 923. Iron and manganese exceeded reference standards in well 923 and EE-01, while manganese exceeded its reference standard at EE-02. No statistically significant trend was detected in the iron and manganese data sets at well 923. Likewise, no trend was detected in the manganese data set for EE-02; however, a statistically significant increase in trend is observable in the manganese data set for EE-01. Other metals were detected at low concentrations in groundwater samples collected from East End Discharge Area in 2010; these results can be viewed in the 2010 Environmental Monitoring Results report (DOE 2010b).

Detection limits for several undetected semivolatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards. Acetone was detected at a low concentration in a sample collected in August 2010 from well 923. Acetone was also detected in the trip blank accompanying that sample. Methylene chloride was found in a laboratory blank and trip blank associated with a sample collected in May 2010 from well 923. In addition, methylene chloride was detected at a low estimated concentration in a sample collected from EE-01 in August 2010.

Exit-Pathway Results for Northwestern Discharge Area

Wells 531, 535, 807, and 808 were sampled in May and August 2010. No radiological parameters exceeded their reference standards at any Northwestern Discharge Area monitoring point. However, gross alpha and beta activity and ^{3}H were detected in low concentrations in well 535. In addition, low concentrations of gross beta activity, total radioactive strontium, and ^{3}H were detected in groundwater samples collected from well 807.

Iron and aluminum concentrations exceeded reference standards in samples collected from well 531. No discernable trend was detected in the data sets for either parameter. Iron and manganese also exceeded reference standards in well 535. Analyses of the historical data sets for iron and manganese indicate the presence of statistically significant increasing trends for both parameters. Additionally, iron and manganese exceeded reference standards in well 807, but trend analyses of the historical data sets for these parameters indicate no discernable trends. Other metals were detected at low concentrations in groundwater samples collected from Northwestern Discharge Area in 2010, and results are provided in the 2010 Environmental Monitoring Results report (DOE 2010b).

Detection limits for several undetected semivolatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards. As a departure from 2009, diethyl phthalate and toluene were not detected in samples collected from well 535. PAH compounds benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and ideno(1,2,3-cd) pyrene were detected at low estimated concentrations in well 807, while benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene were detected at low estimated concentrations in well 808. Benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene were also found in laboratory blanks associated with samples collected from wells 807 and 808. The PAH compound naphthalene was detected at a low estimated concentration in well 535 in 2010. The source of naphthalene, dibenzo(a,h)anthracene, and ideno(1,2,3-cd) pyrene is unknown; however, it is possible that these compounds are legacy soil contaminants found in the main campus of ORNL.

Volatile organics identified in samples collected from Northwest Discharge Area wells included methylene chloride and acetone. Methylene chloride was detected at a low estimated concentration in a groundwater sample collected from well 531. The same compound was also detected in the laboratory and trip blanks associated with the sample. Acetone was detected at a low estimated concentration in well 807 and detected in well 808 during dry season sampling. Acetone was also detected in the trip blanks associated with these samples. Acetone was also identified in the method blank associated with a sample collected from well 535.

Exit-Pathway Results for Southern Discharge Area

Monitoring point S-01 was sampled by UT-Battelle in May 2010, but no samples were collected during the dry season sampling event (August 2010) because the monitoring point was dry. Monitoring point S-02 was sampled in May and August 2010.

No radiological parameters exceeded reference standards at either monitoring point; however, low concentrations of gross alpha and ^{40}K were detected in samples collected from S-02.

Concentrations reported for aluminum and iron exceeded reference standards at S-01. Likewise, iron, aluminum, and manganese concentrations exceeded reference standards at S-02. Trend analyses of the data sets for these metals indicate no discernable trends. Lead was detected in 2009 in samples collected from S-02 in 2009 but was not detected in samples collected in 2010. Other metals were detected at low concentrations in groundwater samples collected from Southern Discharge Area in 2009; these results can be viewed in the 2010 Environmental Monitoring Results report (DOE 2010b).

Detection limits for several undetected semivolatile organic compounds (atrazine, benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol) exceeded reference standards. Unlike 2009, volatile organic compounds were not detected in groundwater samples collected.

5.6.2.2 Active Sites Monitoring

5.6.2.2.1 Active Sites Monitoring—HFIR

Surveillance monitoring of the HFIR site detected a subsurface release of ^{3}H from a process waste drain in the autumn of 2000. At that time, reactor systems were shut down so that the release site could be identified and repaired. The process waste drain was found to be the source of the release and was repaired, ending the release of the ^{3}H to the subsurface. From 2000–2007, monitoring of HFIR-site wells and subsurface drains was conducted to determine the size and scope of the ^{3}H plume that was created by the release. This groundwater monitoring approach was conducted by the UT-Battelle Research Reactor Division (RRD). The main mass of the ^{3}H plume was observed to move from the release area to the south–southeast toward a tributary to Melton Branch and Melton Branch itself. RRD discontinued routine monitoring in 2007 based on a history of zero detectable subsurface releases of ^{3}H from the process waste drain and observations of steep downward trends in ^{3}H concentration reductions in samples collected from monitoring sites down gradient of the release site. The expectation is that ^{3}H concentrations should continue to decrease with the possibility of additional precipitation-driven concentration spikes or drought-induced ^{3}H concentration stagnation. Although RRD has ceased monitoring the ^{3}H plume, ^{3}H monitoring at HFIR has continued under the auspices of the *ORNL Radiological Monitoring Plan*. Please refer to Sect. 5.5 of that document for requirements of 2010 ^{3}H monitoring at HFIR. All wells used in the RRD groundwater monitoring program are being maintained for future use as needed.

5.6.2.2.2 Active Sites Monitoring—SNS

Active sites groundwater surveillance monitoring was performed in 2010 at the SNS site. The site was monitored based on the potential for adverse impact on groundwater resources at ORNL should a release occur. Monitoring at the SNS site was performed in 2010 under the draft *Operational Groundwater Monitoring Plan for the Spallation Neutron Source Site* (Operational Monitoring Plan) (Bonine, Ketelle, and Trotter, 2007). Operational monitoring was initiated following a 2-year (2004–2006) baseline monitoring program and will continue throughout the duration of SNS operations.

The SNS site is located atop Chestnut Ridge northeast of the main ORNL facilities. The site slopes to the north and south, and small stream valleys, populated by springs and seeps, lie on the ridge flanks. Surface water drainage from the site flows into Bear Creek to the north and WOC to the south.

The SNS site is a hydrologic recharge area underlain by geologic formations that form karst geologic features. Groundwater flow directions at the site are based on the generally observed tendency for groundwater to flow parallel to geologic strike (parallel to the orientation of the rock beds) and via karst conduits that break out at the surface in springs and seeps located down gradient of the SNS site. A sizable fraction of infiltrating precipitation (groundwater recharge) flows to springs and seeps via the karst conduits.

SNS operations have the potential for introducing radioactivity (via neutron activation) in the shielding berm surrounding the SNS linac, accumulator ring, and/or beam transport lines. A principal concern is the potential for water infiltrating the berm soils to transport radionuclide contamination generated by neutron activation to saturated groundwater zones. The ability to accurately model the fate and transport of neutron activation products generated by beam interactions with the engineered soil berm is complicated by multiple uncertainties resulting from a variety of factors, including hydraulic conductivity differences in earth materials found at depth, the distribution of water-bearing zones, the fate and transport characteristics of neutron activation products produced, diffusion and advection, and the presence of karst geomorphic features found on the SNS site. These uncertainties led to the initiation of the groundwater surveillance monitoring program at the SNS site. Objectives of the groundwater monitoring program outlined in the Operational Monitoring Plan include the following: (1) determine compliance with applicable environmental quality standards and public exposure limits outlined in DOE Orders 450.1A and 5400.5, respectively, and (2) provide uninterrupted monitoring of the SNS site.

A total of seven seeps/springs and surface water sampling points (seeps/springs S-1, S-2, S-3, S-4, S-5, and SP-1 and surface-water point SW-1) were routinely monitored as analogues to, and in lieu of, groundwater monitoring wells. Locations were chosen based on hydrogeological factors and proximity to the beam line. Figure 5.46 shows the locations of the specific monitoring points sampled during 2010.

Because of the presence of karst geomorphic features at the SNS site (and the lack of groundwater wells at the SNS site), sampling of the seeps/springs was performed quarterly to characterize the radionuclide content of the water throughout the expected range of flow at each monitoring locations. Three grab samples were collected from each seep/spring: one sample to represent base flow (collected during dry periods between rainfall events) and two samples collected during rainfall events representing higher stage/flow rates [i.e., one representing the rising limb of the storm hydrograph (water flow induced by the initial pulse of rainfall percolating through the system) and one representing the falling limb of the storm hydrograph (water flowing in the system after peak flow induced by rainfall has occurred)], as shown in Fig. 5.47. Given their fate and transport characteristics, ^{3}H and ^{14}C are the principal groundwater constituents of concern at the SNS site. In 2010, samples were collected on a quarterly basis for ^{3}H and ^{14}C analyses. Additionally, samples were collected during wet-season base flow conditions for gross activity (alpha and beta) and for selected gamma spectroscopic parameters.

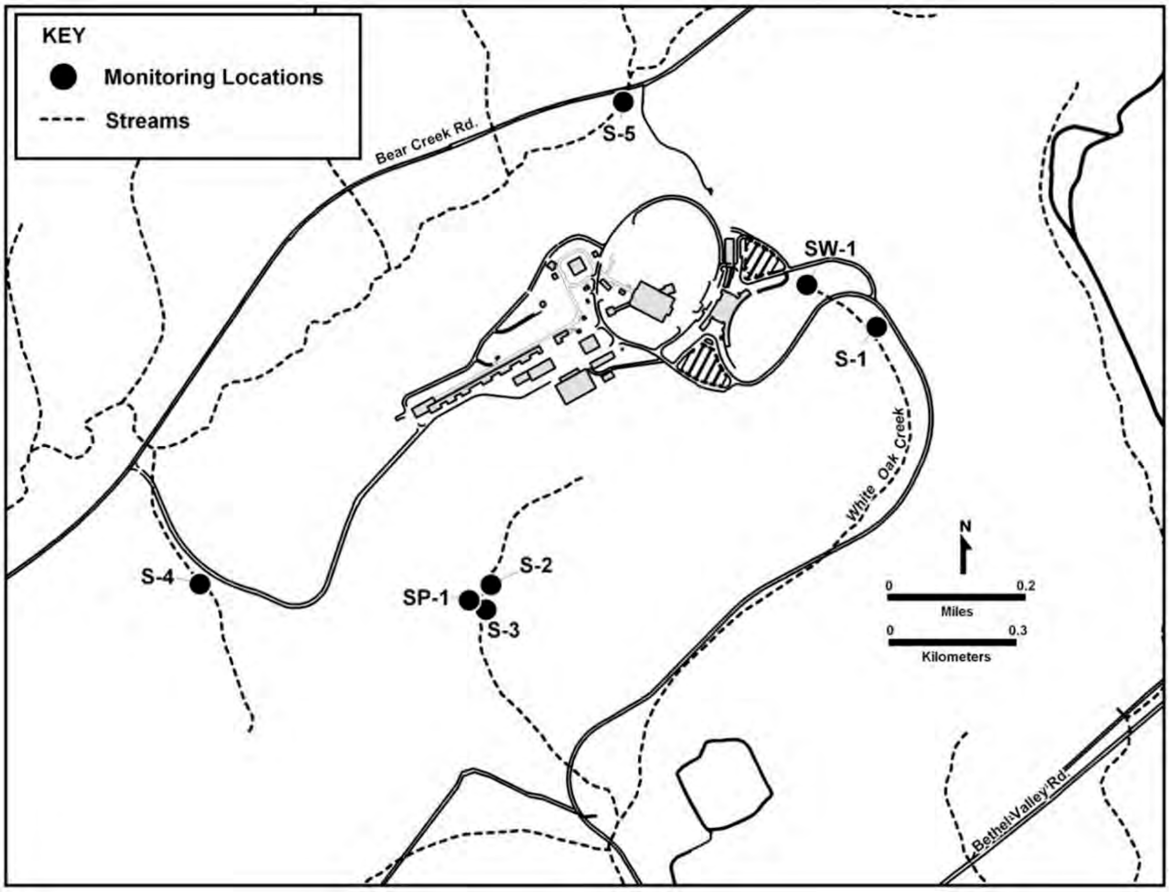

Fig. 5.46. Groundwater monitoring locations at the Spallation Neutron Source, 2010.

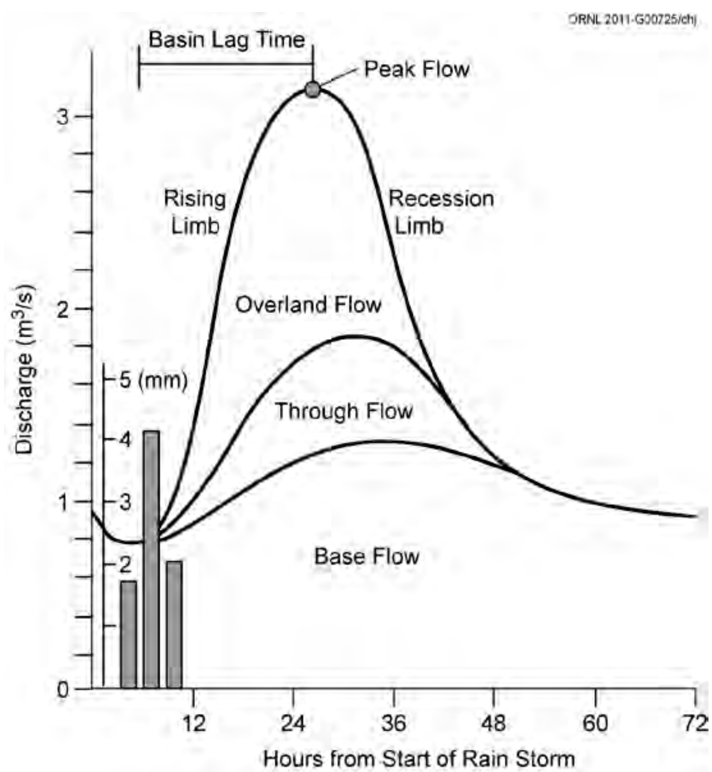

Fig. 5.47. Simple hydrograph.

SNS Site Results

Sampling at the SNS site occurred during March, June, August, and November 2010, and the sampling results were compared to reference standards. No SNS sample results exceeded reference standard thresholds in 2010. Low concentrations of gross alpha and beta activity were detected in samples collected from S-5 during base flow conditions in March. Carbon-14 and gamma-emitting radionuclides were not detected in samples collected at the SNS site during 2010. Low concentrations of ^{3}H were detected numerous times during 2010. None of the ^{3}H concentrations exceeded the corresponding reference standard. The following is a summary of the locations, flow conditions, and sampling events for ^{3}H detections observed during 2010:

1. S-1 – (a) during base flow conditions in August and November and (b) during rising and falling limb conditions in March, June, August, and November.
2. S-2 – (a) during base flow conditions in August and November and during rising and falling limb conditions in March, June, August, and November.
3. S-3 – (a) during base flow conditions in August; (b) during rising limb conditions in March, June, and November; and (c) during falling limb conditions in March, August, and November.
4. S-4 – (a) during base flow conditions in August; (b) during rising limb flow conditions in November; and (c) during falling limb conditions in June and November.
5. S-5 – (a) during base flow conditions in August and November and (b) during rising limb and falling limb conditions in November.
6. SW-1 – ^{3}H was detected in samples collected during all flow conditions and all sampling events (March, June, August, and November).
7. SP-1 – (a) during rising limb flow conditions in March and (b) during falling limb conditions in June.

SNS groundwater monitoring results are found in the 2010 Environmental Monitoring Results report (DOE 2010b).

5.7 Quality Assurance Program

The application of quality assurance (QA)/quality control (QC) programs for environmental monitoring activities on the ORR is essential for generating data of known and defensible quality. Each aspect of an environmental monitoring program from sample collection to data management and record keeping must address and meet applicable quality standards. The activities associated with administration, sampling, data management, and reporting for ORNL environmental programs are performed by the UT-Battelle Environmental Protection and Waste Services Division (EP&WSD).

UT-Battelle utilizes the SBMS to provide a systematic approach for integrating quality assurance, environmental, and safety considerations into every aspect of ORNL environmental monitoring. SBMS is a web-based system that provides a single point of access to all the requirements necessary for staff to safely and effectively perform work. SBMS translates laws, orders, directives, policies, and best-management practices into Laboratory-wide subject areas and procedures.

5.7.1 Work/Project Planning and Control

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

- define scope of work;
- perform work planning—analyze hazards and define controls;
- execute work; and
- provide feedback.

In addition, EP&WSD has approved project-specific standard operating procedures for all activities controlled and maintained through the ORNL Integrated Document Management System.

Environmental sampling standard operating procedures developed for ORNL environmental sampling programs provide detailed instructions on maintaining chain of custody, sample identification, sample collection and handling, sample preservation, equipment decontamination, and collection of quality control samples such as field and trip blanks, duplicates, and equipment rinses.

5.7.2 Personnel Training and Qualifications

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

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

5.7.3 Equipment and Instrumentation

5.7.3.1 Calibration

The UT-Battelle Quality Management System includes subject area directives that require all ORNL staff to use equipment of known accuracy based on appropriate calibration requirements that are traceable to an authority standard. The UT-Battelle Facilities and Operations Instrumentation and Control Technical Support tracks all equipment used in ORR environmental monitoring programs through a maintenance recall program to ensure that equipment is functioning properly and within defined tolerance ranges. The determination of calibration schedules and frequencies is based on a graded approach at the activity planning level. EP&WSD environmental monitoring programs follow rigorous calibration schedules to eliminate gross drift and the need for data adjustments. Instrument tolerances, functions, ranges, and calibration frequencies are established based on manufacturer specifications, program requirements, actual operating environment and conditions, and budget considerations.

5.7.3.2 Standardization

EP&WSD sampling procedures, maintained in the Integrated Document Management System, include requirements and instructions for the proper standardization and use of monitoring equipment. Requirements include the use of traceable standards and measurements, performance of routine, before-use equipment standardizations, and actions to follow when standardization steps do not produce required values. Standard operating procedures for sampling also include instructions for designating nonconforming instruments as “out-of-service” and initiating requests for maintenance.

5.7.3.3 Visual Inspection, Housekeeping, and Grounds Maintenance

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

5.7.4 Assessment

Independent audits, surveillance, and internal management assessments are performed to verify that requirements have been accurately specified and activities that have been performed conform to expectations and requirements. External assessments are scheduled based on requests from auditing agencies. Table 2.1 presents a listing of environmental audits and assessments performed at ORNL in 2010 and information on the number of findings identified. EP&WSD also conducts internal management assessments of ORNL environmental monitoring procedural compliance, safety performance, and work planning and control. Surveillance results, recommendations, and completion of corrective actions, if required, are also documented and tracked in the Assessment and Commitment Tracking System.

The TWPC performs independent audits, surveillances, and internal management assessments to verify that requirements have been accurately specified and activities that have been performed conform to expectations and requirements. Environmental personnel conduct internal assessments of TWPC procedural compliance, environmental compliance, and EMS implementation. Corrective actions, if required, are documented and tracked in the TWPC Issues Management Database.

5.7.5 Analytical Quality Assurance

The contract laboratories that perform analyses of environmental samples from the ORR environmental monitoring programs are required to have documented QA/QC programs, trained and qualified staff, appropriately maintained equipment and facilities, and applicable certifications. UT-Battelle uses a competitive award system to select laboratories that are contracted under basic ordering agreements to perform analytical work to characterize ORNL environmental samples. The DOE Environmental Management Consolidated Audit Program performs oversight of subcontracted commercial laboratories. This program, administered by DOE and subcontractors from across the DOE complex, establishes required internal and external laboratory control and performance evaluation programs and conducts on-site laboratory reviews that monitor the performance of all subcontracted laboratories and verify that all quality requirements are met.

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

5.7.6 Data Management and Reporting

ORNL environmental surveillance and monitoring data management is accomplished using the Environmental Surveillance System (ESS), a web interface data management tool. A software QA plan for ESS has been developed to document ESS user access rules; verification and validation methods; configuration and change management rules; release history; software registration information; and the employed methods, standards, practices, and tools.

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

Following the compliance screening, a series of checks is performed to determine whether results are consistent with expected outcomes and historical data. QC sample results (i.e., blanks and duplicates) are reviewed to check for potential sample contamination and to confirm repeatability of analytical methods within required limits. More in-depth investigations are conducted to explain results that are questionable or problematic.

5.7.7 Records Management

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

The TWPC maintains all records specific to the project, and the records management program includes the requirements for creating and identifying record material, protecting and storing records in applicable areas, and destroying records.

5.8 Environmental Management and Waste Management Activities at ORNL

Because of past waste disposal practices and unintentional releases, portions of land and facilities on the ORR are contaminated with radioactive elements, mercury, asbestos, polychlorinated biphenyls, and industrial wastes. DOE EM conducts cleanup programs across the reservation to correct the contamination remaining from years of energy research and weapons production.

ORNL has become one of the world's most modern campuses for scientific discovery in materials and chemical sciences, nuclear science, energy research, and super-computing. However, the site also includes large contaminated areas that resulted from past operations and waste disposal practices. The Environmental Management Program has divided ORNL into two major cleanup areas: Bethel Valley and Melton Valley. The Bethel Valley area includes reactors and the principal research facilities, and the Melton Valley Area was used for reactors and waste management. The following sections summarize some of the 2010 EM activities undertaken at ORNL. More detailed information is available in the FY 2010 Cleanup Progress Annual Report to the Oak Ridge Community (DOE 2010a).

5.8.1 Demolition Completed at 3026 C&D

In February 2010 demolition and stabilization were completed on the wooden superstructure of one of the highest hazard excess facilities at ORNL—the 3026 C&D Radioisotope Development Laboratory. This building, one of the original Manhattan Project facilities, had a footprint of approximately 24,000 ft^2 and contained several hot cells and associated pipes and ducts that were highly contaminated. The wooden structure in which the hot cells were located had deteriorated significantly over the years due to age and roof leaks. A roof failure in 2007 damaged the fire suppression sprinkler system, requiring it to be deactivated. This deactivation presented potential fire hazards to nearby facilities and the potential for contaminant release if a fire occurred in the facility.

DOE determined that the resulting risks warranted implementing a time-critical Removal Action to remove the 3026 C&D wooden structure and stabilize the hot cells.

More than 160 shipments of building debris, representing 1.7 million pounds of waste, were sent to EMWMF as a result of the 3026 C&D demolition activities. An additional 25 yd^3 of waste was processed and dispositioned via alternative pathways. Of special note was that for personnel safety, a portion of the building had to be demolished with friable asbestos in place. This required the use of supersacks for debris packaging.

As a final step in this phase of the 3026 C&D work, the entire remaining hot cell structures and building slab were coated with polyurea. Polyurea's properties of fast reactivity and relative insensitivity to moisture make it useful for large-surface-area projects. With this final stabilization coating in place, the 3026 C&D area was transitioned on September 23, 2010, to the DOE contractor responsible for removing the hot cells.

5.8.2 2000 Complex Demolition Activities

Demolition was completed on six facilities in the 2000 Complex at ORNL during 2010. The complex, located in the northwest corner of the ORNL central campus, included eight facilities and structures totaling 58,000 ft^2.

The Complex was constructed in the late 1940s to support various ORNL research projects, and included Buildings 2000, 2001, and 2024, and the ancillary support facilities 2019, 2034, 2087, 2088, and 2092. All of these buildings were in severe disrepair and had been vacant for approximately 6 years.

The specific hazards associated with the 2000 Complex include the extremely poor physical condition of the structures, constant flaking of PCB-containing paint, extensive quantities of friable and non-friable asbestos in restricted attic areas, and radiologically contaminated ductwork and fume hoods. The demolition project was divided into two phases.

In FY 2010, demolition of the first phase (2000 Complex East) was completed. This phase consisted of the demolition of six buildings (2001, 2019, 2024, 2087, 2088 and 2092) with a combined area of approximately 35,000 ft^2. Also in FY 2010, the contract was awarded, contractor mobilized, and hazardous material abatement commenced on the second and final phase (2000 Complex West), which consisted of the Buildings 2000 and 2034, with a combined area of 23,200 ft^2.

2010 Phase 1 demolition work resulted in 278 shipments of building debris, representing more than 5700 yd^3 of waste shipped to the Y-12 landfill and 75 yd^3 to EMWMF.

5.8.3 Bethel Valley Burial Grounds Remediation

The Bethel Valley Burial Grounds Project includes capping SWSA 1 in Central Bethel Valley and SWSA 3 in West Bethel Valley, remediation of contaminated hot spots, and placing a cover over disposal areas in the vicinity of the two SWSAs.

Work in the vicinity of SWSA 1 was completed in October 2010. Capping of SWSA 1 involved placement of several layers of cap material to prevent migration of contaminants as a result of infiltration of water. SWSA 1 is divided by a road that required reconstruction as part of the placement of the cap.

Two disposal areas near SWSA 1—the Former Waste Pile Area and the Nonradioactive Wastewater Treatment Plant Debris Pile—were covered with additional soil, and the area was re-seeded during FY 2010.

Work in the vicinity of SWSA 3 is ongoing. Activities to place some of the miscellaneous debris recovered and generated during remedial action operations on SWSA 3 are under way, and vegetation in the area adjacent to SWSA 3 and the Closed Scrap Metal Area has been cleared.

The adjacent contractor's landfill east and west have been cleared, and placement of additional soil has is under way. Hot spots have been sampled, and the data are being evaluated. Ancillary activities include surveying, geophysical investigations, well investigations, well plugging and abandonment, and well installation. These ancillary activities have been completed in the vicinity of SWSA 1 and are ongoing in the vicinity of SWSA 3.

5.8.4 Tank W1A Remediation Under Way

A groundwater plume of contamination emanates from contaminated soil surrounding Tank W-1A in the central portion of ORNL and migrates to a nearby creek.

The principal plume contaminants are ^{90}Sr and uranium isotopes. Since late 1994, DOE has been implementing various actions to minimize the release of groundwater contaminants into First Creek.

During 2010 installation of a weather enclosure, soil sampling, and characterization along a Tank W-1A feed pipeline were completed. Field work is expected to be completed in fall 2011.

5.8.5 Uranium-233 Downblending and Disposition Project

Uranium-233, a special nuclear material that requires strict safeguards and security controls, is currently stored at ORNL in Building 3019A. During 2010, demolition and disposition of related waste for Buildings 3136 and 3074 was completed to allow for construction of an annex facility to Building 3019A. Building 3136 was a wood framed structure with sheet metal siding. Constructed in 1984 and operated as a document storage facility, the 600-ft^2 single-story building was the first of two facilities to be dismantled.

Building 3074 was constructed in 1951 and operated as the hot-cell-manipulator repair and maintenance shop. The 3,500-ft^2 single-story facility contained asbestos material, lead-based paint, polychlorinated biphenyl–containing material, and radioactive contamination. Building debris meeting the definition of mixed low-level waste was sent to the Nevada National Security Site for disposal, while the debris meeting the definition of low-level waste was disposed at Clive, Utah.

5.8.6 Soils and Sediment Remediation

The objective of the Bethel Valley Soils and Sediment Project is to characterize, scope, and complete remediation of contaminated soils and sediments to protect workers and groundwater in the area.

The Remedial Action Work Plan (RAWP) for the project outlines the approach that will be followed to characterize and evaluate soils and sediments, ensuring that the soil cleanup requirements for Bethel Valley are met. The work plan was approved by the regulators in early FY 2010 and field assessment activities, which focused on portions of Bethel Valley west of the ORNL main campus, have been completed. Soils in these areas, which surround the SWSA 3 Burial Ground, have been sampled, and analytical results are being validated and assessed to determine if additional sampling will be necessary.

These efforts have resulted in more than 487 acres of the Raccoon Creek area being identified as requiring no action.

5.8.7 Bethel Valley Groundwater Projects

Several activities were initiated in 2010 to address Bethel Valley groundwater plumes.

5.8.7.1 7000 Area Groundwater Treatability Study

The 7000 Area includes the maintenance facilities on the east end of ORNL and the treatability study will allow the determination of the feasibility of using bacteria to eliminate trichloroethylene in groundwater.

Field activities during 2010 included sampling and analyzing groundwater to determine the presence of naturally occurring DE chlorinating microbes, evaluation of the degradation capacity of indigenous microbes, and dye studies at several wells to determine the groundwater transport characteristics. DOE will perform a pilot study at four wells in the 7000 area to determine if full-scale bioremediation is feasible.

5.8.7.2 Corehole 8 Intercept Extraction System

Surface water monitoring in First Creek has indicated the ^{90}Sr in groundwater is bypassing the Corehole 8 intercept extraction system and surfacing at First Creek on the west side of ORNL. A groundwater engineering study concluded that the Corehole 8 plume is moving along the bedrock deeper than the current interceptor extraction system components, and deeper extraction wells to intercept the deep groundwater are needed.

A sampling campaign was initiated in the summer of 2010 to determine the best location for new extraction wells. Drilling activities were initiated, and two wells will be connected to the extraction system in FY 2011. In addition the system will be upgraded with larger pumps and controllers for the multiple extraction components.

5.8.7.3 SWSA 3 Exit Pathway Monitoring

Three new monitoring wells were installed west of Highway 95 along Raccoon Creek during 2010 to monitor a ^{90}Sr plume that originates at the SWSA 3 landfill. Strontium-90 in the groundwater has been shown to flow both to the west, under Highway 95, surfacing in the Raccoon Creek headwaters, and to the east, surfacing in a tributary flowing to First Creek within the ORNL campus.

5.8.7.4 Off-Site Monitoring Wells

DOE has completed installation of monitoring wells across the Clinch River from ORNL to monitor for potential ORNL site-related contaminants.

Sixteen new monitoring wells were installed during 2010. These wells are now included in the Melton Valley monitoring network and were also incorporated into the recently proposed Melton Valley Monitoring Plan. The 16 new wells and five nearby residential wells will be sampled quarterly with initial results to be published in the FY 2011 Remedial Effectiveness Report (DOE 2011a).

5.8.8 ORNL Waste Management

5.8.8.1 ORNL Wastewater Treatment

At ORNL, 118 million gallons of wastewater were treated and released at the PWTC in 2010. In addition, the liquid low-level waste (LLW) evaporator at ORNL treated 120,000 gallons of waste. The waste treatment activities supported both EM and Office of Science mission activities, ensuring that wastewaters for both programs' activities are managed in a safe and compliant manner.

5.8.8.2 ORNL Newly Generated Waste Management

ORNL is the largest, most diverse Office of Science Laboratory in the DOE Complex. Although much effort is expended to prevent pollution and eliminate waste generation, some waste streams are generated as a by-product of performing research and operational activities and must be managed to ensure that the environment is protected from associated hazards. UT-Battelle, LLC, as the prime contractor for the management of ORNL, is responsible for the management of wastes generated from research and development activities as well as the wastes generated from the operations of the R&D facilities.

Wastes generated from ongoing research and operational activities are termed "newly generated waste." At ORNL, newly generated wastes consist of chemical waste streams, waste containing or contaminated with radioactivity, and chemical waste that also contains radioactivity (known as mixed waste). The majority of ORNL's newly generated radioactive waste meets the definition of low-level radioactive waste, but ORNL does generate a small quantity of waste classified as TRU waste. Most of ORNL's newly generated radioactive waste contains very small quantities of radioactivity and can be handled without special-handling protocols. [This waste is known as contact-handled (CH) waste.] However, some wastes generated in the ORNL's nuclear facilities contain enough radioactivity to require special-handling procedures such as transport in special casks that provide shielding of the radioactivity. [This waste is known as remote-handled (RH) waste.] Less than 5% of the ORNL's newly generated radioactive waste meets the criteria of being RH waste.

Beginning October 1, 2008, ORNL became fully responsible for disposition of almost all of its newly generated waste. Prior to that date, waste management responsibilities at ORNL were a shared responsibility between the DOE Office of Science (and its prime contractor, UT-Battelle) and DOE-EM (and its prime contractor, BJC). DOE initiated the transfer of most waste management responsibilities back to ORNL on October 1, 2008, to give waste generators across ORNL incentive to find new ways of doing business to eliminate and/or reduce waste generation. When the waste-generating organization is fully responsible for managing the waste it generates, it can also experience the full benefit in making investments in new technology and equipment to eliminate the generation of waste streams. Waste management responsibility is currently shared only for those waste streams that are still both being generated by DOE-SC and DOE-EM activities at ORNL (e.g., TRU waste and certain liquid and gaseous waste streams that can be treated by the on-site ORNL liquid and gaseous waste system operated by DOE-EM and its contractors).

The transition of waste management responsibilities at ORNL that took effect the beginning of FY 2009 went smoothly, and ORNL newly generated waste continues to be safely and effectively dispositioned using a combination of commercial waste vendors and government-owned waste disposal sites. ORNL maintains contracts with a variety of commercial waste vendors to provide for the required transport, treatment, and safe disposal of hazardous, mixed, and some radioactive waste streams. The other radioactive waste streams from ORNL are dispositioned at the National Nuclear Security Administration's (NNSA's) Nevada National Security Site (formerly known as the Nevada Test Site), for which ORNL is an approved waste generator. Standard industrial waste generated by ORNL is dispositioned in DOE's ORR industrial waste landfills located near Y-12. Finally, certain waste streams generated from environmental remediation projects at ORNL may also be dispositioned in the Oak Ridge EMWMF located near Y-12, if approved by regulatory agencies in accordance with the Oak Ridge Federal Facilities Agreement.

ORNL management of newly generated waste is fully regulated by a number of federal and state laws and associated regulations. In Oak Ridge, most of these regulations are implemented by the state of Tennessee, with TDEC overseeing waste management activities. ORNL waste management officials routinely meet with TDEC DOE Oversight Division staff to brief them on the status of waste management activities, and compliance audits of waste management activities are routinely performed by TDEC. ORNL's radioactive waste activities are performed under the authority of DOE's Radioactive Waste Management Order (DOE Order 435.1), with which ORNL fully complies. Radioactive waste activities are routinely reviewed with DOE officials to ensure the requirements of the radioactive waste order are being met.

5.8.8.3 Transuranic Waste Processing Center

Transuranic (TRU) waste-processing activities carried out for DOE in 2010 by WAI address the three remaining waste streams stored at ORNL—CH solids/debris, RH solids/debris, and RH sludge—and involve processing, treatment, repackaging, and off-site transportation and disposal at either the Nevada Test Site or the Waste Isolation Pilot Plant in New Mexico.

The TWPC was designed and constructed to treat and dispose of 900 m^3 of RH sludge, 550 m^3 of RH-TRU/alpha LLW solids, 1,600 m^3 of RH LLW supernate, and 1,000 m^3 of CH TRU/alpha LLW solids currently stored in Melton Valley. The forecast for waste quantities to be processed at the TWPC has been updated to include the latest estimates: 2,000 m^3 of RH sludge, 700 m^3 of RH-TRU solids, and 1,500 m^3 of CH-TRU solids. CH-TRU processing started in December 2005, and RH-TRU processing started in May 2008. During CY 2010, 284.9 m^3 of CH waste and 54.2 m^3 of RH waste was processed. In CY 2010, 353.5 m^3 of CH waste and 32.4 m^3 of RH waste was shipped off-site.

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6. ORR Environmental Monitoring Program

In addition to environmental monitoring conducted at the three major Oak Ridge DOE installations, reservation-wide environmental monitoring is performed to measure radiological and nonradiological parameters directly in environmental media adjacent to the facilities. Data from the ORR-wide environmental monitoring program are analyzed to assess the environmental impact of DOE operations on the entire reservation and the surrounding area. Dose assessment information based on data from this program is presented in Chapter 7.

Because of differing permit reporting requirements and instrument capabilities, various units of measurement are used in this report. The list of units of measure and conversion factors provided on page xxv is intended to help readers convert numeric values presented herein as needed for specific calculations and comparisons.

6.1 Meteorological Monitoring

Eight meteorological towers provide data on meteorological conditions and on the transport and diffusion qualities of the atmosphere on the ORR. Data collected at the towers are used in routine dispersion modeling to predict impacts from facility operations and as input to emergency-response atmospheric models, which would be used in the event of accidental releases from a facility. Data from the towers are also used to support various research and engineering projects.

6.1.1 Description

The eight meteorological towers on the ORR are described in Table 6.1 and depicted in Fig. 6.1. The "MT" name format for the meteorological towers is used in this document; however, other commonly used names for the sites are provided in Table 6.1. Meteorological data are collected at different levels (2, 10, 15, 30, 33, 60, and 100 m above the ground) to assess the vertical structure of the atmosphere, particularly with respect to wind shear and stability. Stable boundary layers and significant wind shear zones (associated with the local ridge-and-valley terrain as well as the Great Valley; see Appendix C) can significantly affect the movement of a plume after a facility release (Bowen et al. 2000). Data are collected at the 10-m level at all towers except Towers MT3 and MT9, where lower-level data are collected at 15 m. Additionally, at selected towers, data are collected at the 30-, 33-, 60-, and 100-m levels. At each measurement level, temperature, wind speed, and wind direction are measured. Data needed to determine atmospheric stability (a measure of vertical mixing properties of the atmosphere) are measured at most towers. Barometric pressure is measured at one or more of the towers at each facility (MT1, MT2, MT7, and MT9). Precipitation is measured at MT6 and MT9 at the Y-12 Complex, at MT1 and MT7 at the East Tennessee Technology Park (ETTP), and at MT2 and MT4 at Oak Ridge National Laboratory (ORNL). Solar radiation is measured at MT6 and MT9 at the Y-12 Complex, at MT1 and MT7 at the ETTP, and at MT2 at ORNL. Data are collected at 1-, 15-, and 60- min intervals. Quarterly calibrations of the instruments are managed by UT-Battelle and B&W Y-12.

In addition to the meteorological towers, sonic detection and ranging (SODAR) devices have been located at the east end of Y-12 and at Tower MT2 at ORNL. These devices use acoustic waves to estimate wind direction, wind speed, and turbulence at altitudes higher than the meteorological towers can measure (generally 100 to 400 m above ground level). Although the SODAR measurements are less accurate than meteorological tower measurements, the SODAR devices provide useful information regarding stability, upper air wind conditions, and mixing height. Mixing height is the depth of the air layer adjacent to the ground over which an emitted or entrained inert nonbuoyant tracer will be mixed (by turbulence) within a time scale of about 1 h or less.

Data are collected in real time at 15-min and hourly intervals for emergency-response purposes, such as for input to dispersion models. Data from the eight ORR meteorological towers are distributed to dispersion models at the ORNL and Y-12 Emergency Operations Centers.

Table 6.1. Oak Ridge Reservation meteorological towers

Tower	Alternate tower names	Location lat., long.	Altitude (m MSL)[a]	Measurement heights (m)
		ETTP		
MT1	"K," 1208	35.93317N, 84.38833W	253	10, 60
MT7	"L," 1209	35.92522N, 84.39414W	233	10, 30
		ORNL		
MT2	"C," 1057	35.92559N, 84.32379W	261	10, 30, 100
MT3	"B," 6555	35.93273N, 84.30254W	256	15, 30
MT4	"A," 7571	35.92185N, 84.30470W	263	10, 30
MT10	"M," 208A	35.90947N, 84.38796W	237	10
		Y-12 Complex		
MT6	"W," West	35.98467N, 84.26550W	326	2, 10, 30, 60
MT9	"Y," PSS Tower	35.98745N, 84.25363W	290	15, 33

[a]Mean sea level.

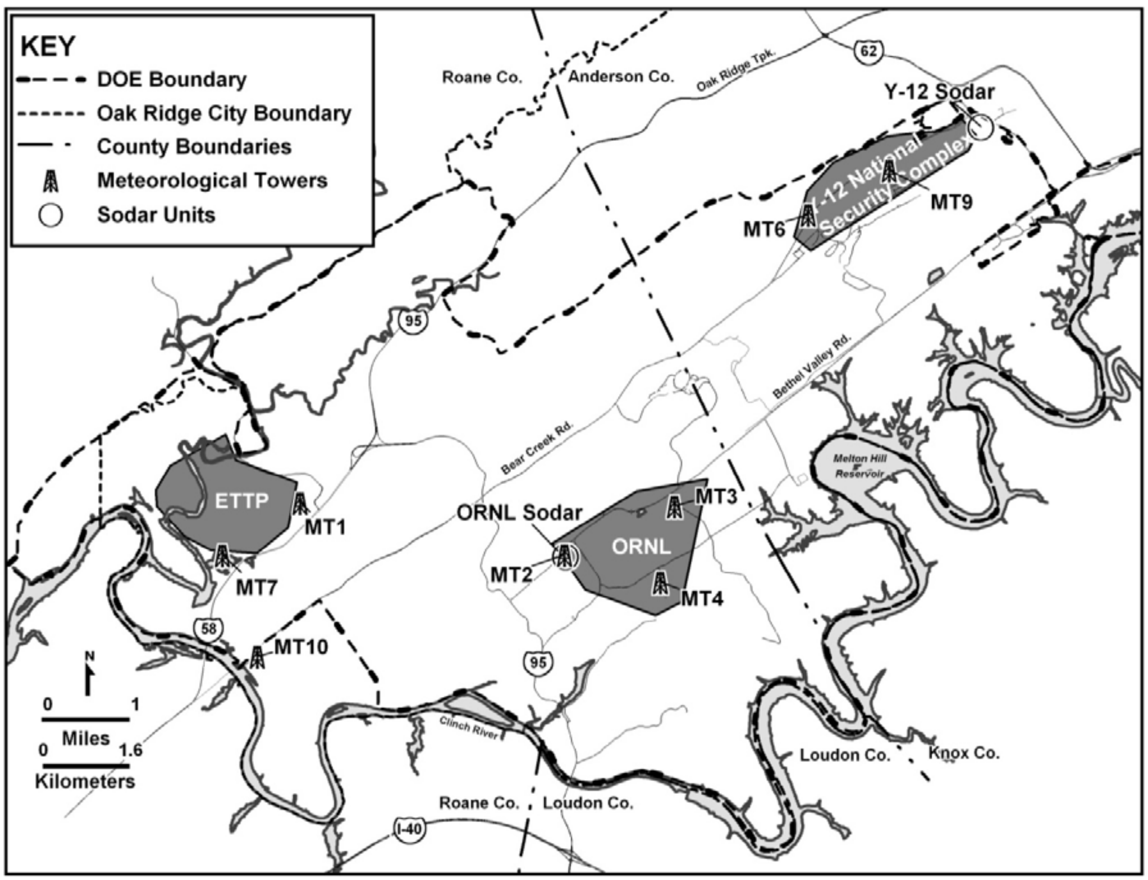

Fig. 6.1. The ORR meteorological monitoring network (SODAR: sonic detection and ranging wind profiler).

Annual dose estimates are calculated using the archived hourly data. Data quality is checked continuously against predetermined data constraints, and out-of-range parameters are marked invalid and are excluded from compliance modeling. Quality assurance records of data problems and errors are routinely kept for all eight tower sites.

6.1.2 Meteorological Impacts on Modeling Results

Prevailing winds are generally up-valley from the southwest and west-southwest or down-valley from the northeast and east-northeast. This pattern is often the result of the channeling effect of the ridges flanking the ORR sites. Winds in the valleys tend to follow the ridge axes, with limited cross-ridge flow within local valley bottoms. These conditions are dominant over most of the ORR, with the exception of the ETTP, which is located in a relatively open valley bottom (resulting in slightly more varied flow).

On the ORR, low-speed winds dominate near the surface. This characteristic is typical of most near-surface measurements (as influenced by nearby ridges and mountains). Winds sometimes accelerate at ridgetop level, particularly when winds are not exactly parallel to the ridges (see Appendix C).

The atmosphere over the ORR is dominated by stable conditions on most nights and for a few hours after sunrise. These conditions, when coupled with the low wind speeds and channeling effects of the valleys, result in poor dilution of material emitted from the facilities. However, high roughness values (caused by terrain and obstructions such as trees and buildings) may partially mitigate these factors through increased turbulence (atmospheric mixing). These features are captured in the data input to the dispersion models and are reflected in the modeling studies conducted for each facility.

Precipitation data from Tower MT2 are used in stream-flow modeling and in certain research efforts. The data indicate the variability of regional precipitation: the high winter rainfall resulting from frontal systems and the uneven, but occasionally intense, summer rainfall associated with thunderstorms. The total precipitation at Oak Ridge (town site) during 2010 (1,306 mm or 51.38 in.) was near the long-term average of 1,343 mm (52.85 in.), yielding only a 3% deficit compared with the 30-year means.

The average data recovery rates (a measure of acceptable data) across locations used for modeling during 2010 were greater than 98.7% for ORNL sites (Towers MT2, MT3, MT4, and MT10); greater than 97.9% for ETTP sites (Towers MT1 and MT7); and 99.2% for Y-12 sites (Towers MT6 and MT9). Nearly all data recovery locations exceeded the required 90% per quarter recovery rate. Those locations that did not exceed the requirement were (1) Tower MT4 10-m temperatures for 2010 Quarters 1 and 2 and (2) Tower MT7 for three weeks of data in the December 2010 4th Quarter. In the former case, temperature data were successfully substituted from Towers MT3/MT4. In the latter case, data recovery was only slightly below the 90% threshold (89.4 to 89.6%). Data loss for Tower MT7 during the 2010 4th Quarter was related to the transfer of electrical power service to the jurisdiction of the City of Oak Ridge.

6.2 External Gamma Radiation Monitoring

6.2.1 Data Collection and Analysis

External gamma measurements (exposure rates) are recorded weekly at six ambient air stations from resident external gross gamma monitors (Fig. 6.2). Each consists of a dual-range, high-pressure ion chamber sensor and digital electronic count-rate meter and a totalizer. Totalizing consists of multiplying the count rate by the time of exposure to obtain total exposure.

6.2.2 Results

Table 6.2 summarizes the data collected at each station during the year. Values in this table have previously been presented as dose rates but this year are reported as exposure rates, in μR/h, to more accurately present actual measured values. The mean observed exposure rate for the reservation network for 2010 was 7. 9 μR/h, and the average at the reference location was 7.1 μR/h. Exposure rates from background sources in Tennessee range from 2.9 to 11 μR/h. The average ORR exposure rate was within the range of normal background levels in Tennessee, indicating that activities on the ORR do not increase external gamma levels in the area above normal background levels.

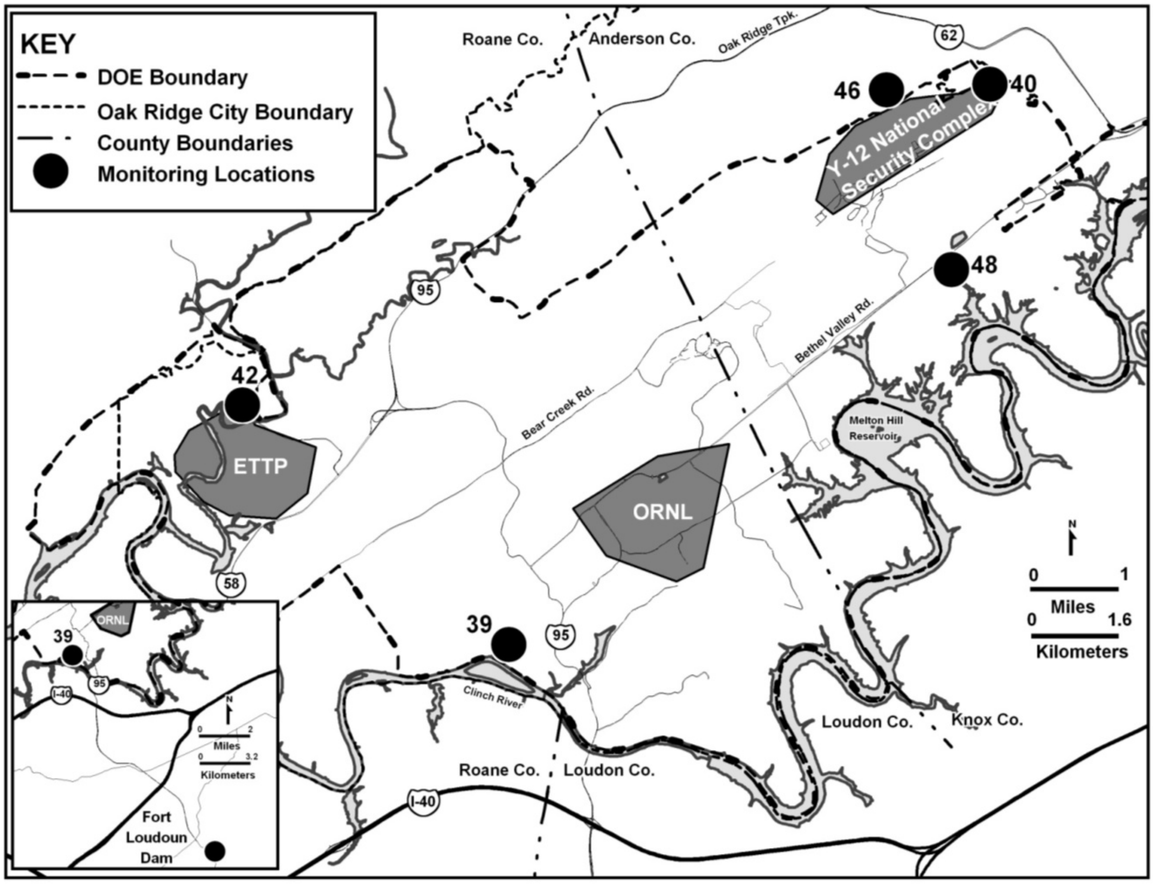

Fig. 6.2. External gamma radiation monitoring locations on the ORR.

Table 6.2. External gamma (exposure rates) averages for the ORR, 2010

Monitoring location	Number of data values collected	Measurement (μR/h)[a]		
		Min	Max	Mean
39	52	8.3	9.7	9.0
40	52	3.5	8.6	8.0
42	52	6.4	8.2	7.2
46	52	7.8	9.5	8.8
48	52	5.5	7.8	6.5
52	47	6.3	7.8.	7.1

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

6.3 Ambient Air Monitoring

In addition to exhaust stack monitoring conducted at the DOE Oak Ridge installations, ambient air monitoring is performed to measure radiological parameters directly in the ambient air adjacent to the facilities (Fig. 6.3). Ambient air monitoring provides a means to verify that contributions of fugitive and diffuse sources are insignificant, serves as a check on dose-modeling calculations, and would allow determination of contaminant levels at monitoring locations in the event of an emergency.

ORNL 2011-G00537/chj

Fig. 6.3. ORR Ambient Air Station

Ambient air monitoring conducted by individual site programs is discussed in Chapters 3, 4, and 5. An ORR ambient air monitoring program complements these individual site programs and permits the assessment of the impacts of ORR operations on an integrated basis. This program is discussed in detail in the following sections.

6.3.1 ORR Ambient Air Monitoring

The objectives of the ORR ambient air monitoring program are to perform surveillance of airborne radionuclides at the reservation perimeter and to collect reference data from a location not affected by activities on the ORR. The ORR perimeter air monitoring network includes stations 35, 37, 38, 39, 40, 42, 46, and 48 (Fig. 6.4). Reference samples are collected from Station 52 (Fort Loudoun Dam). Sampling was conducted at each ORR station during 2010 to quantify levels of alpha-, beta-, and gamma-emitting radionuclides.

Atmospheric dispersion modeling was used to select appropriate sampling locations. The locations selected are those likely to be affected most by releases from the Oak Ridge facilities. Therefore, in the event of a release, no residence or business in the vicinity of the ORR should receive a radiation dose greater than doses calculated at the sampled locations.

The sampling system consists of two separate instruments. Particulates are captured on glass-fiber filters using high-volume air samplers. The filters are collected weekly, composited quarterly, and then submitted to an analytical laboratory to quantify gross alpha and beta activity and to determine concentrations of specific isotopes of interest on the ORR. The second system is designed to collect tritiated water vapor. The sampler consists of a prefilter followed by an adsorbent trap consisting of indicating silica gel. The samples are collected weekly or biweekly, composited quarterly, and then submitted to an analytical laboratory for ^{3}H analysis.

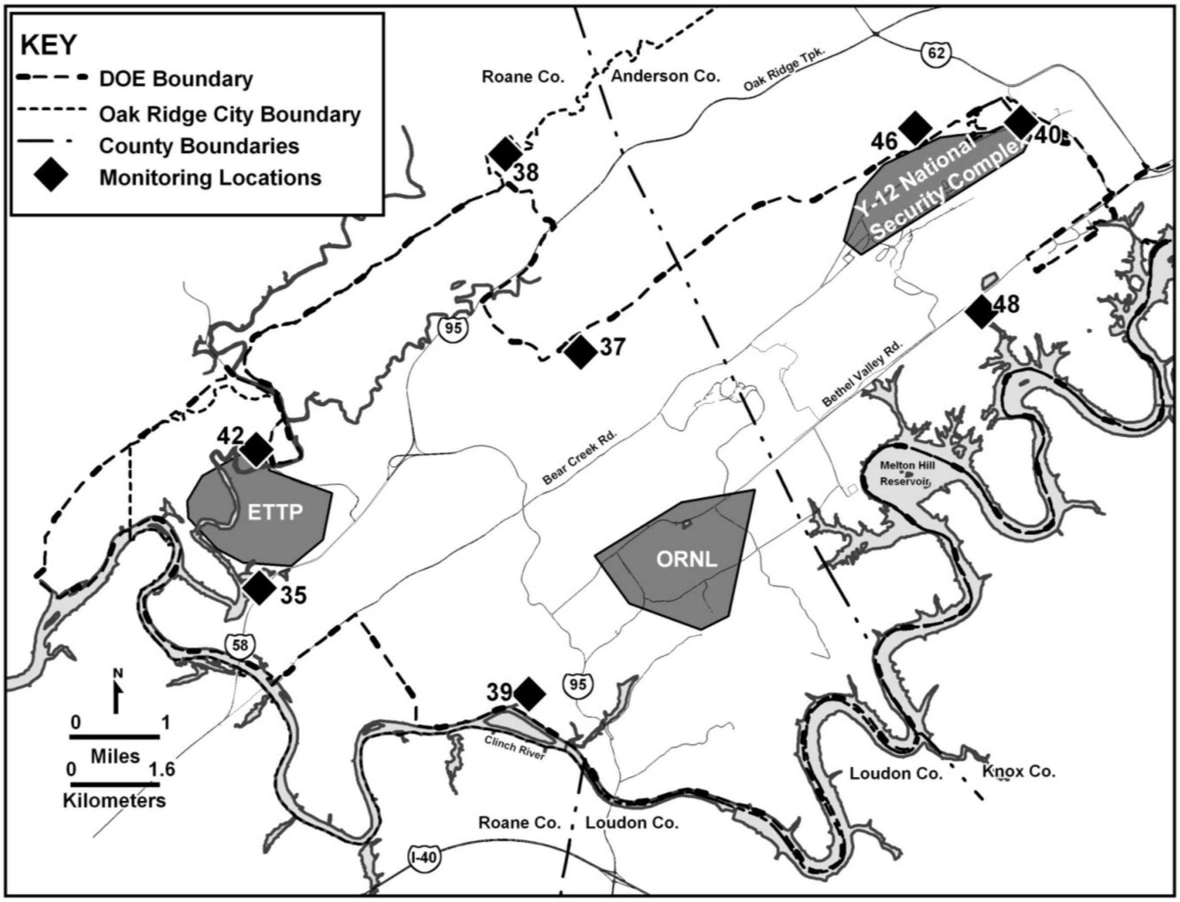

Fig. 6.4. Locations of ORR perimeter air monitoring stations.

6.3.2 Results

Data from the ORR ambient air stations are analyzed to assess the impact of DOE operations on the local air quality. Each measured radionuclide concentration is compared with the appropriate derived concentration guide (DCG). DCGs serve as standard reference values for conducting environmental protection programs at DOE sites. All radionuclide concentrations measured at the ORR ambient air stations during 2010 were less than 1% of applicable DCGs, indicating that activities on the reservation are not adversely affecting local air quality. Statistical significance testing is also performed to compare average radionuclide concentrations measured at ORR ambient air stations with concentrations measured at the reference location. This test reflects the mathematical probability of certain outcomes but is not an indication of environmental significance. There were no calculated statistical differences in average concentrations of ^{7}Be or ^{40}K. The concentrations of ^{3}H, ^{234}U, ^{235}U, and ^{238}U at the ORR ambient air stations were slightly higher than those observed at the background location at the 95% confidence level. A summary of radionuclide concentrations measured at the ambient air stations is presented in Table 6.3.

Table 6.3. Average radionuclide concentrations at ORR perimeter air monitoring stations, 2010

Parameter	No. detected/ no. total	Concentration (pCi/mL)[a,b]		
		Average	Minimum	Maximum
		Station 35		
^{7}Be	4/4	3.31E-08	2.87E-08	3.69E-08
^{40}K	0/4	1.54E-10	−1.48E-10	4.29E-10
^{3}H	2/4	2.01E-05	5.34E-06	4.24E-05
^{234}U	4/4	6.68E-12	4.63E-12	1.19E-11
^{235}U	1/4	1.94E-13	8.95E-14	3.39E-13
^{238}U	4/4	2.96E-12	2.09E-12	4.06E-12
		Station 37		
^{7}Be	4/4	3.36E-08	2.96E-08	3.87E-08
^{40}K	0/4	-1.08E-10	−1.01E-09	6.12E-10
^{3}	0/4	4.03E-06	9.99E-08	9.67E-06
^{234}U	4/4	4.69E-12	3.15E-12	7.02E-12
^{235}U	0/4	1.90E-13	6.87E-14	2.97E-13
^{238}U	4/4	2.04E-12	1.68E-12	2.69E-12
		Station 38		
^{7}Be	4/4	3.53E-08	2.87E-08	4.55E-08
^{40}K	0/4	8.65E-11	−3.15E-10	4.46E-10
^{3}H	1/4	4.04E-06	−6.01E-07	1.50E-05
^{234}U	4/4	6.83E-12	3.24E-12	1.67E-11
^{235}U	1/4	5.85E-13	1.43E-13	1.18E-12
^{238}U	4/4	3.16E-12	2.32E-12	3.88E-12
		Station 39		
^{7}Be	4/4	3.40E-08	2.79E-08	4.13E-08
^{40}K	0/4	-1.60E-10	−7.23E-10	2.30E-10
^{3}H	0/4	5.11E-06	2.92E-06	7.17E-06
^{234}U	4/4	4.91E-12	3.61E-12	8.02E-12
^{235}U	1/4	2.49E-13	4.39E-14	6.42E-13
^{238}U	4/4	2.20E-12	1.71E-12	2.57E-12
		Station 40		
^{7}Be	4/4	3.31E-08	2.84E-08	3.68E-08
^{40}K	0/4	-3.06E-10	−6.33E-10	2.13E-10
^{3}H	0/4	4.43E-06	7.62E-08	1.01E-05
^{234}U	4/4	2.12E-11	1.61E-11	2.50E-11
^{235}U	3/4	7.87E-13	5.00E-13	1.05E-12
^{238}U	4/4	4.16E-12	3.89E-12	4.77E-12
		Station 42		
^{7}Be	4/4	3.61E-08	3.12E-08	4.40E-08
^{214}Bi	1/4	1.68E-10	1.68E-10	1.68E-10
^{40}K	0/4	-1.40E-10	−3.59E-10	8.88E-11
^{3}H	1/4	8.36E-06	4.78E-06	1.80E-05
^{234}U	4/4	1.80E-11	4.22E-12	4.46E-11
^{235}U	1/4	1.08E-12	2.32E-13	3.01E-12
^{238}U	4/4	3.49E-12	1.52E-12	5.03E-12
		Station 46		
^{7}Be	4/4	3.85E-08	3.33E-08	4.37E-08
^{40}K	0/4	-6.70E-11	−3.73E-10	4.26E-10
^{3}H	0/4	2.14E-06	−4.36E-07	4.23E-06
^{234}U	4/4	1.61E-11	8.51E-12	2.28E-11
^{235}	2/4	4.96E-13	−4.08E-14	8.79E-13
^{238}U	4/4	4.60E-12	3.95E-12	5.00E-12

Table 6.3. (continued)

Parameter	No. detected/ no. total	Concentration (pCi/mL)[a,b]		
		Average	Minimum	Maximum
		Station 48		
^{7}Be	4/4	3.78E-08	3.32E-08	4.22E-08
^{40}K	0/4	-6.99E-11	−4.10E-10	1.31E-10
^{3}H	0/4	3.42E-06	5.53E-07	5.03E-06
^{234}U	4/4	7.09E-12	4.93E-12	9.84E-12
^{235}U	0/4	3.58E-13	8.46E-14	6.79E-13
^{238}U	4/4	3.65E-12	3.21E-12	4.50E-12
		Station 52		
^{7}Be	4/4	4.22E-08	3.55E-08	5.09E-08
^{40}K	0/4	3.32E-10	−2.73E-10	7.80E-10
^{3}H	0/4	6.24E-07	−2.51E-06	4.31E-06
^{234}U	4/4	4.48E-12	3.28E-12	5.36E-12
^{235}U	0/4	3.01E-13	2.41E-13	3.92E-13
^{238}U	4/4	2.81E-12	2.08E-12	3.93E-12

[a]Units are picocuries per milliliter.

[b]Radiological results are reported after background activity has been subtracted. In cases where background activity exceeds the sample activity, this will result in negative values.

6.4 Surface Water Monitoring

6.4.1 ORR Surface Water Monitoring

The ORR surface water monitoring program consists of sample collection and analysis from five locations on the Clinch River, including public water intakes (Fig. 6.5). This program is conducted in conjunction with site-specific surface water monitoring activities to enable an assessment of the impacts of past and current DOE operations on the quality of local surface water.

Grab samples are collected quarterly at all five locations and are analyzed for general water quality parameters, screened for radioactivity, and analyzed for mercury and specific radionuclides when appropriate. Table 6.4 lists the specific locations and associated sampling frequencies and parameters.

The sampling locations are classified by the state of Tennessee for recreation and domestic use. Tennessee water quality criteria associated with these classifications are used as references where applicable (TDEC 2008). The Tennessee water quality criteria do not include criteria for radionuclides. Four percent of the DOE DCG is used for radionuclide comparison because this value is roughly equivalent to the 4-mrem dose limit from ingestion of drinking water on which the U.S. Environmental Protection Agency radionuclide drinking water standards are based.

6.4.2 Results

Comparison of 2010 surface water sample results from locations upstream of DOE inputs with results from surface water samples obtained downstream of DOE inputs shows no statistically significant difference for any of the radionuclides; none of the radionuclides at any location was detected above 4% of the respective DCG or the 4-mrem dose limit, which is the maximum contaminant limit (MCL) for beta and photon emitters in community drinking water systems (Code of Federal Regulations: Title 40: Protection of the Environment, 40 CFR 141.66, December 2005). There were no mercury detections above MCLs at the three designated sampling locations for this parameter.

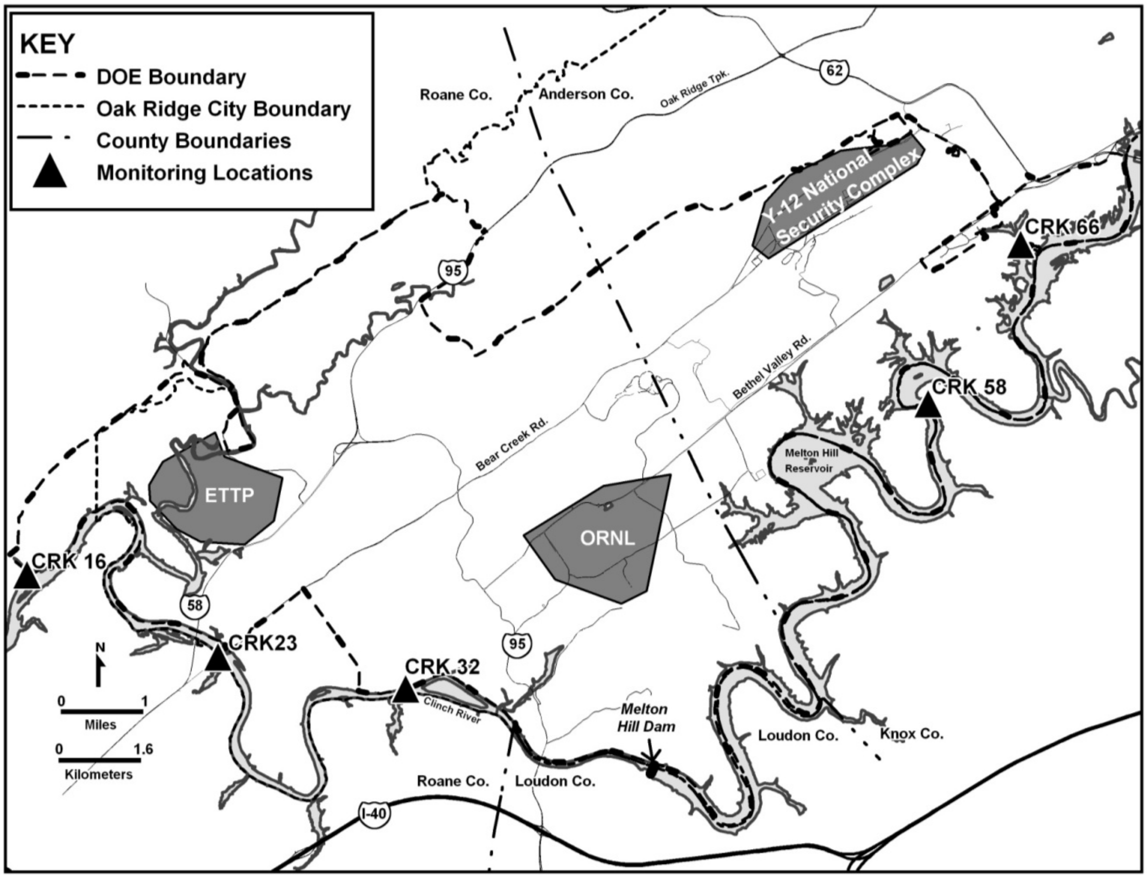

Fig. 6.5. ORR surface water surveillance sampling locations.

Table 6.4. ORR surface water sampling locations, frequencies, and parameters, 2010

Location[a]	Description	Frequency	Parameters
CRK 16	Clinch River downstream from all DOE ORR inputs	Quarterly	Mercury, gross alpha, gross beta, gamma scan, ^{3}H, field measurements[b]
CRK 23	Water supply intake for the ETTP	Quarterly	Mercury, gross alpha, gross beta, gamma scan, ^{3}H, field measurements[b]
CRK 32	Clinch River downstream from ORNL	Quarterly	Gross alpha, gross beta, gamma scan, total radioactive strontium, ^{3}H, field measurements[b]
CRK 58	Water supply intake for Knox County	Quarterly	Gross alpha, gross beta, gamma scan, ^{3}H, field measurements[b]
CRK 66	Melton Hill Reservoir above city of Oak Ridge water intake	Quarterly	Mercury, gross alpha, gross beta, gamma scan, total radioactive strontium, ^{3}H, field measurements[b]

[a]Locations indicate bodies of water and distances (e.g., Clinch River kilometer 16 = 16 km upstream from the confluence of the Clinch River with the Tennessee River, Watts Bar Reservoir).

[b]Field measurements consist of dissolved oxygen, pH, and temperature.

6.5 Food

Vegetation samples are collected from areas that could be affected by activities on the reservation. Analysis of the samples enables the evaluation of potential radiation doses received by people who consume local food crops. Food crop monitoring data are also used to monitor trends in environmental contamination and possible long-term accumulation of radionuclides.

6.5.1 Vegetables

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

6.5.1.1 Results

Samples were analyzed for gross alpha, gross beta, gamma emitters, and uranium isotopes. No gamma-emitting radionuclides were detected above the minimum detectable activity (MDA), with the exception of the naturally occurring radionuclides ^{7}Be and ^{40}K. Concentrations of radionuclides detected above MDA are shown in Table 6.5.

6.5.2 Milk

Ingestion is one of the pathways of exposure to radioactivity for humans. Radionuclides can be transferred from the environment to people via food chains such as the grass–cow–milk pathway. Milk is a potentially significant source to humans of some radionuclides deposited from airborne emissions because of the relatively large surface area that a cow can graze daily, the rapid transfer of milk from producer to consumer, and the importance of milk in the diet.

The 2010 milk-sampling program consisted of grab samples collected every other month from a commercial dairy in Claxton and two reference locations, one in Maryville and one in Louisville (Fig. 6.6). Sampling at the Louisville reference location was discontinued after June 2010. Milk samples are analyzed for gamma emitters and for total radioactive strontium (^{89}Sr + ^{90}Sr) by chemical separation and low-background beta counting. Liquid scintillation is used to analyze for ^{3}H.

6.5.2.1 Results

Concentrations of radionuclides detected above MDA in milk are presented in Table 6.6. Total radioactive strontium (^{89}Sr + ^{90}Sr) was detected twice at the Claxton location. Total radioactive strontium (^{89}Sr + ^{90}Sr) was also detected three times at the reference locations. The total radioactive strontium measurement for the December sampling event at the Claxton location was 6.96 pCi/L, which is the highest level that has been detected at this site since sampling began in 2000. Total radioactive strontium was also detected at the reference location (unaffected by DOE activities) at 3.15 pCi/L, indicating a potential analytical laboratory interference. Investigations, including laboratory inquiries, identification of feed and water sources, and benchmarking with other DOE facilities, were conducted to determine potential causes for these atypical results. No identifiable cause has been identified. Two subsequent rounds of sampling were conducted in February and April of 2011, and results indicate that there are no ongoing issues or developing trends.

Table 6.5. Concentrations of radionuclides detected in vegetables, 2010 (pCi/kg)[a]

Location	Gross alpha	Gross beta	^{7}Be	^{40}K	^{234}U	^{235}U	^{238}U
			Lettuce				
East of ORR (Claxton vicinity)	0.000041	0.0026	*b*	0.0030	*b*	*b*	*b*
North of ETTP	0.000034	0.0040	*b*	0.0046	0.0000087	*b*	0.0000056
Northeast of Y-12, Scarboro #2	*b*	0.0026	*b*	0.0048	0.000022	*b*	0.000028
Southwest of ORNL, Lenoir City #1	0.000046[c]	0.0045	*b*	0.0053	*b*	*b*	*b*
Southwest of ORNL, Lenoir City #2	0.000022	0.0020	*b*	0.0058	*b*	*b*	*b*
Reference location, Maryville	0.000027	0.0022	*b*	0.0064	*b*	*b*	*b*
			Tomato				
East of ORR (Claxton vicinity)	*b*	0.00080	*b*	*B*	0.000027	*b*	*b*
North of ETTP	*b*	0.00082	*b*	0.0025	*b*	*b*	*b*
Northeast of Y-12, Scarboro #2	*b*	0.00095	*b*	0.0012	*b*	*b*	*b*
Southwest of ORNL, Lenoir City #1	*b*	0.00064	*b*	0.0020	*b*	*b*	*b*
Southwest of ORNL, Lenoir City #2	*b*[d]	0.0011	*b*	0.0013	0.0000041	*b*	*b*
Reference location, Maryville	0.000026	0.00045	*b*	0.0017	*b*	*b*	*b*
			Turnips				
East of ORR (Claxton vicinity)	0.00028	0.0011	*b*	0.0022	*b*	*b*	*b*
North of ETTP	0.000032	0.0016	*b*	0.0026	*b*	*b*	*b*
Northeast of Y-12, Scarboro #2	0.00019	0.0018	*b*	0.0032	*b*	*b*	*b*
Southwest of ORNL, Lenoir City #1	*b*	0.0011	*b*	0.0033	*b*	*b*	*b*
Southwest of ORNL, Lenoir City #2	*b*	0.0014	*b*	0.0026	*b*	*b*	*b*
Reference location, Maryville	0.000031	0.00099	*b*	*b*	*b*	*b*	*b*

[a]Detected radionuclides are those at or above minimum detectable activity. 1 pCi = 3.7×10^{-2} Bq.

[b]Value was not above minimum detectable activity.

[c]Additional analyses were conducted to identify alpha activity: ^{241}Am was detected at 0.0000034 pCi/kg and ^{232}Th was detected at 0.000016 pCi/kg; none of the following were above minimum detectable activity: ^{242}Cm, ^{244}Cm, ^{237}Np, ^{238}Pu, $^{239/240}$Pu , ^{228}Th, and ^{230}Th.

[d]Additional analyses were conducted to identify alpha activity: ^{232}Th was detected at 0.000017 pCi/kg; none of the following were above minimum detectable activity: ^{241}Am, ^{242}Cm, ^{244}Cm, ^{237}Np, ^{238}Pu, $^{239/240}$Pu , ^{228}Th, and ^{230}Th.

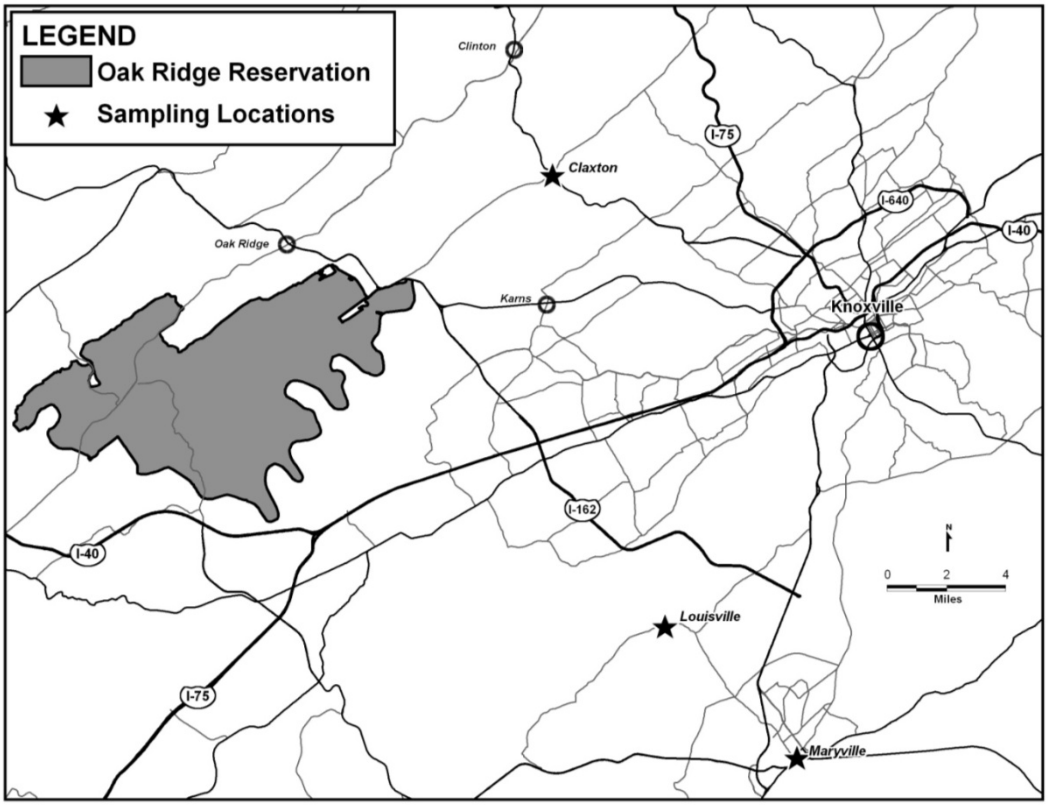

Fig. 6.6. Milk sampling locations in the vicinity of the ORR.

Table 6.6. Concentration of radionuclides detected in raw milk, 2010

Analysis	No. detected/ no. total	Detected concentration (pCi/L)[a] Max	Min	Avg	Standard error of mean
		Claxton			
Potassium-40	6/6	1400[b]	1100[b]	1200[b]	52
Total rad Sr	2/6	7.0[b]	−0.29	2.4[b]	1.0
		Combined reference locations			
Potassium-40	9/9	1500[b]	1100[b]	1300[b]	47
Total rad Sr	3/9	3.2[b]	−0.053	1.5[b]	0.39

[a]Detected radionuclides are those above minimum detectable activity.
1 pCi = 3.7×10^{12} Bq.

[b]Individual and average concentrations significantly greater than zero at the 95% confidence level.

6.6 Fish

Members of the public could be exposed to contaminants originating from DOE-ORO activities through consumption of fish caught in area waters. This potential exposure pathway is monitored by collecting fish from three locations on the Clinch River annually and analyzing edible fish flesh for specific contaminants. The locations are as follows (Fig. 6.7):

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

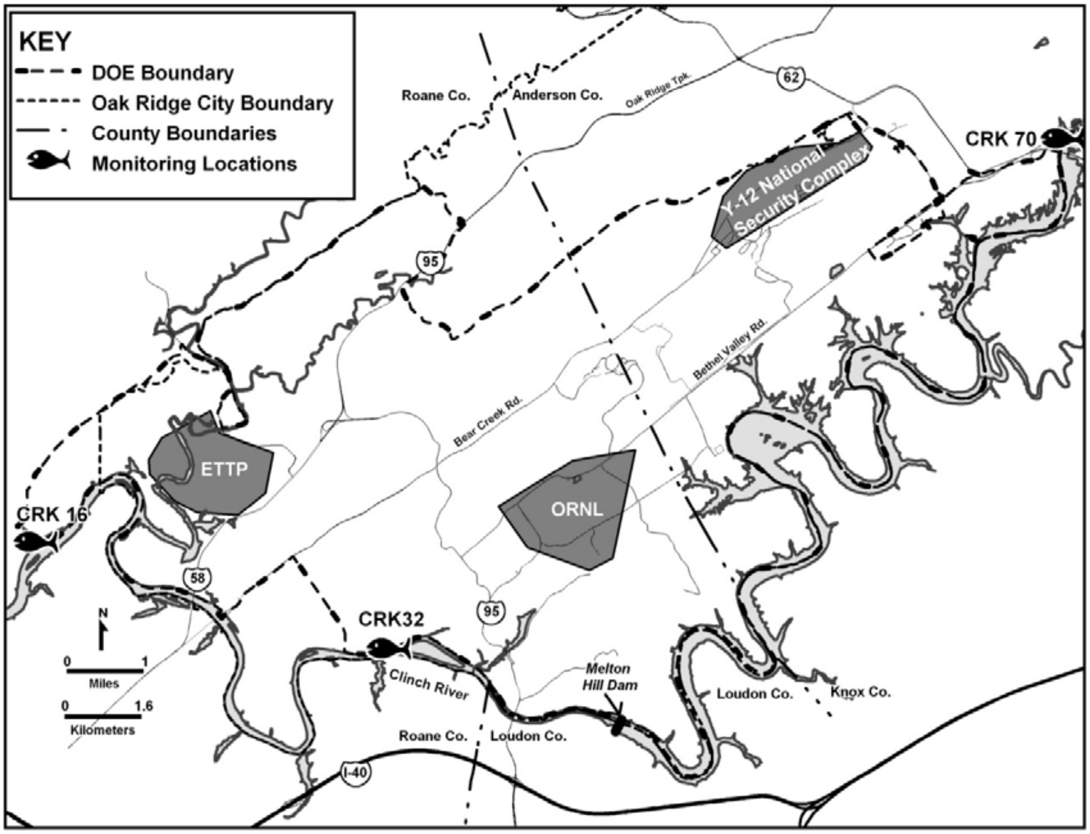

Fig. 6.7. Fish sampling locations for the ORR.

Sunfish (*Lepomis macrochirus*, *L. auritus*, and *Ambloplites rupestris*) and catfish (*Ictalurus punctatus*) are collected from each of the three locations to represent both top-feeding and bottom-feeding-predator species. In 2010, a composite sample for each of these species at each location was analyzed for selected metals, polychlorinated biphenyls (PCBs), ^{3}H, gross alpha, gross beta, gamma-emitting radionuclides, and total radioactive strontium. In order to accurately estimate exposure levels to consumers, only edible portions of the fish were submitted for analyses.

It should be noted that TDEC issues advisories for consumption of certain species of fish caught in specified Tennessee waters. These advisories apply to fish that could contain potentially hazardous contaminants. A “do not consume” advisory has been issued by TDEC for catfish in the Melton Hill Reservoir in its entirety, and not just in those areas that could be impacted by ORR activities, because of PCB contamination. Similarly, a precautionary advisory for catfish in the Clinch River arm of Watts Bar Reservoir has been issued because of PCB contamination (TDEC 2008).

6.6.1 Results

Detected PCBs, mercury, and radionuclides are shown in Table 6.7. PCBs and mercury were detected in both sunfish and catfish at all three locations in 2010. Aroclor-1260 was detected in both species at all locations; Aroclor-1254 was observed in the both species of fish at CRK 32 (Aroclor-1260 and -1254 are PCBs). These results are consistent with the TDEC advisories discussed above.

Radiological analyses for fish tissues sampled in 2010 showed statistical differences (at the 95% confidence level) in gross beta results from sunfish collected upstream from ORNL relative to results from sunfish collected downstream of ORNL. Similarly, results for ^{90}Sr in both catfish and sunfish indicated statistical differences between ^{90}Sr levels observed in upstream and downstream samples. There were no other statistical differences in radionuclide concentrations in upstream and downstream locations, indicating that DOE activities on the ORR are not significant contributors to public radiological dose from fish consumption.

Table 6.7. 2010 tissue concentrations in catfish and sunfish for mercury, detected PCBs, and detected radionuclides[a]

Parameter	Catfish[b]	Sunfish[b]
Clinch River downstream from all DOE ORR inputs (CRK 16)		
Metals (mg/kg)		
Mercury	0.33	0.39
Pesticides and PCBs (µg/kg)		
PCB-1260	300	31
Radionuclides (pCi/g)[c]		
Beta activity	2.9*	1.8*
Potassium-40	3.7*	3.2*
Strontium-90	.079*	0.0057
Clinch River downstream from ORNL (CRK 32)		
Metals (mg/kg)		
Mercury	0.31	0.11
Pesticides and PCBs (µg/kg)		
PCB-1254	39	U20
PCB-1260	120	J17
Radionuclides (pCi/g)[c]		
Beta activity	2.6*	1.9*
Potassium-40	3.0*	2.1*
Strontium-90	0.0031	0.042*
Clinch River (Solway Bridge) upstream from all DOE ORR inputs (CRK 70)		
Metals (mg/kg)		
Mercury	0.16	0.16
Pesticides and PCBs (µg/kg)		
PCB-1260	140	34
Radionuclides (pCi/g)[c]		
Beta activity	2.6*	0.92*
Potassium-40	4.8*	2.3*

[a]Only parameters that were detected for at least one species are listed in the table. The sampling and analysis plan contains a complete list of analyses performed.

[b]Prefix "U" indicates that the value was undetected at the analytical detection limit and prefix "J" indicates that the result is estimated.

[c]Radionuclide concentrations significantly greater than zero are identified by an asterisk (*). Detected radionuclides are those at or above MDA.

[d] Radiological results are reported after background activity has been subtracted. Where background activity exceeds sample activity, this will result in negative values.

Abbreviations

CRK = Clinch River kilometer

MDA = minimum detectable activity

PCB = polychlorinated biphenyl

6.7 White-Tailed Deer

Three deer hunts were held on the ORR during the final quarter of 2010. ORNL staff, Tennessee Wildlife Resources Agency (TWRA) personnel, and student members of the Wildlife Society (University of Tennessee chapter) performed most of the necessary operations at the checking station.

The 2010 hunts were held on three weekends. Shotgun/muzzleloader and archery hunts were held October 23–24, November 13–14, and December 11–12. In 2010, there were about 450 shotgun/muzzleloader–permitted hunters and 675 archery-permitted hunters. The Tower Shielding area, Park City Road/Chestnut Ridge area, and Poplar Creek Road area were opened for an archery-only hunt on all three weekends. There was a two-deer limit for the November and December hunts; one could be an antlered buck.

The year's total harvest was 357 deer. From the total deer harvest, 216 (60.5%) were bucks and 141 (39.5%) were does. The heaviest buck had ten antler points and weighed 181 lb. The greatest number of antler points found on one buck was 13. The heaviest doe weighed 112 lb.

Since 1985 11,056 deer have been harvested. Of these only 200 (1.8%) have been retained as a result of potential radiological contamination. The heaviest buck was 218 lb (harvested in 1998); the average weight is 85.9 lb. The oldest deer harvested was 12 years old; the average age is 2.0 years. For more information, see the ORNL wildlife webpage: http://www.ornl.gov/sci/rmal/huntinfo.htm.

6.7.1 Results

The wildlife administrative release limits associated with deer, turkey, and geese harvested on the ORR are conservative and were established based on as-low-as-reasonably-achievable (ALARA) principles to ensure that doses to consumers of wildlife harvested on the reservation are managed and controlled to levels well below regulatory dose thresholds. The ALARA concept is not a dose limit but rather a philosophy that has the objective of maintaining exposures to workers, members of the public, and the environment below regulatory limits. The administrative release limit of 5 pCi/g for ^{137}Cs is based on the assumption that one person consumes all of the meat from a maximum-weight deer, goose or turkey. This limit ensures that members of the public who harvest wildlife on the reservation will not receive significant radionuclide doses from this consumption pathway. Similarly, the gross beta count administrative limit of 2.5 times background is near the detection limit for field measurements.

During the 2010 hunts, 357 deer were harvested on the ORR, and 3 (0.84%) were retained for exceeding the administrative release limits [1.5 times the background for beta activity in bone (~20 pCi/g) or 5 pCi/g of ^{137}Cs in edible tissue]. The three retained deer exceeded the limit for beta-particle activity in bone. The average weight of the released deer was 87.3 lb; the maximum weight was 181 lb. The average ^{137}Cs concentration in the released deer was 0.5 pCi/g, and the maximum ^{137}Cs concentration in the released deer was 1 pCi/g.

Total field-dressed weight of the released deer was 30,893 lb. It is assumed that 55% of the field weight is edible meat; therefore, the total harvest of edible meat (357 released deer) is estimated to be 16,991 lb.

6.8 Fowl

6.8.1 Waterfowl Surveys—Canada Geese

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

From the roundup, 46 geese were subjected to live whole-body gamma scans. The geese were collected from ORNL (17), Y-12 (10), and Clark Center Park (19). None exceeded the administrative release limits.

The same ^{137}Cs release administrative limit as is applied to deer is also applied to geese. For ^{137}Cs, the administrative release limit of 5 pCi/g assumes one person consumes all of the meat from a maximum-weight goose. The administrative limits were established to keep doses ALARA and to be consistent among harvested wildlife.

6.8.1.1 Results

The average ^{137}Cs concentration in the released geese was about 0.16 pCi/g. However, most of the ^{137}Cs concentrations were less than the minimum detection level. The maximum ^{137}Cs concentration in the released geese was about 0.41 pCi/g. The average weight of the geese screened during the roundup was 10.4 lb, and the maximum goose weight was 14.8 lb. No geese were sacrificed for radiological analyses in 2010.

6.8.2 Turkey Monitoring

Three wild turkey hunts managed by DOE and TWRA were held on the reservation (April 10 and 11, April 17 and 18, and November 13 and 14, 2010). Hunting was open for both shotguns and archery. Fifty-six turkeys were harvested, of which 5 (9%) were juveniles and 51 (91.1%) were adults. The average turkey weight was about 19.4 lb. The largest tom weighed 23.9 lb. The longest beard was 12 inches, and the average was 9.4 inches. The longest spur was 1.5 in. and the average was 0.9 in.

Since 1997, 602 turkeys have been harvested. Of these, only three (0.5%) have been retained because of potential radiological contamination. The heaviest turkey was 25.7 lb; the average weight is 18.8 lb. The longest spur on a turkey harvested on the ORR was 1.5 in. (average 0.8 in.) and the longest beard was 13.5 in. (average 9.2 in.). For additional information, see the ORNL wildlife webpage: http://www.ornl.gov/rmal/huntinfo.htm.

The same ^{137}Cs release administrative limits as are applied to deer and geese are also applied to turkey. For ^{137}Cs, the administrative release limit of 5 pCi/g assumes one person consumes all of the meat from a maximum-weight turkey. The administrative limits were established to keep doses ALARA and to be consistent between harvested wildlife.

6.8.2.1 Results

In 2010, none of the 56 turkeys harvested exceeded the administrative release limits established for radiological contamination. The average ^{137}Cs concentration in the released turkeys was 0.1pCi/g, and the maximum ^{137}Cs concentration in the released turkeys was 0.2 pCi/g. Most of the ^{137}Cs concentrations were less than the minimum detection level. It is assumed that about 50% of the field weight is edible meat; therefore, the average turkey would yield about 9.7 lb of meat. Based on the individual weights, the total harvest of edible meat (56 released turkeys) is estimated to be about 542 lb. No turkeys were sacrificed for radiological analyses in 2010.

6.9 Quality Assurance

The activities associated with administration, sampling, data management, and reporting for the ORR environmental surveillance programs are performed by the UT-Battelle Environmental Protection and Waste Services Division. Project scope is established by a task team whose members represent DOE, UT-Battelle, B&W Y-12, and BJC. UT-Battelle integrates quality assurance, environmental, and safety considerations into every aspect of ORR environmental monitoring. See Sect. 5.8 for a discussion of UT-Battelle quality assurance program elements for environmental monitoring and surveillance activities.

6.10 References

Bowen, B. M., J. A. Baars, and G. L. Stone. 2000. "Nocturnal Wind Shear and its Potential Impact on Pollutant Transport." *Journal of Applied Meteorology* **39**(3), 437–45.

TDEC. 2008. *The Status of Water Quality in Tennessee*. 305b Report. Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Nashville, Tennessee. April.

7. Dose

Activities on the ORR have the potential to release small quantities of radionuclides and hazardous chemicals to the environment. These releases could result in exposures of members of the public to low concentrations of radionuclides or chemicals. Monitoring of materials released from the reservation and environmental monitoring and surveillance on and around the reservation provide data used to show that doses from released radionuclides and chemicals are in compliance with the law.

A hypothetical maximally exposed individual could have received a total effective dose (ED) of about 0.4 mrem from radionuclides emitted to the atmosphere from all of the sources on the ORR in 2010; this is well below the National Emission Standards for Hazardous Air Pollutants standard of 10 mrem for protection of the public.

A worst-case analysis of exposures to waterborne radionuclides for all pathways combined gives a maximum possible individual ED of about 0.9 mrem. This dose is based on a person eating 21 kg/year of the most contaminated accessible fish, drinking 730 L/year of the most contaminated drinking water, and using the shoreline near the most contaminated stretch of water for 60 h/year. The estimated dose to an individual from the direct radiation pathway (e.g., shoreline use) is estimated to be approximately 0.3 mrem.

In addition, if a hypothetical person consumed one deer, one turkey, and two geese (containing the maximum ^{137}Cs concentration and maximum weights), that person could have received an ED of approximately 3 mrem. This calculation is conducted to provide an estimated upper-bound ED from consuming wildlife harvested from the ORR.

Therefore, the annual dose to a maximally exposed individual from all these potential exposure pathways was estimated to be approximately 4 mrem. DOE Order 5400.5 limits the ED that an individual may receive from all exposure pathways from all radionuclides released from the ORR during 1 year to no more than 100 mrem. The 2010 maximum ED was approximately 4% of the limit given in DOE Order 5400.5.

7.1 Radiation Dose

Small quantities of radionuclides were released to the environment from operations at ORR facilities during 2010. Those releases are described, characterized, and quantified in previous chapters of this report. This chapter presents estimates of potential radiation doses to the public from the releases. The dose estimates are performed using monitored and estimated release data, environmental monitoring and surveillance data, estimated exposure conditions that tend to maximize the calculated effective doses, and environmental transport and dosimetry codes that also tend to overestimate the calculated effective doses. Thus, the presented doses are conservative estimates of the potential doses received by people in the vicinity of the ORR.

7.1.1 Terminology

Exposures to radiation from nuclides located outside the body are called external exposures; exposures to radiation from nuclides deposited inside the body are called internal exposures. This distinction is important because external exposures occur only when a person is near or in a radionuclide-containing medium, whereas internal exposures continue as long as the radionuclides remain inside a person. Also, external exposures may result in uniform irradiation of the entire body, including all organs, while internal exposures usually result in nonuniform irradiation of the body and organs. When taken into the body, most radionuclides deposit preferentially in specific organs or tissues and thus do not irradiate the body uniformly.

A number of the specialized terms and units used to characterize exposures to ionizing radiation are defined in Appendix F. An important term to understand is “effective dose” (ED). ED is a risk-based equivalent dose that can be used to estimate health effects or risks to exposed persons. It is a weighted sum of dose equivalents to specified organs and is expressed in rems or sieverts (1 rem = 0.01 Sv).

One rem of ED, regardless of radiation type or method of delivery, has the same total radiological (in this case, also biological) risk effect. Because the doses being considered here are very small, EDs are expressed in millirem (mrem), which is one one-thousandth of a rem. (See Appendix F, Sects. F.5.6 through F.5.12 for a comparison and description of various dose levels.)

7.1.2 Methods of Evaluation

7.1.2.1 Airborne Radionuclides

The radiological consequences of radionuclides released to the atmosphere from ORR operations during 2009 were characterized by calculating, for each major facility and for the entire ORR, EDs to maximally exposed off-site individuals, to on-site members of the public, and to the entire population residing within 50 miles of the center of the ORR. The dose calculations were made using CAP-88PC Version 3 software program (CAP-88) developed under EPA sponsorship to demonstrate compliance with 40 CFR 61, Subpart H, which governs the emissions of radionuclides other than radon from DOE facilities. CAP-88 implements a steady-state Gaussian plume atmospheric dispersion model to calculate concentrations of radionuclides in the air and on the ground and uses food-chain models to calculate radionuclide concentrations in foodstuffs (vegetables, meat, and milk) and subsequent intakes by humans.

CAP-88 PC Version 3 calculates EDs using radionuclide-specific dose coefficients (ED per unit intake) from Federal Guidance Report (FGR) Number 13 (EPA 1999). The dose coefficients were calculated using the methods of Publication 72 of the International Commission on Radiological Protection (ICRP 1996). These coefficients are weighted sums of equivalent doses to 12 specified tissues or organs plus a remainder term that accounts for the rest of the tissues and organs in the body.

A total of 39 emission points on the ORR, each of which includes one or more individual sources, were modeled during 2010. The total includes three (two combined) points at the Y-12 Complex, 29 points at ORNL, and seven points at ETTP. Table 7.1 lists the emission-point parameter values and receptor locations used in the dose calculations.

Meteorological data used in the calculations for 2010 were in the form of joint frequency distributions of wind direction, wind speed class, and atmospheric stability category. (See Table 7.2 for a summary of tower locations used to model the various sources.) During 2010, rainfall, as averaged over the five rain gauges located on the ORR, was 128.9 cm. The average air temperature was 14.2°C, and the average mixing-layer height was 591.9 m. The mixing height is the depth of the atmosphere adjacent to the surface within which air is mixed.

For occupants of residences, the dose calculations assume that the occupant remained at home (actually, unprotected outside the house) during the entire year and obtained food according to the rural pattern defined in the National Emission Standards for Hazardous Air Pollutants (NESHAPs) background documents (EPA 1989). This pattern specifies that 70% of the vegetables and produce, 44.2% of the meat, and 39.9% of the milk consumed are produced in the local area (e.g., a home garden). The remaining portion of each food is assumed to be produced within 80 km of the ORR. The same assumptions are used for occupants of businesses, but the resulting doses are divided by 2 to compensate for the fact that businesses are occupied for less than one-half a year and that less than one-half of a worker's food intake occurs at work. For collective ED estimates, production of beef, milk, and crops within 80 km of the ORR was calculated using production rates provided with CAP-88.

Table 7.1. Emission point parameters and receptor locations used in the dose calculations

Source ID	Stack height (m)	Stack diameter (m)	Effective exit gas velocity (m/s)	Exit gas temperature (°C)	Distance (m) and direction to the maximally exposed individual[a]			
					Plant maximum		Oak Ridge Reservation maximum	
X-Lab Hoods								
X-1000 Lab Hoods	15	0.5	0	Ambient	430	N	430	N
X-2000 Lab Hoods	15	0.5	0	Ambient	100	SSW	100	SSW
X-3000 Lab Hoods	15	0.5	0	Ambient	570	W	570	W
X-4000 Lab Hoods	15	0.5	0	Ambient	790	W	790	W
X-6000 Lab Hoods	15	0.5	0	Ambient	1460	WSW	1460	WSW
X-7000 Lab Hoods	15	0.5	0	Ambient	1890	WNW	1890	WNW
X-2026	22.9	1.05	9.81	Ambient	210	W	210	W
X-2099	3.66	0.178	16.67	Ambient	240	W	240	W
X-3018	61	4.11	0.17	Ambient	NA[a]		NA	
X-3020	61	1.22	15.66	Ambient	380	WSW	380	WSW
X-3026								
3026 Tritium Lab	0	0.203	0	Ambient	NA[a]		NA	
3026 Counting Rm	0	0.203	0	Ambient	NA[a]		NA	
X-3039	76.2	2.44	12.6	Ambient	5070	SW	5070	SW
X-3544	9.53	0.279	24.22	Ambient	600	WNW	600	WNW
X-3608 Air Stripper	10.97	2.44	0.57	Ambient	750	WNW	750	WNW
X-3608 Filter Press	8.99	0.36	9.27	Ambient	NA		NA	
X-5505								
X-5505M	11	0.305	2.8	Ambient	NA		NA	
X-5505NS	11	0.96	0	Ambient	1180	W	1180	W
X-7503	30.5	0.91	11.45	Ambient	1670	WNW	1670	WNW
X-7830 Group	4.6	0.248	8.73	Ambient	2020	NNW	2020	NNW
X-7856-CIP	18.29	0.483	10.62	Ambient	2060	NNW	2060	NNW
X-7877	13.9	0.406	13.56	Ambient	2090	NNW	2090	NNW
X-7880	27.7	1.52	14.47	Ambient	2060	NNW	2060	NNW
X-7911	76.2	1.52	12.67	Ambient	1910	WNW	1910	WNW
X-7935								
7935 Bldg Stack	18.29	0.6096	0	Ambient	NA		NA	
7935 Glove Box	9.14	0.254	0	Ambient	NA		NA	
X-7966	6.096	0.292	11.58	Ambient	1750	WNW	1750	WNW
X-8915	24.38	1.219	6.71	Ambient	3400	SSW	3400	SSW
X-Decon Areas	15	0.5	0	Ambient	820	WSW	820	WSW
K-413 Pipe Cutting	2.13	0.3	0	Ambient	1030	NW	6820	E
K-1407-U CNF	7.16	1.22	0.625	Ambient	1770	W	5980	E
K-2500								
K-2500-H-A	8.23	0.61	12.9	Ambient	960	WSW	6840	E
K-2500-H-C	8.23	0.61	12.9	Ambient	960	WSW	6830	E
K-2500-H-D	8.23	0.91	12.9	Ambient	940	WSW	6850	E
K-2527-BR	2.13	0.3	0	Ambient	850	W	6890	E
K-WWTF	4.3	0.34	0	Ambient	2280	W	5440	E
Y-Monitored	20	0.5	0	Ambient	1090	NNE	8670	SW
Y-Unmonitored Processes	20	0.5	0	Ambient	1090	NNE	8670	SW
Y-Unmonitored Lab Hoods	20	0.5	0	Ambient	1090	NNE	8670	SW

[a]NA: effective doses (EDs) were calculated to be zero; therefore, distance and direction to maximally exposed individuals could not be determined.

"X" prefix designates Oak Ridge National Laboratory.

"K" prefix designates East Tennessee Technology Park.

"Y" prefix designates Y-12 National Security Complex.

Table 7.2. Meteorological towers and heights used to model atmospheric dispersion from source emissions

Tower	Height (m)	Source
		Y-12 Complex
MT6	30[a]	All Y-12 sources
MT6	60	Spallation Neutron Source (ORNL)
		East Tennessee Technology Park
MT7	10	K-413, K-1407-U, K-2500-HA, K-2500-HC, K-2500-HD, K-2527-BR, And WWTF
		Oak Ridge National Laboratory
MT4	10	X-7830, X-7966, X-7935
MT4	30	X-7503, X-7856-CIP, X-7855, X-7877, X-7880, X-7911, and X-7000 Lab Hoods, X-7953
MT3	30	X-6000 Lab Hoods
MT2	10	X-2099, X-2523, X-3074, X-3544, X-3608FP, and X-3508AS
MT2	30	X-2026, X-5505(NS & M), X-Decon Areas, and X-1000, 2000, 3000, & 4000 Lab Hoods
MT2	100	X-3018, X-3020, and X-3039

[a]Wind speeds adjusted to match conditions at a height of 30 m.

7.1.2.1.1 Results

Calculated EDs from radionuclides emitted to the atmosphere from the ORR are listed in Table 7.3 (maximum individual) and Table 7.4 (collective). The hypothetical maximally exposed individual for the ORR was located about 8,670 m southwest of the main Y-12 National Security Complex release point, about 1910 m west-northwest of the 7911 stack at ORNL, and about 5,980 m east of the K-1407-U Central Neutralization Facility (CNF) at the ETTP. (The Toxic Substances Control Act (TSCA) Incinerator is no longer in operation.) This individual could have received an ED of about 0.4 mrem, which is well below the NESHAPs standard of 10 mrem and is 0.1 % of the 310 mrem that the average individual receives from natural sources of radiation. Based on the 2010 population census data, the calculated collective ED to the entire population within 80 km of the ORR (about 1,172,530 persons) was about 16.2 person-rem, which is approximately 0.004 % of the 363,484 person-rem that this population received from natural sources of radiation (based on an individual dose of 310 mrem/year).

Table 7.3. Calculated radiation doses to maximally exposed off-site individuals from airborne releases, 2010

Plant	Effective dose, mrem (mSv)	
	At plant max	At Oak Ridge Reservation max
Oak Ridge National Laboratory	0.3 (0.003)[a]	0.3 (0.003)
East Tennessee Technology Park	0.3 (0.003)[b]	0.006 (0.00006)
Y-12 National Security Complex	0.2(0.002)[c]	0.02(0.0002)
Entire Oak Ridge Reservation	*d*	0.4(0.004)[e]

[a]The maximally exposed individual was located 510 m WSW of X-3039 and 1910 m WNW of X-7911.

[b]The maximally exposed individual was located 1770 m W of K-1407-U CNF.

[c]The maximally exposed individual is located 1090 m NNE of the Y-12 National Security Complex release point.

[d]Not applicable.

[e]The maximally exposed individual for the entire ORR is the ORNL maximally exposed individual.

Table 7.4. Calculated collective effective doses from airborne releases, 2010

Plant	Collective effective dose[a]	
	Person-rem	Person-Sv
Oak Ridge National Laboratory	12.6	0.126
East Tennessee Technology Park	1.5	0.015
Y-12 National Security Complex	2.2	0.022
Entire Oak Ridge Reservation (ORR)	17	0.17

[a]Collective effective dose to the 1,040,041 persons residing within 80 km of the ORR (based on 2010 census data).

The maximally exposed individual for the Y-12 National Security Complex was located at a residence about 1,090 m north-northeast of the main Y-12 Complex release point. This individual could have received an ED of about 0.2 mrem from Y-12 emissions. Inhalation and ingestion of uranium radioisotopes (i.e., ^{232}U, ^{233}U, ^{234}U, ^{235}U, ^{236}U, and ^{238}U) accounted for essentially all (about 99%) of the dose. The contribution of Y-12 Complex emissions to the 50-year committed collective ED to the population residing within 80 km of the ORR was calculated to be about 2.2 person-rem, which is approximately 14% of the collective ED for the ORR.

The maximally exposed individual for ORNL was located at a business about 510 m west-southwest of the 3039 stack and 4,220 m east-northeast of the 7911 stack. This individual could have received an ED of about 0.34 mrem from ORNL emissions. Radionuclides contributing 1% or more to the dose include ^{212}Pb (75%), ^{125}I (10%), ^{238}U (2.5%), ^{11}C (4%), ^{138}Cs (1.3%), and ^{41}Ar (1%). The contribution of ORNL emissions to the collective ED to the population residing within 80 km of the ORR was calculated to be about 12.6 person-rem, approximately 78% of the collective ED for the ORR.

The maximally exposed individual for the ETTP was located at a business about 1770 m west of the K-1407-U-CNF (TSCA Incinerator is no longer in operation). The ED received by this individual was calculated to be about 0.3 mrem. About 53% of the dose is from ingestion and inhalation of ^{237}Np, and about 47% of the dose is from uranium radioisotopes (^{234}U, ^{235}U, ^{238}U). The contribution of ETTP emissions to the collective ED to the population residing within 80 km of the ORR was calculated to be about 1.5 person-rem, or approximately 9% of the collective ED for the reservation.

The reasonableness of the estimated radiation doses can be inferred by comparing EDs estimated from measured radionuclide air concentrations with EDs estimated from calculated (using CAP-88 and emission data) radionuclide air concentrations at the ORR perimeter air monitoring stations (PAMs) (Table 7.5). Based on measured radionuclide air concentrations that could have been released from operations on the ORR (i.e., excluding naturally occurring ^{7}Be and ^{40}K), hypothetical individuals assumed to reside at the PAMs could have received EDs between 0.02 and 0.2 mrem/year. Based on calculated radionuclide air concentrations released from operations on the ORR, hypothetical individuals assumed to reside at the PAMs could have received EDs between 0.07 and 0.3 mrem/year. As shown in Table 7.5, EDs calculated using CAP-88 tend to be higher than or equivalent to EDs calculated using measured air concentrations, with the exception of the estimated doses at PAM 35.

An indication of doses from sources other than those on the ORR can be obtained from the ED calculated from measured air concentrations at the background air monitoring station (Station 52), which was 0.03 mrem/year. (The isotopes ^{7}Be and ^{40}K also were not included in the background air monitoring station calculation.) It should be noted that measured air concentrations of ^{7}Be were similar at the PAMs and at the background air monitoring station.

Table 7.5. Hypothetical effective doses from living at the Oak Ridge Reservation and the East Tennessee Technology Park ambient-air monitoring stations, 2010

Station	Calculated effective doses			
	Using air monitor data		Using CAP-88[a] and emission data	
	mrem/year	mSv/year	mrem/year	mSv/year
35	0.2	0.002	0.1	0.001
37	0.1	0.001	0.1	0.001
38	0.1	0.001	0.07	0.0007
39	0.09	0.0009	0.3	0.003
40	0.05	0.0005	0.3	0.003
42	0.08	0.0008	0.2	0.002
46	0.02	0.0002	0.2	0.002
48	0.04	0.0004	0.2	0.002
52	0.03	0.0003	*b*	*b*
K2	0.03	0.0003	0.08	0.0008
K6	0.008	0.00008	0.2	0.002
K9	0.01	0.0001	0.05	0.0005
K11	0.04	0.0004	0.3	0.003

[a]CAP-88PC Version 3 software, developed under EPA sponsorship to demonstrate compliance with 40 CFR 61, Subpart H.

[b]Effective dose was not calculated using CAP-88 and emission data at the given ambient air monitoring location.

Of particular interest is a comparison of doses calculated using measured air concentrations of radionuclides at PAMs located near the maximally exposed individuals for each plant and doses calculated for those individuals using CAP-88 and measured emissions. PAM 46 is located near the maximally exposed individual for the Y-12 Complex. The ED calculated using measured air concentrations was 0.02 mrem/year, which is less than the ED of 0.2 mrem/year calculated at the PAM 46 air monitor station using CAP-88. This year the maximally exposed individual location for ORR/ORNL was located at ORNL near an onsite air monitoring location (FRD-6); the ED calculated using measured air concentrations was 0.09 mrem/year, which was considerably less than the 0.2 mrem/year calculated using CAP-88. The K-6 Air Monitoring Station is located relatively near the ETTP maximally exposed individual (at a business); the ED calculated using measured air concentrations was about 0.008 mrem/year, which is considerably lower than the ETTP maximally exposed individual annual dose of 0.3 mrem estimated using CAP-88.

7.1.2.2 Waterborne Radionuclides

Radionuclides discharged to surface waters from the ORR enter the Tennessee River system by way of the Clinch River (see Sect. 1.3.4 for the surface water setting of the ORR). Discharges from the Y-12 Complex enter the Clinch River via Bear Creek and East Fork Poplar Creek, both of which enter Poplar Creek before it enters the Clinch River, and by discharges from Rogers Quarry into McCoy Branch and then into Melton Hill Lake. Discharges from ORNL enter the Clinch River via White Oak Creek and enter Melton Hill Lake via some small drainage creeks. Discharges from the ETTP enter the Clinch River either directly or via Poplar Creek. This section discusses the potential radiological impacts of these discharges to persons who drink water; eat fish; and swim, boat, and use the shoreline at various locations along the Clinch and Tennessee Rivers.

For assessment purposes, surface waters potentially affected by the ORR are divided into seven segments: (1) Melton Hill Lake above all possible ORR inputs, (2) Melton Hill Lake, (3) Upper Clinch River (from Melton Hill Dam to confluence with Poplar Creek), (4) Lower Clinch River (from confluence with Poplar Creek to confluence with the Tennessee River), (5) Upper Watts Bar Lake (from near confluence of the Clinch and Tennessee rivers to below Kingston), (6) the lower system (the remainder of Watts Bar Lake and Chicamauga Lake to Chattanooga), and (7) Poplar Creek (including the confluence of East Fork Poplar Creek).

Two methods are used to estimate potential radiation doses to the public. The first method uses radionuclide concentrations in the medium of interest (i.e., in water and fish) determined by laboratory analyses of water and fish samples (see Sects. 6.4 and 6.6). The second method calculates possible radionuclide concentrations in water and fish from measured radionuclide discharges and known or estimated stream flows. In both methods, reported concentrations of radionuclides were used if the reported value was both statistically significant and greater than one-half its detection limit. The advantage of the first method is the use of radionuclide concentrations measured in water and fish; disadvantages are the inclusion of naturally occurring radionuclides (e.g., ^{40}K, uranium and its progeny, thorium and its progeny, and unidentified alpha and beta activities), the possible inclusion of radionuclides discharged from sources not part of the ORR, and the possibility that some radionuclides of ORR origin might be present in quantities too low to be measured. Estimated doses from measured radionuclide concentrations are presented with and without contributions of naturally occurring radionuclides. The advantages of the second method are that most radionuclides discharged from the ORR will be quantified and that naturally occurring radionuclides will not be considered or will be accounted for separately; the disadvantage is the use of models to estimate the concentrations of the radionuclides in water and fish. Both methods use the same models (Hamby 1991) to estimate radionuclide concentrations in media and at locations other than those that are sampled (e.g., downstream). However, combining the two methods allows the potential radiation doses to be bounded. The EDs estimated by both methods, in each of the surface water segments, are provided in Appendix F.

7.1.2.2.1 Drinking Water

Several water treatment plants that draw water from the Clinch and Tennessee River systems could be affected by discharges from the ORR. No in-plant radionuclide concentration data are available for any of these plants; all of the dose estimates given below likely are high because they are based on radionuclide concentrations in water before it enters a processing plant. For purposes of assessment, it was assumed that the drinking water consumption rate for the maximally exposed individual is 730 L/year and the drinking water consumption rate for the average person is 370 L/year. The average drinking water consumption rate is used to estimate the collective ED. At all locations in 2010, estimated maximum EDs to a person drinking water were calculated using both measured radionuclide concentrations in and measured radionuclide discharges to off-site surface water, excluding naturally occurring radionuclides such as ^{40}K.

Upper Melton Hill Lake above all possible ORR inputs. Based on samples from Melton Hill Lake above possible ORR inputs (at Clinch River kilometer [CRK] 66), EDs to a hypothetical maximally exposed person drinking such water was estimated to be 3×10^{-9} mrem. The collective ED to the 31,495 persons who drink water from the city of Oak Ridge water plant could have been 5×10^{-8} person-rem. If naturally occurring radionuclides are included, individual and collective EDs could have been 1 mrem and 16 person-rem, respectively.

Melton Hill Lake. The only water treatment plant located on Melton Hill Lake that could be affected by discharges from the ORR is a Knox County plant. This plant is located near surface water sampling location CRK 58. A maximally exposed individual could have received an ED of about 3×10^{-6} mrem; the collective dose to the 60,688 persons who drink water from this plant could have been 1×10^{-4} person-rem. If naturally occurring radionuclides are included, the EDs could have been 1 mrem and 30 person-rem, respectively.

Upper Clinch River. The ETTP (Gallaher) water plant draws water from the Clinch River near CRK 23. For assessment purposes, it is assumed that workers obtain half their annual water (370 L) intake at work. Such a worker could have received an ED of about 0.07 mrem; the collective dose to the 843 workers who drink water from this plant could have been about 0.03 person-rem. If naturally occurring radionuclides are included, the EDs could have been about 1 mrem and 0.6 person-rem, respectively.

Lower Clinch River. There are no known drinking water intake sections in this river segment (from the confluence of Poplar Creek to the confluence of the Tennessee River).

Upper Watts Bar Lake. The Kingston and Rockwood municipal water plants draw water from the Tennessee River not very far from its confluence with the Clinch River. A maximally exposed individual could have received an ED of about 0.02 mrem; the collective dose to the 22,319 persons who drink water from these plants could have been about 0.2 person-rem. If naturally occurring radionuclides are included, the EDs could have been 0.3 mrem and 3 person-rem, respectively.

Lower system. Several water treatment plants are located on tributaries of Watts Bar Lake and Chickamauga Lake. Persons drinking water from these plants could not have received EDs greater than the 0.02 mrem calculated for drinking Kingston and Rockwood water. The collective dose to the 276,026 persons who drink water within the lower system could have been about 2 person-rem. If naturally occurring radionuclides are included, the EDs could have been about 0.3 mrem and 32 person-rem, respectively.

Poplar Creek/Lower East Fork Poplar Creek. There are no drinking water intake locations on Poplar Creek or on Lower East Fork Poplar Creek.

7.1.2.2.2 Eating Fish

Fishing is quite common on the Clinch and Tennessee River systems. For assessment purposes, it was assumed that avid fish consumers would have eaten 21 kg of fish during 2009 and that the average person, who is used for collective dose calculations, would have consumed 6.9 kg of fish. The estimated maximum ED will be based on either the first method, measured radionuclide concentrations in fish, or by the second method, which calculates possible radionuclide concentrations in fish from measured radionuclide discharges and known or estimated stream flows. The EDs estimated by both methods, in each of the surface water segments, are provided in Appendix F. The number of individuals who could have eaten fish is based on lake creel surveys conducted annually by Tennessee Wildlife Resources Agency (TWRA). The 2009 Melton Hill, Watts Bar, and Chickamauga creel surveys are used to estimate the number of individuals who harvested fish from these water bodies.

Upper Melton Hill Lake above all possible ORR inputs. For reference purposes, a hypothetical avid fish consumer who ate fish caught at CRK 66, which is above all possible ORR inputs, could have received an ED of about 6×10^{-26} mrem. The collective ED to the 34 persons who could have eaten such fish could have been 6×10^{-28} person-rem. If naturally occurring radionuclides are included, the EDs could have been 2 mrem and 0.03 person-rem, respectively.

Melton Hill Lake. An avid fish consumer who ate fish from Melton Hill Lake could have received an ED of about 0.00001 mrem. The collective ED to the 309 persons who could have eaten such fish could be about 1×10^{-6} person-rem. If naturally occurring radionuclides are included, the EDs could have been 1 mrem and 0.1 person-rem, respectively.

Upper Clinch River. An avid fish consumer who ate fish from the Upper Clinch River could have received an ED of about 0.1 mrem. The collective ED to the 468 persons who could have eaten such fish could have been about 0.02 person-rem. If naturally occurring radionuclides are included, the EDs could have been 6 mrem and 1 person-rem, respectively.

Lower Clinch River. An avid fish consumer who ate fish from the Lower Clinch River (CRK 16) could have received an ED of about 0.3 mrem. The collective ED to the 1,091 persons who could have eaten such fish could have been about 0.1 person-rem. If naturally occurring radionuclides are included, the EDs could have been 20 mrem and 7 person-rem, respectively.

Upper Watts Bar Lake. An avid fish consumer who ate fish from Upper Watts Bar Lake could have received an ED of about 0.1 mrem. The collective ED to the 3,118 persons who could have eaten such fish could be about 0.1 person-rem. If naturally occurring radionuclides are included, the EDs could have been 6 mrem and 7 person-rem, respectively.

Lower system. An avid fish consumer who ate fish from the lower system could have received an ED of about 0.1 mrem. The collective ED to the 28,555 persons who could have eaten such fish could have been about 0.8 person-rem. If naturally occurring radionuclides are included, the EDs could have been 6 mrem and 53 person-rem, respectively.

Poplar Creek/Lower East Fork Poplar Creek. An avid fish consumer who ate fish from Lower East Fork Poplar Creek above its confluence with Poplar Creek could have received an ED of about 0.8 mrem. Assuming 100 people could have eaten fish from Lower East Fork Poplar Creek and 100 from Poplar Creek, the collective ED could have been about 0.03 person-rem. If naturally occurring radionuclides are included, the EDs could have been 8 mrem and 0.4 person-rem, respectively.

7.1.2.2.3 Other Uses

Other uses of the ORR area waterways include swimming or wading, boating, and use of the shoreline. A highly exposed "other user" was assumed to swim or wade for 30 h/year, boat for 63 h/year, and use the shoreline for 60 h/year. The average individual, who is used for collective dose estimates, was assumed to swim or wade for 10 h/year, boat 21 h/year, and use the shoreline for 20 h/year. Measured and calculated concentrations of radionuclides in water and the LADTAP XL code (Hamby 1991) were used to estimate potential EDs from these activities. At all locations in 2009, the estimated maximally exposed individual EDs were based on measured off-site surface water radionuclide concentrations and exclude naturally occurring radionuclides such as ^{40}K.

The number of individuals who could have been other users is different for each section of water because the data sources differ. For Watts Bar parts (Upper Clinch River through Lower Watts Bar), the assumption for other users is five times the number of people who harvest fish. For Chickamauga and Melton Hill, the number for other users is based on surveys conducted by TVA.

Upper Melton Hill Lake above all possible ORR inputs. A maximally exposed other user of upper Melton Hill Lake above possible ORR inputs (CRK 66) could have received an ED of about 0.0003 mrem. The collective ED to the 10,412 other users could have been 0.0007 person-rem. If naturally occurring radionuclides are included, individual and collective EDs could have been 0.003 mrem and 0.008 person-rem, respectively.

Melton Hill Lake. An individual other user of Melton Hill Lake could have received an ED of about 2×10^{-6} mrem. The collective ED to the 24,294 other users could have been about 1×10^{-5} person-rem. If naturally occurring radionuclides are included, the EDs could have been 0.003 mrem and 0.02 person-rem, respectively.

Upper Clinch River. An individual other user of the upper Clinch River could have received an ED of about 0.009 mrem. The collective ED to the 4,083 other users could have been about 0.001 person-rem. If naturally occurring radionuclides are included, the EDs could have been 0.1 mrem and 0.02 person-rem, respectively.

Lower Clinch River. An individual other user of the lower Clinch River could have received an ED of about 0.3 mrem. The collective ED to the 9,527 other users could have been about 0.9 person-rem. If naturally occurring radionuclides are included, the EDs could have been 0.3 mrem and 0.9 person-rem, respectively.

Upper Watts Bar Lake. An individual other user of upper Watts Bar Lake could have received an ED of about 0.1 mrem. The collective ED to the 27,221 other users could have been about 1 person-rem. If naturally occurring radionuclides are included, the EDs could have been 0.1 mrem and 1 person-rem.

Lower system. An individual other user of the lower system could have received an ED of about 0.1 mrem. The collective ED to the 420,531 other users could have been about 10 person-rem. If naturally occurring radionuclides are included, the EDs could have been 0.1 mrem and 10 person-rem, respectively.

Poplar Creek/Lower East Fork Poplar Creek. An individual other user of Lower East Fork Poplar Creek, above its confluence with Poplar Creek, could have received an ED of about 0.03 mrem. The collective ED to the 200 other users of Poplar Creek and Lower East Fork Poplar Creek could have been about 0.001 person-rem. If naturally occurring radionuclides are included, the EDs could have been 0.2 mrem and 0.002 person-rem, respectively.

7.1.2.2.4 Summary

Table 7.6 is a summary of potential EDs from identified waterborne radionuclides around the ORR. Adding worst-case EDs for all pathways in a water-body segment gives a maximum individual ED of about 0.9 mrem to a person obtaining his or her full annual complement of fish from and participating in other water uses on Lower East Fork Poplar Creek. The maximum collective ED to the 50-mile population could be as high as 15 person-rem. These are small percentages of individual and collective doses attributable to natural background radiation, about 0.3 % of the average individual background dose of 310 mrem/year and 0.004% of the 363,484 person-rem that this population received from natural sources of radiation.

Table 7.6. Summary of annual maximum individual (mrem) and collective (person-rem) effective doses (EDs) from waterborne radionuclides[a,b]

	Drinking water	Eating fish	Other uses	Total[c]
Upstream of all Oak Ridge Reservation discharge locations (Clinch River kilometer [CRK] 66, City of Oak Ridge Water Plant)				
Individual ED	0.000000003	0	0.0003	0.0003
Collective ED	0.00000005	0	0.0007	0.0007
Melton Hill Lake (CRK 58, Knox County Water Plant)				
Individual ED	0.000003	0.00001	0.000002	0.00002
Collective ED	0.0001	0.000001	0.00001	0.0001
Upper Clinch River (CRK 23, Gallaher Water Plant, CRK 32)				
Individual ED	0.07	0.1	0.009	0.2
Collective ED	0.03	0.02	0.001	0.05
Lower Clinch River (CRK 16)				
Individual ED	NA[d]	0.3	0.3	0.6
Collective ED	NA[d]	0.1	0.9	1
Upper Watts Bar Lake, Kingston Municipal Water Plant				
Individual ED	0.02	0.1	0.1	0.3
Collective ED	0.2	0.1	1	2
Lower system (Lower Watts Bar Lake and Chickamauga Lake)				
Individual ED	0.02	0.1	0.1	0.3
Collective ED	2	0.8	10	13
Lower East Fork Poplar Creek and Poplar Creek				
Individual ED	NA[d]	0.8	0.03	0.9
Collective ED	NA[d]	0.03	0.001	0.04

[a]1 mrem = 0.01 mSv.

[b]Doses based on measured radionuclide concentrations in water or estimated from measured discharges and known or estimated stream flows.

[c]Total doses and apparent sums over individual pathway doses may differ due to rounding.

[d]Not at or near drinking water supply locations.

7.1.2.3 Radionuclides in Other Environmental Media

The CAP-88 computer codes are used to calculate radiation doses from ingestion of meat, milk, and vegetables that contain radionuclides released to the atmosphere. These doses are included in the dose calculations for airborne radionuclides. However, some environmental media, including milk and vegetables, are sampled as part of the surveillance program. The following dose estimates are based on environmental sampling results and may include contributions from radionuclides occurring in the natural environment, released from the ORR, or both.

7.1.2.3.1 Milk

During 2010, milk samples were collected from two “locations”: a nearby dairy and a composite of several reference locations. Significant concentrations of ^{40}K were detected in all samples and radioactive strontium was detected in one of six samples from the nearby dairy. Potential EDs attributable to ^{40}K at both “locations” were about 9 mrem/year. The dose due to strontium at the nearby dairy was about 0.04 mrem.

7.1.2.3.2 Food Crops

The food-crop sampling program is described in Sect. 6.5. Samples of tomatoes, lettuce, and turnips were obtained from seven gardens, six local and one distant. These vegetables represent fruit-bearing, leafy, and root vegetables. All radionuclides found in the food crops are found in the natural environment and in commercial fertilizers, and all but ^{7}Be and ^{40}K also are emitted from the ORR. Dose estimates are based on hypothetical consumption rates of vegetables that contain statistically significant amounts of detected radionuclides that could have come from the ORR. Based on a nationwide food consumption survey (EPA 1997), a hypothetical home gardener was assumed to have eaten 30 kg of homegrown tomatoes, 10 kg of homegrown lettuce, and 20 kg of homegrown turnips. The hypothetical gardener could have received a 50-year committed ED of between 0.02 and 0.4 mrem, depending on garden location. Of this total, between 0 and 0.1 mrem could have come from eating tomatoes, between 0.006 and 0.4 mrem from eating lettuce, and between 0 and 0.06 mrem from eating turnips. The highest dose to a gardener could have been about 0.4 mrem from consuming all three types of homegrown vegetables. A person eating food from the distant (background) garden could have received a committed ED of about 0.03 mrem, 0.02 mrem from tomatoes, and 0.01 mrem from lettuce.

An example of a naturally occurring and fertilizer-introduced radionuclide is ^{40}K, which is specifically identified in the samples and accounts for most of the beta activity found in them. The presence of ^{40}K in the samples adds, on average, between 3 and 4 mrem to the hypothetical home gardener’s ED.

Many of the samples contained detected activities of unidentified beta- and alpha-emitting radionuclides. By subtracting identified activities of beta- and alpha-emitting radionuclides from the unidentified beta and alpha activities, excess beta and alpha activities were estimated. If the excess unidentified beta and alpha activities were from ^{90}Sr and ^{210}Po, a hypothetical home gardener could have received an additional ED of between 4 and 55 mrem. Of this total, between 0 and 54 mrem could have come from eating tomatoes, between 0.9 and 3 mrem from eating lettuce, and between 0.2 and 10 mrem from eating turnips. It is believed that most of the excess unidentified beta and alpha activities are due to naturally occurring or fertilizer-introduced radionuclides (e.g., ^{210}Po), not radionuclides discharged from the ORR. Excess beta activity was detected at only two locations, one of which was the distant garden.

Tomato samples at two locations, lettuce samples at one location, and turnip samples at three locations were analyzed for an additional suite of alpha-emitting nuclides. For tomatoes, results of the additional sampling had no effect on one sample and caused the estimated dose to increase by a factor of 4.7 over the dose attributed to radionuclides in the normal sampling menu for the other location. For lettuce, the additional sampling caused the estimated dose to increase by a factor of 12 over normal sampling at the one sampled location. For turnips, the additional sampling had no effect at two locations and increased the estimated dose by a factor of 6.8 over the dose estimated using the normal sampling menu.

7.1.2.3.3 White-Tailed Deer

The Tennessee Wildlife Resources Agency (TWRA) conducted three 2-day deer hunts during 2010 on the Oak Ridge Wildlife Management Area, which is part of the ORR (see Sect. 6.7). During the hunts, 357 deer were harvested and were brought to the TWRA checking station. At the station, a bone sample and a tissue sample were taken from each deer; these samples were field counted for radioactivity to ensure that the deer met wildlife release criteria (less than 20 pCi/g of beta-particle activity in bone or 5 pCi/g of ^{137}Cs in edible tissue). Three deer exceeded the limit for beta-particle activity in bone and were retained. The remaining 354 deer were released to the hunters.

The average ^{137}Cs concentration in tissue of the 354 released deer, as determined by field counting, was 0.5 pCi/g; the maximum ^{137}Cs concentration in a released deer was 1 pCi/g. Many of the ^{137}Cs concentrations were less than minimum detectable levels. Of the released deer, the average weight was 87.3 lb and the maximum weight was 181 lb. The EDs attributed to field-measured ^{137}Cs concentrations and actual field weights of the released deer ranged from about 0.004 to 1.3 mrem.

Also evaluated were potential doses attributed to deer that might have moved off the ORR and been harvested elsewhere. In this scenario, an individual who consumed one hypothetical average-weight (87.3 lb) deer (assuming 55% field weight is edible meat) containing the 2010 average field-measured concentration of ^{137}Cs (0.5 pCi/g) could have received an ED of about 0.6 mrem. The maximum field-measured ^{137}Cs concentration was 1 pCi/g, and the maximum deer weight was 181 lb. A hunter who consumed a hypothetical deer of maximum weight and ^{137}Cs content could have received an ED of about 1.4 mrem.

The average estimated ED from consuming venison from an actual released deer (based on average field ^{137}Cs concentrations and weights) and including the average 2010 detected analytical ^{90}Sr result (0.12 pCi/g) is estimated to be about 0.9 mrem. The maximum estimated ED from consuming venison from an actual released deer (based on maximum field ^{137}Cs concentrations and weights) and including the maximum 2010 detected analytical ^{90}Sr result (0.24 pCi/g) is estimated to be about 4 mrem.

Tissue samples collected in 2010 from 15 deer (12 released and 3 retained) were subjected to laboratory analysis. Requested radioisotopic analyses included ^{137}Cs, ^{90}Sr, and ^{40}K radionuclides. Comparison of the field results to analytical ^{137}Cs concentrations found that the field concentrations were all but in one case greater than the analytical results and all were less than the administrative limit of 5 pCi/g. Using ^{137}Cs and ^{90}Sr (at maximum measured concentrations and excluding ^{40}K, a naturally occurring radionuclide) analytical tissue data and actual deer weights, the estimated doses for the 15 deer (both retained and released) ranged between 0.07 and 1 mrem**.**

The maximum ED to an individual consuming venison from two or three deer was also evaluated. There were about 32 hunters/households who harvested two deer or more from the ORR. Based on ^{137}Cs concentrations determined by field counting and actual field weight, the ED range to a hunter who consumed two or more harvested deer was estimated to range between 0.6 to 3.5 mrem**.**

The collective ED from eating all the harvested venison from ORR with a 2010 average field-derived ^{137}Cs concentration of 0.5 pCi/g and average weight of 86.3 lb is estimated to be about 0.2 person-rem.

7.1.2.3.4 Canada Geese

During the 2010 goose roundup, 46 geese were weighed and subjected to whole-body gamma scans. The geese were field counted for radioactivity to ensure that they met wildlife release criteria (less than 5 pCi/g of ^{137}Cs in tissue). The average ^{137}Cs concentration was 0.16 pCi/g, with a maximum ^{137}Cs concentration in the released geese of 0.41 pCi/g. Most of the ^{137}Cs concentrations were below minimum detectable activity levels. The average weight of the geese screened during the roundup was about 10.4 lb, and the maximum weight was about 14.8 lb.

The EDs attributed to field-measured ^{137}Cs concentrations and actual field weights of the geese ranged from 0.002 to 0.02 mrem. However, for bounding purposes, if a person consumed a released goose with an average weight of 10.4 lb and an average ^{137}Cs concentration of 0.16 pCi/g, the estimated ED would be about 0.02 mrem. It is assumed that approximately half the weight of a Canada goose is edible. The maximum estimated ED to an individual who consumed a hypothetical released goose with the maximum ^{137}Cs concentration of 0.41 pCi/g and the maximum weight of 14.8 lb was about 0.07 mrem, although the actual maximum dose to an individual who could consumed one of the roundup geese was estimated to be 0.02 mrem.

It is possible that a person could eat more than one goose that spent time on the ORR. Most hunters harvest on average one to two geese per hunting season (USFWS 1995). If one person consumed two hypothetical geese of maximum weight with the highest measured concentration of ^{137}Cs, that person could have received an ED of about 0.1 mrem.

No geese tissue samples were analyzed since 2008. In 2007, a muscle sample from a seriously injured goose that had to be euthanized was analyzed for ^{3}H, ^{40}K, ^{137}Cs, ^{90}Sr, thorium (^{228}Th, ^{230}Th, ^{232}Th), uranium ($^{233/234}$U, ^{235}U, ^{238}U), and transuranics (^{241}Am, $^{243/244}$Cm, ^{238}Pu, $^{239/240}$Pu). Many of the analytical results were below minimum detectable activity (MDA) levels. Assuming MDA levels, excluding ^{40}K concentrations (naturally occurring radionuclide), and average weight from the goose roundup, the estimated dose from consuming this goose would have been about 0.3 mrem.

7.1.2.3.5 Eastern Wild Turkey

Participating hunters are allowed to harvest one turkey from the reservation in a given season unless a harvested turkey is retained, in which case, the hunter is allowed to hunt for another turkey. Three wild turkey hunts were held on the reservation in 2010: April 10–11, April 12–13, and November 13-14. Fifty-six birds were harvested, and none were retained. The average ^{137}Cs concentration measured in the released turkeys was 0.1 pCi/g, and the maximum ^{137}Cs concentration was 0.2 pCi/g. The average weight of the turkeys released was about 19.4 lb. The maximum turkey weight was about 23.9 lb.

The EDs attributed to field-measured ^{137}Cs concentrations and actual field weights of the released turkeys ranged from about 0.0003 to 0.03 mrem. Potential doses were also evaluated for turkeys that might have moved off the ORR and been harvested elsewhere. In this scenario, if a person consumed a wild turkey with an average weight of 19.4 lb and an average ^{137}Cs concentration of 0.1 pCi/g, the estimated ED would be about 0.02 mrem. The maximum estimated ED to an individual who consumed a hypothetical released turkey with the maximum ^{137}Cs concentration of 0.2 pCi/g and the maximum weight of 23.9 lb was about 0.05 mrem. It is assumed that approximately half the weight of a wild turkey is edible. No tissue samples were analyzed in 2010.

The collective ED from consuming all the harvested wild turkey meat (56 birds) with an average field-derived ^{137}Cs concentration of 0.1 pCi/g and average weight of 19.4 lb is estimated to be about 0.001 person-rem.

7.1.2.3.6 Direct Radiation

External exposure rates due to background sources in the state of Tennessee average about 6.4 μR/h, and range from 2.9 to 11 μR/h (Myrick 1981). These exposure rates correspond to ED rates between 18 and 69 mrem/year, with an average of 40 mrem/year.

External radiation exposure rates are measured at numerous locations on and off the ORR. Exposure rates measured at five PAMs around the ORR during 2010 averaged about 7.9 μR/h and ranged from 3.5 to 9.7 μR/h. These exposure rates correspond to an average ED rate of about 49 mrem/year and a range of 22 to 60 mrem/year. At the remote PAM, the exposure rate averaged 7.1 μR/h (approximately 44 mrem/year) and ranged from 6.3 to 7.8 μR/h (39 to 49 mrem/year). All measured exposure rates at or near the ORR boundaries fall within the range of state-wide background levels.

7.1.3 Current-Year Summary

A summary of the maximum EDs to individuals by pathway of exposure is given in Table 7.7. In the unlikely event that any person was irradiated by all of those sources and pathways for the duration of 2010, that person could have received a total ED of about 4 mrem. Of that total, 0.4 mrem would have come from airborne emissions and 1.2 mrem from waterborne emissions, (0.07 mrem from drinking water, 0.8 mrem from consuming fish, and 0.3 mrem from other water uses along the upper Clinch River), and no appreciable dose above background from external radiation.

Table 7.7. Summary of maximum potential effective doses to an adult by exposure pathway

Pathway	Dose to maximally exposed individual		Percentage of DOE mrem/year limit (%)	Estimated population dose		Population within 80 km	Estimated background radiation population dose (person-rem)[a]
	mrem	mSv		person-rem	person-Sv		
Airborne effluents:							
All pathways	0.4	0.004	0.4	16	0.16	1,172,530[b]	
Liquid effluents:							
Drinking water	0.07	0.0007	0.07	2	0.02	391,371[c]	
Eating fish	0.8	0.008	0.8	0.8	0.008	33,741[d]	
Other activities	0.3	0.003	0.3	10	0.1	485,856[d]	
Eating deer	2[e]	0.02	2	0.2	0.002	354	
Eating geese	0.2[f]	0.002	0.2	*g*	*g*		
Eating turkey	0.05[h]	0.0005	0.05	0.001	0.00001	56	
Direct radiation	na[i]	na					
All pathways	4	0.04		29	0.29	1,172,530	363,484

[a]Estimated background population dose is based on 310 mrem/year individual dose and the population within 80 km of the Oak Ridge Reservation.

[b]Population based on 2010 census data.

[c]Population estimates based on community and non-community drinking water supply data from the Tennessee Department of Environment and Conservation, Division of Water.

[d]Population estimates based on population within 80 km and fraction of fish harvested from Melton Hill, Watts Bar, and Chickamauga reservoirs. Melton Hill and Chickamauga recreational use information was obtained from the Tennessee Valley Authority (Stephens, B. et al. 2006 and Stephens, B., et al. 2007).

[e]From consuming one hypothetical worst-case deer, a combination of the heaviest deer harvested and the highest measured concentrations of ^{137}Cs in released deer on the ORR in 2010; population dose based on number of hunters that harvested deer.

[f]From consuming two hypothetical worst-case geese, each a combination of the heaviest goose harvested and the highest measured concentrations of ^{137}Cs in released geese.

[g]Population doses were not estimated for the consumption of geese since no geese were brought to checking station during the goose hunt.

[h]From consuming one hypothetical worst-case turkey, a combination of the heaviest turkey harvested and the highest measured concentrations of ^{137}Cs in released turkey. The population dose is based on the number of hunters that harvested turkey.

[i]Direct radiation dose estimates were conducted, although exposure rates near the Clinch River were near background levels. In addition, direct radiation monitoring is no longer conducted for locations that were formerly the UF_6 cylinder storage yards and the K-770 Scrap Yard. Direct dose measurements have been taken and have confirmed that there is no longer a source of potential dose to the public above the background levels.

The dose of 4 mrem is about 1% of the annual dose (310 mrem) from background radiation. The ED of 4 mrem includes the person who received the highest EDs from eating wildlife harvested on the ORR. If the maximally exposed individual did not consume wildlife harvested from the ORR, the estimated dose would be about 2 mrem.

DOE Order 5400.5 limits the ED that an individual may receive from all exposure pathways from all radionuclides released from the ORR during 1 year to no more than 100 mrem. The 2010 maximum ED should not have exceeded about 4 mrem, or about 4% of the limit given in DOE Order 5400.5. (For further information, see Sects. F.5.6 through F.5.12 in Appendix F, which summarize dose levels associated with a wide range of activities.)

The total collective ED to the population living within an 80-km radius of the ORR was estimated to be about 29 person-rem. This dose is about 0.008% of the 363,484 person-rem that this population received from natural sources during 2010.

7.1.4 Five-Year Trends

Dose equivalents associated with selected exposure pathways for the years from 2006 to 2010 are given in Table 7.8. In 2010, a decreased in the dose from fish consumption was observed as compared to earlier years. Also doses from external radiation have dropped due to the cleanup of the UF_6 cylinder storage yards and K-770 Scrap Yard. Recent measurements along the Clinch River indicate doses near background levels.

Table 7.8. Trends in effective dose (mrem)a for selected pathways

Pathway	2006	2007	2008	2009	2010
All air	0.8	0.3	0.4	0.3	0.4
Fish consumption (Clinch River)	0.7	0.9	0.6	1.2	**0.3**
Drinking water (Kingston)	0.02	0.04	0.05	0.03	0.02
Direct radiation (Clinch River)	0.5[b,c]	0.4[d]	0.4[d]	0.4[d]	**NA[d]**
Direct radiation (Poplar Creek)	0.8[b]	NA[d]	NA[d]	NA[d]	NA[d]

[a]1 mrem = 0.01 mSv.

[b]Included gamma and neutron radiation measurement data. In 2006, the Poplar Creek location was near the K-1066E Cylinder Yard.

[c] This location is along the bank of the Clinch River near the K-770 Scrap Yard.

[d] Direct radiation dose estimates were conducted, although exposure rates near the Clinch River were near background levels. In addition, direct radiation monitoring is no longer conducted for locations that were formerly the UF_6 cylinder storage yards and the K-770 Scrap Yard. Direct dose measurements have been taken and confirmed that there is no longer a source of potential dose to the public above the background levels.

7.1.5 Potential Contributions from Non-DOE Sources

There are several non-DOE facilities on or near the ORR that could contribute radiation doses to the public. These facilities submit annual reports to demonstrate compliance with NESHAPs regulations and the terms of their operating licenses. DOE requested information pertaining to potential radiation doses to members of the public who also could have been affected by releases from these facilities. Seven facilities responded to the DOE request. One facility, which used the COMPLY screening tool for evaluating radiation exposure from atmospheric releases of radionuclides, stated only that the facility is in compliance and the annual dose is less than 10 mrem; three other facilities stated estimated annual doses from airborne emissions at about 1E-3 mrem, 0.9 mrem, and 1.1 mrem, respectively. Therefore, doses from airborne emissions from both non-DOE and DOE sources should be less than 10 mrem. A maximally exposed individual dose of about 14.5 mR/year due to direct radiation was estimated at the along a protected boundary of one of the facilities. One facility provided a dose estimate of external radiation; however, the area monitoring station was located in this facility's laboratory. Three facilities reported no air or water radioactive emissions. Therefore, doses from air and water emissions and external radiation from both non-DOE and DOE sources should be less than DOE Order 5400.5 requirement of 100 mrem.

7.1.6 Doses to Aquatic and Terrestrial Biota

7.1.6.1 Aquatic Biota

DOE Order 5400.5, Chap. II, sets an absorbed dose rate limit of 1 rad/day to native aquatic organisms from exposure to radioactive material in liquid wastes discharged to natural waterways (see Appendix F for definitions of absorbed dose and rad). To demonstrate compliance with this limit, the aquatic organism assessment was conducted using the RESRAD-Biota code (Versions 1.21 and 1.5), a companion tool for implementing the DOE technical standard, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002). The code serves as DOE's biota dose evaluation tool and uses the screening (i.e., biota concentration guides [BCGs]) and analysis methods in the technical standard. The BCG is the limiting concentration of a radionuclide in sediment or water that would not cause dose limits for protection of aquatic biota populations to be exceeded.

The intent of the graded approach is to protect populations of aquatic organisms from the effects of exposure to anthropogenic ionizing radiation. Certain organisms are more sensitive to ionizing radiation than others. Therefore, it is generally assumed that protecting the more sensitive organisms will adequately protect other, less sensitive organisms. Depending on the radionuclide, either aquatic organisms (e.g., crustaceans) or riparian organisms (e.g., raccoons) may be considered to be the more sensitive and are typically the limiting organisms for the general screening phase of the graded approach for aquatic organisms. The screening conceptual model for generating the media-specific BCGs places both the aquatic and riparian animal at the sediment-water interface. In the screening conceptual model, sediment presents an external dose hazard to the aquatic animal, whereas water presents both an internal and external dose hazard. For riparian animals, sediment and water present both internal and external dose hazards. The riparian pathways of exposure combine aspects of both terrestrial and aquatic systems.

The graded approach for evaluating radiation doses to aquatic biota consists of a three-step process that involves (1) data assembly, (2) general screening of media-specific radionuclide concentrations to media-specific BCGs, and (3) site-specific screening and analysis. In the general screening phase, surface water radionuclide concentrations and sediment radionuclide concentrations can be compared to the media-specific BCGs using default parameters. This aquatic dose assessment was based primarily on surface water sampling data.

At ORNL, doses to aquatic organisms are based on surface water concentrations at the following 10 different instream sampling locations.

- Melton Branch (Melton Branch kilometer [MEK] 0.2),
- White Oak Creek (White Oak Creek kilometers [WCK] 1.0, 2.6, and 6.8),
- First Creek,
- Fifth Creek,
- Raccoon Creek,
- Northwest Tributary, and
- Clinch River (CRKs 23 and 66).

All locations, except MEK 0.2 and WCK 1.0 passed the initial screening phase (comparison of maximum radionuclide water concentrations to default BCGs). MEK 0.2 and WCK 1.0 (White Oak Creek at the dam) passed comparing average radionuclide water concentrations to default BCGs. This resulted in absorbed dose rates to aquatic organisms below the DOE aquatic dose limit of 1 rad/day at all 10 sampling locations.

At the Y-12 Complex, doses to aquatic organisms were estimated from surface water concentrations at the following five different instream sampling locations.

- Surface Water Hydrological Information Support System Station 9422-1 (also known as Station 17)
- Outfall 200
- Discharge Point S24, Bear Creek at Bear Creek kilometer (BCK) 9.4
- Discharge Point S17 (unnamed tributary to the Clinch River)

- Discharge Point S19 (Rogers Quarry)

Surface Water Hydrological Information Support System 9422-2, Discharge Points S17 and S19 passed the general screening phase (maximum water concentrations and default parameters for BCGs). Discharge Point S24 and Outfall 200 passed using average water concentrations. This resulted in absorbed dose rates to aquatic organisms below the DOE aquatic dose limit of 1 rad/day at all five Y-12 locations.

At ETTP, doses to aquatic organisms were estimated from surface water concentrations at the following 13 different instream sampling locations.

- Mitchell Branch at K1700, MIKs 0.45, 0.59, 0.71, 0.84, and MIK 1.4 (upstream location)
- Poplar Creek at K-716 (downstream)
- K1007-B and K-1710 (upstream location)
- K-700 Slough and K901-A (downstream of ETTP operations)
- Clinch River (CRK 16 and CRK 23)

All of these locations passed the initial general screening (using maximum concentrations and default parameters for BCGs). This resulted in absorbed dose rates to aquatic organisms below the DOE aquatic dose limit of 1 rad/day at all 13 sampling locations.

7.1.6.2 Terrestrial Biota

To evaluate impacts on biota, in accordance with requirements in DOE Order 450.1, a terrestrial organism assessment was conducted. An absorbed dose rate of 0.1 rad/day is recommended as the limit for terrestrial animal exposure to radioactive material in soils. As for aquatic and riparian biota, certain terrestrial organisms are more sensitive to ionizing radiation than others, and it is generally assumed that protecting the more sensitive organisms will adequately protect other, less sensitive organisms. Soil sampling for terrestrial dose assessment was initiated in 2007. This biota sampling strategy was developed taking into account guidance provided in *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002) and existing radiological information on the concentrations and distribution of radiological contaminants on the ORR. The soil sampling focused on unremediated areas, such as floodplains and some upland areas. Floodplains are often downstream of contaminant source areas and are dynamic systems where soils are eroding in some places and being deposited in others. Soil sampling locations are identified as follows.

- White Oak Creek floodplain and upland location
- Bear Creek Valley floodplain
- Mitchell Branch floodplain
- Two background locations: Gum Hollow and near Bearden Creek

With the exception of samples collected on the White Oak Creek floodplain (collected on the confluence of Melton Branch and White Oak Creek and collected on the White Oak Creek floodplain upstream from White Oak Dam), samples taken at all other soil sampling locations passed either the initial-level screening (comparison of maximum radionuclide soil concentrations to default BCGs) or second-level screening, for which BCG default parameters and average soil concentrations were used. Cesium-137 is the primary dose contributor in the soil samples collected on the White Oak Creek floodplain. Radiological risk to wildlife associated with ^{137}Cs on the White Oak Creek floodplain is known and will be addressed in future Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) records of decisions.

Biota sampling in the White Oak Creek floodplain was conducted in 2009. White-footed mice (*Peromyscus leucopus*), deer mice (*Peromyscus maniculatus*), and hispid cotton rats (*Sigmodon hispidus)* were selected for sampling since they live and forage in these areas, are food for other mammals, and have relatively small home ranges. The biota sampling locations were at confluence of Melton Branch and White Oak Creek and in the floodplain upstream of White Oak Lake. In addition, biota samples were collected at a background location (Gum Hollow). The maximum radionuclide tissue concentrations and maximum soil radionuclide concentrations for each sample location were used to estimate the terrestrial dose. The tissue concentrations were used to estimate the internal dose. To evaluate the external dose, the soil concentrations previously collected were also included in the dose assessment. The external dose was the primary contributor to the total dose. For White Oak Creek, ^{137}Cs was the major contributor to the total dose (0.023 rad/day) with ^{90}Sr and ^{40}K and as secondary contributors (7.0E-4 and 5.97E-4 rad/day, respectively). For Melton Branch, ^{137}Cs was the major contributor to dose (0.009 rad/day) with ^{90}Sr and ^{40}K as secondary contributors (8.2E-4 and 7.8E-4 rad/day, respectively). For the background location, Gum Hollow, ^{40}K was the major contributor to dose (7.4E-4 rad/day) with ^{238}U as the secondary dose contributor (3.5E-4 rad/day). Based on measured concentrations in soil and tissue, the absorbed doses to the mice and voles analyzed along the confluence of Melton Branch and White Oak Creek and in the floodplain upstream of White Oak Lake were less than 0.1 rad/day.

Based on the results of the aforementioned terrestrial organism assessment, only periodic evaluation of radionuclide concentrations in soil will be conducted.

7.2 Chemical Dose

7.2.1 Drinking Water Consumption

To evaluate the drinking water pathway, hazard quotients (HQs) were estimated downstream and downstream of the ORR discharge points (Table 7.9). The HQ is a ratio that compares the estimated exposure dose or intake to the reference dose. (See Appendix G for a detailed description of the chemical dose methodology.) Chemical analytes were measured in surface water samples collected at CRK 23 and CRK 16. CRK 23 is located near the water intake for ETTP; CRK 16 is located downstream of all DOE discharge points. As shown in Table 7.9, HQs were less than 1 for detected chemical analytes for which there are reference doses or maximum contaminant levels.

Acceptable risk levels for carcinogens typically range from $10E^{-4}$ to $10E^{-6}$. A risk value greater than 10^{-5} was calculated for the intake of arsenic in water collected at both locations.

7.2.2 Fish Consumption

Chemicals in water can be accumulated by aquatic organisms that may be consumed by humans. To evaluate the potential health effects from the fish consumption pathway, HQs were estimated for the consumption of noncarcinogens, and risk values were estimated for the consumption of carcinogens detected in sunfish and catfish collected both upstream and downstream of the ORR discharge points. In the current assessment, a fish consumption rate of 60 g/day (21 kg/year) is assumed for both the noncarcinogenic and carcinogenic pollutants. This is the same fish consumption rate used in the estimation of the maximum exposed radiological dose from consumption of fish. (See Appendix G for a detailed description of the chemical dose methodology.)

As shown in Table 7.10, for consumption of sunfish and catfish, HQ values of less than 1 were calculated for the all detected analytes except for mercury and Aroclor-1260 (which is a PCB, also referred to as PCB-1260). An HQ greater than 1 for mercury was estimated in sunfish at one location (CRKs 16). An HQ greater than 1 for Aroclor-1260 was estimated in catfish at three locations (CRKs 16, 32, and 70) and at two locations (CRK 16 and 70) in sunfish. Overall, the HQs were approximately within the same order of magnitude as those estimated in 2009, with the exception of mercury in sunfish.

For carcinogens, risk values at or greater than 10^{-5} were calculated for the intake of Aroclor-1254 found in sunfish and catfish collected at one location (CRK 32). For sunfish and catfish, risk values at or greater than 10^{-5} were also calculated for the intake of Aroclor-1260 collected at all three locations. TDEC has issued a fish advisory that states that catfish should not be consumed from Melton Hill Reservoir (in its entirety) because of PCB contamination and has issued a precautionary fish consumption advisory for catfish in the Clinch River arm of Watts Bar Reservoir (TWRA 2009). Overall, the risk values were approximately within the same order of magnitude to those estimated in 2009.

Table 7.9. Chemical hazard quotients and estimated risks for drinking water, 2010

Chemical	Hazard quotient[a]	
	CRK 23[b]	CRK 16[c]
Arsenic	J 0.07	J 0.07
Barium	J 0.005	J 0.005
Beryllium	J 0.0009	
Boron	J 0.002	J 0.003
Cadmium	J 0.007	
Chromium	J 0.003	J 0.003
Copper	J 0.0006	J 0.001
Lead	J 0.1	J 0.1
Manganese	0.007	0.008
Mercury	0.0003	0.0003
Nickel	J 0.0008	J 0.0009
Selenium	J 0.003	
Thallium	J 0.2	
Uranium	0.02	0.02
Vanadium	J 0.002	J 0.002
Zinc	J 0.0003	J 0.0004
Risk for carcinogens		
Arsenic	J 2E-5	J 1E-5

Abbreviations:

CRK = Clinch River kilometer

[a]Melton Hill Reservoir near the water intake for ETTP.

[b]Clinch River downstream of all U.S. Department of Energy inputs.

[c]A prefix "J" indicates that the value is estimated at or below the analytical detection limit.

Table 7.10. Chemical hazard quotients and estimated risks for carcinogens in fish, 2010[a]

Carcinogen	Sunfish			Catfish		
	CRK 70[b]	CRK 32[c]	CRK 16[d]	CRK 70[b]	CRK 32[c]	CRK 16[d]
Hazard quotient for metals						
Antimony	0.5	0.5	0.4	0.5	0.4	0.6
Barium	0.001	0.001	0.0005	0.00007	0.0002	0.0003
Beryllium	0.001	0.002		<0.001	<0.001	
Chromium	0.03	0.03	0.02	0.02	0.03	0.05
Copper	0.004	0.006	0.007	0.3	0.008	0.02
Lead	<0.1	0.3	<0.1	0.5	0.2	0.4
Manganese	0.01	0.008	0.006	0.001	0.005	0.006
Mercury	0.4	0.3	1	0.4	0.9	0.9
Nickel	<0.0004		0.001	0.2		0.007
Selenium	0.2	0.2	0.2	0.2	0.1	0.1
Strontium	0.004	0.004	0.002	0.0001	0.0007	0.0004
Thallium	0.1	0.2	0.2	0.1	0.1	0.1
Uranium	0.0002	<0.0002	0.0002	<0.0002	0.0002	0.0006
Vanadium	0.002	0.003		<0.001	<0.0009	
Zinc	0.04	0.04	0.04	0.02	0.02	0.02
Hazard quotient for pesticides and Aroclors						
Aroclor-1254		0.8			2	
Aroclor-1260	1.4	0.7	1.3	6	5	12
Risks for carcinogens						
Aroclor-1254		1E-5			3E-5	
Aroclor-1260	2E–5	1E–5	2E–5	1E–4	9E–5	2E–4
PCBs (mixed)[e]	2E–5	3E–5	2E–5	1E–4	1E–4	2E–4

CRK=Clinch River kilometer

[a]The symbol “<” indicates the value for a parameter was not quantifiable at the analytical detection limit, and a blank space indicates that the parameter was undetected.

[b]Melton Hill Reservoir, above the city of Oak Ridge Water Plant.

[c]Clinch River, downstream of Oak Ridge National Laboratory.

[d]Clinch River, downstream of all U.S. Department of Energy inputs.

[e]Mixed polychlorinated biphenyls (PCBs) consist of the summation of Aroclors detected or estimated.

7.3 References

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